Gorge Road Hazards

Social and Economic Impacts Report

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Prepared for

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Executive Summary

This report provides an assessment of the social and economic costs and benefits of four proposed management options to address natural hazard risks present in two discrete locations on the western side of Gorge Road, near the Queenstown CBD. This study has been undertaken to provide part of an RMA Section 32 evaluation report for the proposed Plan Change.

Research Context

The two areas (Brewery Creek in the north and Reavers Lane in the south) are located on the surface of geological features known as alluvial fans. Over time the land on these fans has been developed for residential, commercial, and industrial uses. The District Plan makes provision for intensive land use activity in these locations, however recently these areas have been identified as having elevated levels of risk for rockfall and debris flow hazards that exceed published guidelines for tolerability.

There have been some hazard events recorded in recent history in 1986 and 1999 for the Brewery Creek fan that caused minor damage to buildings and no injuries. Looking towards the future, climate change is expected to increase the risks associated with the hazards, with increased frequency and scale of damage. A report prepared by Beca identifies that there are approximately 25 residential properties on the Reavers Fan that would not be tolerable for developments of new or existing properties, with a total of 41 properties unsuitable for new slopes or developments. At Brewery Creek there are 17 properties that are currently occupied by a mixture of residential and business uses that would not be tolerable for developments of new or existing properties, and a total of 24 properties unsuitable for new slopes and developments. That is to say that those properties exceed the acceptable levels of risk to life as outlined in published guidance (AGS[1]).

Council is investigating four management options to address the natural hazard risks in these locations. Those options represent a range of land use and engineering management options. The options are:

1. Status Quo: Risk would be assessed on a case-by-case basis when resource consent applications for developments or alterations are required and when there is scope to consider the effects of natural hazards on the proposed development. Proposed District Plan ("PDP") zones will be applied to the area in the absence of any specific controls relating to natural hazards. These include a mix of high density residential, business mixed use and general industrial and service zones. The Status Quo option is a do-nothing option for managing risk.
2. Manage Risk: Land use planning controls, including specific provisions relating to natural hazards, would be used to achieve particular risk outcomes, relative to the level of risk present. This involves identifying areas of significant, intolerable, and tolerable risk, based on the risk contouring undertaken by Beca and imposing commensurate restrictions, for example:

[1] Australian Geomechanics Society (2007). Practice Note Guidelines for Landslide Risk Management 2007. Journal and News of the Australian Geomechanics Society, Vol 42 No 1. March 2007.

a) no further development in areas of significant risk and encouraging more vulnerable activities to not locate in those areas.

b) minor additions and alterations in intolerable areas with no subdivision and height increases and encouraging more vulnerable activities to not locate there, and

c) restricted development in tolerable areas with limits to site coverage, height and density and managing the location of vulnerable activities.

3. Reduce Risk: In areas of significant risk and intolerable risk, all built form and activities would be removed, such as by acquiring land, and further development in areas of tolerable risk would not be permitted. Land located outside of high-risk areas would not be subject to any specific hazard provisions.
4. Engineering Intervention: Engineering structure(s) would be constructed to reduce the level of risk, and permit development to continue without additional hazard related restrictions for managing natural hazard risk. PDP zones will be applied to the area in the absence of any specific controls relating to natural hazards including a mix of high density residential, business mixed use and general industrial and service zones. The engineering options can be divided into two streams:
    a. Option A: provides for rockfall fences and debris flow channels to be constructed.
    b. Option B: provides for rockfall fences and debris flow fences and mesh to be constructed.

One of the critical concepts to reconcile is what do the technical time periods provided for the small, moderate, and large events mean in real world terms? Many property owners will be thinking that the likelihood of a small event happening once over the next 50-200 years for Brewery Creek and Reavers Lane (100-2,500 years) is low. For moderate events (200-2,500 years for Brewery Creek and 2,500-6,700 years for Reavers Lane) and large events (2,500-10,000 years for Brewery Creek and 6,700-10,000 years for Reavers Lane) the timeframes seem long, and almost incomprehensible, but they do warrant consideration as they could occur at any point and have the potential to cause significant impacts.

It is important to compare these timeframes with recent New Zealand natural hazard events to put the likely social outcomes in perspective. The largest event in recent history, in terms of the number of people and businesses affected, was the 2011 Christchurch earthquake which had a probability of occurring once every 2,500 years and caused significant medium-term impacts to the community, businesses, emergency response organisations, local authorities and central government. Other examples include the Kaikoura earthquake (2016), White Island eruption (2019), and Matata debris flow (2005).

Social Impact Assessment

Social impacts refer to changes to individuals and communities which are generated by a proposed action that will alter the ways in which people live, work, play, relate to each other, organise to meet their needs, and generally participate as members of society each day. A Social Impact Assessment ("SIA") is the documentation and processing of a broad range of social, cultural, demographic, and economic consequences of activities and possible alternatives for all major stakeholders (individuals, groups, communities, and sectors of society), that have an interest in, or are likely to be affected by a proposed action.

An SIA attempts to address the following questions:

- What will happen if a proposed action were to be implemented – why, when and where?
- Who will be affected?
- Who will benefit and who will lose?
- What will change under different alternatives?
- How can adverse impacts be avoided or mitigated, and benefits enhanced?

Social impacts vary in their nature, and can be:

- Positive and/or negative
- Tangible or intangible
- Direct, indirect, or cumulative
- Directly, indirectly or partly quantifiable, or only able to be described and assessed in qualitative terms.
- Experienced differently, by different people and groups, by different communities and at different stages of the project.

The value of costs and benefits for social impacts from natural hazards are often underestimated, mainly due to the difficulties associated with quantifying intangible costs.[2] International literature suggests that social impacts can be 2.4 times those of tangible impacts (insurance claims from property damage). The intangible costs or social outcomes tend to persist over a person's lifetime and can have profound effects on communities as they recover. For this reason, it is important to consider social costs as being equally as important as the tangible (or financial) costs that are more easily able to be quantified.

The SIA outcome framework in this report uses the Treasury Living Standards Framework ("LSF") to structure the range of social outcome wellbeings that have been identified as being important to understand in relation to natural hazard risks and management options. There are four Capital stocks in the LSF including human, financial and physical, social and natural. These Capital stocks are intrinsically linked, requiring policy makers to consider the different dimensions of wellbeing. It is important to understand what those impacts might be, to place the costs and benefits of management options in the context of what the outcomes may be if a do-nothing approach is taken. For this assessment, we have been asked to separate out the council costs to provide consistency with the Cost Benefit Approach. Those costs would ordinarily fall within the four capital stocks described by the LSF.

Community Situation

In 2018, there were 920 people living within the wider Brewery Creek and Reavers Lane locations in 250 households. Approximately 2% of Queenstown's population lived in the two study areas. In 2020, there were 210 businesses located there providing employment for 1,330 people. Approximately two thirds of that employment was in Brewery Creek. There are tourism businesses in the fans including the Qbox

[2] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

Motorhome Queenstown in Brewery Creek and Coronet View Apartments, Reavers Lodge and Pinewood Lodge being located within the hazard risk areas in Reavers Lane.

Population growth has been slower than expected in the location, given its strategic importance being proximate to the CBD. There is evidence of some conversions of older dwelling stock into multi-unit developments and pressure from tourism accommodation providers. Given the high residential growth pressures in Queenstown, up until the natural hazard risks were identified, the hazard area was viewed as potentially providing capacity for growth and redevelopment. Under the Status Quo development scenario, the built floorspace may grow by 98% for both areas by 30,600m^2 in 2021 to 60,710m^2 by 2051.[3] The number of people present in the fans may grow by nearly 90% (840 people, workers and visitors) from 960 in 2021 to 1,800 in 2051.

Figure 0.1: Development Path Built out and Community Activity - Status Quo Scenario

	2021	2031	2041	2051
Built Floorspace (sqm)				
Reavers Fan	19,660	24,510	29,360	34,210
Brewery Creek	10,970	16,150	21,320	26,500
Total	30,630	40,660	50,680	60,710
Community (Live, Work and Visit)				
Reavers Fan	630	790	940	1,100
Brewery Creek	330	450	580	700
Total	960	1,240	1,520	1,800

One key objective of this assessment was to identify the potential scale of vulnerable populations living, working, and staying in the fans. The demographic assessment has highlighted that most of the population will be able to escape in a natural hazard event if there is sufficient evacuation warning time, with much lower shares of children and elderly people in the community (100 people in 2018). Many of the households are transient in nature, and likely to be occupied by seasonal, tourism and hospitality workers. A high proportion of the dwellings are rented, and the population is much more ethnically diverse than the district overall. Those people are more likely to be physically capable of responding to a natural hazard risk, but less likely to be able to cope with the financial outcomes. They are likely to be more mobile and less connected to the local area, so will potentially find it easier to relocate to other locations in Queenstown than homeowners, families and older generations.

