8.2. Head of Lake Whakatipu Natural Hazards Adaptation

Prepared for:	Safety and Resilience Committee
Report No.	HAZ2301
Activity:	Governance Report
Author:	Ann Conroy, Team Leader Natural Hazards Adaptation Tim van Woerden, Natural Hazards Analyst Jamie MacKenzie, Natural Hazards Adaptation Specialist Jean-Luc Payan, Manager Natural Hazards
Endorsed by:	Gavin Palmer, General Manager Operations
Date:	10 August 2023

PURPOSE

[1] To inform the Committee of the approach and progress towards development of a natural hazards adaptation strategy for the area at the head of Lake Whakatipu.

EXECUTIVE SUMMARY

[2] The Otago Regional Council (ORC) led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing towards delivery of a first iteration of the Adaptation Strategy document by June 2024.

[3] ORC is using the Dynamic Adaptative Pathways Planning (DAPP) approach as a framework for development of a natural hazards adaptation strategy.[1] Current work under the programme is primarily focussing on the second and third Phases, *"What matters most?"* and *"What can we do about it?"* (Figure 1).

[4] The Strategy will be delivered in the form of two complementary documents. The first is a 'Condensed Strategy' document, focussed on key points, with accessible language and imagery. The second is an accompanying guidance document with underlying details of the decision-making process and Action Plans.

[5] This paper outlines key activities in this work programme to develop a natural hazards adaptation strategy, including community and partner engagement, and technical and supporting assessments.

[6] The next stages of the DAPP cycle (from now to June 2024) have three main themes to explore with the community and partners through community engagement activities:

- Views, values and aspirations for the future
- Adaptation pathways and desired outcomes
- Feedback on design and implementation of first iteration of an adaptation strategy

RECOMMENDATION

That the Safety and Resilience Committee*:*

[1] van Woerden T & Payan J, 2021. *Natural Hazards Adaptation in the Head of Lake Whakatipu*. ORC Report HAZ2105, Report to 27 May 2021 meeting of the Otago Regional Council.

1) ***Notes*** *this report.*

2) ***Notes*** *the Head of Lake Whakatipu natural hazards adaptation work programme and community engagement.*

BACKGROUND

[7] ORC, in collaboration with project partners, is leading a programme of work to develop a natural hazard adaptation strategy for the head of Lake Whakatipu area.

[8] The Long-Term Plan (LTP) targets for the adaptation strategy are shown in Table 1.

Table 1: 2021-2031 Long-Term Plan (LTP) targets for the head of Lake Whakatipu natural hazards adaptation strategy

2021/22 TARGET	2022/23 TARGET	2023/24 TARGET
The Head of Lake Whakatipu natural hazards adaptation strategy progresses as per annual work plan	The Head of Lake Whakatipu natural hazards adaptation strategy progresses as per annual work plan	The first Head of Lake Whakatipu natural hazards adaptation strategy completed by 30 June

[9] The adaptation project approach and work activities previously completed are outlined in the update papers presented in May 2021,[2] June 2022,[3] and May 2023.[4]

[10] In May 2023, technical reports were presented to the committee which outlined assessments of potential hazard management interventions for liquefaction and flooding hazards.

[11] This paper provides an update focused on development of the natural hazards adaptation strategy for the head of Lake Whakatipu area, and the associated community engagement activities and social impact assessment.

[12] Updates for other activities in this work programme since the May 2023 paper are included as Appendix 1. These include flood hazard assessment for the Buckler Burn, development of a flood forecasting model for the Glenorchy Lagoon, and commencement of a natural hazard risk assessment project.

[13] Figure 1 shows an overview of key activities in the head of Lake Whakatipu natural hazards adaptation work programme, with the programme currently essentially focussing on the second and third Phases, "*What matters most?"* and "*What can we do about it?*" and building towards delivery of a first iteration of the strategy document by June 2024. This diagram updates the similar figure compiled for, and presented in, the previous (May 2023) committee paper.

[2] van Woerden T & Payan J, 2021. *Natural Hazards Adaptation in the Head of Lake Whakatipu*. ORC Report HAZ2105, Report to 27 May 2021 meeting of the Otago Regional Council.

[3] van Woerden T & Payan J, 2022. *Head of Lake Whakatipu flooding and liquefaction hazard investigations*. ORC Report HAZ2202, Report to 9 June 2022 meeting of the Otago Regional Council Data and Information Committee.

[4] van Woerden T & Payan J, 2023. *Head of Lake Whakatipu floodplain and liquefaction hazard intervention assessments*. ORC Report OPS2256, Report to the 10 May 2023 meeting of the Otago Regional Council Safety and Resilience Committee.

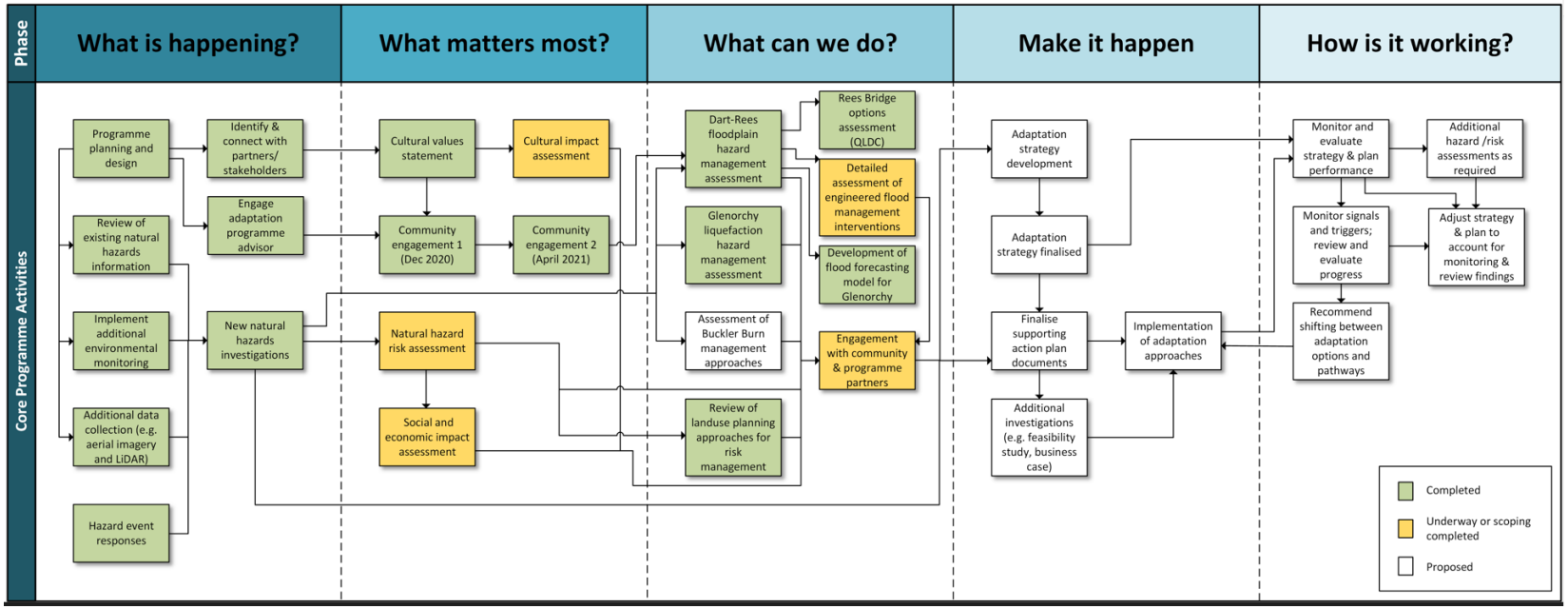

Figure 1: Head of Lake Whakatipu programme overview of key activities. This diagram updates Figure 4 from the previous (May 2023) committee paper.

