



Managing Risk & Uncertainty

Identifying and communicating risk and uncertainty in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Area planning process (Bay of Plenty Regional Water and Land Plan Change 12)

June 2017

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Report Date: June 2017

Quality Assurance Statement


Version	Reviewed By	
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Final	Simon Harris	

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Executive Summary

The Bay of Plenty Regional Council (BOPRC) is currently running a community engagement process to identify freshwater values, objectives, and associated limits to resource use for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas.

The objective of this sub-project was to provide a practical approach to identifying and expressing risk and uncertainty in the process of identifying freshwater quality and quantity objectives, limits, and other management options.

LWP Limited worked with a BOPRC multi-disciplinary team to run two workshops based on the three stage framework for handling uncertainty described in: *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016). The material in the Draft Guide was used to generate discussion on local examples where handling uncertainty is proving a challenge in the BOPRC's current process.

The methods used for the workshops are described, and the agendas, run-sheets, presentations and group exercises are provided in appendices to this report.

Outcomes and learnings from this sub-project include:

- There is considerable value in sharing the “burden” of uncertainty by simply communicating it within multidisciplinary project teams.
- Communication within multidisciplinary project teams would be helped by agreeing on a common language, such as consistent use of the terms uncertainty, risk, likelihood, consequence and reversibility, as well as consistent descriptors of points on a scale of likelihood (e.g., very likely, likely, about as likely as not, unlikely, very unlikely).
- It is useful to systematically identify, acknowledge, assess, reduce and quantify uncertainties and risk, so that sensible project decisions can be made on a suitable level of effort to manage different risks.
- To some extent this approach to handling uncertainty is about developing a useful “mind-set” for each individual to employ continuously in a manner suitable for their particular role. However, there is also value in periodically documenting key uncertainties for the project as a whole, such as the draft “risk register” table produced during this project.
- It is clear that communication of uncertainties is universally important when informing plan development processes, and ultimately for decision-making.
- BOPRC staff already use some of the many available methods for communicating uncertainty. The workshops increased collective capacity amongst participants through sharing ideas and approaches, and considering examples in the Draft Guide. Consistent use of terminology suggested at bullet 2 above would help further.
- It is clear that incorporating uncertainty into decision-making is challenging for many reasons. Running community engagement processes and testing alternative future scenarios both help expose uncertainties and risks to be managed. BOPRC is already doing both of these things. Workshop participants also specifically identified that communicating “reversibility” is useful to inform decision-making.

BOPRC's proposed approach arising out of this sub-project is summarised in Figure 1.

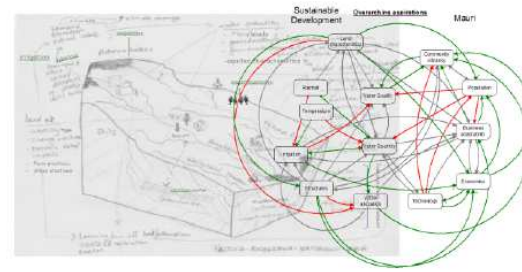
Managing risk & uncertainty in freshwater management

Application in the Kaituna-Pongakawa-Waitahanui and Rangitāiki Water Management Areas, Bay of Plenty

ASSESS & REDUCE UNCERTAINTY

Acknowledge uncertainty is inevitable

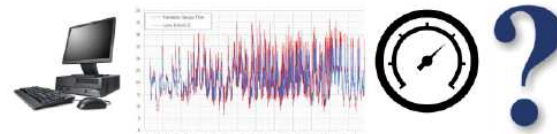
Start with a simple exercise (e.g. causal loop or catchment diagrams) to develop a basic shared understanding of how the system works and the process being followed. This may help to highlight key uncertainties.



Example of a catchment diagram for the Kaituna-Pongakawa-Waitahanui WMA and casual loop diagram developed by members of the Rangitāiki WMA Freshwater Futures Community Group

Identify key risks and uncertainties in the system

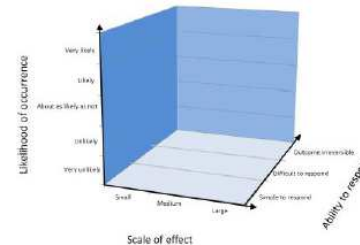
Are these due to natural variability, model/parameter uncertainty or deep uncertainty?



As part of this project, BOPRC staff developed a draft register of natural resource risks and uncertainties which identifies our initial assessment of likelihood, consequence and degree of irreversibility/ability to respond. For example, some impacts from poor water quality on estuaries could be very hard to reverse.

Assess likelihood and consequence

Start thinking about degree of irreversibility if we get it wrong and our ability to respond in light of new information



Reduce uncertainty where possible and appropriate

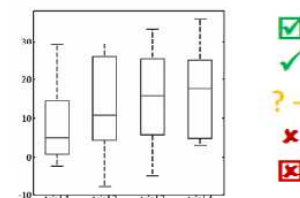
Could we do more monitoring or research? Could we further develop our catchment model? Is it worth it? What additional work should be prioritised?



Additional data, research and monitoring can reduce uncertainty. For example, improved water metering data, flow records, economic impact assessments, relationship between E. coli and pathogens, etc.

Quantify, semi-quantify or qualify uncertainty

Where possible, present value ranges, standard deviations, confidence intervals, sample statistics and undertake sensitivity analysis. Where not possible, undertake qualitative assessments.

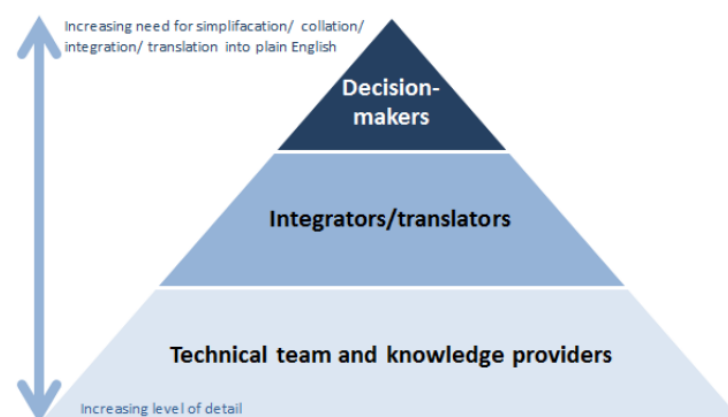


Examples of ways to present uncertainty quantitatively and qualitatively.

COMMUNICATE UNCERTAINTY

“Share the burden”:

- Use a range of tools (tables, graphs, text, maps, diagrams, etc.) and build in repetition
- Be cognisant of the needs and interests of different audiences and the need to move up and down the pyramid in different circumstances
- Watch out for biases, be the “honest broker”
- Be open about limitations and uncertainties



Councillors
Co-governance Fora
Council Management Staff
Tangata whenua, stakeholders and general public
Territorial Local Authorities
Freshwater Futures Community groups
Council policy and other staff
Economists
Council Scientists
Catchment modellers

An example of what the ‘information pyramid’ could look like in the Bay of Plenty

INCORPORATE UNCERTAINTY INTO DECISION-MAKING

Issue/Scenario	Value	Uncertainty	Impact	Response	Notes
1) Water allocation and use (Kaituna, Pongakawa & Waitahanui)	High	Medium	High	Water allocation	Water allocation is a key issue for the Bay of Plenty. It is a complex issue that involves many stakeholders and requires a coordinated approach.
2) Water quality (Kaituna, Pongakawa & Waitahanui)	High	Medium	High	Water quality	Water quality is a key issue for the Bay of Plenty. It is a complex issue that involves many stakeholders and requires a coordinated approach.
3) Water quantity (Kaituna, Pongakawa & Waitahanui)	High	Medium	High	Water quantity	Water quantity is a key issue for the Bay of Plenty. It is a complex issue that involves many stakeholders and requires a coordinated approach.
4) Water security (Kaituna, Pongakawa & Waitahanui)	High	Medium	High	Water security	Water security is a key issue for the Bay of Plenty. It is a complex issue that involves many stakeholders and requires a coordinated approach.
5) Water sustainability (Kaituna, Pongakawa & Waitahanui)	High	Medium	High	Water sustainability	Water sustainability is a key issue for the Bay of Plenty. It is a complex issue that involves many stakeholders and requires a coordinated approach.

Scenarios: exploring possible alternative futures

	A		
	Current farming practice	Good Management Farming Practice	Best Management Farming Practice
Current land & water use or land use change trend	B1 (status quo scenario)	B2	B3
Development scenarios:			
High intensity land & water use	C1	C2	C3
Low intensity land & water use	D1	D2	D3

Also different climate scenarios, timeframes to achieve objectives and point source management scenarios.

Freshwater Futures Community Groups



To effectively incorporate uncertainty into decision-making, BOPRC will continue to work with community groups, including by considering alternative future scenarios. The draft register of natural resource risks and the principles from the Guide will be further developed and applied in subject-specific work streams.

Figure 1. Summary of BOPRC’s approach to managing risk and uncertainty.

1 Introduction

1.1 Background

Bay of Plenty Regional Council (BOPRC) is undertaking regional plan development processes in accordance with the requirements of the National Policy Statement for Freshwater Management (2014) (NPSFM). The BOPRC is currently seeking to establish freshwater objectives for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas, based on a community engagement process to identify freshwater values, objectives and associated limits to resource use. Community group members cover a range of land use and water interests within the catchments, including farming, horticulture, cultural, environmental and recreational.

Once freshwater objectives are developed, BOPRC will identify feasible policy options that may fully or partially achieve the stated objectives, thereby addressing the resource issues identified by the community. BOPRC has identified that incomplete information is inevitable when making policy decisions. While incomplete information creates uncertainty and risk, there are costs to gathering information; these costs may be financial, and they can also involve time – possibly years, and still it will not be possible to know everything or accurately predict the future. Waiting for complete information can increase environmental risk.

This BOPRC sub-project recognises:

- (1) risk is inherent in environmental policy;
- (2) information is not costless, or not always possible, and the benefits and costs of additional information must be considered; and
- (3) policy effectiveness can be jeopardised by failing to identify, assess and communicate policy risk.

This sub-project focuses on uncertainty, and is designed to integrate thinking about risk and uncertainty into the policy process using frameworks for identifying, assessing and communicating risk.

BOPRC recognises that a multi-disciplinary approach is essential to its planning process, and there is a focus on 'learning by doing'. The outputs of this sub-project will feed into the assessment of the effectiveness and efficiency of plan provisions in achieving the objectives, and assessing the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the provisions¹.

1.2 Objective

The objective of this sub-project was to provide a practical approach to identifying and expressing risk and uncertainty in the process of identifying freshwater quality and quantity objectives, limits, and management options for the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas.

¹ i.e., as part of fulfilling BOPRC's functions and duties under section 32(1)(b)(ii) of the RMA.

2 Approach

LWP Limited (LWP) was contracted to provide thought leadership and discussion on assessing and expressing uncertainty and risk, working with the BOPRC multi-disciplinary team in workshops, based on the framework published in: *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014* (Ministry for the Environment, 2016)² (Figure 2).