Social Impact Assessment Findings

We have assessed the social outcomes (including economic impacts) of the proposed management options for the four Living Standards Capitals using a traffic light system, where the worst outcomes are coded red, and the best outcomes are coloured green. Our assessment has been separated into an examination of the costs incurred by residents, workers, tourists, property owners and the Council to implement the hazard management options (Figure 0.2), and a description of the likely benefits that will arise when a natural hazard event occurs (Figure 0.3).

[3] The Status Quo scenario is based on QLDC Uncontrolled plan enabled capacity and an assumed development path, which assumes that the theoretical plan enabled capacity is development evenly over the coming century.

Figure 0.2: Rating of All Socio-Economic Costs

Capital Stock	Socio-economic Outcome	Brewery Creek					Reavers Lane				
		Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact											
Financial and Physical	*Material Wellbeing*										
	Effects on property values and capital gain										
	Effects on property insurance										
Social	*Fears and aspirations - public acceptability of proposals*										
	Aspirations for outcomes from proposals										
	Fears for outcomes from proposals										
	Perceptions about safety and security										
All Council	Communication and public safety management										
	Community engagement										
	Capital costs										
	Operational Costs										
Moderate Impact											
Human	Uncertainty while awaiting planning decisions										
Financial and Physical	Displacement of businesses										
Social	Displacement of residents										
	Community cohesion, stability and character										
	Sense of place										
Natural	Environmental and landscape effects										
Low Impact											
Human	Disruption during construction of engineering options and removal of structures										
	Daily travel movements										
Financial and Physical	Additional employment opportunities										
	Loss of tourist numbers and expenditure										
	Flow-on impacts into other industry sectors										
Social	Way of life and reverse sensitivity										
	Culture and identity, including community aspirations, heritage and cultural values										
	Impacts on te ao Maori										
	Grassroots community organisations										
	Legend										
	No Change										
	Most Positive										
	Positive										
	Negative										
	Most Negative										

Figure 0.3: Rating of All Socio-Economic Benefits

Capital Stock	Socio-economic Outcome	Brewery Creek					Reavers Lane				
		Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact											
Human	Loss of life										
	Number of injuries										
	Health and wellbeing										
	Impacts for vulnerable populations										
Financial and Physical	Loss of, and damage to, private property										
	Loss of, and damage to, public property										
	Material Wellbeing										
	Household Income and Unemployment										
	Effects on property values and capital gain										
	Effects on property insurance										
Social	Perceptions about safety and security										
Council Benefits	Community engagement										
	Clean-up costs										
	Disruption to ratepayers revenue collection										
Moderate Impact											
Financial and Physical	Loss of, and interruption to, business activity										
	Displacement of businesses										
	Network resilience to disruption caused by natural hazards										
Social	Displacement of residents										
	Community cohesion, stability and character										
Low Impact											
Human	Daily travel movements										
Financial and Physical	Loss of tourist numbers and expenditure										
	Flow-on impacts into other industry sectors										
Social	Way of life and reverse sensitivity										
	Legend										
	No Change										
	Most Positive										
	Positive										
	Negative										
	Most Negative										

Costs of the Hazard Management Options

For the most important elements (high impact), the Manage Risk option has the least costs of the management options for both fans. The Reduce Risk option has the greatest costs.

The pattern for moderate impact social wellbeings is different, with the Status Quo and Engineering B options having the least negative costs. The Reduce Risk option has the greatest costs in Brewery Creek and Reavers Lane, followed closely by the Engineering A option. The scale of negative impacts for each of those options is much higher in Reavers Lane than for Brewery Creek. That means the Manage Risk option is the middle of the road option for moderate impact wellbeing elements.

For the low impact social wellbeing elements, the Status Quo option has no changes from the present situation. The Reduce Risk and Engineering A options have the greatest costs for Brewery Creek, while the Engineering A option has the greatest costs in Reavers Lane. The Engineering B option has the second least costs, followed by the Manage Risk option.

In summary, the Status Quo option has some negative impacts for some of the high impact elements but has the least change from the current situation for most other elements. The Reduce Risk and Engineering A option in Reavers Lane have the greatest costs. The Engineering A option in Brewery Creek has lower costs than for Reavers Lane. After Status Quo, Manage Risk is the next best option, followed by Engineering B.

Benefits After a Natural Hazard

For the high impact social wellbeings, the Reduce Risk option has the greatest benefits of the four management options for both fans. The Status Quo option has the least benefits for Brewery Creek especially, but also for Reavers Lane. The pattern of benefits for moderate and low impact elements is much the same as the high impact elements. In summary, the Reduce Risk option has the greatest benefits in, and after, a natural hazard event across all capital stocks. The Status Quo option has the least benefits. On balance, there are fewer benefits arising from the Manage Risk option than for the engineering options.

Cost Benefit Analysis

A key part of this research was to identify and understand the full range of the economic benefits and costs associated with the different management options. The economic assessment in this report applies a standard Cost Benefit Analysis ("CBA"), which assesses values of costs and benefits that may arise, to whom they accrue and when they may occur. Results of the CBA are designed to provide an understanding of which management options are preferred from an economic point of view and may be taken further for more detailed assessment, but these findings must be viewed in relation to the findings of the overall SIA.

Based on the indicative CBA, the Status Quo, Reduce Risk and Engineering A management options are not preferred over the other management options. The outcomes of the CBA are broadly consistent with the outcomes of the SIA, with Manage Risk presenting the best outcome.

These results must be viewed in relation to the findings of SIA and international literature which indicates that the intangible impacts are often as important than the tangible costs. Also, the impacts of the hazard events are significant, with loss of life and destruction of many buildings, which would generate significant social impacts at the time that they occur (as discussed in the SIA).

Findings of Socio-economic Assessment

In summary, both the SIA and CBA indicate that the QLDC should actively undertake management of the risks associated with rockfall and debris flow in Gorge Road area. Specifically, the Status Quo option of doing nothing would not improve wellbeing or economic outcomes in, and after, a natural hazard event. This report has shown that the socio-economic issues associated with the different management options would suggest that the Manage Risk management option is preferred, followed closely by the Engineering B option. The Reduce Risk option has the greatest benefits in, and after, a natural hazard, but it also has the greatest costs. The Engineering A option has the most significant costs, especially for Reavers Lane, and while there will be benefits for small events, the option will not create significant benefits for moderate and large events.

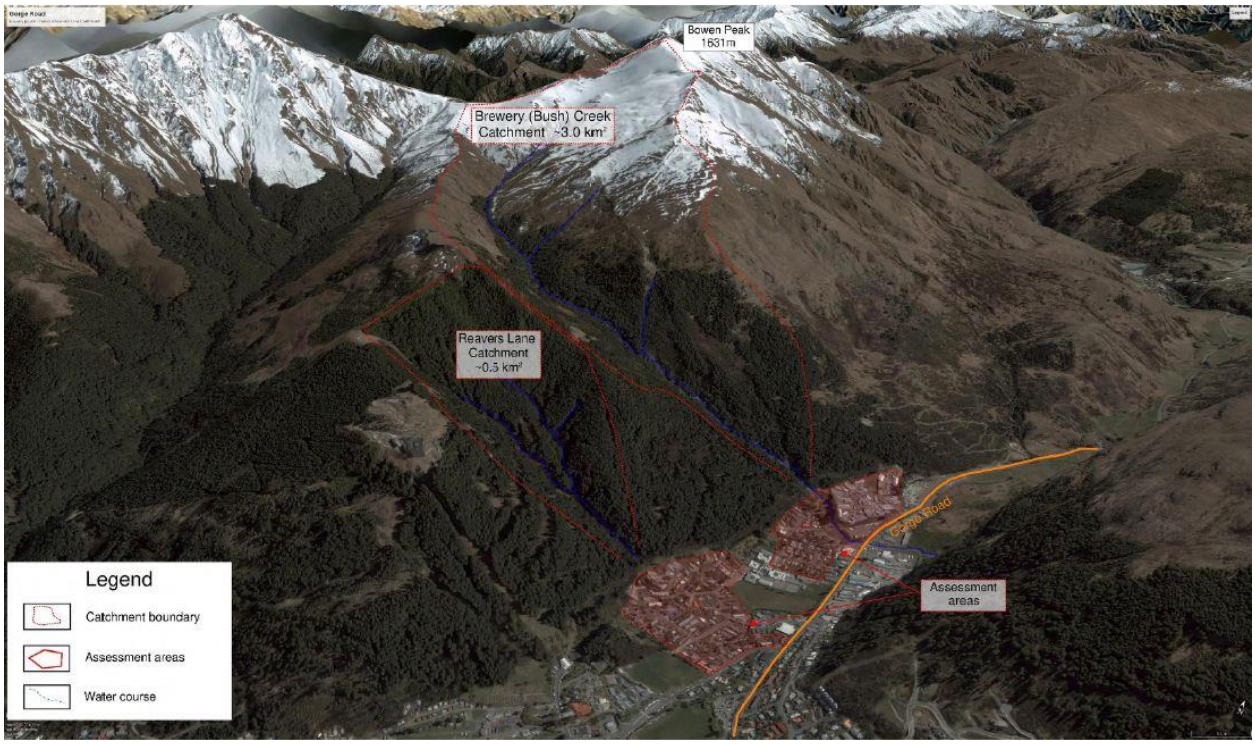
1 Introduction

There are two proximate locations in the vicinity of Gorge Road, Queenstown, identified as having elevated levels of risk that exceed guidelines for tolerability in some areas for rockfall and debris flow natural hazards. This report examines the range of socio-economic impacts that may arise from proposed mitigation measures to manage the higher levels of risk from natural hazards.