ADAPTATION STRATEGY DEVELOPMENT

[14] Timing for delivery of the first iteration of the Strategy is June 2024, aligning with the target specified in the 2021-31 Long-Term Plan.[1]

[15] It is proposed to deliver the Strategy in the form of two complementary documents. The first is a 'Condensed Strategy' document, focussed on key points, with accessible language and imagery. The second is an accompanying guidance document, with underlying details of the decision-making process and Action Plans. The intent of the guidance document is to increase confidence in the strategy through transparency.

[16] The Strategy will support the community's vision and objectives for the future by enabling flexible and adaptive decision making, and for planning under conditions of uncertainty. Figure 2 shows how physical, social, cultural and economic elements will be monitored ("signals") and pathways or responses can be revisited when pre-defined decision points ("triggers") occur. This is part of how the Strategy will evolve through future iterations.

[17] The "PARA" framework (Protect/Accommodate/Retreat/Avoid)[2] is an accessible way to introduce the types of high-level adaptation responses available and guide discussions around responses, opportunities and constraints (Table 2). Figure 3 is a conceptual example of how PARA responses for flood hazard adaptation could fit into the pathway concept. A range of potential hazard management responses for liquefaction hazards are illustrated in Figure 4, showing their potential implementation either proactively or following a major earthquake.

[18] The development of adaptation or hazard management approaches should be an integrated response considering the full multi-hazard risk profile, and the potential cascading hazard interactions between different hazard types.

[19] For example, liquefaction or lateral spreading may damage flood protection structures, and may also cause widespread ground subsidence which would increase the areas exposed to flooding. Assessments of the feasibility of any new or modified flood protection structures should therefore consider both flooding and geological hazard types.

Table 2: Types of potential adaptation responses, summarised as the 'PARA' framework (Protect/Accommodate/Retreat/Avoid).

Type of response	Explanation	Examples
Protect	Reduce risks through 'holding the line' using natural buffers or hard structures.	Construction of floodbanks or erosion protection structures. Geotechnical ground improvements to reduce liquefaction or lateral spreading susceptibility.
Accommodate	Adjustment of existing assets to anticipate hazard risk and reduce future hazard impacts.	Retrofit building modifications to reduce potential damage such as raising floor levels above flooding

[1] The LTP target for the 2023/24 year is "*The first Head of Lake Whakatipu natural hazards adaptation strategy completed by 30 June.*"

[2] Peart R, Boston J, Maher S, Konlechner T, 2023. *Aotearoa New Zealand's Climate Change Adaptation Act: Building a Durable Future. Principles and funding for managed retreat*. Environmental Defence Society Incorporated.

		level, or for seismic strengthening of existing foundations. Flood warning and Civil Defence planning. Insurance cover to mitigate financial impacts.
Retreat (also known as "Relocation")	Moving existing people and assets away from the hazards in a managed way over time,[1] or as a consequence of damage after natural hazard events.	Relocation from higher-risk areas following hazard impacts (e.g. subsequent to Cyclone Gabrielle, or the Canterbury earthquake sequence) or intolerable repeat events.
Avoid	Stop putting people and assets in harm's way.	Using land use planning rules to prevent further growth into areas prone to natural hazard impacts.

[20] The first iteration of the Strategy will include preferred adaptation pathways agreed with community and partner input. Adaptation responses in the preferred pathways will be at various levels of maturity, from detailed planning (e.g. funding secured and work programme underway) through to screening level (e.g. requires further feasibility assessment and business case).

[21] Action Plans will be included for agreed adaptation responses that are implementable within current constraints, consistent with the elements of good decision making discussed in IPCC Foundations for Decision Making (2014)[2].

[22] These supporting Action Plan documents could include; floodplain management; monitoring of the physical and social indicators; emergency preparedness; major event recovery; and strategy review.

[23] Other responses will be in the strategy pathways at a screening level, with current constraints clearly identified. Decision points may be defined for review and further investigation. Some constraints may change in the future, for example policy reform, or opportunities following major hazard events.

[24] Constraints to potential implementation of adaptation responses may include;

- timescale required for implementation
- effectiveness of the response
- level of remaining residual risk
- consideration of possible maladaptation and lock-in
- resourcing (e.g. public or private funding of geotechnical ground improvements)
- community or partner capacity
- level of current knowledge
- legislation, governance and institutional frameworks, systems and processes

[1] Retreat from risk can also be "unmanaged", i.e. an unplanned, uncoordinated ad-hoc response where individuals make their own decisions as to whether and when to move from areas of higher natural hazard risk (Peart *et al*, 2023).

[2] Jones RN *et al*, 2014: *Foundations for decision making*. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