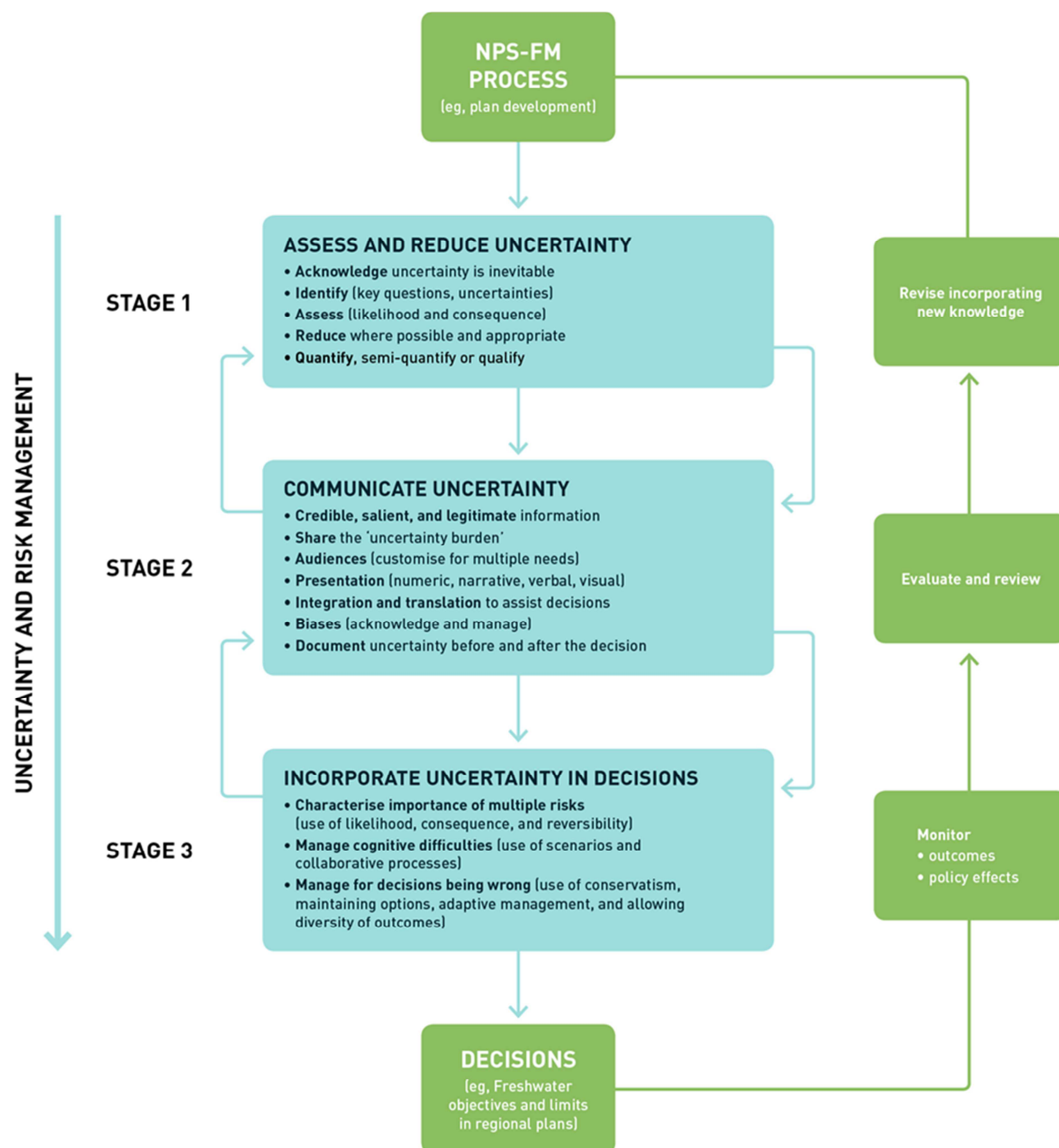


Figure 2. Three stage iterative process to manage uncertainty in NPSFM processes (from Ministry for the Environment, 2016).

² Ministry for the Environment. 2016. *A Draft Guide to Communicating and Managing Uncertainty When Implementing the National Policy Statement for Freshwater Management 2014*. Wellington: Ministry for the Environment.

The general approach was to run two workshops based on the three stage framework described in the Draft Uncertainty Guide (Figure 2). Each workshop included presentations of the theory and examples from the Draft Guide, as well as group exercises designed to facilitate discussion, co-learning, and development of locally relevant approaches for the current Rangitāiki and Kaituna-Pongakawa-Waitahanui planning processes. The intent of this approach was to build capacity of knowledge on approaches to handling uncertainty used elsewhere, and to thereby develop with BOPRC staff practical and fit-for-purpose approaches for use in the technical modelling and community engagement projects.

Broadly, the first workshop (in March 2017) covered Stage 1 in the Draft Uncertainty Guide, while the second workshop (in May 2017) covered Stages 2 and 3 (Figure 2). All BOPRC staff who were directly involved in the Rangitāiki and Kaituna-Pongakawa-Waitahanui processes were invited, including technical, planning, community engagement and management staff. As preparation for the workshops all invitees were encouraged to read the Draft Uncertainty Guide and to consider its relevance for their individual roles.

The method and content for each workshop is described in more detail in the following sections.

3 Workshop 1: Assessing & reducing uncertainty

Workshop 1 was held on 9 March 2017 at the BOPRC offices in Whakatāne.

3.1 Agenda and run-sheet

The agenda, run-sheet and resources used for Workshop 1 are provided in Appendix 1. In brief, Workshop 1 involved:

- An introduction to the project and scene-setting by BOPRC staff for the current stage of BOPRC's processes.
- An introductory presentation to some necessary terminology and theory around uncertainty and risk.
- An overview presentation of Stage 1 in the Uncertainty Guide (on “assessing and reducing uncertainty”) followed by three group exercises designed to put the three steps of Stage 1 of the Guide into practice with local examples (see below).

3.2 Presentations

The presentations used for Workshop 1 are provided in Appendix 2.

3.3 Group exercises

Three group exercises were designed (see run-sheet in Appendix 1 for detail) to:

- Identify and acknowledge examples of key uncertainties in the Rangitāiki and Kaituna-Pongakawa-Waitahanui projects;
- Consider methods to assess and reduce uncertainties, if appropriate, from the list of identified local examples;
- Consider methods to quantify or semi-quantify the identified local examples of uncertainty

3.4 Participants' reflections

The last exercise of the day was to go around the room asking all participants for their take-home reflections. These are provided as recorded on the day in Appendix 3.

4 Workshop 2: Communicating & incorporating uncertainty in decisions

Workshop 2 was held on 2 May 2017 at the BOPRC offices in Whakatāne.

4.1 Agenda and run-sheet

The agenda, run-sheet and resources used for Workshop 2 are provided in Appendix 4. In brief Workshop 2 involved:

- A progress update by BOPRC staff of the current state of BOPRC's processes, and a reminder of the relevance of handling uncertainty and risk for those processes.
- An overview presentation of Stage 2 in the Uncertainty Guide (on "communicating uncertainty") interspersed with pauses for prompted discussion on examples of communication challenges in the local BOPRC projects.
- An overview presentation of Stage 3 in the Uncertainty Guide (on "informing decision-making"), followed by two group discussion exercises designed to put the elements of Stage 3 of the Guide into practice with local examples (see below).

4.2 Presentations

The presentations used for Workshop 2 are provided in Appendix 5.

4.3 Group exercises

Two group exercises were designed (see run-sheet in Appendix 4 for detail) to:

- Review a list of uncertainties and risks previously identified in Workshop 1 for the Rangitāiki and Kaituna-Pongakawa-Waitahanui projects (i.e., the "risk register" – see Appendix 4) and assess likelihood, impact and degree of irreversibility for each;
- Discuss how the use of scenario testing and stakeholder engagement in collaborative processes can be part of the approach to handling uncertainty and incorporating uncertainty and risk into decision-making.

4.4 Participants' reflections

The last exercise of the day was to go around the room asking all participants for their take-home reflections. These are provided as recorded on the day in Appendix 6.

5 Outcomes and learnings

The authors offer the following reflections on the process of running the workshops, as well as on the project objective to provide a practical approach to identify and express risk and uncertainty during the process of developing regional plans.

5.1 Learnings about the workshop process

- When participants at the first workshop were asked to identify key uncertainties they would have to deal with in their project roles (see group exercise 1 in Appendix 1), they identified a wide range of uncertainties not only about the information needed to inform the plan development process, but also uncertainties around project structure, roles, responsibilities, timelines, and even governance issues. It then took time to narrow the discussion down to the intended focus of the workshops; i.e., developing approaches to handling natural resource uncertainties in informing the plan development process. The other uncertainties around project structure and governance are also obviously important; the discussion was a reminder of the importance of communication between BOPRC staff to improve clarity around these aspects outside the scope of this sub-project (see reflections from Workshop 1 in Appendix 3).
- While the presentation of a certain amount of theoretical material was arguably necessary at the workshops, it was very important to intersperse this with questions and activities to stimulate discussion and sharing of local examples. It was clear that most participants had many local examples of situations involving uncertainties that “struck a chord” with the examples and approach promulgated in the Draft Uncertainty Guide. This was particularly evident by the second workshop where interactive and useful discussion characterised the day.

5.2 Outcomes and learnings about uncertainty in planning processes

- There is considerable value in acknowledging and sharing the challenge of uncertainty within the multidisciplinary project team (i.e., “sharing the uncertainty burden”), as occurred simply by holding the workshops. Participants reflected that acknowledging uncertainties represents “real life” (see Appendix 6).
- Communication within the team could be helped by agreeing on a common language, such as consistent use of the terms uncertainty, risk, likelihood, consequence and reversibility, as well as consistent descriptors of points on a scale of likelihood (e.g., very likely, likely, about as likely as not, unlikely, very unlikely).
- It is useful to spend some effort systematically identifying, acknowledging, assessing, reducing and quantifying uncertainties and risk, so that sensible project decisions can be made on a suitable level of effort to manage different risks. To some extent this is about developing a useful “mind-set” for each individual to employ continuously in a manner suitable for their particular role. There is also value in periodically documenting key uncertainties for the project as a whole, such as the draft “risk register” table produced for discussion at Workshop 2 (see Appendix 4).
- It is clear that communication of uncertainties is universally important when informing plan development processes and ultimately for decision-making. There are many methods for this and BOPRC staff already use some of them. The workshops served to build collective capacity amongst participants through sharing ideas and approaches, and considering examples in the Draft Uncertainty Guide. It seems clear that consistent use of terminology developed within multidisciplinary teams (e.g., as suggested in bullet 2 above) would also be useful for communicating out beyond the project team to the community and decision-makers.

- A summary list of tips for communicating uncertainty was developed as part of preparing the Draft Uncertainty Guide and this list is provided, with permission from the Ministry for the Environment, in Appendix 7.
- It is clear that incorporating uncertainty into decision-making is challenging for many reasons. Workshop participants largely agreed that effective characterisation and communication of uncertainty and risk by BOPRC teams could help decision-making. It was also acknowledged by participants that use of scenarios and community engagement processes are process tools that help expose uncertainties and risks to be handled. In this respect the BORC projects are already on a useful path. Participants specifically also identified the concept of communicating “reversibility” as a useful feature to inform decision-making.

Acknowledgements

The authors of this report gratefully acknowledge the other co-authors of the Draft Uncertainty Guide (Ministry for the Environment 2016), Simon Harris (LWP) and Helen Rouse (NIWA). Also sincere thanks to all of those who provided input to the development of the Draft Guide including the Ministry for the Environment who funded the Draft Uncertainty Guide project and also co-funding the present BOPRC project.