1.1 Situation

Queenstown Lakes District Council ("QLDC") is currently reviewing the District Plan in two discrete locations on the western side of Gorge Road, near the Queenstown CBD. The two areas are located on the surface of geological features known as alluvial fans. The northernmost is referred to as Brewery Creek, and the southernmost is referred to as Reavers Lane. The two alluvial fans are located approximately 1km north of the Queenstown CBD (Figure 1.1). Brewery Creek mostly covers land that is used for industrial and commercial accommodation purposes. Reavers Lane hazard area is mostly used for commercial accommodation and some residential.

Figure 1.1: Brewery Creek and Reavers Lane Fans[4]



[4] Beca Ltd (2020). Natural Hazards Affecting Gorge Road, Queenstown.

1.1.1 Natural Hazard Risk

For Brewery Creek, the areas with the highest natural hazard risks are currently used for commercial accommodation. There have been previous flood and debris flow events in 1986 and 1999. The 1999 debris flow caused scarring to trees on the Brewery Creek fan along Bowen Street. The Beca Report[5] identified that hazard events could arise in Brewery Creek in the following manner:

- Liquefaction damage is possible for the distal areas, but unlikely for the upper fans.
- In a 100-year flooding event, there is likely to be overflow in the wetlands north of the creek, and minor flooding south of the creek would travel south towards Sawmill Road/Fryer Street and towards the former Wakatipu High School site.
- Debris flood events and rockfall hazard have the highest risk associated with them. The main area of significant levels of hazard will be within the channel.
    - 5 residential and 12 business properties have been identified as not tolerable for new or existing slope developments, based on the probability that an individual most at risk is killed in any one year as a result of debris flow or rockfall (Figure 1.2).
    - A further 5 residential and 2 business properties have been identified as not tolerable for new slope developments (Figure 1.2).

For Reavers Lane Fan, properties with the highest natural hazard risks are currently occupied by commercial visitor accommodation providers and residential properties. There have been no historical records of debris or flood events[6] here. Beca[7] identified that potential hazard events could arise in Reavers Fan in the following ways:

- Liquefaction damage is possible for the distal areas, but unlikely for the upper fans.
- In a 100-year flooding event:
    - There is likely to be overflow across the fan surface at depths of 100mm to 200mm across private property and Creeksyde Holiday Park is likely to flood, even without considering associated debris flows.
    - Horn (Brewery) Creek will cause the majority of the flooding and because the Robbins Road bridge will not cope with the water flow, there will be an increase in water level upstream impacting the Creeksyde Holiday Park.
    - A potential and minor hazard exists from a small unnamed stream which originates near Kiely Lane and traverses south down the fan towards Fryer Street.
- Reavers Fan is subject to higher risk from debris flow/flood events and rockfall than flooding.

[5] Beca Ltd (2020). Natural Hazards Affecting Gorge Road, Queenstown.

[6] During a site visit conducted in March 2021, a property owner that has experienced impacts from flooding of blocked culverts that caused property damage, provided anecdotal evidence of the impact of small-scale flooding on property owners.

[7] Beca Ltd (2020). Natural Hazards Affecting Gorge Road, Queenstown.

- 25 residential zoned properties have been identified as not tolerable for new or existing slopes developments. Most of these properties are currently used by three commercial accommodation providers (Figure 1.2).
- A further 16 residential properties have been identified as not tolerable for new slope developments (Figure 1.2).

The Beca Reports have used the likelihood of loss of life (Annual Individual Fatality Risk – "AIFR") within the catchments as a proxy for tolerability levels for risk, based upon international best practice. For both Brewery Creek and Reavers Lane the total number of properties which exceed the tolerable levels of risk to life is identified in Figure 1.2. The overall outcome is that the risk to life exceeds published guidance (Australian Geomechanics Society "AGS") on tolerability for both existing and new developments for some properties on Brewery Creek and Reavers Fan, and it is for this reason that potentially amendments to the PDP are required.

Figure 1.2: Number of Properties with AIFR exceeding tolerable guidelines recommended by AGS (2007)[8]

AIFR	Tolerability (AGS, 2007)	Brewery Creek Fan Residential	Brewery Creek Fan Business	Reavers Fan
$>1x10^{-4}$	Not tolerable for new or existing slopes/developments	5	12	25
$>1x10^{-5}$	Not tolerable for new slopes/developments	10	14	41

1.1.2 Proposed Management Options

Urban development has been enabled by the District Plan in both locations, including residential, visitor accommodation, commercial, service and industrial land uses. However, each of these areas are subject to risk from rockfall, debris flows, liquefaction, and flooding hazards. Expert technical advice has identified that the levels of risk from rockfall and debris flow exceed published guidelines for tolerability in some areas. Council is considering four key risk management options to address the risk in these areas,

The four management options are:

1. Status Quo: Risk would be assessed on a case-by-case basis, when resource consent applications for developments or alterations are required and when there is scope to consider the effects of natural hazard on the proposed development[9]. PDP zones will be applied to the area in the absence of any specific controls relating to natural hazards. These include a mix of high density residential, business mixed use and general industrial and service zones. The Status Quo option is a do-nothing option for managing risk.
2. Manage Risk: Land use planning controls, including specific provisions relating to natural hazards, would be used to achieve particular risk outcomes, relative to the level of risk

[8] Beca Ltd (2020). Natural Hazards Affecting Gorge Road, Queenstown. Table 17.

[9] Not all development will trigger the need to consider natural hazards within a resource consent, i.e. only subdivision and multi-unit development of more than three units triggers this consideration.

present. This involves identifying areas of significant, intolerable, and tolerable risk, based on the risk contouring undertaken by Beca[10] and imposing commensurate restrictions for example:

a. no further development in areas of significant risk and encouraging more vulnerable activities to not locate in those areas[11],

b. minor additions and alterations in intolerable areas with no subdivision and height increases and encouraging more vulnerable activities to not locate there[12], and

c. restricted development in tolerable areas with limits to site coverage, height and density and managing the location of vulnerable activities[13].

3. Reduce Risk: In areas of significant risk and intolerable risk all built form and activities[14] would be removed, such as by acquiring land. Further development in areas of tolerable risk would not be permitted[15]. Land located outside of the high-risk areas would not be subject to any specific hazard provisions.

4. Engineering Intervention: Engineering structure(s) would be constructed to reduce the level of risk, and permit development to continue without additional hazard related restrictions for managing natural hazard risk. PDP zones will be applied to the area in the absence of any specific controls relating to natural hazards including a mix of high density residential, business mixed use and general industrial and service zones. The engineering options can be divided into two options:

d) Option A: provides for rockfall fences and debris flow channels to be constructed.

e) Option B: provides for rockfall fences and debris flow fences and mesh to be constructed.

Beca[16] has considered the following three concept engineering options for managing the debris flow and rockfall hazards likely to impact each fan, a mixture of the three are included in Engineering Options A and B. The key nature and objectives of them are outlined below:

- Rockfall fences and mesh – are a system of steel cables and anchors that are designed to absorb energy impacts associated with rockfall debris. The fences would prevent rocks released from upslope outcrops impacting properties located further downslope[17].
- Debris flow channels – designed to allow debris to be directed to safer run out locations, consisting of built-up channel banks (deflection bunds) which will be designed to deflect

[10] Beca Ltd (2020). Natural Hazards Affecting Gorge Road, Queenstown.
[11] The area with Annual Individual Fatality risk of over 10^{-3}.
[12] The area with Annual Individual Fatality risk of between 10^{-3} and 10^{-4}.
[13] The area with Annual Individual Fatality risk of between 10^{-4} and 10^{-6}.
[14] The area with Annual Individual Fatality risk of over 10^{-4}.
[15] The area with Annual Individual Fatality risk of between 10^{-4} and 10^{-6}.
[16] Beca Ltd (2021). Gorge Road Natural Hazards – Engineering Options Report – DRAFT.
[17] Our understanding is that the rockfall fences have been designed to capture 99% of rocks.

flows away from critical areas. Brewery Creek already has a channel, which would be upgraded to reduce the risks of debris flow. There is no channel in Reavers Lane, so there would need to be more earthworks to create a channel in this location.