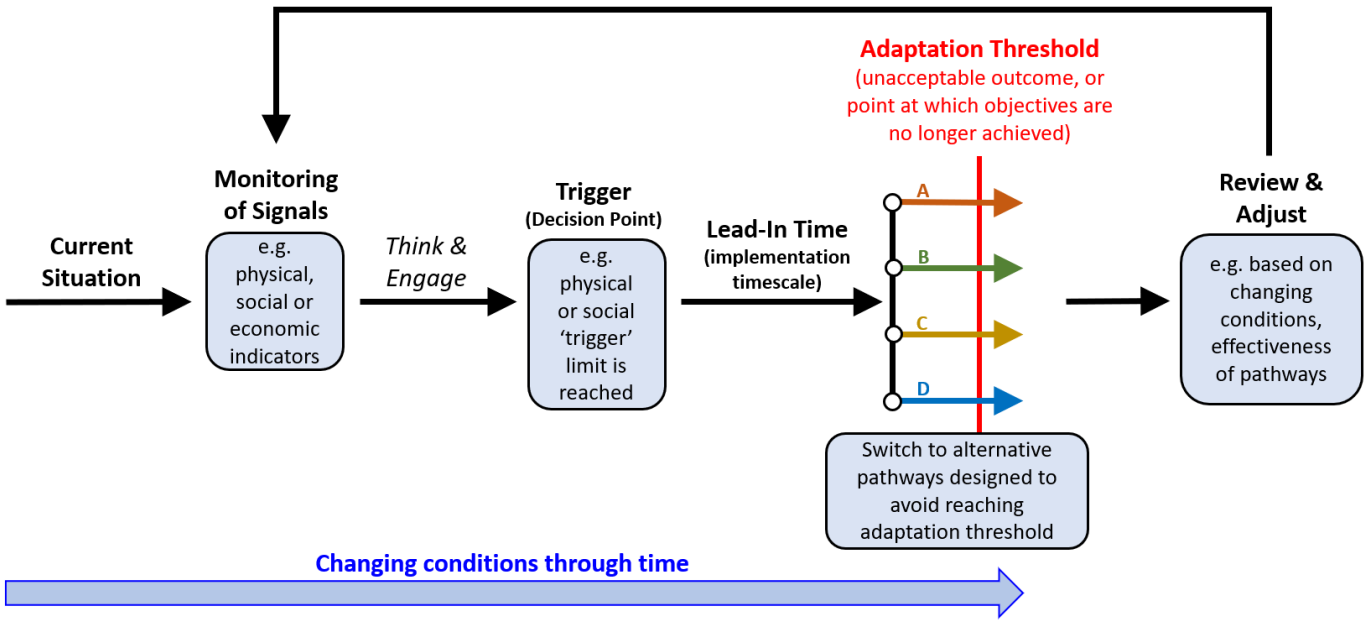

Figure 2: Conceptual outline of the adaptation pathways decision-making process.[1]

[1] Figure based on NZ adaptation guidance documents, e.g. the MfE (2017) Coastal hazards and Climate change guidance.

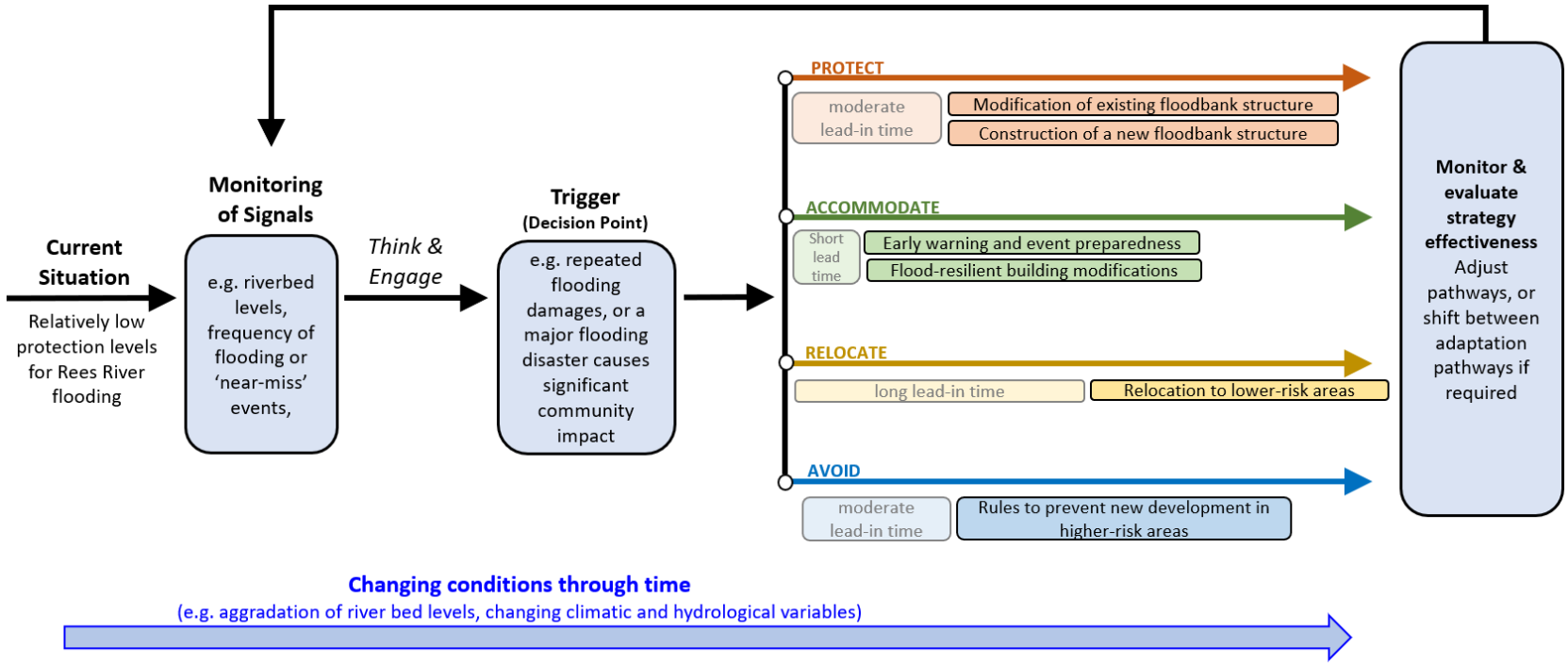

Figure 3: Example of the adaptation pathways concept showing some possible management responses for flood hazard.

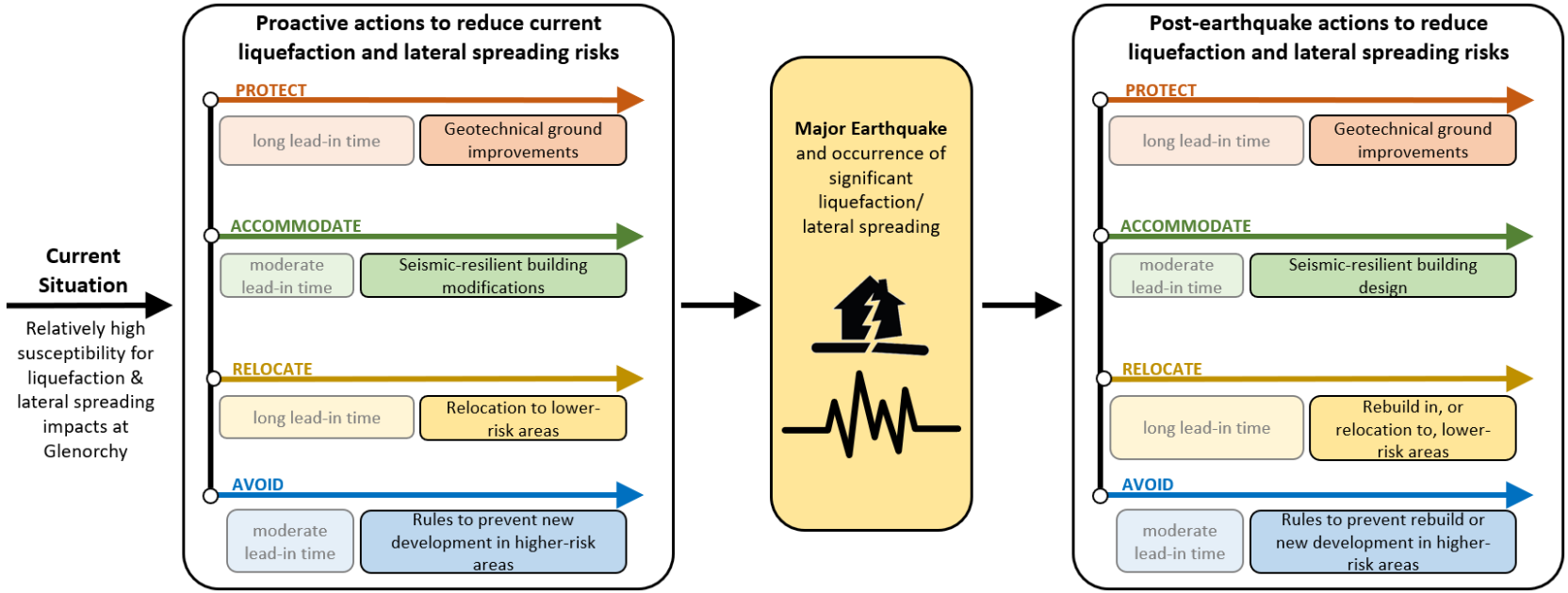

Figure 4: Example of the possible hazard management responses for liquefaction and lateral spreading hazards.