Appendix 1: Workshop 1 agenda, group exercises & resources

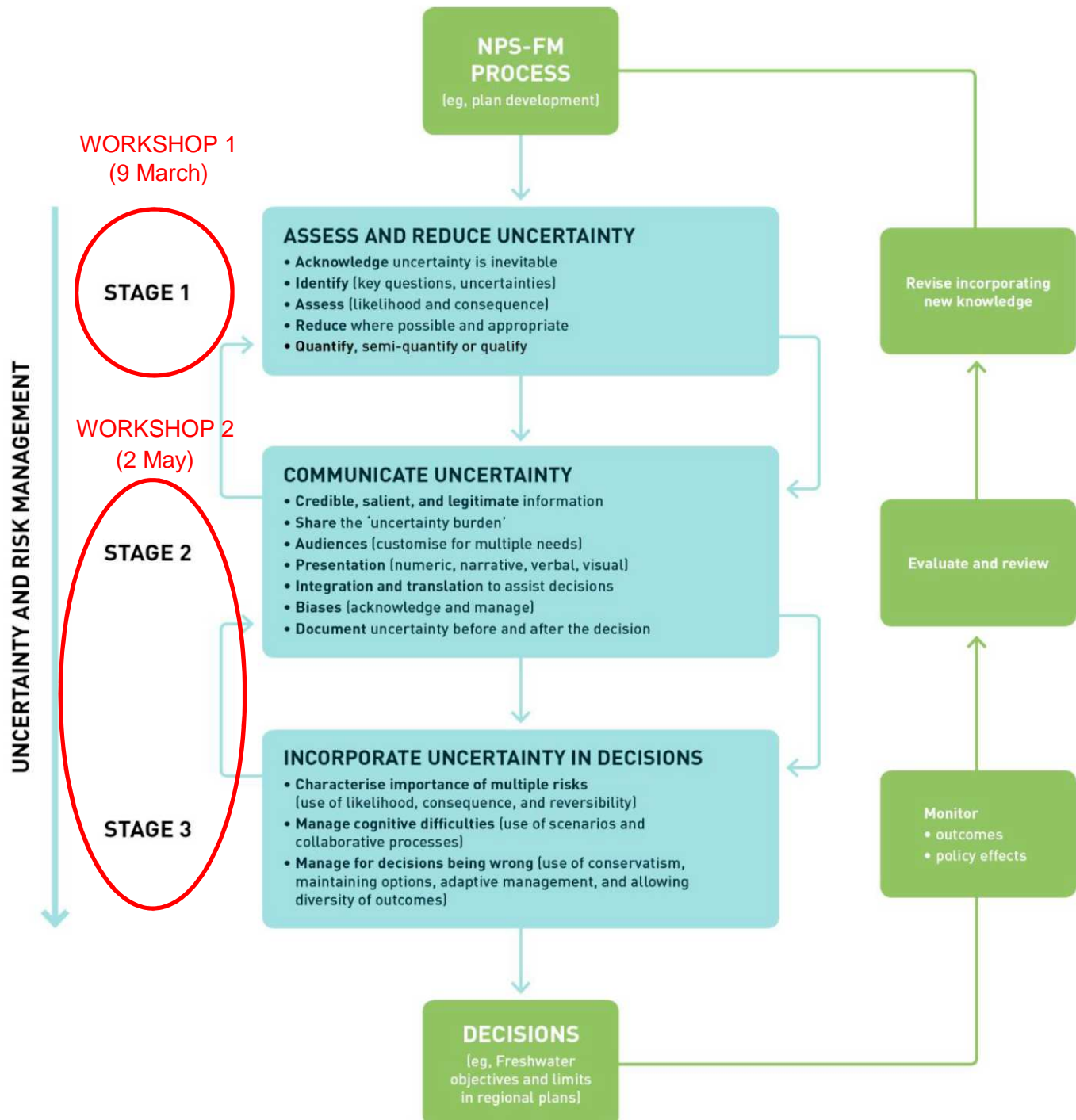
MANAGING RISK & UNCERTAINTY WORKSHOP 1: Run sheet & resources

Thursday 9 March 2017; 9am to 1pm; Pohutukawa Room, BOPRC, Whakatāne

Time	Activity/Resources	Lead
8-9 am	Set up (Flip charts, markers, post-it notes, pens, printed agendas, printed exercise sheets, poster with WMA diagram?, A3s with issues table, computer & projector, whiteboard & markers)	Santiago /Ned/ Toni
9-9.15am	Introduction <ul style="list-style-type: none"> - Introductions (Santiago, Ned, participants) - Reminder of where we are at in planning process - Relevance of this workshop in that context - Purpose for the day: consistent treatment, etc. - Outline for the day (refer to the agenda) 	Santiago
9.15-9.55am	Introduction to risk & uncertainty	Ned
9.55-10.05am	Morning tea	
10.05-10.25am	Overview of Stage 1 in Uncertainty Guide This covers the three parts in Stage 1 of the Uncertainty Guide and explains how we will look at each of those 3 parts sequentially in the 3 group exercises to follow.	Ned
10.25-11.05am	EXERCISE 1 – Identify and acknowledge uncertainty (See below)	Ned/ Santiago
11.05-11.45pm	EXERCISE 2 – Assess and reduce uncertainty (See below)	Ned
11.45-12.10pm	Lunch	
12.10-12.50pm	EXERCISE 3 – Quantify or semi-quantify uncertainty (See below)	Ned
12.50-1pm	Wrap up and next steps <ul style="list-style-type: none"> - Key take outs: common language, immediate future applications - Workshop 2 	Santiago /Ned/All

Diagram from the MfE Uncertainty Guide – showing areas of focus for Workshops 1 and 2

Figure 2: Three stage iterative process to manage uncertainty in NPS-FM processes



GROUP EXERCISES

Exercise 1 (everyone together) – Identify and acknowledge uncertainty (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (15 minutes)

To set the scene, and remind everyone involved in the project, a summary will be provided of: i) our current high level conceptual understanding of the study catchments (Kaituna-Pongakawa-Waitahanui and/or Rangitāiki); and ii) our current understanding of the key land and water resource management issues and pressures in these catchments.

Step 2: (5 minutes)

Everyone spend five minutes, on your own, writing down your top five bullet point uncertainties that are troubling you with regard to the questions you think you will be asked in your role in the project.

Step 3 (10 minutes)

We will go around the room getting everyone to verbally give us your one top troubling uncertainty. We will collect all the written “top fives” - put your name on them.

Step 4: (5 minutes)

We will try to use the uncertainties we hear above to identify three key example project questions, around which there is concern about uncertainty. We will then break the workshop attendees into three groups and give one question to each group for the remaining workshop exercises below.

By way of pre-preparation, based on what we’ve heard already, we anticipate that choosing three from the following three example questions may suffice:

1. What constraint on nitrogen losses from land uses (e.g., what nitrogen limits) would be necessary in order to meet identified ecological health, mahinga kai, cultural and recreational outcomes desired for the Maketu/Waihi estuaries as well as likely socio-economic outcomes desired for the wider WMA?
2. What constraint on nitrogen losses from land uses (e.g., what nitrogen limits) would be necessary in order to meet identified ecological health, mahinga kai, cultural and recreational outcomes desired for the Rangitāiki River as well as likely socio-economic outcomes desired for the wider WMA?
3. What surface and groundwater allocation limits would be needed in order to achieve outcomes that support ecological, cultural, recreational and socio-economic values in the Kaituna-Pongakawa-Waitahanui WMA and/or Rangitāiki WMA?

Exercise 2 (small groups) - Assessing and reducing uncertainty, where appropriate (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (20 minutes)

Make a bullet list of uncertainties associated with answering your group's question and, for each bullet on the list, try to assess what would be a cost effective amount of effort to employ to try and reduce that uncertainty. You could use Box 2 from the Guide below to help your discussions. Identify and assess as many uncertainties as you have time for. You will need to make notes against each bullet so that a representative from your group can report back to everyone at the end on what you found.

Step 2: (15 minutes everyone together)

A group representative is to give a verbal summary to everyone – 5 minutes per group.

Your group's note sheet could be organised like this....

Uncertainty	Approach to reduce...
1.
2.
3.

Box 2 – Summary of approaches for assessing and reducing uncertainty

- Assess the type and nature of uncertainties and associated risks.
- Assess priorities – which uncertainties justify the effort to reduce?
- Consider the merits and costs of gathering more data.
- Consider the pros and cons of using more sophisticated models.
- Consider more technical expertise, research, and/or peer review.
- Consider multiple parallel methods to produce converging lines of evidence.
- Making cost-effective decisions concerning effort to reduce uncertainty.

Exercise 3 (small groups) – Quantify or semi quantify uncertainty, where possible (40 minutes)

Introduce the exercise (5 minutes)

Step 1: (10 minutes)

Start with the bullet list of uncertainties your Group created in Exercise 2. For each bullet consider what the options are for expressing that uncertainty in terms of likelihood and consequence, and whether this can be done quantitatively (e.g., can likelihood be quantified using a probability from 0 to 1?) or only narratively – perhaps using some sort of likelihood scale like that shown in Table 3 from the Guide below. You could use Box 4 from the Guide below to help your discussions. Record a Q (for quantitative) or N (for narrative) against each uncertainty in your bullet list.

Step 2: (10 minutes)

As a group address the following questions:

- *Do you think by the end of the project you could be able to answer questions put to you in terms of likelihood and consequence? - at the level of very likely, likely, about as likely as not,...etc.?*
- *How do you feel about that? – is narrative expression sufficient? - is it likely to be useful or not?*
- *Is there technical or professional discomfort with using such narrative expression?*
- *Could there be agreement across the team to adopt the same language around likelihood?*
- *Is there an alternative useful way to express uncertainties in a common way across the project?*

Step 3: (15 minutes everyone together)

A group representative is to give a verbal summary to everyone – 5 minutes per group.

Table 3: A simplified narrative scale of likelihood combined with a visual colour code³⁵

Narrative descriptor³⁶	Probability class	Description³⁷	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	
Likely	67–90%	Expected to occur in normal conditions	
About as likely as not	33–67%	About an equal chance of occurring as not	
Unlikely	10–33%	Not expected to occur in normal conditions	
Very unlikely	0–10%	Not likely to occur even in extreme conditions	

Box 4 – Summary of methods and approaches for quantifying uncertainty

- Consider how much the uncertainty can be quantified.
- Use data ranges, standard errors and confidence intervals to quantify uncertainties associated with sample statistics such as the mean and median, where appropriate.
- Quantify uncertainty associated with model predictions where possible (eg, statistical errors, sensitivity analysis, Monte Carlo and other technical methods).
- Develop semi-quantitative or qualitative methods where full quantification is not possible, and express results using narrative descriptors of likelihood (eg, very likely, likely, about as likely as not, unlikely, very unlikely).
- Acknowledge limitations and ignorance.