- Debris flow fences – are flexible ring net barriers which would be constructed across the channel and be designed to resist the dynamic and static loads of debris flows. Debris would become trapped in the barriers, and barriers could be installed at several locations along the channel to increase the retention capacity. Fences which are positioned upstream of the fan apex would allow some of the debris to be trapped before entering the channels and fans. Maintenance tracks would need to be constructed to allow clearing of the debris following flood events, as well as conducting routine maintenance.

1.1.3 Policy Context

The Queenstown-Lakes District PDP identifies that the key natural hazard issues are to ensure 'that when development is proposed on land potentially subject to natural hazards, the risk is managed or mitigated to tolerable levels and significant risks avoided'[18]

Queenstown-Lakes District lies within the wider Otago Region, and the Otago RPS provide strong direction about the management of natural hazards in Chapter 4.

1.2 Scope

QLDC requires an assessment of the social and economic costs and benefits of the four risk management options, developed by Council planners in conjunction with technical consultants, Beca Limited and the Institute of Geological and Nuclear Sciences. The purpose of this work is to inform the proposed plan change by providing an assessment forming part of an RMA S32 evaluation report.

1.3 Data Sources

The assessment contained in this report draws on information contained in a range of Council documents and other reports undertaken for Council. We have also conducted a comprehensive literature review regarding the likely social impacts arising from natural hazards and hazard mitigation. Those academic articles are referenced throughout the report. The following key reports have been reviewed to undertake this socio-economic assessment:

- Beca Ltd (12 November 2020). Natural Hazards Affecting Gorge Road, Queenstown
- Beca Ltd (2 March 2021). Gorge Road Natural Hazards – Engineering Options Report
- Institute of Geological and Nuclear Sciences (2021). Gorge Road Natural Hazards – Riskscape Assessment.
- Queenstown Lakes District Council (2020) Gorge Road Hazard Build Environment.
- QLDC Proposed District Plan

[18] Section 28.1 Natural Hazards Purpose Proposed District Plan

- Otago RPS

1.4 Report Structure

There are six sections in this report, with the content of the remaining sections outlined below:

- Section 2: Outlines the methodology employed to undertake the socio-economic impact assessment. It outlines the definition of social impacts and the key elements of SIAs. It also describes at a high-level the Cost-Benefit Assessment methodology that has been utilised to estimate the tangible impacts of the proposed management options.
- Section 3: Describes the range of social wellbeing outcomes that are identified in the international literature regarding the range of social wellbeing outcomes that may arise if a natural hazard event occurs. It is important to understand what those impacts might be, to place the costs and benefits of management options in the context of what the outcomes may be if a do-nothing approach is taken and a hazard event occurs.
- Section 4: Information about the types of households and businesses located in the Brewery Creek and Reavers Lane fans is provided to identify who will be affected if a natural hazard occurs. The section also contains a description of the likely growth future for the wider area by examining the range of development provisions in the PDP and identifying the scale of development pressure that has been present in recent years.
- Section 5: Provides detailed information about the range of costs and benefits associated with each of the management options, both in economic and social terms. We have grouped the social wellbeing outcomes into our key areas and provides summary tables which show the relative impacts of each management option.
- Section 6: Summarises the key findings from the socio-economic impact assessment and provides a high-level description of the important concepts raised throughout the report.

2 Socio-economic Impact Methodology

This section outlines the methodology that was adopted in the socio-economic impact assessment of the natural hazards in Gorge Road, Queenstown. The following subsections define what social impacts are, and the key elements of good social impact assessments, and describe the cost-benefit approach.

2.1 Social Impact Assessment

2.1.1 What are Social Impacts?

Social impacts refer to changes to individuals and communities which are generated by a proposed action that will alter the day-to-day way in which people live, work, play, relate to each other, organise to meet their needs, and generally participate as members of society[19]. Social impacts can involve changes to people's[20]:

- Way of life, including:
    - How people live, for example, how they move around places and provision of adequate housing.
    - How people work, e.g., access to adequate employment, working conditions or practices.
    - How people play, for example, access to recreation activities.
    - How people interact with each other daily.
- Community, including its composition, cohesion, character, how it functions and sense of place.
- Access to, and use, of infrastructure, services, and facilities.
- Culture, including shared beliefs, customs, values and stories, and connections to land, places, and buildings.
- Health and wellbeing, including physical and mental health.
- Surroundings, including access to, and use of, ecosystem services and the natural and built environment, and its aesthetic value and/or amenity, public safety and security.
- Personal and property rights, including whether economic livelihoods are affected, and whether personal disadvantages or civil liberties will be affected.

[19] Burdge, R.J. 2004. Social Impact Assessment: Definition and Historical Trends, in Burdge, R.J (2004) The Concepts, Process and Methods of Social Impact Assessment.

[20] NSW Department of Planning and Environment (2017). Social Impact Assessment Guideline.

- Decision-making systems, particularly the extent to which people can have a voice in decisions that affect their lives, and have access to complaint, remedy, and grievance mechanisms.
- Fears and Aspirations, related to one or a combination of the above, or about the future of their community.

2.1.2 Key Elements of a Social Impact Assessment

A social impact assessment is the documentation and processing of a broad range of social, cultural, demographic, and economic consequences of activities and possible alternatives for all major stakeholders (individuals, groups, communities, and sectors of society), that have an interest in, or are likely to be affected by a proposed action.

An SIA attempts to address the following questions:

- What will happen if a proposed action were to be implemented – why, when and where?
- Who will be affected?
- Who will benefit and who will lose?
- What will change under different alternatives?
- How can adverse impacts be avoided or mitigated, and benefits enhanced?

Social impacts vary in their nature, and can be[21]:

- Positive or negative
- Tangible or intangible
- Direct, indirect, or cumulative
- Directly, indirectly or partly quantifiable, or only able to be described and assessed in qualitative terms.
- Experienced differently, by different people and groups, by different communities and at different stages of the project.

The SIA process includes milestones and deliverables such as reports and plans during the project cycle. The process should start as early as possible, at the inception stage (prior to implementation), during the project delivery and continue after the project has concluded. The key steps to understanding the SIA process are:

- Analysis of the current situation – the analysis includes population and households, and demographics such as age, ethnicity, income, education, employment status and home ownership.
- Social overview – this should be developed from the findings of the current situation and outline any historic social issues or trends as well as the current conditions, any social and

[21] NSW Department of Planning and Environment (2017). Social Impact Assessment Guideline.

economic linkages between the project and community and any important values held in the community in relation to the proposal.

- Estimation of effects – in this step the effects from the policy options are estimated. The impact assessment will compare the current situation with the expected effects from the different options. A description of the potential impacts will be included and, in some cases, supplemented by quantitative data.
- Social impact management – if required this is the ongoing monitoring, management and engagement after the project has concluded.

2.1.3 Treasury Living Standards Framework

We have used the Treasury Living Standards Framework (LSF) to structure our Outcome Framework (Section 2.3) according to the four Capital stocks that support wellbeing. The LSF represents a shared understanding of the building blocks needed to grow and support New Zealanders' wellbeing, now and into the future. The LSF consists of 12 domains of current wellbeing, the 4 Capital stocks which support wellbeing, and risk and resilience. The four Capital stocks are[22]:

- Human Capital - This encompasses people's skills, knowledge and physical and mental health which enable people to participate fully in work, study, recreation and in society more broadly.
- Financial and Physical Capital - This includes both financial and man-made physical assets which make up the country's produced assets and have a direct role in supporting incomes and material living conditions. This includes things like houses, roads, buildings, hospitals, factories, equipment, and investments.
- Social Capital - This describes the norms and values that underpin society which influence the way people live and work together and experience a sense of belonging. It includes things like trust, the rule of law, the Crown-Maori relationship, cultural identity, traditions and the connections between people and communities.
- Natural Capital - Refers to all aspects of the natural environment needed to support life and human activity. It includes soil, land, water, plants, and animals, as well as minerals and energy resources.

These Capital stocks are intrinsically linked, requiring policy makers to consider the different dimensions of wellbeing. Fostering intergenerational wellbeing means growing the four Capitals to be strong individually, but also together.