COMMUNITY ENGAGEMENT

[25] There is no single 'best' approach to engagement as every community and every context is different. The work programme is guided by best-practice principles for community engagement to natural hazards and climate change adaptation (Table 3).

[26] NIWA[10] is providing ORC with expertise in implementing the adaptative pathways approach and social science aspects of the programme, including engagement. Engagement design and planning is also informed by recent Master's research which evaluated the effectiveness of the ORC's engagement activities as part of this programme from 2019 to mid-2022.[11]

Table 3: Principles for natural hazards and climate change adaptation engagement, adapted from Barth et al (2023).[12]

Principles for effective community engagement	
Understand the problem and context before starting to develop solutions (place-based).	Prioritise clear communication on expectations and processes (transparency and accountability)
Develop council-community relationships that are grounded in trust, reciprocity and care.	Value local knowledge, experiences and expertise, including Indigenous knowledge.
Utilise existing networks and relationships.	Recognise and seek to minimize existing injustices (inclusivity).
Use a variety of engagement tools to suit different contexts, goals, groups of people and timeframes (inclusivity and accessibility).	Recognise that the community can benefit from good engagement processes as well as from collaboratively designed adaptation solutions.

[27] Adaptation guidance[13] emphasises that effective community engagement is essential for successful adaptation action. Engagement with Head of Lake Whakatipu communities has taken place since 2019 (Table 4). Engagement so far has had significant focus on building relationships, supporting community buy-in to the adaptation programme, gaining a shared understanding of the natural hazards and adaptation challenges ahead, and initial thoughts on values.

Table 4: Summary of community engagement activities completed for the head of Lake Whakatipu natural hazards programme.

Engagement Activity	Date	Purpose
Presentations to Glenorchy Community Association (GCA)	2019-2020	To update the GCA on ORC's completed and planned natural hazards activities.
e-newsletter	Ongoing, 2020-present	To provide progress updates for the work programme and give an indication of upcoming project work.
Community drop-in session	December 2020	Discuss and provide information on the range of natural hazard events the community is exposed to, and how these events and landscape changes have impacted the community in the past.
Public talk	April 2021	Provide an expert (Prof. James Brasington, University of

[10] Dr Paula Blackett, an Environmental Social Scientist.

[11] MacKenzie, J. 2023. *Telling Stories: Community engagement in a complex and dynamic natural hazards adaptation context at the Head of Lake Whakatipu* (Thesis, Master of Arts). University of Otago. Available at: http://hdl.handle.net/10523/15469

[12] Barth J, Bond S & Stephenson J, 2023. *Community engagement for climate change adaptation*. Research Summary for the South Dunedin Future Programme. Centre for Sustainability, University of Otago. Available at: http://hdl.handle.net/10523/15157

[13] e.g. Ministry for the Environment (MfE), 2017. *Coastal Hazards and Climate Change: Guidance for Local Government.*

		Canterbury) overview of the river processes and changes of the Dart-Rees floodplain, and their implications for natural hazards.
Community drop-in session	April 2021	Discuss with the community the natural hazards challenges facing this area in the future, and to initiate discussions about what adaptation to those challenges could look like
Online presentation	June 2022	To present and update on investigation findings into liquefaction and flood hazards
Community drop-in session	June 2022	An in-person opportunity to discuss in more detail the investigation findings into liquefaction and flood hazards

[28] The next stages of the DAPP cycle (from now to June 2024) have three main themes to explore with the community and partners through community engagement activities:

- Views, values and aspirations for the future
- Adaptation pathways and desired outcomes
- Feedback on design and implementation of first iteration of an adaptation strategy

[29] This engagement phase offers community and partners the following opportunities to shape the strategy:

- Vision and objectives for community
- Principles of adaptation at Head of Lake Whakatipu
- What's most important to address, protect, recognise, respect for Head of Lake Whakatipu's future
- Potential adaptation pathways
- Signals, triggers, adaptation thresholds
- Overall scope and content of the adaptation strategy
- How we engage in the future

[30] There are some aspects of the programme that are fixed:

- Timeframe for delivery of first iteration in June 2024 (specified in ORC 2021-31 Long Term Plan).
- Use of the adaptation pathways framework (DAPP).
- Natural hazards and climate change science – the Strategy is supported by the best available science and technical guidance.

[31] The proposed community engagement activities through to June 2024 are outlined in Table 5. Proposed community engagement includes ongoing activities such as regular e-newsletter updates to community members (see example in Appendix 2), as well as focussed activities relating to various stages of the programme.

Table 5: Community engagement overview

Activities	Jul-Sep 2023	Oct-Dec 2023	Jan-Mar 2024	Apr-Jun 2024
Workshop session(s) • Collaboratively develop adaptation strategy principles and shared strategy vision with community and partners. • Build community understanding of the range of potential adaptation and hazard management responses, benefits and constraints.				
Series of community engagements to co-develop and identify preferred outcomes, signals and triggers, and preferred pathways to get to preferred outcomes				
Gain feedback from community members on the draft adaptation strategy.				
Present to community about the finalised adaptation strategy (1st iteration) and action plans.				
Actively use the programme webpage and e-newsletter to inform the community on programme activities and engagement outcomes.				
Ongoing activities (e.g.ArcGIS StoryMap, stall at community events) to increase understanding of programme with a wider audience and promote two-way communication and engagement about adaptation strategy and pathways.				

[32] Planning is underway for the next in-person engagement sessions in Glenorchy in late August 2023. The purpose of the sessions is to develop principles, shared vision and preferred outcomes; build community understanding of a range of potential adaptation responses; facilitate discussion about key aspects of responses; and start thinking about pathways. It is also an opportunity to give an update of the programme plan for the next 12 months.

[33] It is proposed to have multiple sessions on the day, including an evening session. The suggested workshop format is expected to include the following content:

- **Short presentation/floating materials:** Overview of programme, where we've been, where we're going in next 12 months.
- **Activity about strategy:** key principles, vision and preferred outcomes for the future.
- **Discussion and activity:** possible hazard management interventions and adaptation responses (PARA framework), realities/constraints/benefits of each response, participants can then experiment with building an adaptation pathway.