Tentative groups

Group 1 – Nitrogen limit in Kaituna-Pongakawa-Waitahanui WMA	
Toni Briggs	Project manager
Pim De Monchy (or delegate)	Relationship and catchment management
Anaru Vercoe	Māori Policy Team Leader
Stephen Park	Coastal scientist
Rochelle Carter	Surface freshwater quality scientist
Janine Barber	Groundwater scientist
Jo Watts	Water Policy
Group 2 – Nitrogen limit in Rangitāiki WMA	
Lisa Baty	Project Coordinator
Simon Stokes (or delegate)	Relationship and catchment management
Sandy Hohepa	Māori Policy
Paul Scholes	Surface freshwater quality scientist and team leader
Kerry Gosling	Community engagement
Michelle Lee	Water Policy
Jo Armstrong	MfE
Group 3 – Water quantity allocation limits in Kaituna-Pongakawa-Waitahanui WMA and/or Rangitāiki WMA	
Sharon Pimlott	Science work project manager. Catchment modelling project manager.
Clarke Koopu	Māori Policy
Raoul Fernandes	Groundwater science and team leader (groundwater-surface water interactions)
Andrew Millar	Water Policy
Alastair Suren	Freshwater ecologist
Nic Conland	Consultant – Catchment Modelling
Janie Stevenson	Community engagement

Issue	Description	Kaituna-Pongakawa-Waitahanui	Rangitāiki
Estuary health	Ecological health, mahinga kai, cultural and recreational values are significantly degraded in Maketū and Waihi estuaries. Nutrient (nitrogen and, to a lesser extent, phosphorus), sediment, and faecal contaminants from the catchment and modified freshwater flows are key stressors. ³	✓	✗
Nutrient enrichment of HEP dam lakes	The Matahina and Aniwhiwa Hydro-electric power (HEP) Dam Lakes are “human made” receiving water bodies in the Rangitāiki River. Sedimentation, nutrient enrichment and resulting algal/macrophyte growth affects dam operations, ecological health ⁴ and recreational values.	✗	✓
Rising nitrates and land use intensification	Nitrates are increasing (all monitored river and stream sites in the Kaituna, Pongakawa and Waitahanui catchments ⁵ and also in upper Rangitāiki). Current and potential land use change and intensification (and historic changes in the last few decades) pose a significant risk that nitrogen levels will continue to increase for some time, potentially affecting ecological health, amenity and recreation values in freshwater bodies.	✓	✓
Increasing water demand	There is increasing water demand for agricultural/horticultural and municipal uses in Kaituna catchment and Waihi Estuary catchment, and this has potential to cause adverse effects on ecological cultural and recreational values. Current allocation significantly exceeds current region-wide water allocation limits in several sub-catchments and in the Kaituna aquifer ⁶ . There is current and potential future demand for water in the mid-upper Rangitāiki catchment to enable land use intensification and/or change in land use, but surface water and groundwater is fully allocated to currently consenting irrigators and the HEP schemes ³ . There is increasing demand for water in the lower Rangitāiki River catchment and this may affect the upstream extent of the saline wedge, recreational and ecological values. Surface and groundwater are closely connected across the Rangitāiki Plains. Availability and effects are heavily dependent on the HEP scheme managed flow regime.	✓	✓
Risk of phosphorous inputs increasing	Soil phosphorous levels (using Olsen-P) under kiwifruit have increased significantly from 71 to 106 mg/kg between 1999/2000 and 2009 and the risk of runoff to water bodies is high, with potential effects on receiving environment ecological values. Olsen-P levels on dairying soils have also increased. Other soil quality issues include the increasing mineralisable N concentrations in dairying soils with the mean now above the target band, increasing the risk of N leaching, and the high anaerobically mineralisable N on sheep and beef soils. ⁷	✓	✓
Sediment loads, particularly in high rainfall events	Sediment monitoring data for high flow events is limited. Community group members expressed significant concern about sediment affecting water quality and river substrate particularly in Waihi Estuary catchment. The majority of this sediment load is likely to be generated in high rainfall events for which there is currently limited data available.	✓	✓
Indigenous fish species habitat and passage	Tuna/eel and other indigenous fish species are heavily impacted by structural changes to/loss of habitat and obstacles to fish passage, and also by water quality, changes to flow regime and possibly harvesting. While this is not primarily caused by water quality and quantity management, this is a key freshwater issue for community members.	✓	✓
Swimming at some locations	Monitoring results available for some recreation sites show E. coli concentrations do not meet the <i>current</i> minimum acceptable state for swimming (full immersion) stated in the NPSFM (Pongakawa River at SH2, and Waitahanui River at SH2). Information is being reviewed in light of the proposed amendments in Clean Water 2017. Community group members in the WMAs and nationally are strongly voicing the expectation that all freshwater bodies should be safe to swim in. Some popular swimming spots are not monitored, and State of the Environment monitoring indicates that some of these sites may also not meet the current safe swimming standard. The lower reaches of the Kaituna River are an example of this ⁸ .	✓	✓
Mahinga kai and natural character in lowlands	Mahinga kai and natural character values are significantly impacted by water quality and waterbody modification (drainage schemes) in the lower Rangitāiki, lower Kaituna catchment and lower reaches of rivers draining to Waihi Estuary. Community groups show strong support for restoration of whitebait spawning areas and natural character while acknowledging the need for flood and drainage schemes.	✓	✓
Ecological health in pasture and urban areas	The Macro-invertebrate Community Index (MCI) values are lowest in streams/rivers draining pasture. MCI is relatively stable. In some areas, particularly the upper Pongakawa, indicators show improving trends.	✓	✓

³ Donald, Rob (2016). Ecological Health of Waihi Estuary. Agenda Report to Bay of Plenty Regional Council's Regional Direction and Delivery Committee, 31 March 2016.

⁴ Scholes, P and McKelvey, T (2015). Recreational Waters Surveillance Report 2014/2015. Bay of Plenty Regional Council Environmental Publication 2015/2016. ISSN: 1175 9372 (Print) ISSN: 1179 9471 (Online)

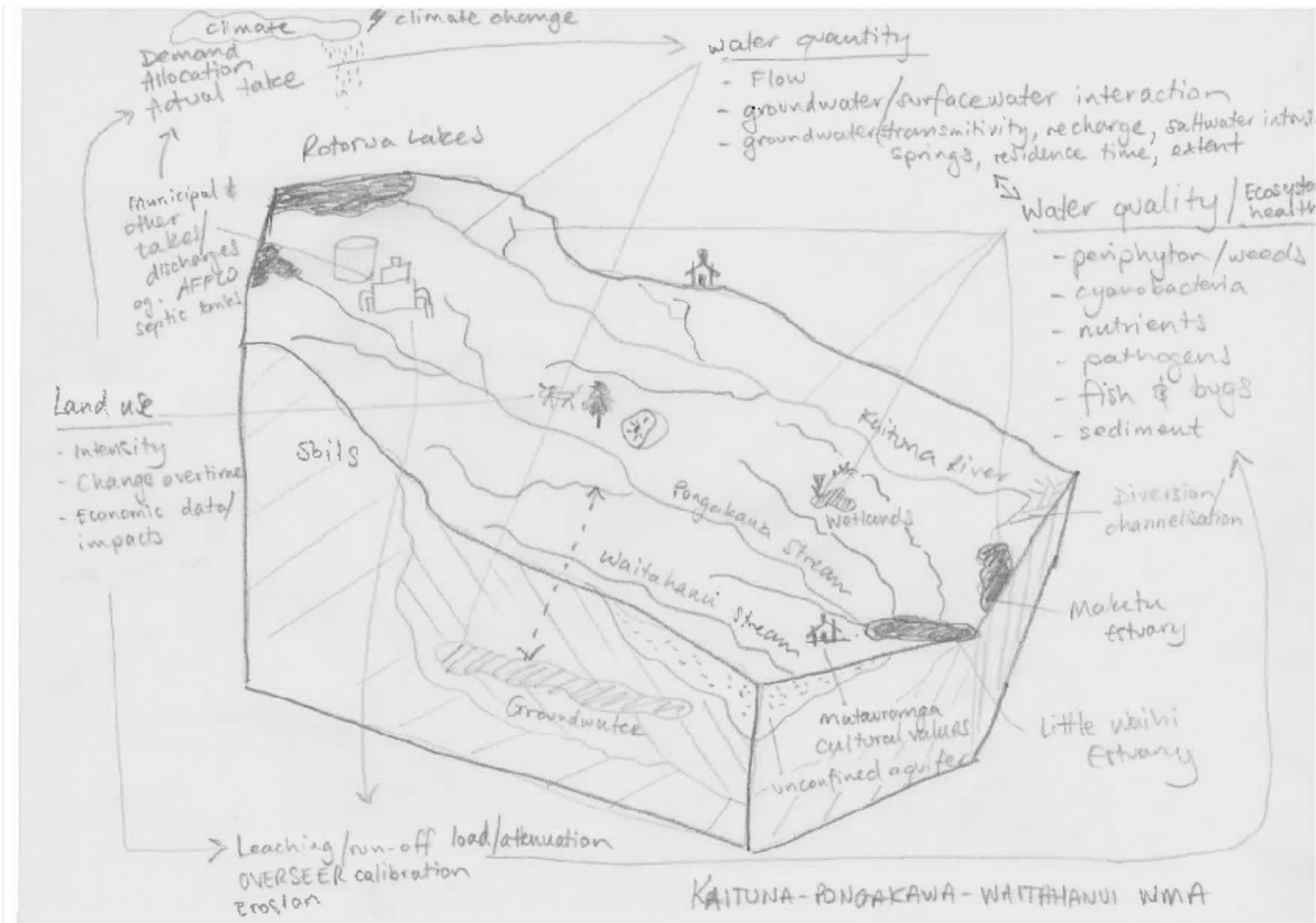
⁵ Scholes, P. and Carter, R. (2015). Freshwater in the Bay of Plenty – Comparison against the National Objectives Framework. Bay of Plenty Regional Council, Environmental Publication 2015/04. ISSN: 11750-9372 (Print), 9471 (Online). April 2015.

⁶ Kroon, Glenny (2016). Assessment of water availability and estimates of current allocation levels October 2016. Bay of Plenty Regional Council

⁷ Carter, R., Suren, A., Fernandes, R., Bloor, M., Barber, J., and Dean, S. (2015). Kaituna-Pongakawa-Waitahanui Water Management Area: Current State and Gap Analysis. Bay of Plenty Regional Council Environmental Publication 2016/01. ISSN: 1175-9372(print),ISSN: 1179-9471 (online). March 2015.

⁸ http://www.boprc.govt.nz/media/99812/2010_22_soil_quality_in_the_bay_of_plenty_2010_update.pdf (Guinto/BOPRC, 2010)

⁹ Scholes, P and McKelvey, T (2015). Recreational Waters Surveillance Report 2014/2015. Bay of Plenty Regional Council Environmental Publication 2015/2016. ISSN: 1175 9372 (Print) ISSN: 1179 9471 (Online)



Appendix 2: Workshop 1 presentations



Managing risk & uncertainty

Staff Workshop 1
9 March 2017



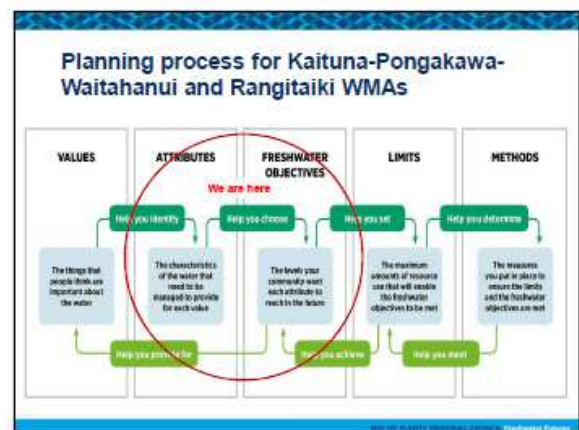
BAY OF PLENTY REGIONAL COUNCIL

Introduction

Relevance & purpose

- Acknowledge we won't have all the answers
- Shared understanding of how we will manage risk & uncertainty in the planning process (and catchment modelling)...
- ...so we have a robust approach when we get to hearings, s. 32 report writing, etc.
- Prioritise additional gap filling required?