2.2 Economic Assessment

In addition to the Social Impact Assessment, described above, a second key part of this research was to identify and understand the full range of the economic benefits and costs associated with the different management options. The economic assessment applies a standard Cost Benefit Analysis (CBA), which

[22] The Treasury (2019). Our living standards framework. Retrieved from https://www.treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework

assesses values of the costs and benefits that may arise, to whom they accrue and when they may occur. The results of the CBA are designed to provide an understanding of which management options are preferred from an economic point of view and may be taken further for more detailed economic assessment.

In summary, CBA are commonly used by local and central government to improve government decisions on public spending or policy. There are a number of guidelines that outline the process that should be followed when undertaking a CBA, but a key aspect of the assessment is to quantify the flow of costs and benefits that are expected to be generated in future from the public spending or policy options.[23] These values can then be compared with the investment of public money to establish whether the benefits of the investment outweigh the costs, i.e. what is the Net position of the public spending or policy.

A key feature of CBA is that it adopts a common unit of value – today's dollars, which is referred to as Present Value. Specifically, CBA convert future values into Present Values using a process called discounting. The discounting conversion means that costs or benefits which occur later are given less weight than costs or benefits which occur sooner, with larger reductions the further into the future the costs or benefits occur. This conversion accounts for the fact that people, communities, businesses, and government place greater value on outcomes that occur today, than those that will occur in the future.[24]

The combined process of establishing a net position and converting values using discounting is referred to as Net Present Value (NPV). Simply, the NPV is the sum of all quantified benefits and costs (in today's value) that accrue from the public spending or policy. This is important as in many cases governments tend to invest in a project today, which then generates a flow of benefits and costs that accrue in the future. The NPV provides a method for comparing the outcome of a project over a period of time. Specifically, if the NPV that is returned from the CBA is positive then the benefits of the project outweigh the costs.

The following subsection provides a brief discussion of the key settings that have been applied in the CBA, including the key groups that are impacted by the proposed management options and modelling assumptions.

2.2.1 CBA Impacted Groups

The assessment has been designed to provide an indicative understanding of how the costs and benefits are likely to be distributed among communities of interest. The assessment provides results for the key stakeholders that will be impacted by the policy, namely:

- Council/rate payers: will likely bear the capital costs and ongoing operating costs to implement the preferred option, and consenting costs associated with managing land use within the area.
- Property Owners: a significant proportion of the land and buildings that are within the hazard area are owned by landlords or entities that do not reside or work there. The management options will impact what some of that land can be used for and/or in some

[23] NZ Treasury (2015) Guide to Social Cost Benefit Analysis.
NZTA (2020) Monetised Benefits and Costs Manual.
Auckland Council (2013) Cost Benefit Analysis Primer.
[24] Reader should refer to any of the documents above to find out more about discounting and Net Present Value.

cases may need to be used by Council to allow the construction of engineering protections. The change in the potential use of the land may have impacts on the value of the land and there may be impacts on the capital values and increased costs for insurance.

- Businesses: there are several businesses operating within the hazard area, with commercial accommodation operators such as Reavers Lodge, Pinewood Lodge and Qbox Motorhome, etc. and industrial activities (in Industrial Place and Repco Boulevard)
- Local Community: the people that live and work within the local area. None of the management options completely remove all risks from rockfall and debris flow hazards, and do not address issues regarding liquefaction and flooding. This means that there will be negative impacts if an event occurs, however the degree of the impacts will be different under each management option.
- Queenstown Community: the wider Queenstown community will also be impacted by the different management options. Firstly, as ratepayers, the community may be required to fund the council costs associated with each management option, though this aspect is uncertain at this stage. Also, the land use implications associated with each option may result in changed outcomes in the district, with economic and residential growth in the suburbs potentially being different under each management option.

2.2.2 CBA Assumptions

As with any CBA, the most important task is to value the cost and benefits associated with the proposed policies. Broadly, the valuations in the CBA were established by developing an understanding of the key economic processes through which these benefits arise and the cost implications – as well as the trade-offs, implied choices, opportunity costs and foregone options (as these also have costs). In many cases there are no direct market values that can be used, so it is common to identify proxy measures for the costs and benefits that are not already expressed in monetary terms.

The following discussion outlines the key model assumptions that have been used to develop the estimates of values for each cost and benefit. This study has included sensitivity analysis to establish which assumptions are critical to the findings of the economic assessment.

The following key model assumptions have been applied in the assessment:

1) Evaluation Period: has been defined as the next three decades. This evaluation period was chosen because it is sufficiently long to provide information about the relative merits of the management options while not being so long as to include too much uncertainty. The selected period is longer than the lifespan of the District Plan (of a decade). However, shorter than the engineering protection design (five decades or more) or the return period of the small events in each fan (Brewery Creek 125years and Reavers 1300years+).
2) Annualising Assumption: as noted in Treasury guidelines "*costs and benefits should be identified for each year over the life of the project*". This standard assessment method has also been adopted in this CBA. This is important as it is impossible to say when exactly one of the hazard events will occur in the future. Therefore, the only practical way to deal with this uncertainty is to assess the outcomes in terms of average annual expected outcome, which is drawn directly from GNS Riskscape outputs.

3) Discount Rate: has been set as 5% per annum, which is applied to future values to convert them into today's values. This is the standard public sector discount rate applied by Treasury for government CBA.[25]
4) Hazard Extents: have been defined based on the hazard layers provided by Beca and GNS. These layers are used to establish the amount of land, building space and the potential number of people that could be impacted by each event.
5) Real Values: all values are assessed in terms of 2021 dollar terms. The model does not assess future nominal values.
6) Development Path: the base data used in this assessment was drawn from QLDC build environments modelling, which estimates the potential future development outcomes.[26] To emphasise the comparison between the management options the QLDC built environment modelling assumed maximum development as enabled within the planning provisions under each of the scenarios. No attempt was made to apply a filter to reflect a level of development that might realistically be expected over time. Therefore, it is likely that not all the theoretical development capacity will be achieved within the evaluation period. However, there is limited information from which we can establish the potential uptake. It is reasonable in this indicative CBA to make an assumption and then use sensitivity testing to understand the influence of this assumption. In this indicative CBA it is assumed that 1% of the development potential is achieved each year, with buildings transitioning from existing outcome to the three alternative outcomes over a century.[27] The only difference being Reduced management option, which assumes that buildings within the hazard area are removed over the coming decade.
7) Community/People in Hazard Area: to estimate the potential risks to the local community, the CBA has calculated the numbers of people that may be present in the buildings that may be impacted by the hazards. In any given year, the built space is divided by an assumed average floorspace ratio for each type of activity – residential[28], business[29] and commercial accommodation[30]. This provides an estimate of the local community in any given year, within each AIFR contour.

The discussion in the following section and the appendix outlines specific assumptions for each of the costs and benefits. For this assessment information has been sourced from QLDC, Stats NZ, GNS, Beca and other secondary sources.

2.3 SIA Outcome Framework

The outcome framework is used as a tool to summarise the range of social impacts of the proposed management options for both costs and benefits. The summary charts incorporate outcomes from the economic CBA as well as a more subjective assessment of the range of social effects of the proposed

[25] Treasury (2020) Recommended Discount Rates.

[26] Queenstown Lakes District Council (2020) Gorge Road Hazard Build Environment Modelling.

[27] The influence of development path assumption is examined in the sensitivity testing.

[28] Assumed to be one resident person per 30m^2 of residential floorspace. This assumption is broadly based on the size of the dwellings in the area and the household sizes.

[29] Assumed to be one worker per 50m^2 of commercial space. This assumption is based on the nature of the commercial floorspace in the area and our research on workspace ratios.

[30] Assumed occupancy of 62% commercial unit.

management options, some of which will not accrue until natural hazard events occur. We have used the four Capital stocks, Human, Social, Natural, and Financial and Physical from the Treasury Living Standards Framework to group the outcomes in section 5.7. We have separated out the costs to Queenstown-Lakes District Council to provide the Council with a sound understanding of the relative costs.

For each outcome we have described the impact of the various management options and where relevant quantified the likely effect. In addition to the described impacts, we have adopted a traffic light system to indicate the best and worst management options for each social outcome. Green indicates the best management option for an outcome, yellow presents good outcomes but with some issues, orange reflects a wide range of costs/issues and red represents the worst option. We have adopted a clear coding format for situations where there is unlikely to be any change from the likely outcomes under the current planning regime. Colour coding of the outcome framework allows decision makers to instantly see the preferred/best option that delivers the most quality outcomes across the four Capital stocks.

In addition to colour coding the costs and benefits of the hazard use management options, we have also provided judgement about which of the social wellbeing effects will have the greatest impact and which will have the least (Section 3).