[34] Engagement planning is considering other community engagement programmes across Queenstown Lakes District, or that local communities may be interested over the same time period (i.e. engagement on the proposed ORC Land and Water Regional Plan and Queenstown Lakes District Future Development Strategy/Spatial Plan 2024 Gen 2.0). This aims to avoid engagement fatigue and better support alignment across ORC community engagement programmes.

SOCIAL IMPACT ASSESSMENT

[35] A social impact assessment (SIA) is needed to better understand the impacts of natural hazards on local communities in the Head of Lake Whakatipu area. In broad terms, social impacts are any changes to the wellbeing of people and communities, planned or unplanned, that arise from human actions or natural events, including economic impacts. The SIA is a key piece of work under the DAPP process to support decision-making.

[36] A two-phase approach to undertaking the SIA is proposed, due to dependencies with other pieces of the work programme.

- Between September to November 2023, Phase 1 will focus on understanding the social and economic baseline; and impacts of potential natural hazard scenarios on the wellbeing of people and communities. Local knowledge will be collected through the use of both desktop and first-person methods. Three natural hazards scenarios will be assessed 1) repeated impacts of frequent storm events; 2) a major earthquake; 3) a major storm scenario. All scenarios will be based on "status quo", defined as current baseline development, and the existing mix of management actions already in place to manage natural hazard risks in the project area (such as emergency preparedness, flood warning, floodbank protection, road and river maintenance, and reactive road repair). Procurement for Phase 1 of the SIA commenced in late July.
- Between late 2023 and early 2024 (to be confirmed), Phase 2 will focus on the impacts of preferred adaptation pathways, once these are identified and defined.

[37] QLDC and the community, through the Glenorchy Community Association (GCA), provided feedback on the proposed SIA scope and suggestions were incorporated. Both QLDC and the GCA will be involved further in the process of the SIA assessment, for example to provide feedback on the methods and draft assessment report.

[38] Mana whenua, represented by Aukaha and Te Ao Marama, were also invited to provide feedback on the SIA scope and be further involved in the SIA process. Aukaha have indicated that their preferred approach for assessing cultural impacts is a separate Cultural Impact Assessment, with further discussions to take place in early August.

DISCUSSION

[39] The ORC-led natural hazards adaptation programme for the area at the Head of Lake Whakatipu is progressing towards delivery of a first iteration of the Adaptation Strategy document by June 2024.

[40] The Adaptation Strategy will include both the strategy documents, and action plans. The first iteration will include preferred pathways agreed with community and partner input. Adaptation responses in the pathways will be at various levels of maturity, from detailed planning level through to screening level only.

[41] Some of the adaptation responses identified may be implementable within the current constraints and actionable within relatively short timeframes. For example, the flood warning and response improvements, which have already been designed and implemented (Appendix 1).

[42] Other adaptation responses are more complex and may require significant further investigations. These may include feasibility studies, cost-benefit analysis and business case development, investigations of potential funding options, and consideration of environmental, legal, technical and planning factors. Realistic timescales for implementation of complex responses may range from 5 years to a decade (or longer).

[43] It is expected that the management of these hazards may require use of a series of diverse responses (e.g. Table 2) implemented progressively over time. Monitoring will provide feedback on effectiveness and changing conditions, and pre-defined decision points will guide when to review and adjust the strategy (e.g. Figures 2, 3 and 4).

[44] "Residual risk" is the risk that remains after risk treatment or management actions have been applied and is inherent in areas where people and assets are exposed to natural hazards[14]. It is a key concept when talking about the benefit and effectiveness of adaptation responses. Many responses are only partially effective, in that they reduce risk without eliminating it, and thus the remaining risk is "residual risk". Community understanding and tolerance of residual risk is an important factor in decision-making.

[45] No hazard management responses or interventions considered have yet been selected or ruled out. All of these responses are still 'on the table' and will be considered further in a collaborative decision-making process.

[46] Continued collaborations and consideration of all engagement input will be essential to ongoing progress in development and implementation of an adaptation strategy.

[47] As has been seen following the North Island flooding damages earlier this year, the occurrence of any catastrophic natural hazard events may alter the context and constraints for implementation of adaptation responses, with opportunities for new governance, funding arrangements and timescales.[15]

[48] Toka Tū Ake/EQC is a stakeholder in the level of risk associated with liquefaction and lateral spreading at Glenorchy, and the steps that could be taken to manage that risk. The commission has been informed of progress with the Head of Lake Whakatipu programme and asked how it wishes to be involved in, and engaged with, the programme.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[49] The information presented and the adaptation approach discussed in this paper reflects Council's Strategic Directions where our vision states: communities that are resilient in the face of natural hazards, climate change and other risks.

[50] The proposed Otago Regional Policy Statement June 2021[16], states that ORC and territorial authorities are both responsible for specifying objectives, policies and methods in regional and district plans for managing land subject to natural hazard risk. ORC specifically is responsible for "*identifying areas in the region subject to natural*

[14] Ministry for the Environment (MfE), 2017. *Coastal Hazards and Climate Change: Guidance for Local Government*.
[15] New Zealand Government, 2023. *Cyclone Gabrielle Recovery Taskforce terms of reference*.
[16] Section HAZ–NH–M1

hazards and describing their characteristics as required by Policy HAZ–NH–P1, mapping the extent of those areas in the relevant regional plan(s) and including those maps on a natural hazard register or database."[17]

Financial Considerations

[51] The budget in the 2023/24 Annual Plan provides for the forward work programme described in this paper. The budget for the 2023/24 financial year for professional services for the Head of Lake Whakatipu natural hazards adaptation programme is $470,000.

[52] ORC has applied for funding from The Ministry for the Environment (MfE) funding programme, *Nature Based Solutions for Resilience Planning* towards the investigation of 'soft engineering' flood protection responses for Glenorchy.

Significance and Engagement Considerations

[53] This paper does not trigger ORC's policy on Significance and Engagement.

Legislative and Risk Considerations

[54] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA.

[55] ORC has the functions and responsibilities of a catchment authority under the Soil Conservation and Rivers Control Act (1941). The functions of the Act include the power to execute works necessary for "*preventing or lessening any likelihood of the overflow or breaking of the banks of any watercourse*".[18] The Act enables ORC to "*erect any new defence against water, or carry out any other work it thinks necessary or desirable for the purpose of controlling or preventing damage by flood waters.*"[19]

[56] ORC has no obligation to carry out specific engineered mitigation works for the management of liquefaction or lateral spreading hazards. However, having initiated a process to develop long-term responses to natural hazards for the Glenorchy community, ORC must exercise reasonable care, and be cognisant of its various statutory functions and duties, in assessing whether mitigation or other measures should be undertaken.