BAY OF PLENTY REGIONAL COUNCIL



Outline

Time	Activity
9-9.15am	Introduction
9.15-9.55am	Introduction to risk & uncertainty
9.55-10.05am	Morning tea
10.05-10.25am	Overview of Stage 1 in Uncertainty Guide
10.25-11.05am	EXERCISE 1 – Identify and acknowledge uncertainty
11.05-11.45pm	EXERCISE 2 – Assess and reduce uncertainty
11.45-12.10pm	Lunch
12.10-12.50pm	EXERCISE 3 – Quantify or semi-quantify uncertainty
12.50-1pm	Wrap up and next steps

BAY OF PLENTY REGIONAL COUNCIL

Introduction to Risk & Uncertainty

Managing Risk & Uncertainty - Workshop 1
Thursday 9 March 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatane

...in context of...

National Policy Statement for Freshwater Management (NPS-FM)

Ned Norton¹, Simon Harris¹,
Helen L. Rouse²
¹ LandWaterPeople (LWP)
² NIWA



Draft MfE guide: <http://www.mfe.govt.nz/publications/fresh-water/draft-guide-communicating-and-managing-uncertainty-when-implementing>

Outline

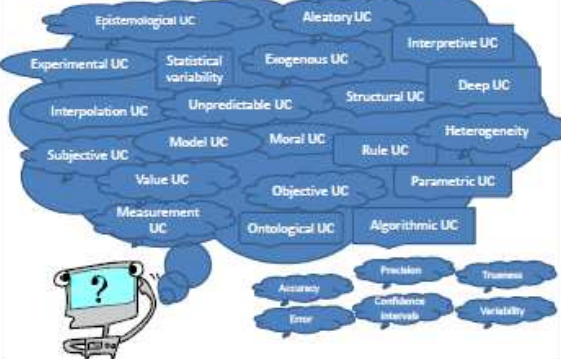
1. What is uncertainty?
2. Types of uncertainty – broadly?
3. What is risk?
4. How does this help in terms of NPS-FM?
 - Events & consequences
 - Likelihood (and probability)
5. Likelihood can be narrative – it's OK!
6. Simple, traditional risk framework is useful
7. Ability to respond (reversibility) also important
8. Summary of key messages

What is uncertainty?

"There are some things that you know to be true, and others that you know to be false; yet, despite this extensive knowledge that you have, there remain many things whose truth or falsity is not known to you. We say that you are uncertain about them. You are uncertain, to varying degrees, about everything in the future; much of the past is hidden from you; and there is a lot of the present about which you do not have full information. Uncertainty is everywhere and you cannot escape from it."

Dennis Lindley in *Understanding Uncertainty* (Lindley 2006).

Types of uncertainty? – really?....can be overwhelming...



Three broad types of uncertainty?

Natural variability refers to the natural variations in many aspects of the environment that we measure.

Model and parameter uncertainty includes uncertainty due to the limited scientific knowledge about the nature of models that link causes, environmental effects and mitigation actions, as well as about model parameters.

Deep uncertainty is uncertainty about the fundamental processes or assumptions underlying an assessment, which is not likely to be reduced by additional technical work within the project timeframe (i.e. the period in which a decision must be made).

Standard definitions of uncertainty & risk...¹

Uncertainty is "the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood"

Risk is "the effect of uncertainty on objectives"

Note the terms uncertainty and risk here are inseparable

¹ = Joint Australian New Zealand International Standard for Risk Management (AS/NZS ISO 31000:2009)

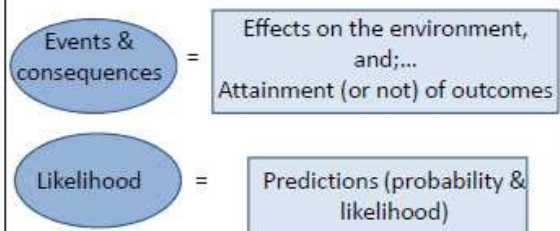
Furthermore...(& usefully)...

Risk "is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence"¹

... we suggest the standard approach to risk assessment is useful in an NPS-FM context!

¹ = Joint Australian New Zealand International Standard for Risk Management (AS/NZS ISO 31000:2009)

How this helps – in terms of NPS-FM?



Events/Conseq. = Effects/Outcomes

- Assessments of effects on outcomes take many forms – we've all been doing this for a long time in NZ under the RMA. Some outcomes are now defined numerically using NPS-FM "attributes" (thresholds define an acceptable state)
- For now – to make a point – we'll simplify to "small", "medium", "large" effects on outcomes (or low, medium, high thresholds for attributes)

...just hold this thought for a minute while we deal with "likelihood" ...

Predicting likelihood & probability

Table 1: Probability scale and alternative narrative scales of likelihood²³

Probability	Intergovernmental Panel on Climate Change (IPCC) scale ²⁴	Scale based on legal standards of proof ²⁵	Environmental Risk Management Authority (ERMA) scale ²⁶
100%	–	Beyond any doubt	–
>99%	Virtually certain	Beyond a reasonable doubt	Highly likely
90–99%	Very likely	Clear and convincing evidence	Highly likely
80–90%	Likely	Clear showing	Highly likely
67–80%	Likely	Substantial and credible evidence	Likely
50–67%	About as likely as not	Preponderance of evidence	Likely
33–50%	About as likely as not	Clear indication	Unlikely (occasional)
10–33%	Unlikely	Probable cause, reasonable belief	Very unlikely
1–10%	Very unlikely	Reasonable grounds for suspicion	Highly improbable
<1%	Exceptionally unlikely	No reasonable grounds for suspicion	Highly improbable
0%	–	Impossible	–

Quantitative versus narrative expression of likelihood

Simplified scale might be sufficient?

(in context of NPSFM?)

Table 3: A simplified narrative scale of likelihood combined with a visual colour code²⁷

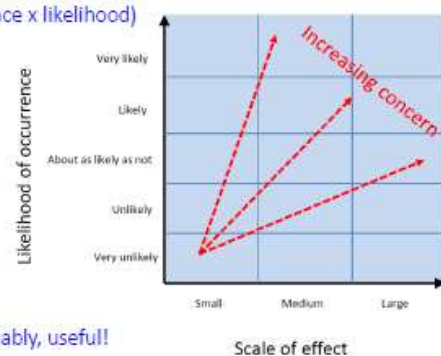
Narrative descriptor ²⁸	Probability class	Description ²⁷	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	Green
Likely	67–90%	Expected to occur in normal conditions	Yellow-green
About as likely as not	33–67%	About an equal chance of occurring as not	Yellow
Unlikely	10–33%	Not expected to occur in normal conditions	Orange
Very unlikely	0–10%	Not likely to occur even in extreme conditions	Red

Narrative expression of likelihood is OK? – even inevitable?

Consistent language across disciplines in a project is useful?

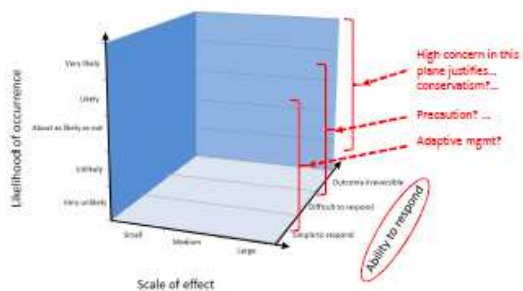
So... the traditional risk framework...

(consequence x likelihood)



...is, arguably, useful!

But other things come into it...
(in particular assessing reversibility is also useful)



Key messages...

1. Uncertainty is, at some level, inevitable
2. Risk is the effect of uncertainty on objectives
3. Risk is expressed as likelihood & consequence of events
4. In NPS-FM context - the events we are typically interested in are the effects of resource use and achievement (or failure) of outcomes.
5. It is useful to predict effects and achievement of outcomes in terms of likelihood, and the magnitude and/or significance of the effect or outcome.

and...

...Key messages (continued)

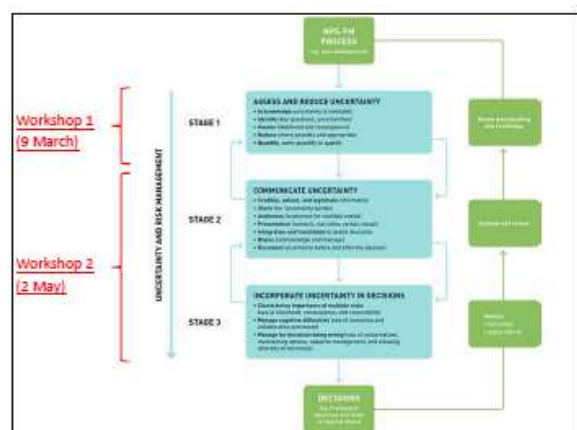
6. Expressing likelihood: is sometimes possible quantitatively (e.g. probabilities) but more often narrative is required (e.g. likely, very likely etc.).
7. It is also useful to describe ability to respond (reversibility), as part of the context of a risk.
8. Communicating on consequences, likelihood and ability to respond ultimately can help decision-making.

Personal observations...

- Awareness of this framework, and constructive use, can be helpful and liberating for information providers.
- For decision-makers it is at first frustrating - they'd rather have certain answers - but ultimately helpful – decisions in the face of uncertainty are tough.
- Some parties may choose to exploit your transparency about uncertainty for advocacy.

...that's the introductory background...

What next?...



Acknowledgements...

- Ministry for Environment, Guidance Team, Water Directorate
- The Environment Canterbury team
- NIWA
- The MBIE funded Management of Cumulative Effects of Stressors on Aquatic Ecosystems Programme, CO1X1005



LWP



Overview of Stage 1 in the Guide

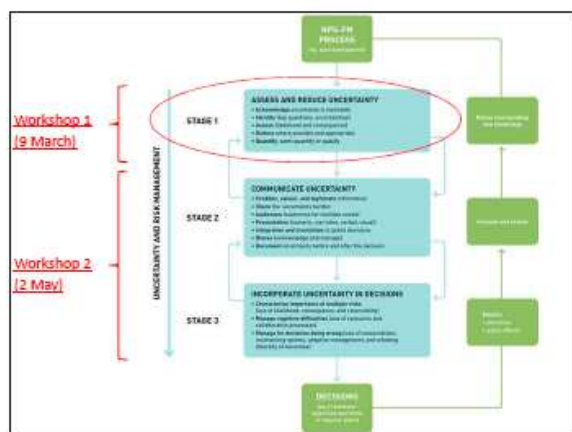
Managing Risk & Uncertainty - Workshop 1

Thursday 9 March 2017

Pohutukawa Room

Bay of Plenty Regional Council

Whakatāne



Stage 1: Assessing & reducing uncertainty

Three parts to this in the Guide...

1. Identify & acknowledge sources of uncertainty
2. Assess & reduce uncertainty
3. Quantify or semi-quantify uncertainty, where possible

- We will do a workshop exercise on each of these three shortly
- I will do quick overview of Stage 1 of the Guide...

but first...

The Point of this?...

- Is **NOT** to try and solve every uncertainty today, but to...
- Practice & develop an approach to handling uncertainty by working some examples and sharing ideas, so that...
- Many uncertainties in the project can be subsequently worked through in a way that is as systematic and consistent across the project(s) as possible.

1. Identify & acknowledge uncertainty

- Uncertainty is everywhere, is inevitable, and is normal in natural resource management and planning.
- Identification of uncertainties begins at the outset of a project and should be continually revisited.
- Conceptual diagrams are a useful tool to help frame the key project questions, and to thus identify the knowledge providers needed – these providers (i.e., you) help identify where the uncertainties are.

We will do exercise on this shortly

2. Assess & reduce uncertainty

This involves...

- Identifying whether the uncertainty is around *natural variability*, *model uncertainty* or *deep uncertainty* - because methods to reduce these differ.
- Identifying whether the uncertainty relates to a likelihood or a consequence – because methods to reduce these differ.
- Prioritising the uncertainty's likely importance in the decision.
- Thereby determine how much effort to put into reducing the uncertainty.