2.4 Report Methodology Summary

To undertake the socio-economic impact assessment, we have undertaken the following key tasks:

- Reviewed Existing Reports – we have reviewed the engineering reports and work undertaken by Beca and GNS for QLDC, and other material provided by the Council (including community consultation) to understand the natural hazard risks and the management options to address the risk.
- Literature Review – we have conducted a comprehensive literature review to understand the major themes outlined in academic research and identify the range of impacts likely to be generated if a natural hazard occurred. The socio-economic framework has incorporated elements highlighted in the literature review.
- Secondary Data Analysis –we have drawn on established household and business data to provide an indication of the types of people and businesses that may be affected by the hazard management options to describe the baseline community situation.
- Site visit – we visited Queenstown in March 2021 to ground-truth the desktop analysis.
- Social Impact Assessment (SIA) – a framework has been developed to describe the range of costs and benefits for different groups within the community, and across business sectors. It examines the micro and macro level outcomes, ranging from the effects on individuals through to the likely effects on the broader community.
- Costs and Benefits Assessment (CBA) – a model has been developed to identify and describe the full range of benefits and costs associated with the different proposed management options.

3 What are the Social Impacts of Natural Hazards?

It is important for Council to understand the likely consequences for individuals, businesses, and the wider community if natural hazard events were to occur without management options that intervene to minimise the likely effects. Climate change is expected to increase the likelihood of some natural hazards, such as flooding, debris flows, rockfalls and coastal inundation in New Zealand. In this location, climate change is likely to increase the likelihood of rockfall, flooding and debris flow events. This section describes the key social wellbeing outcomes identified in the literature review.

3.1.1 Why are Natural Hazard social impacts important?

A report prepared by Deloitte for *The Australian Business Roundtable for Disaster Resilience and Safer Communities* assessed the economic cost of the social impacts of Australia's natural disasters and the planning and approval process for new infrastructure[31]. The report recognised that natural disasters have wide-ranging social impacts beyond the known economic costs. These impacts are felt immediately following a disaster, but often persist for the remainder of people's lives. The economic costs of social impacts are not well understood and are complex, interrelated, and difficult to quantify. However, evidence in that report showed the social costs of natural disasters are equal to and sometimes higher than the traditionally defined economic costs, and account for a significant part of the total economic costs of natural disasters.

The Deloitte Access Economics (2009) report identified that the value of social impacts from natural hazards are often underestimated, mainly due to the difficulties associated with quantifying intangible costs. That report concluded that social impacts are 2.4 times those of tangible impacts (which relate to insurance claims from property damage). The intangible costs or social outcomes are likely to persist over a person's lifetime and will have profound effects on communities as they recover. For this reason, it is important to consider social costs as being equally as important as the costs that are more easily able to be quantified.

3.1.2 Certainty about likelihood of Natural Events occurring over time

One of the critical concepts to reconcile is how to interpret the technical return periods provided for the small, moderate, and large events and what they mean in real world terms. Many property owners will be thinking "so what?", the likelihood of a small event happening once over the next 125 years for Brewery Creek and once in Reavers Lane over the next 1,300 years, is very unlikely to impact them. For moderate events (1,300 years for Brewery Creek and 4,600 years for Reavers Lane) and large events (6,250 years for

[31] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

Brewery Creek and 13,350 years for Reavers Lane), these timeframes seem too long to warrant giving any consideration to.

The Beca Report provides an explanation of how to understand the probabilities in the context of a person's lifetime. Considering the Annual Individual Fatality Risk assessment undertaken by Beca, this allows a person to understand their individual chance of being killed by a natural hazard event over their lifetime.

In order to understand how a particular event with a long return period can occur at any point in time, we can compare these timeframes with recent New Zealand natural hazard events. This puts the likely social outcomes in perspective:

- The 2011 Christchurch earthquake had a probability of 1:2,500 years and caused medium-term impacts for a range of households, businesses, emergency response organisations, local authorities and central government[32].
- The 2016 Kaikoura earthquake was an unpredictable event, that had ruptures across many faults, but experts agree that the likelihood of that event happening was a one in 300+ year event[33]. The earthquakes, and tsunamis, caused significant social impacts.
- There were significant debris flows in Matata in 2005 which has resulted in managed retreat from the location. The probability of the debris flows prior to the 2005 event were estimated as a 10% probability within 50 years[34].
- Volcanic eruptions are much harder to predict as the probability of eruptions varies over time depending on the levels of activity[35]. The White Island volcanic eruption in 2019 is a recent New Zealand example that has had widespread media coverage regarding the long-term health and wellbeing impacts of those caught up in the eruption.

These are important reference points for the Queenstown situation, because even though some of the probabilities are low, with very long timeframes, they are examples of events that happened within recent history which have had significant social outcome impacts that probably were not anticipated to happen in our lifetime.

This section is separated into sections that contain a discussion about each of the social wellbeing effects that need to be considered in relation to natural hazards. Each effect has been categorised according to the LSF Capital stocks and ordered according to whether the management options will generate costs or benefits.

3.2 Human Capital

This encompasses people's skills, knowledge and physical and mental health. These are the things which enable people to participate fully in work, study, recreation and in society more broadly. The management

[32] Storey, B., Owen, S., Noy, I. & Zammit, C. (2020). Insurance Retreat: Sea level rise and the withdrawal of residential insurance in Aotearoa New Zealand. Report for the Deep South National Science Challenge, December 2020.

[33] https://www.sciencedaily.com/releases/2017/04/170412111125.htm

[34] https://static.geonet.org.nz/info/reports/landslide/CR_2005-071.pdf

[35]https://www.nzherald.co.nz/nz/white-island-eruption-how-do-scientists-forecast-potential-further-eruptions/NHESSFPIVPL75OGTRMHRMBJZLA/

options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely outcomes if natural hazards were to occur in a do-minimum scenario.

3.2.1 Loss of Life

The likely scale of the loss of life varies significantly across different hazards and geographies (Lindell et al, 2003; Ademola et al, 2016). A tangible aspect of loss of life is the long-term loss of economically active individuals. According to the statistics from The Centre for Research on the Epidemiology of Disasters (CRED), landslides contribute to around 17% of total fatalities due to natural hazards[36]. Loss of life in undeniably one of the most significant outcomes that could occur from natural hazard events and is an eventuality that should be avoided. The benefit of introducing natural hazard management options is a likely reduction in the loss of life if a natural hazard occurs. The most critical impact of a natural hazard, and potentially the least palatable by the general public, is loss of life. For this reason, we have classified loss of life as an effect that will have a 'high impact'.

3.2.2 Number of Injuries

The likely scale of the number of injuries varies significantly across different hazards and geographies (Lindell et al, 2003; Ademola et al, 2016). Measures of the economic impact of injuries include costs of medical treatment, and temporary loss of economic activity by productive individuals[37]. Direct costs include hospital, medical, paramedical and ambulance costs. Treatment may be provided by emergency services for those injured in a natural hazard, or others may receive treatment from their GP[38]. There are long-term costs to individuals and society from severe injuries that need on-going treatment. The number of injuries from a natural hazard and the long-term cost of this to both individuals and society is significant and should be mitigated or avoided altogether. The benefit of introducing natural hazard management options is a likely reduction in the number of injuries if a natural hazard occurs. The number of injuries is likely linked to the scale of loss of life, though in this case we have been advised by GNS that people are more likely to lose their life as a result of debris flows, rather than become injured. For these reasons, we have classified loss of life as an effect that will have a 'high impact'.

3.2.3 Health and Wellbeing

Natural hazards are likely to impact negatively on people's health. Injuries sustained during disaster events, exposure to weather hazards, poor sanitation due to septic tank and sewerage supply damage, congested living conditions, and pollution of water sources all impact negatively on the physical and psychological health status of the people affected by natural disasters[39].

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[36] Kjekstad, O., & Highland, L. (2009). Economic and social impacts of landslides. In Landslides–disaster risk reduction (pp. 573-587). Springer, Berlin, Heidelberg.

[37] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[38] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[39] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

According to Lindell et al (2003) the likely psychophysiological effects include fatigue, gastrointestinal upset and tics, as well as cognitive symptoms such as confusion, impaired concentration, anxiety, depression, grief, and attention deficits. Behavioural effects can include changes to sleep patterns and appetite, ritualistic behaviour, and substance abuse (such as smoking, drinking alcohol)[40][41]. Typically, these effects are likely to be mild and transitory i.e., "normal people, responding normally, to a very abnormal situation".