[57] Although ORC does not have an obligation to undertake engineered mitigation works, a number of other actions have been carried out in response to reports on liquefaction hazard and its management.[20] [21] These actions have included;

- Making the investigation reports publicly available, and presenting mapping of liquefaction-prone land on the ORC Natural Hazards Portal.[22] Toka Tū Ake/EQC's

[17] ORC Natural Hazards Portal: http://hazards.orc.govt.nz
[18] SCRA 1941: Section 126, 2(c)
[19] SCRA 1941: Section 133, 1(c)
[20] Tonkin + Taylor Ltd, 2022. *Glenorchy Liquefaction Vulnerability Assessment*. Report prepared for Otago Regional Council.
[21] Tonkin + Taylor, 2023. *Engineering Approaches for Managing Liquefaction Related Risk*. Report prepared for Otago Regional Council.
[22] http://hazards.orc.govt.nz

recently released Natural Hazards Portal includes a link to ORC's Natural Hazards Portal.[23]

- Ensuring that resource consent staff are aware of the liquefaction risk so that the risk can be taken into account in the consideration of resource consent applications.
- The liquefaction hazard reports and mapping information have been provided to the Queenstown Lakes District Council (QLDC), so they can be taken into account in their assessment of building consent applications and other decisions of QLDC.

[58] Toka Tū Ake/EQC provide natural disaster insurance for residential homes and land. The Natural Hazards Insurance Act passed into law in February 2023 and will come into force on 1 July 2024, replacing the Earthquake Commission Act (1993). The EQC will be transitioning to a new name - Toka Tū Ake/Natural Hazards Commission (NHC). There is no obligation for Toka Tū Ake/EQC to carry out liquefaction mitigation work, and the new Act does not introduce any obligation on NHC to implement risk mitigation (e.g. to reduce or avoid liquefaction risk).

[59] The likely reforms of the Resource Management system[24] and strengthening of provisions to do with local authority leadership for climate change adaptation are noted.[25]

Climate Change Considerations

[60] The effects of climate change have been considered in flood hazard assessments for Dart and Rees Rivers, and Buckler Burn, and in the assessment of risks and potential hazard management responses for those hazards.

Communications Considerations

[61] ORC will continue to make all investigation findings available to the head of Lake Whakatipu community and provide regular programme updates via the e-newsletter.

[62] Community engagement planning is discussed in paragraphs 25-34.

NEXT STEPS

[63] The key next step activities for the work programme which are in progress or scheduled are identified in Figure 1.

[64] These activities will include;

- Continued planning for community engagement activities, the next of which is scheduled for late August 2023.
- Completion of social and cultural impact assessment studies, and a natural hazard risk assessment

[23] www.NaturalHazardsPortal.govt.nz

[24] A summary of reform work programmes is outlined here: https://www.dia.govt.nz/diawebsite.nsf/Files/Local-Government-2023/$file/Central-government-reforms-impacting-on-local-government-July-2023.pdf

[25] Government is expecting to introduce a Climate Adaptation Bill into Parliament by the end of 2023.

[65] Programme updates for ORC councillors are scheduled for November 2023, and February and June 2024. These may include workshops and/or committee papers, as appropriate.

ATTACHMENTS

1. Update on other activities in the adaptation programme [**8.2.1** - 6 pages]
2. Example of newsletter July 2023 update [**8.2.2** - 6 pages]

Appendix 1: Updates on activities in the Head of Lake Whakatipu natural hazards adaptation programme.

1. INTRODUCTION

The paper presented to the committee provides an update focused on development of the natural hazards adaptation strategy for the head of Lake Whakatipu area, and the associated community engagement activities and social impact assessment.

This appendix provides supporting information summarising other technical activities in this work programme completed since the May 2023 paper.

2. ACTIONS FOLLOWING FROM FLOODPLAIN MITIGATION ASSESSMENTS

The May 2023 Committee paper[1] presented a report compiled by Damwatch Engineering Ltd[2] which identified the potential engineering or river management approaches available for management of flooding and floodplain hazards on the Dart-Rees floodplain. The report assessed possible management interventions for areas where flooding or erosion may impact the community or infrastructure in the head of Lake Whakatipu area.

The report listed four potential immediate short-term actions[3] which could assist with flood hazard preparedness for Glenorchy;

- Flood warning improvements.
- Revision and communication of flood response procedures.
- Consideration of improvements to the existing stopbank (e.g. raising the crest profile, improving the structural quality and integrity).
- Investigation of vegetation planting on the left bank of the Rees River where flood breakouts into the lagoon area occur.

The report also listed a series of potential investigations and monitoring actions[4] which may be required for assessment of potential hazards to the Rees River bridge.

Table 1 and Sections 2.1-2.3 of this appendix describe the actions which have subsequently been undertaken to address those recommended actions for Glenorchy flood preparedness and Rees Bridge management.

[1] van Woerden T & Payan J, 2023. *Head of Lake Whakatipu floodplain and liquefaction hazard intervention assessments*. ORC Report OPS2256, Report to the 10 May 2023 meeting of the Otago Regional Council Safety and Resilience Committee.
[2] Damwatch Engineering Ltd, 2022. *Dart-Rees floodplain adaptation – Report on 23-24 February workshop*. Report prepared for Otago Regional Council.
[3] Section 7.2 of the November 2022 report by Damwatch Engineering Ltd.
[4] Section 7.4 of the November 2022 report by Damwatch Engineering Ltd.

Table 1: Summary status of short-term floodplain management actions recommended by the 2022 report by Damwatch Ltd.

Action	Status
Flood warning improvements, Revision and communication of flood response procedures.	A flood forecasting model to forecast water levels in the Glenorchy Lagoon has been developed and is now in a testing phase. Internal flood response procedures have been updated to include model use (Section 2.1 of appendix).
Consideration of improvements to the existing stopbank, Investigation of vegetation planting on the left bank of the Rees River	A technical assessment has been scoped, and procurement is expected to commence in August 2023 (Section 2.2 of appendix).
Assessment of potential hazards to the Rees River bridge	QLDC consultants have completed a structural options assessment (Section 2.3 of appendix).

2.1. FLOOD WARNING AND FLOOD RESPONSE PROCEDURES

There are now >18 months of monitoring data available from the three new environmental monitoring sites established by ORC in the Rees-Glenorchy area as part of the Head of Lake Whakatipu natural hazard adaptation programme. These three new sites are;

1. Rees River flows at Invincible (site established December 2021),
2. Glenorchy Lagoon water level (site established October 2020), and
3. Lake Wakatipu level at Glenorchy marina (site established January 2021).

These new datasets provide opportunity to investigate further developments of flood forecasting systems to improve the flood warning capability for Rees River flooding events at Glenorchy township.

HydroScience consultancy[5] have reviewed hydrological datasets and carried out analyses required to inform development of a flood forecasting model. Hydrological analysis has investigated and established the relationships between rainfalls, Dart and Rees River flows, Lake Whakatipu levels at Glenorchy, and Glenorchy Lagoon levels. Multiple regression analysis has then informed development of a flood forecasting model which can be used to estimate water levels for Glenorchy Lagoon.