...Assess & reduce... (continued)

Typically...

- For attributes that have '*natural variability*' we cannot reduce the variability but we can improve our estimates of the statistics (mean, ranges, std errors) by taking more samples.
- Uncertainties with '*models and their parameters*' can be reduced by employing greater technical effort (e.g. more studies) – but there will be budget and time trade-offs, potentially diminishing returns, and complexity issues to consider.
- '*Deep uncertainties*' by definition cannot be reduced in the project timeframe – acknowledge these transparently

...Assess & reduce - Summary

Box 2 – Summary of approaches for assessing and reducing uncertainty

- Assess the type and nature of uncertainties and associated risks.
- Assess priorities – which uncertainties justify the effort to reduce?
- Consider the merits and costs of gathering more data.
- Consider the pros and cons of using more sophisticated models.
- Consider more technical expertise, research, and/or peer review.
- Consider multiple parallel methods to produce converging lines of evidence.
- Making cost-effective decisions concerning effort to reduce uncertainty.

3. Quantify or semi-quantify

As a project progresses and uncertainties are reduced as much as possible with the time and resources available, it is useful to characterise the key remaining uncertainties:

- Quantitatively (e.g. numeric probabilities where possible)
- Semi-quantitative or qualitatively (e.g. unlikely, likely, etc)
- By weak descriptions where there is deep uncertainty
- Acknowledging ignorance about unknowns

...Quantify or semi-quantify... (continued)

Typically...

- Uncertainties in estimating attributes that have '*natural variability*' can be shown by describing statistics (mean, ranges, std errors)
- Uncertainties with '*models and their parameters*' may sometimes be shown using a variety of statistical techniques, sensitivity analysis and Monte Carlo analysis, but..
- Often may require expert judgements using narrative expressions
- '*Deep uncertainties*' by definition cannot be quantified in the project timeframe

Narrative expression – as shown previously

Table 3: A simplified narrative scale of likelihood combined with a visual colour code¹⁶

Narrative descriptor ¹⁶	Probability class	Description ¹⁷	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	Green
Likely	67–90%	Expected to occur in normal conditions	Light Green
About as likely as not	33–67%	About an equal chance of occurring as not	Yellow
Unlikely	10–33%	Not expected to occur in normal conditions	Orange
Very unlikely	0–10%	Not likely to occur even in extreme conditions	Red

...Quantify/semi-quantify - Summary

Box 4 – Summary of methods and approaches for quantifying uncertainty

- Consider how much the uncertainty can be quantified.
- Use data ranges, standard errors and confidence intervals to quantify uncertainties associated with sample statistics such as the mean and median, where appropriate.
- Quantify uncertainty associated with model predictions where possible (eg. statistical errors, sensitivity analysis, Monte Carlo and other technical methods)
- Develop semi-quantitative or qualitative methods where full quantification is not possible, and express results using narrative descriptors of likelihood (eg. very likely, likely, about as likely as not, unlikely, very unlikely).
- Acknowledge limitations and ignorance.

EXERCISE 1 - Identify and acknowledge uncertainty

Kaituna-Pongakawa-Waitahanui WMA



Our understanding of key issues

- Estuary health (K-P-W)
- Nutrient enrichment of HEP dam lakes (Rangitāiki)
- Rising nitrates and land use intensification
- Increasing water demand/over-allocation
- Risk of phosphorus inputs increasing
- Sediment loads, particularly in high rainfall events

Our understanding of key issues

- Indigenous fish species habitat and passage
- Unsuitability for swimming
- Mahinga kai and natural character in lowlands
- Ecological health in pasture and urban areas
- BUT, also socio-economic values (e.g. "community vibrancy", "financial viability", etc.)

EXERCISE 2 - Assess and reduce uncertainty

EXERCISE 3 - Quantify or semi- quantify uncertainty (where possible)

Wrap-up and next steps

- Key take home messages
- Next steps:
 - Communicating uncertainty:
 - » To tangata whenua & stakeholders, Managers, Councillors, Commissioners, etc.
 - » Ways to present it
 - Incorporating uncertainty in decisions

Appendix 3: Workshop 1 – participants’ reflections

The last task of the day (9 March 2017) was to go around the room asking all participants for their take-home reflection.

1. Many uncertainties have been raised during the day about the “process” and how the team is operating together.
2. Uncertainty of direction of the group (i.e., the project team)
3. Maybe limits should be a range (maybe the goal is to be somewhere in the A Band or B Band for example) rather than a single number.
4. Important to communicate that we know enough to move forward but don’t overstate our confidence.
5. Might need to present our information in terms of ranges
6. Everyone is putting a lot of hope in modelling – but uncertainties in there too and won’t provide all the answers.
7. We work with uncertainty every day – this workshop has helped put it in a bit of a context/construct.
8. Two types of uncertainty have come up today – i) operational uncertainty around the project/process; and ii) handling uncertainty in technical assessments. In terms of the latter this workshop has helped by the Guide/workshop – in particular the 3D diagram incorporating reversibility with likelihood and consequence.
9. Increased awareness of uncertainty that others in the project are dealing with – but how do we communicate it together as a team?
10. A challenge is how we are going to communicate all this information – and its uncertainties – together.
11. Our teams need to do this kind of get-together more often. Need to have these conversations – how to have them too with our Māori partners and our Councillors.
12. We can have some confidence in being able to express our level of uncertainty.
13. When we end up on the stand we need to know that others in our team understand the level of certainty we are going to express – need to have pre-discussed these as a team.
14. Communicating all this is a big challenge.
15. Has highlighted the usefulness of getting together as a wider project team – despite how busy we are and that it is hard to find time – every time we do it is worthwhile. We need to keep doing this to become more cohesive in our thinking as a team.
16. BOPRC team need to get together before next Uncertainty Workshop 2 to progress this discussion further.

Appendix 4: Workshop 2 agenda, group exercises & resources

MANAGING RISK & UNCERTAINTY WORKSHOP 2: Run sheet & resources

Tuesday 2 May 2017; 10am to 1.30pm

Mānuka Meeting Room (CMR4), Bay of Plenty Regional Council, Whakatāne

Time	Activity/Resources	Lead
9.30-10 am	Set up (Flip charts, markers, post-it notes, pens, printed agendas, printed exercise sheets, computer & projector, whiteboard & markers, coffee!)	Toni/ Santiago /Ned
10–10.15am	Introduction <ul style="list-style-type: none"> - Introductions (Santiago, Ned, participants – if any new participants) - FEC projects - Reminder of where we are at in planning process, process diagram - Relevance of this workshop in that context - Reminder of what was covered last time, including internal process uncertainties and purpose of the day - Outline for the day (refer to the agenda) 	Santiago
10.15-11.15am	Communicating scenario outputs	Ned
11.15-11.30am	Morning tea	
11.30am-12.30pm	Informing decisions, including Exercises/Discussion Points EXERCISE 1 – Review of risks’ likelihood, impact and degree of irreversibility EXERCISE 2 – Managing risk through scenarios and stakeholder engagement EXERCISE 3 – Implications of getting it wrong	Ned/ Santiago
12.30-1pm	Wrap up and key points	Santiago /Ned/All
1-1.30pm	Lunch	

	Risk/uncertainty	Type	Likelihood of not getting it right	Impact of not getting it right	Degree of irreversibility	Implication for management	Approach to reduce/manage
QUANTITY	1) Water allocation and use data (including permitted & s.14(3)(b))*	Parameter	Likely	Medium	Simple to respond: correct limits	Under/over-estimate allocation and use	<ul style="list-style-type: none"> - Improve data (e.g. require reporting) - Adopt estimation method - Modelling scenarios? - Conservative management/precautionary approach.
	2) Flow data (to identify Q5) for unmonitored streams*	Model/parameter?	Likely	Medium	Simple to respond	Over/under estimate available resource	<ul style="list-style-type: none"> - Additional monitoring - Additional research/modelling - Conservative/adaptive management
	3) Flow records where ratings shift due to mobile beds	Model/parameter?	Unlikely?	Small	Simple to respond	Over/under estimate available resource	Additional research/monitoring
BIT OF BOTH	4) Socio-economic impacts (e.g. cost of options)	Model/parameter?	About as likely as not	Medium	Difficult to respond	Too much/little importance given to socio-economic objectives	<ul style="list-style-type: none"> - Economic analysis on the back of bio-physical model - Stakeholder engagement
	5) Measurement of Māori cultural values/Matauranga (qualitative) – e.g. in relation to in-stream flow requirements	Deep?	About as likely as not	Medium	Difficult to respond, subject to how distant from cultural values outcomes are	Outcomes will not meet Māori cultural values	- Matauranga project? Engagement with tangata whenua
	6) Current farm practices*	Parameter	About as likely as not	Medium	Simple to respond	Over/under estimate	<ul style="list-style-type: none"> - Modelling scenarios - Stakeholder engagement
	7) Time to achieve objectives*	Model?	Likely	Small	Simple to respond	Over/under-estimate time to achieve	- Modelling includes time as a scenario
	8) Surface-groundwater interaction	Deep?	Likely	Medium	Difficult to respond	Over/under-represent interaction, affects SW and GW quality and quantity limits	<ul style="list-style-type: none"> - Additional research - Modelling scenarios (informed assumptions) - Conservative/adaptive management.
	9) Drivers of ecological state other than physical/chemical attributes in NOF Quantity-quality-ecology relationships	Model/parameter? Natural variability	Likely	Large	Difficult to respond	Management settings exclude other factors important for ecological health	<ul style="list-style-type: none"> - Use ecological state indicators (e.g. MCI) - Additional research on factors that affect ecological health. - Conservative/adaptive management.
QUALITY	10) Relationship between indicator bacteria (E. coli) and actual pathogens	Natural variability?	Likely	Medium	Simple to respond	E. coli limits may pose higher risk to human health than anticipated	<ul style="list-style-type: none"> - Wait for national direction on this? - Additional research - Conservative management
	11) Impacts of nutrients on pumice bed streams	?	?	?	?	?	- ?
	12) Estuary & coastal impacts	Deep? Or Model/parameter?	Likely	Large	Could be irreversible for estuaries, probably reversible for coastal area	Freshwater objectives/limits do not provide for estuary/coastal environment health	<ul style="list-style-type: none"> - Additional research on impacts on estuaries (e.g. A Dewes?) - Expert judgement? - Modelling scenarios? - Integrated management, limits set for fresh water take into account estuaries/coastal area as far as possible. - Stakeholder engagement - Conservative/adaptive management
	13) Load to come/attenuation/lags*	Deep?	Likely	Large	Difficult to respond	Over/under estimate, affects limits and objectives	<ul style="list-style-type: none"> - Additional research - Modelling scenarios - Conservative/adaptive management

*Catchment modelling is expected to address these?