There are also psychosocial impacts, such as changes in risk perception (beliefs in the likelihood of the occurrence of a natural hazard) and its personal consequences for the individual and increased hazard intrusiveness (frequency of thought, discussion and information received about a hazard). A positive outcome can be the adoption of a disaster preparedness strategy[42]. Research carried out by Flood Hazard Research Centre identified many people affected by flooding events had increased their risk perception by regularly monitoring river levels out of fear of another event[43].

The Christchurch Health and Development Study assessed the extent of earthquake exposure on a birth-cohort in the Christchurch community and found that members had mental disorder rates 1.4 times those who were not exposed. The study showed an increase in major depression, post-traumatic stress disorder, nicotine dependence and other anxiety disorders[44]. Another Christchurch based study showed middle-aged residents had mean scores significantly lower than population norms in mental health, vitality, and social functioning.

Another impact of natural disasters on people with chronic diseases such as cardiovascular issues, cancers, respiratory issues, and diabetes, can be disruption to treatment if public health infrastructure is damaged. The effect of this can be a decline in their health and sometimes even death[45].

Some health impacts tend to persist over a person's lifetime. For example, a proportion of people will suffer from chronic disease or mental health problems post disaster. These impacts may also be multiple and compounding (not necessarily linear)[46].

Poor health outcomes are associated with reduced labour force participation and lower productivity. The loss of productivity is experienced by the individual and the wider economy. Those losses will occur either permanently, temporarily in the short-term, or over a longer time frame.

Households may shift their expenditure away from leisure-based activities towards health costs. Personal savings may be depleted, and other activities may be foregone, such as for education.

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[40] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[41] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[42] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[43] Tapsell, S. M., Penning-Rowsell, E. C., Tunstall, S. M., & Wilson, T. L. (2002). Vulnerability to flooding: health and social dimensions. Philosophical transactions of the royal society of London. Series A: Mathematical, Physical and Engineering Sciences, 360(1796), 1511-1525.

[44] Taylor, J. E., Chang, S. E., Elwood, K. J., Seville, E., & Brunsdon, D. (2012). Learning from Christchurch: Technical decisions and societal consequences in post-earthquake recovery. Resilient Organisations, Christchurch.

[45] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[46] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

A common measure of overall disease burden is disability adjusted life year ("DALY"). A loss of DALY can be conceptualised as the loss of a year of 'healthy' life. The disease burden across the total population would be captured in the measure of DALY. It estimates the years of lives lost to a disease and years of life lost to a disability[47]. The value of a statistical life ("VOSL") is also a measure that places a value on quality of life resulting from premature death, disability or ill health, and on the pain and suffering of friends and families[48].

Health and wellbeing are a very important wellbeing outcome immediately following a natural disaster, but also the psychosocial effects which often persist for the rest of people's lives manifest across the long term. The benefit of introducing natural hazard management options is a likely reduction in the number of people who incur health and wellbeing impacts if a natural hazard occurs. The Deloitte Access Economics research identified that the long-term impacts on people's health and wellbeing can be significant in dollar terms, and for this reason we have classified health and wellbeing effects as 'high-impact'.

3.2.4 Impacts for Vulnerable Populations

Vulnerability can be defined as the exposure of an individual to stress due to social or environmental changes that disrupts livelihoods[49]. Vulnerability to natural hazards refers to the potential for loss[50,51]. Losses vary geographically, over time and among different groups of society. Vulnerability is the partial outcome of social inequalities, or the social factors that influence susceptibility of specific groups to harm and impact their ability to respond appropriately.

Certain population segments require special attention and active assistance in the case of hazard emergencies. These include children, elderly, low-income households, large families, single parents, lower educated populations, people with pre-existing mental illness, individuals who are diseased or disabled, unemployed populations, transient populations, homeless, racial and ethnic minorities, immigrants, gender, individuals impacted by violence, isolated and rural dwellers, and the families of those who have died or been injured in the disaster event.

Natural hazards affect vulnerable communities in different ways, for example:

- Low-income households and large families may not be able to afford to hazard proof their homes. Lower income households are also likely to have fewer resources on which to draw for recovery, which means that they are likely to take longer to transition through the stages of housing recovery and are more likely to remain for extended periods in damaged housing. In some cases, they may be forced to accept what was originally intended as temporary housing as permanent, meaning their social connections in their original

[47] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[48] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[49] Frigerio, I. and De Amicis, W. (2016). Mapping social vulnerability to natural hazards in Italy: A suitable tool for risk mitigation strategies in Environmental Science & Policy (63), 187-196.

[50] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[51] Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. Social science quarterly, 84(2), 242-261.

location will be diminished[52]. This can be a significant issue for some businesses, such as restaurants, hotels, and other tourist-oriented businesses that employ low-skilled and low-income employees[53]. It is an important consideration for Queenstown which is primarily a tourism-based economy. Low-income households are less likely to be able to absorb additional insurance costs that may arise from living in a natural hazard risk zone.

- Children have less physical strength to survive natural disasters and are often more susceptible to diseases. In addition, children are reliant on others for survival and, it is necessary that their caregivers and children stay alive and stay together to survive[54]. Children are more likely to suffer longer-term physical health problems, psychological health symptoms, and lower educational achievement through missed school attendance and learning difficulties, beyond the immediate trauma and harm and danger involved in the hazard events[55].
- Older people have less physical strength to survive natural disasters and are often more susceptible to diseases. In addition, elderly people are reliant on others for survival, and it is necessary that their caregivers and the victims stay alive and stay together[56]. Elderly are less able to place sandbags in front of their doors to protect them from flood waters. Therefore, it is an obligation of local authorities to identify where vulnerable communities reside to develop place specific risk mitigation strategies[57].
- People with disabilities are especially vulnerable to natural hazards and some emergency response technologies do not meet the needs of disabled populations. For example, deaf people cannot be warned about a potential threat by radio or loud hailer. People who have mobility issues may struggle to evacuate. Often family members and caregivers find it difficult to get into the area likely to be impacted by a natural hazard to help disabled people evacuate[58].
- Populations with non-English speaking languages, cultural difference and lower education levels can create barriers to communication for emergency procedures during, pre, and post natural hazard events. For this reason, it is important that local authorities use appropriate communication tools and install information panels and leaflets that describe evacuation routes and recovery areas in different languages[59]. When populations are literate, written material can be used to spread information about natural hazards and specific events.

[52] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[53] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[54] https://www.e-education.psu.edu/geog30/node/379

[55] https://www.srcd.org/research/understanding-impacts-natural-disasters-children

[56] https://www.e-education.psu.edu/geog30/node/379

[57] Frigerio, I. and De Amicis, W. (2016). Mapping social vulnerability to natural hazards in Italy: A suitable tool for risk mitigation strategies in Environmental Science & Policy (63), 187-196.

[58] https://www.e-education.psu.edu/geog30/node/379

[59] Frigerio, I. and De Amicis, W. (2016). Mapping social vulnerability to natural hazards in Italy: A suitable tool for risk mitigation strategies in Environmental Science & Policy (63), 187-196.

- **Women** are more likely to be impacted during recovery than men, often due to their dual roles of family care, and working in sector specific employment, as well as earning lower wages[60], which means there is less disposable income available in an emergency.
- **Emergency workers** will also need additional support because they often work long hours without rest, have witnessed horrific sights, and are members of organisations in which talking about emotional issues may be regarded as a weakness or just part of the job[61].
- Social norms and discrimination may occur based on **sex, sexual orientation and race**, for example LGBTI people may face issues in temporary shelters.

Combinations of vulnerability factors in individuals can make them more susceptible to higher levels of vulnerability.

Key impacts can be:

- Family violence and relationship breakdown are well recorded outcomes from natural hazards. Women and families are the most vulnerable from those impacts[62]. Increased domestic violence rates have been observed after Hurricane Katrina, the Christchurch earthquakes, and after flooding and bushfire events in Australia. Studies have found that violence can continue for many years after the event has occurred.
- There are well recognised impacts on education after natural hazard events, including academic outcomes, school enrolments, and completion of education[63]. Following the 1998 flooding event in Australia, children were largely forgotten about by authorities with many suffering from behavioural problems and increased anxiety during rainfall[64].

Family and friends caring for individuals with health issues, or younger children who need care will be impacted in time and monetary terms[65].

Impacts on vulnerable populations is an important outcome for natural hazard risk as these populations are the most susceptive to adverse impacts pre, during and post disaster.

Can Tourists Be Considered as Vulnerable Populations?

Tourists are more vulnerable to risks from natural hazards because they are less familiar with the local situation and more reliant on advice and help when they are away from home[1]. As with non-English speaking communities, tourists may not be able to communicate well in the case of a natural hazard. They

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[60] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[61] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[62] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[63] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[64] Tapsell, S. M., Penning-Rowsell, E. C., Tunstall, S. M., & Wilson, T. L. (2002). Vulnerability to flooding: health and social dimensions. Philosophical transactions of the royal society of London. Series A: Mathematical, Physical and Engineering Sciences, 360(1796), 1511-1525.