The Glenorchy flood forecasting model uses inputs of;

- Forecast or recorded rainfall totals for Paradise, Hillocks and Cascade Hut.
- Initial flows for the Rees and Dart rivers
- Initial water levels in the Glenorchy Lagoon and for Lake Whakatipu at Glenorchy.

The model is used by ORC's 24/7 flood response team to forecast possible water levels at Glenorchy Lagoon when significant rainfall totals are forecast for the Rees catchment. The model can provide up to about three days early warning (Figure 1) and estimates the final lagoon level for a rainfall event. ORC's flood response procedures have been updated to incorporate use of this new model, and Emergency Management Otago have been briefed on the model capability.

Following completion of the model in mid-May 2023, the model was tested during a series of moderate Rees catchment rainfall events in late May/early June. Based on the actual rainfall totals

[5] HydroScience, 2023. *Flood forecasting for Glenorchy township*. Prepared for Otago Regional Council.

recorded during these events, the modelled levels were within the ±2 standard error range estimated. This is considered acceptable.

This is a new model and is still in a testing phase, and so requires application in a wider range of future rainfall and flood events to better evaluate model performance and accuracy. The model will then be revised once longer monitoring data series are available or following the occurrence of any very large flooding events.

The forecast results and observed water levels in the Glenorchy Lagoon are related to flood warning thresholds in ORC 's flood response procedure. The thresholds are defined in relation to the crest of the Glenorchy floodbank. Their purpose is to assist ORC and Emergency Management Otago flood response in Glenorchy.

This new forecasting model for Glenorchy Lagoon complements an existing ORC flood forecasting model which estimates high lake levels for Lake Whakatipu based on forecast or recorded rainfall totals.

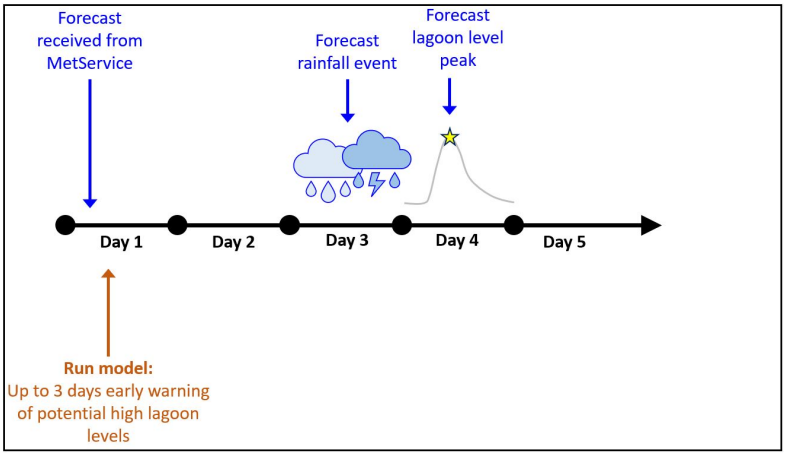

Figure 1: *Sketch showing the timeline of up to three days early warning which may be provided for high levels in the Glenorchy Lagoon.*

2.2. FLOOD PROTECTION FEASIBILITY ASSESSMENTS

A technical feasibility study to investigate potential engineered flood protection improvements for the lower Rees floodplain and Glenorchy township is currently in scoping and procurement. This study will build on the initial assessments of benefits, challenges and constraints for flood hazard management interventions outlined in the report compiled by Damwatch Engineering Ltd.

Investigations are proposed to assess and describe the conceptual designs of interventions, associated technical challenges for implementation, the identification of environmental impacts, a review of consenting requirements and indicative costings. Assessments will consider the use of both 'hard' engineering approaches (e.g. engineered structures such as floodbanks) and 'soft' engineering

solutions (e.g. vegetative buffers). The existing hydraulic model for the Dart-Rees floodplain[6] will be used to assess the flood hazard performance provided by the range of approaches assessed.

The investigation scope includes consideration of (at least) the following potential engineered flood management interventions for the lower Rees River floodplain and Glenorchy township;

a. raising or modifying the existing Rees-Glenorchy floodbank structure;
b. construction of bunding or new floodplain structures to reduce overland flood flows from the Rees River into Glenorchy Lagoon; or
c. the use of 'soft engineering' approaches such as vegetative buffers to modify overland flood flows from the Rees River into Glenorchy Lagoon; or
d. any combinations of these interventions a-c.

ORC has applied for funding from The Ministry for the Environment (MfE) funding programme, *Nature Based Solutions for Resilience Planning* towards the investigation of the 'soft engineering' aspects of the study.

2.3. REES BRIDGE ASSESSMENTS

The report compiled by Damwatch Engineering Ltd confirmed the threat of riverbed aggradation reducing waterway flood capacity at the Rees River bridge, and increased potential for scour impacts or structural damages to the structure.

Queenstown Lakes District Council (QDC) has since completed a structural options assessment[7] to help provide direction and guidance towards a long-term asset management strategy for the bridge structure. Assessments completed for QLDC included geomorphic and hydraulic analysis, and consideration of several potential structural investment options.

ORC collaborated with QLDC and supported the project through providing relevant ORC information and datasets. ORC and QLDC are discussing the report findings and recommendations. There are no recommendations for physical interventions in the short term, but a focus on and allocation of respective responsibilities for recommended structural and environmental monitoring and river management actions.

3. BUCKLER BURN FLOOD HAZARD ASSESSMENTS

Glenorchy township is developed on the alluvial fan formed by Buckler Burn and therefore may be exposed to flooding, debris-flooding or debris flow hazards from this catchment (Figure 2). A flood hazard assessment for the Buckler Burn and Glenorchy is being completed by Land River Sea Consulting Ltd (LRS). The draft assessment report has been completed and is currently being externally reviewed by Tonkin + Taylor Ltd.

The investigation is being undertaken to understand in more detail the flooding characteristics (e.g. floodwater extent, depth, velocity) and potential impacts of the flooding hazard from the Buckler Burn for the Glenorchy township.

[6] Land River Sea Consulting Ltd, 2022. *Dart-Rees flood hazard modelling*. Report prepared for Otago Regional Council.
[7] WSP New Zealand Limited, 2023. *Rees River Bridge Options Assessment.* Report prepared for Queenstown Lakes District Council.

Modelled flooding scenarios have included combinations of large (up to 300 cumec) river flows, and the effects of alluvial fan aggradation on fan morphology. There is uncertainty in the magnitude of floodwater flows from the Buckler Burn catchment, but the modelled design flows of 250 and 300 cumec exceed previous estimates of the 1% AEP (100-year ARI) flood event.

Figure 2: *Overview of the Buckler Burn stream and alluvial fan, with Glenorchy township located the northern side of stream's active channel. The full township area is developed on Buckler Burn alluvial fan deposits, and the higher terraces to each side of the stream are remnants of older alluvial fan-delta surfaces formed when the lake was at higher levels. Photograph dated May 2018.*

4. NATURAL HAZARD RISK ASSESSMENT

The natural hazard investigations completed by ORC for flooding,[8] liquefaction[9] and alluvial fan[10] hazards have identified that these events pose a risk to the Glenorchy or Kinloch areas, but these risks have not yet been systematically assessed through a detailed qualitative approach; or using a quantitative approach.