Appendix 5: Workshop 2 presentations

Managing risk & uncertainty

when implementing the
National Policy Statement for Freshwater Management 2014

Staff Workshop 2
2 May 2017



DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

Today:

communicating risk & uncertainty and
incorporating them in decision-making

- 10-10.15am: Introduction
- 10.15-11.15am: Communicating risk & uncertainty
- 11.15-11.30am: Morning tea
- 11.30am – 12.30pm: Informing decisions and exercises/discussion points
- 12.30-1pm: Wrap up
- 1-1.30pm: Lunch

DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

The process

Quantity	Quality	Quantity	Quality
Flow regime and aquatic level integrity	Required by NPS-FMU: - Phytoplankton or Nitrate Toxicity (where relevant) - Ammonia Toxicity - Dissolved Oxygen - E. coli - Cyanobacteria - Total phosphorus - Total nitrogen - Playhousin - Sediment, clarity - TSS	Infrastructure - Allocation policy - Metering - Monitoring	Mitigation and farming practice change/controls - Stocking rate controls - Land use change controls - Quantity management - Point source management (e.g. sewage treatment upgrade) - NDA allocation
ATTRIBUTES	OBJECTIVE		METHODS

DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

The process

Freshwater Management Units



Outstanding concerns & uncertainties:
- surface water vs. groundwater FMUs
- Where in the FMU are objectives measured/tested (monitoring, modelling nodes)?

FRESHWATER MANAGEMENT UNIT

What do we set at the level of a

ATTRIBUTES OBJECTIVES LIMITS METHODS

DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

The process (continued):

How modelling will help us to come up with management options




Scenario	Current farming practice	Mitigation scenarios	Best Management Practice
Development scenarios			
Current land & water use or land use change based	61	61	61
High intensity land & water use	84	85	85
Low intensity land & water use	17	18	18

DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

The process (continued):

How modelling will help us to come up with management options



Option assessment/re-assessment against agreed criteria

Management options	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9	Option 10
Phosphorus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitrogen	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ammonia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Soil erosion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quantity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quantity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quantity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

DEFRA | NPS FOR FRESHWATER | 2014 | Freshwater Policy

Communicating Scenario Outputs

Lessons & reflections from practice

Managing Risk & Uncertainty - Workshop 2

Tuesday 2 May 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne

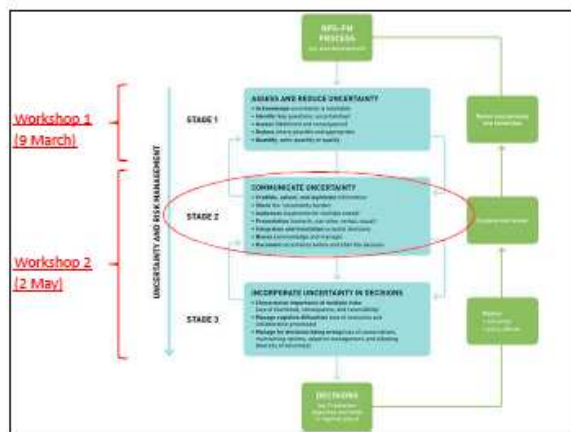
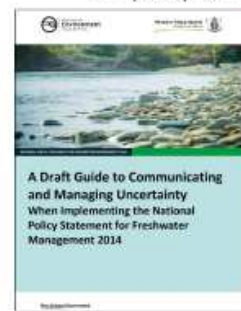
Recent gathering of lessons & ideas from processes to date in here... →

...structured around uncertainty... but applies to technical communication generally...

...you're an audience that reads!... so lets assume that....

...and so lets come into this from a different angle....

MfE (2016) - draft



Outline

1. Establishing a useful mind-set

- Knowing your role – specifically in “this” process
- Walking in the communities’ shoes
- Relationships are crucial
- Listening ears on

2. Applying that mind-set to the task at hand

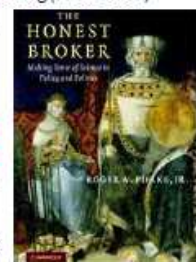
- Communication is critical
- Establish purpose – why scenarios?
- Identify target audiences
- Presenting complex information – team members
- A bit about uncertainty
- Presenting complex information – integrators
- Acknowledging and managing biases
- Managing communication risks

1. Establishing a useful mind-set

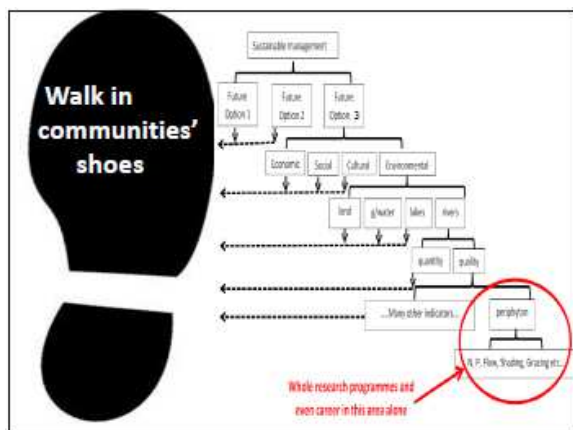
Knowing your role – specifically in “this” process, which is informing policy development

Four idealised roles for scientists in decision-making (Pielke 2007)

Pure Scientist	Issue Advocate
Science Arbitrer	Honest Broker of Policy Alternative



“...the preferred position for the professional researcher embedded within the policy process is as an ‘honest broker’ explaining what is known, what is not known, and thus the implications of the options that emerge.” Gluckman (2014) – NZ’s PMCSA



Mind-set things...

- Relationships are crucial
- Listening ears on

It helps to think in terms of telling a story

- Helps uptake – open, grounded, logical
- Content (science) is important, but so is..
- Building rapport and trust

2. The task at hand...

“Communicating scenario outputs (& uncertainty) to diverse audiences”

Communication is critical

New Zealand research into what the public thinks about science found that in general:²⁷

- “New Zealanders are not inclined to take scientific claims on trust. They are likely to judge research as irrelevant or unconvincing if they do not understand the research methods and/or the meaning of evidence is not immediately apparent.”
- “Openness about uncertainty is seen as evidence of honesty on the part of scientists. Open acknowledgement of areas of uncertainty and new questions are preferable to bland assurances of safety or predictability.”

Quote from Parliamentary Commissioner for the Environment (2004)

Establish purpose – why scenarios?

Scenarios enable us to explore what the future might look like – for everyone’s values, if we did certain things (including limits in the plan). They make trade-offs and win-wins visible.

- Must accept best estimates – no crystal ball
- Scenarios are not necessarily options (but lie within)
- Scenarios *inform* **choices** (of limits & other actions)

How scenarios inform choices?

ZC OUTCOMES	TECHNICAL INDICATORS	SCENARIOS							
		Status Quo – pre HDIS			HDIS as consented		Advanced mitigations		
		1a	1b	1c	2a	2b	3a	3b	
Outcome A e.g. Wetland habitat is a healthy ecosystem	Indicator 1	1a	1b	1c	2a	2b	3a	3b	
	Indicator 2	2	2	2	2	2	2	2	
	Indicator 3	3	3	3	3	3	3	3	
	Etc.								
Outcome B e.g. Coastal resources have high water quality	Indicator 1								
	Indicator 2								
	Indicator 3								
	Etc.								
Outcome C e.g. Wetland ecosystem growth	Indicator 1								
	Indicator 2								
	Indicator 3								
	Etc.								
Etc.									

Establish purpose – why scenarios?

- Scenarios also directly assist with delivering the process mapped out in NPSFM Policy CA2(f)

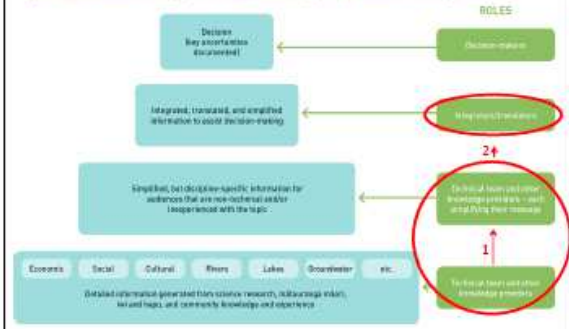
Policy CA2
... required consult applying the following process: ...

(f) considering the following matters at all relevant points in the process described in Policy CA2(a) to (e):

- (i) the current state of the freshwater management system, and its anticipated future state on the basis of past and current resource use;
- (ii) the spatial scale at which freshwater management exists or develops;
- (iii) the limits that would be imposed to achieve the freshwater objectives;
- (iv) any choices between the values that the freshwater objectives and associated limits would require;
- (v) any implications for resource users, people and communities arising from the freshwater objectives and associated limits including implications for actions, investments, ongoing management changes and any social, cultural or economic implications;
- (vi) the information required to achieve the freshwater objectives, including the ability of regional councils to set long term targets for achieving targets and such other matters relevant and reasonably necessary to give effect to the objectives and policies in this national policy statement, in particular Objective A2.

Identify target audiences – multiple!

Figure 5: Illustration of the 'pyramid' of information typically needed in NPS-FM processes



Presenting complex information – tech team members

Pros/cons of numeric, narrative, verbal, visual, graphic etc.

Key messages:

- People differ
- Use as many as possible
- Repetition in diff ways

Table 2: Pros and cons of different communication methods

Method	Pros	Cons
Numeric	Provides a clear, concise summary of complex information.	Can be difficult to interpret for non-technical audiences.
Narrative	Provides a clear, concise summary of complex information.	Can be difficult to interpret for non-technical audiences.
Verbal	Provides a clear, concise summary of complex information.	Can be difficult to interpret for non-technical audiences.
Visual	Provides a clear, concise summary of complex information.	Can be difficult to interpret for non-technical audiences.

Why uncertainty is important

Box 5 – A key message is: "Communicating uncertainty shares the burden"

- Scientists and other technical contributors to a public policy process have a responsibility to identify and communicate the uncertainties in their work.
- Acknowledging uncertainty can relieve the burden felt by scientists who are often unreasonably expected to have high confidence in their conclusions.
- When uncertainty is communicated its burden is shared amongst technical people, the community, and decision-makers, and decisions can be more transparent.
- Limit-setting decisions require weighing of values and their uncertainties. Communicating uncertainty is therefore critical for good decision-making.

Simplify uncertainty if possible...

An example of numeric, narrative and visual methods of communicating the likelihood of attaining a given outcome (e.g. a freshwater objective)

Table 3: A simplified narrative scale of likelihood combined with a visual colour code¹⁸

Narrative descriptor ⁽¹⁾	Probability class	Description ⁽²⁾	Colour code
Very likely	90–100%	Likely to occur even in extreme conditions	Green
Likely	67–90%	Expected to occur in normal conditions	Yellow
About as likely as not	33–67%	About an equal chance of occurring as not	Orange
Unlikely	10–33%	Not expected to occur in normal conditions	Red
Very unlikely	0–10%	Not likely to occur even in extreme conditions	Dark Red

Presenting complex information – integrators

There is a need for some(one) to:

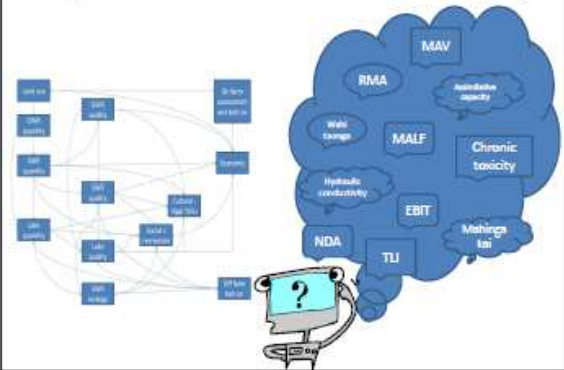
- Integrate
- Translate
- Simplify



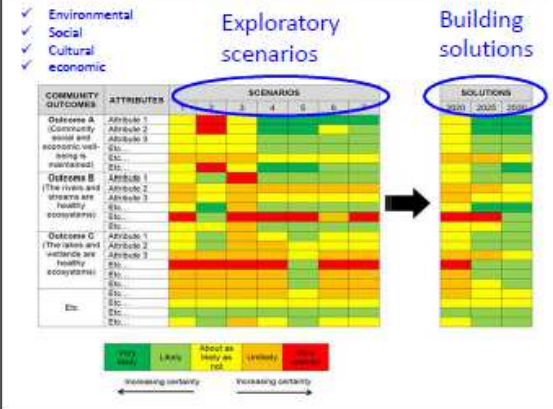
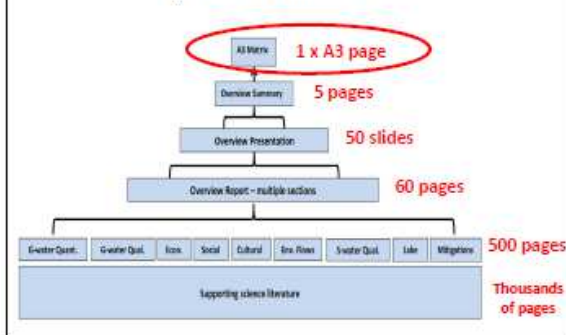
Why do we need to integrate!?!