[8] Land River Sea Consulting Ltd, 2022. *Dart-Rees flood hazard modelling.* Report prepared for Otago Regional Council.
[9] Tonkin + Taylor Ltd, 2022. *Glenorchy Liquefaction Vulnerability Assessment*. Report prepared for Otago Regional Council.
[10] Land River Sea Consulting Ltd, 2023. *Buckler Burn flood hazard modelling.* Report prepared for Otago Regional Council.

The May 2023 committee paper[11] assessed the risks of flooding and liquefaction/lateral spreading using the approach described in the proposed Otago Regional Policy Statement 2021. This preliminary assessment evaluated the risks of flooding and liquefaction/lateral spreading as being "significant".

According to the risk assessment guidance in the proposed Otago Regional Policy Statement (RPS), a more detailed quantitative assessment should be undertaken for any hazards which are determined as being "significant". ORC has procured consultant expertise to undertake the natural hazard risk assessment, and this project has commenced in late July 2023.

The risk assessment findings are intended to be used for the following purposes;

1. Providing the head of Lake Whakatipu community with information on the relative levels of natural hazard risk in the township. This information has been specifically requested by the community as feedback during community engagement sessions and as feedback on behalf of the Glenorchy Community Association.
2. Provide justification for adaptation or risk management activities, including potential use of land use planning controls. This would provide a robust evidence base for any future land use decision making, such as if avoidance or relocation approaches may be appropriate for higher-risk areas.
3. To complement and provide information which will feed into other proposed studies, such as a social impact assessment, and more detailed review of engineered floodplain management interventions.
4. To provide information to inform next steps, for example, to help determine requirements and priority for any additional hazards or risk analysis necessary.

[11] Paragraphs 41-44 in the 10 May 2023 committee paper, *Head of Lake Whakatipu floodplain and liquefaction hazard intervention assessments*.

Appendix 2: July 2023 newsletter for the Head of Lake Whakatipu natural hazards adaptation programme.

View this email in your browser

HEAD OF LAKE WHAKATIPU

COMMUNITY UPDATE 27 | JULY 2023

Kia ora koutou,

Here is our programme update for July, with information about the Buckler Burn flood hazard assessment, our social impact assessment, and when we're next coming to Glenorchy.

We are nearing the end of the project's stage that focuses on what is happening in terms of natural hazards as we ask what matters most and what we can we do about it.

We know that at times it has not been easy to understand the purpose of each assessment, or what the differences are between a hazard study and a risk study. In this edition, we try to make things a bit clearer.

And as we wrap up this part of the programme, with a lot of technical information and science, we get closer to development of adaptation options and pathways that will enable us and the community to collectively make some decisions about how to adapt to the changing landscape and natural hazards at the head of the lake.

Buckler Burn update

A flood hazard assessment for the Buckler Burn has been completed. It will be reviewed by an independent expert before being finalised later this month.

This study is looking at whether flooding from the Buckler Burn could affect the Glenorchy township, and what the characteristics of a flood might be, for example, the depth or velocity of flood waters.

As with all our hazard assessment reports, we will share these investigation findings on the HOTL programme page as soon as they are available and invite your feedback/comments.

Image: Buckler Burn flowing into Lake Whakatipu

Assessing the social impact

We have put together a scoping document for a social and economic impact assessment.

Social impacts refer to changes to the wellbeing of individuals and communities, which occur when human actions or natural events alter the way people live, work, play, and participate as members of society.

Social impacts can be negative or positive. This information will help us inform our decision making and adaptation pathways.

This scoping part is about laying out the proposed work plan so that we can get community feedback at the early stage, before the work starts. The scoping discussion document includes the following:

- Why we are proposing a two-phase social impact assessment at the Head of Lake Whakatipu.
- Baseline data collection and proposed scenarios that will be assessed in the first phase.
- Proposed methods to undertake the data collection, assessment, and how the local community could be involved in the process.
- The general objectives of the second phase, which will be scoped further once we have collaborated on the preferred pathways later this year.

We shared this scoping discussion document with the Glenorchy Community Association earlier this week to get some feedback from the community about whether we're on the right track. Once scoping is complete, there will be a request for tender advertised and an independent consultant will undertake the assessment.

Keep an eye out, as there will be other ways for community members to be involved at different steps of the social impact assessment. You can also get in touch with us at any time to ask questions or provide comments.

Image: Glenorchy boat shed

What is a risk assessment?

And how is it different to other technical assessments we've done at the Head of the Lake?

We have undertaken many different hazard investigations and assessments over the years, which helped us to better understand the different hazards at the Head of Lake Whakatipu, for example, our assessment of flooding of the Buckler Burn.

We have also looked at ways to adapt to or manage these various hazards. We are now at the stage where we are undertaking a risk assessment.

The risk assessment captures all these technical investigations and other data to calculate the likely consequences of potential hazard events for the community, their homes and other infrastructure.

Risk is calculated by the nature of the hazard, as well as what is exposed to the hazard (i.e. what is in harm's way), and factors that make people, communities or places more vulnerable to harm from the impacts of hazards (i.e. socio-economic status, age, ability, gender).

This is an important part of the programme, and it will help inform our adaptation and hazard management planning.

If you're unsure about how this works and why this work is a critical foundation to future decision making, please call us.

We are happy to talk to anyone who lives or has a vested interest in the area at the Head of Lake Whakatipu about what this means for them.

Image: Mt Alfred

Our next community engagement update

We are planning a community session in a couple of months.

This is an opportunity to further refine community values and objectives and discuss possible adaptation and hazard management options at the Head of the Lake and what it all means for you as a community.

We'd like to give an in-person update about the programme and where we are heading over the next 12 months.

We also want to check in with you, the community, about the different perspectives on the future of adaptation and natural hazard management for Glenorchy and surrounds to guide our work and the strategy.

Later in the year, we will be coming back with a shortlist of adaptation options and pathways to discuss. These will be possible pathways for the future of the Head of the Lake.

More details to come in our next newsletter!

As always, we value your feedback

This adaptation programme was initiated because complex, increasing natural hazards in the Head of Lake Whakatipu require a comprehensive management response that takes a long-term view and encompasses all types of natural hazards.

This is your community, and we want to work with you to develop understanding and resilience. Check here to learn more about the whole programme.

If you have questions or need information, visit our website to see the reports and get answers.

You can also contact ORC Natural Hazards Manager Jean-Luc Payan on 0800 474 082 or email us for more information at headofthelake@orc.govt.nz.

This email will go to our Natural Hazards team, and we will provide responses to any emailed questions and facilitate answers from our consultants if needed.

Head of Lake Whakatipu newsletter sign-up
If you are currently not receiving our monthly newsletters, you can sign up here and view archives of past editions.

Contacts
If you have any questions or would like to get in touch with us, please email us at headofthelake@orc.govt.nz.

Otago Regional Council