Why do we need to translate & simplify?



Communicating complex info “Pyramid” of information



Acknowledging & managing biases

There are many biases professionals working in this space should be aware of:

- Availability bias
- Confirmation bias
- Confidence bias
- Group bias
- Framing bias
- Anchoring bias

See Appendix 2 in MfE 2016 guide – also Kahneman (2011) “Thinking, Fast and Slow” is a fascinating read

Managing communication risks

There are many risks including criticism for:

- Not enough information/knowledge (on “my” needs)
- Over-complicating (and then) over-simplifying
- Bias
- Not giving us the answer/decision
- Too fast / too slow / too uncertain

Also, RC experience has shown that open communication of uncertainty may be abused by some who use it for advocacy.

That’s life – the first step in managing these is to be aware of them – the tools discussed here can help

Finally...

also try to keep a sight-line thru to...

- Community decision-making needs (see S5 in guide)
- Plan-writing needs (a whole subsequent step)
- Plan decision-makers needs

...as well as beyond that to...

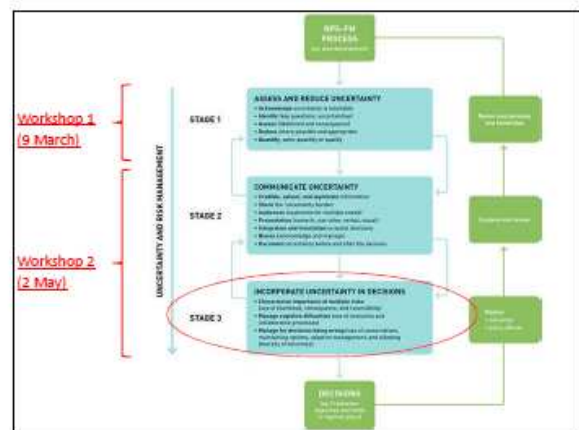
- The community that implements it!

End

Informing Decision-Making

Managing Risk & Uncertainty - Workshop 2

Tuesday 2 May 2017
Pohutukawa Room
Bay of Plenty Regional Council
Whakatāne



Three parts to this in the Guide...

1. Characterise the importance of multiple risks
2. Manage cognitive difficulties
3. Manage for decisions being wrong

The Point of this?...

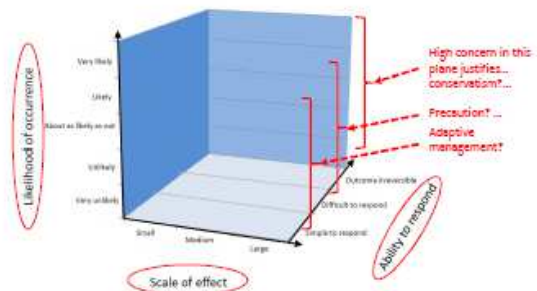
- Is NOT to try and be decision-makers if we are in an informing role, but to...
- Imagine ourselves in their shoes, understand the difficulties they face, and so best assist with our information.

1. Characterise the relative importance of multiple risks

- How can decision-makers grapple with the importance of any particular risk or uncertainty relative to other risks and uncertainties in that decision?
- We can help by describing likelihood and consequence, but also...
- Other contextual things like... reversibility!

However, we should leave the weighting to decision-makers?

Likelihood, Scale of effect, & reversibility



Key messages on the relative importance of multiple risks (Box 8)

- Characterise the nature of risks and uncertainties through the technical informing process. These can be usefully described in terms of the likelihood of occurrence, the scale and significance of the effect or outcome, and reversibility.
- Particular attention should be paid to irreversibility of consequences across the range of values, since this will drive approaches to manage for the situation where the decision turns out, over time, to be wrong (eg, use of precaution, conservatism and adaptive management).

Discussion 1:

- ☐ **Lets consider some of the risks identified last time, their likelihood, impact and degree of irreversibility...do you agree with how we've categorised them?**
- ☐ **What is the implication of getting it wrong?**
- ☐ **How do we manage that?**
- ☐ **What other major risks should be included in the list?**

2. Manage cognitive difficulties

- Human brains and "heuristics"
- Biases
- Value judgements
- Process tools to help include:
 - Use of scenarios
 - Use of collaborative approaches

Key messages on managing cognitive difficulties (Box 8)

- Cognitive difficulties with making decisions under uncertainty place a considerable burden on decision-makers. Scenarios provide a useful tool for exposing and understanding uncertainties.
- Because NPS-FM decisions on limits involve value judgements, some level of stakeholder engagement is essential. Consensus-based collaborative processes are particularly useful in policy problems where there is uncertainty of knowledge and disagreement over norms and values (ie, in 'wicked' problems), as is typically the case with limit setting under the NPS-FM. Experience suggests collaborative processes also provide assistance with the cognitive difficulties of making decisions under uncertainty.

Discussion 2:

- ❑ *How could testing scenarios through modelling help us to incorporate risk & uncertainty in decision-making?*
- ❑ *What other scenarios could be considered? Are those able to be modelled?*
- ❑ *Do you agree that involving (community groups, tangata whenua, large resource users, others?), rather than consulting, is an additional way of handling difficulties associated with managing risk & uncertainty?*

3. Managing the certainty of being wrong

The future is uncertain. It is certain we will be inaccurate or wrong – by how much we don't know...

This is not a reason for inaction – but measured action?

Precautionary Principle:

- Conservatism
- Consideration of irreversibility
- Adaptive management

Key messages on the certainty of being wrong (Box 8)

- It is useful to start from the premise that decisions will, in time, turn out to be wrong, although we cannot tell how wrong or in what respect. Approaches to managing this situation then become an essential part of the decision, and include conservatism, maintaining options, adaptive management, and allowing for a diversity of outcomes.

End

Appendix 6: Workshop 2 – participants' reflections

The last task of the day (3 May 2017) was to go around the room asking all participants for their take-home reflection.

1. Usefulness of a risk register, with assessed likelihood, consequence, reversibility and response.
2. Value in transparent acknowledgement of past errors or things not handled well – humility in this regard can diffuse tension and rebuild relationships, respect and help progress towards trust.
3. This workshop has been timely for process design.
4. Risk register useful but would be good to progress further.
5. The concept of establishing a useful mind-set is useful.
6. Some good references to follow up on.
7. Risk register useful but need to progress and take care as might be misused by some for advocacy.
8. The hierarchy/pyramid concept is useful.
9. Usefulness of open, honest communication.
10. The value of transparency and objectivity.
11. Remember the value of repetition is useful.
12. Critical importance of relationships and trust.
13. Things useful to apply in local work now are i) to help prioritise information/analysis work needs in the project; ii) consistent use of terminology; iii) increase awareness of the upper and lower levels of the pyramid and the needs and challenges faced by others in the project team operating at those levels.
14. Really like acknowledgement of uncertainty, concepts and the fact there is a guide on it – it is real life.
15. Risk register could be really useful – without prejudice – good start to a useful tool.
16. Honesty/transparency very welcome.
17. Good reminder of usefulness of openness.
18. Risk register good start – maybe could use to help resource planning beyond life of the current project as well.
19. Well done for taking on the topic – usually technical people in the past have been pressured to give certain answers.
20. Need to communicate/signal which numbers/answers might change in the future – and allow or at least be aware of that in plans.
21. Applicable to other projects in the engagement section of the council – not just in water management project – in particular the good general principles about openness/honesty and grass-roots communications.

Appendix 7: Tips for communicating uncertainty

- **Set the scene** - uncertainty is common in day-to-day life, but we are not 'paralysed' by it in our daily lives. Uncertainty is not a reason for inaction, and inaction has its own consequences.
- **Build trust first** - allow the conversations about uncertainty to come at a point in the process when some degree of trust is already built in the group. Uncertainty discussions may be most useful at dialogue stage - assuming the group may progress through dialogue (what does this mean?), debate (what could we do?) and negotiation (what will we do?) stages during the limit-setting process.
- **Don't mask the message** – while you need to be clear about uncertainties, lead with the key message (for example, “the trend is definitely downwards over the next 50 years”) before you provide the uncertainty estimates.
- **Differentiate the three types of uncertainty** – it might help to explain what can and can't be done to help reduce uncertainties, in which case these 'types' may be useful:
 - 'Variability' is a natural characteristic of the environment. It can't be reduced but our estimates of current state and trends, and their variability, can be improved with more work if we have the time and resources.
 - 'Model and parameter uncertainty' can be reduced to some extent by more data, different models and further work.
 - 'Deep uncertainty' cannot be reduced, at least in the timeframes of the decision at hand, and must be acknowledged and accepted.
- **Develop common terminology** – you could borrow some calibrated language (such as the IPCC's language to express likelihood, e.g., very likely, likely, about as likely as not, unlikely, very unlikely etc.), which can help integrate between different disciplines so that everyone has a shared understanding.
- **Ensure information is (and is seen to be) credible, salient and legitimate** - i.e., is scientifically accurate and believable, relevant to the decision at hand, and arises from a procedurally unbiased and fair process.
- **Use analogies** to equate the management of uncertainty in freshwater management decisions to general day-to-day decision making (what car shall I buy?) or common examples of risk-based action (taking out insurance, abiding by speed limits, wearing seat-belts).
- **Use story-lines** - how does the predicted future (i.e., the outcome of decisions to be made) look from certain perspectives – for a farmer, a kayaker, a small business person, iwi and hapū on a marae?
- **Make it personal** - use the values identified as important to the community for the freshwater body/river or freshwater management unit (FMU) so that they can better appreciate the impact of the predicted outcomes.
- **Use photos** - or maps, which help to ground any discussions in real environments (their river, their farm, etc.).
- **Use a variety of methods** – for example use tables, words, or different types of diagrams such as box-and-whisker plots to explain any specific technical uncertainties. Don't worry that this may cause repetition – this will actually reinforce the message and help it to sink in.
- **Use scenarios** – to explore different possible futures and the uncertainties with each. Try to ensure that the range of scenarios considered spans (and thus acknowledges) the aspirations of everyone in the community.

- ***Collate, integrate, translate*** – bring together the key messages and their uncertainties, show how they balance out, and most importantly explain in English what effect these uncertainties may have on the decision.
- ***Share the uncertainty burden*** – when uncertainty is communicated the burden is shared amongst council staff (technical and planning), the community and decision-makers, and decisions can be more transparent.
- ***Finally, decisions are normative*** - the decisions at hand are likely to involve value judgements, and the uncertainties you have outlined may or may not fundamentally affect the decision at hand. Make sure the group have the best available information in front of them. The key for the decision becomes, what as a group can they all live with?