[65] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

may not also understand where to find information about what to do and where to go in the case of a natural hazard.

In terms of the impacts on tourism activity, Weber (2006) identifies that the impacts can be differentiated into three timing phases:

1. During the event – for example roads and facilities are closed and inaccessible.
2. Immediately after the event – movement is impacted by reconstruction efforts, emergency roads, and limited operability.
3. Long term effects – the image of the destination is impacted by the perception of increased risk due to natural hazards.

For Queenstown, tourists are considered a key vulnerable population.

The benefit of introducing natural hazard management options is a likely reduction in the number of vulnerable people who will incur impacts if a natural hazard occurs and a commensurate reduction in costs to emergency management organisations for providing assistance to vulnerable people and households. For this reason, we have classified impacts to vulnerable populations as 'high-impact'.

3.2.5 Uncertainty while awaiting planning decisions

Emotional stress regarding the "what ifs" that will be experienced and social division for and against the options will be generated. Speculative activity may take place around decisions, such as retreat from the location by businesses and households. Uncertainty may result in decisions being deferred, and a feeling of not being in control of significant life influencing events. In the scheme of things, this outcome is less important compared to other outcomes in this assessment, however for individuals and households there will be significant levels of unanticipated stress for reasonably short timeframes. That stress and uncertainty is a cost associated with introducing land use management options. We have classified the effects of uncertainty while awaiting planning decisions as 'moderate-impact' due to high levels of stress that will be created for individuals which can often be difficult to measure, even if they are experienced only over a short timeframe.

3.2.6 Disruption during construction of engineering options and removal of structures

Noise, dust, heavy traffic movements, traffic delays and safety issues are well documented for construction activity. These have a broad range of consequences for people, businesses and communities. In addition, local movement patterns can be affected by construction which can have a range of positive or negative impacts on households and businesses over the short to medium term.

The negative impacts from construction of engineering options and the removal of structures have the potential to be somewhat disruptive to individuals and households' daily activities, as well as to businesses and is an important outcome to consider in the delivery phase of the project. However, relative to the other outcomes within Human Capital, it is somewhat less significant due to the temporary inconvenience that is created. The disruption is a cost associated with introducing natural hazard management options, or more

specifically engineering options. We have classified these effects as 'low-impact' due to their short-term and temporary nature.

3.2.7 Daily Travel Movements

Roading networks are often negatively impacted by floods and landslides, when bridges are washed away, and culverts and road signs are damaged. Access to places and facilities can become constrained and this will in turn affect people's movement patterns[66].

Impacts to roading networks due to damage can impact tourism activities as well. In the Swiss Alps case studies, Weber (2006) stated that in some natural hazard events tourists were unable to arrive in the locations and/or had to be evacuated due to roading damage. Disruption to peoples' daily travel movements is an important outcome, especially if people cannot travel to work, education and recreation locations.

In this context, the disruptions to daily travel movements are likely to arise when engineering structures are being built, or houses are being demolished or relocated. The disruption is a cost associated with introducing natural hazard management options. We have classified these effects as 'low-impact' due to the short-term and temporary nature. In the event of natural hazards, there will be some benefits from having roads protected from debris flows, though the scale of area that is likely to be affected will be small, and the disruptions are likely to be limited. We have classified these effects as 'low-impact' due to the short-term and temporary nature of effects.

3.3 Financial and Physical Capital

This includes things like houses, roads, buildings, hospitals, factories, equipment and investments. These are the things which make up the country's produced assets which have a direct role in supporting incomes and material living conditions. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely outcomes if natural hazards were to occur in a do-minimum scenario.

3.3.1 Loss of, and damage to, private property

The damage to private property relates both to the damage to structures, as well as to the contents of those structures (Lindell et al, 2003; Ademola et al, 2016) and tourism facilities (Weber, 2006). Apart from camping sites, which react particularly sensitively to weather events, built accommodation tends to be more resilient to disturbances.

Property damage causes direct economic losses including a loss of asset value, which can be measured by the cost of repair or replacement. Some of the damaged assets will not be replaced, and the loss of those assets will cause a reduction in consumption (loss of quality of life) or a reduction in investment (loss of economic productivity).

[66] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

Some assets, such as the contents of properties will be replaced, by purchasing replacement items or being gifted items through donations. There are a range of financial mechanisms for recovery including tax deductions or deferrals, unemployment benefits, loans, grants, insurance payments or additional employment. Other sources include depleting cash financial assets (e.g., savings accounts), selling tangible assets, by transferring money from one group to another at a given time, such as from insurance providers, or moving to another location that has available housing and employment or is less prone to hazard risk.

There are however some contents of properties that cannot easily be replaced such as memorabilia, treasured possessions, and photographs, which do not carry a monetary value[67]. Sometimes the loss of these types of personal possessions can be much more significant to people than items which carry no emotional attachment and are now commonly recovered through household insurance or easily replaced.

The loss of, and damage to, private property does not hold as much weight in terms of importance as the majority can be replaced via insurance pay-outs and other financial mechanisms. The benefit of introducing natural hazard management options is a likely reduction in the loss of, and damage to, private property if a natural hazard occurs. While the loss of, and damage to property can often be replaced through insurance pay-outs, the inconvenience of finding alternative accommodation or business premises while buildings are repaired or replaced can take a considerable amount of time for individuals, households and businesses. For many households, their homes will be their largest financial asset, and there will be considerable stress involved in organising new homes. For this reason, we have classified loss of, and damage to, private property as an effect that will have a 'high impact'.

3.3.2 Loss of, and damage to, public property

A wide range of public infrastructure can be damaged in a natural hazard event, including roads, tunnels, bridges, trails, power lines, telephone lines, community facilities, climbing routes, huts, and hiking trails.

If the loss of, and damage to, public property following a natural hazard is widespread and prevents or is highly disruptive to peoples' everyday lives or personal movements, a greater level of importance would be placed on this outcome.

The benefit of introducing natural hazard management options is a likely reduction in the loss of, and damage to, public property if a natural hazard occurs. The loss of, and damage to, public property does not hold as much weight in terms of importance as the majority can be replaced via insurance pay-outs and other financial mechanisms. While the loss of, and damage to property can often be replaced through insurance pay-outs, the inconvenience of having roads, power lines and telephone lines can be disruptive. For this reason, we have classified loss of, and damage to, public property as an effect that will have a 'high impact'.

[67] Tapsell, S. M., Penning-Rowsell, E. C., Tunstall, S. M., & Wilson, T. L. (2002). Vulnerability to flooding: health and social dimensions. Philosophical transactions of the royal society of London. Series A: Mathematical, Physical and Engineering Sciences, 360(1796), 1511-1525.

3.3.3 Material Wellbeing

Poverty and hardship are key social measures. Household incomes and non-income factors affect the ability of households to obtain sufficient food, clothing, housing, transport, etc as per the Treasury Living Standards Framework.

Household Income and Unemployment

Household income may be impacted by short and long-term unemployment[68]. The Commonwealth Bank of Australia (2011) reported that there were large downturns in salary payments during and after bushfire and flooding events in Australia, and that income levels on average took between four to eight months to recover[69]. Additionally, property owners may lose their ability to earn income from rental properties if they are directly damaged.

Insurance costs can become prohibitively high when properties are identified as being within a high-risk natural hazard path.

Households will incur unexpected costs, such as those for legal services (associated with family violence, relationship breakdowns, child custody, tenant/landlord disputes, neighbour disputes, planning and crime), temporary accommodation, paid care, funerals, insurance excesses, and other services[70], and this will reduce the available spend for other goods and services and may in some cases contribute to financial pressure. It is well recognised that the levels of crime often go up after a natural disaster, including from looting, burglary and family violence[71].

The benefit of introducing natural hazard management options is a likely reduction in the loss of household income and employment if a natural hazard occurs. Material wellbeing is very important, both in the short-term and long-term following a natural hazard and is directly related to households' ability to live day to day. For this reason, we have classified household income and unemployment as an effect that will have a 'high impact'.

Property Values and Income Gain

Property prices may fall in the aftermath of a natural hazard due to the increased risk of another hazard occurring and negative public perceptions of living near or within a hazard zone. Bin and Landry (2013) show that in the US property prices are lower in flood-prone areas and attract lower income households and vulnerable populations[72]. However, in the Netherlands this price differential was less pronounced

[68] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[69] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[70] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[71] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[72] Koks, E. E., Jongman, B., Husby, T. G., & Botzen, W. J. (2015). Combining hazard, exposure and social vulnerability to provide lessons for flood risk management. Environmental science & policy, (47), 42-52.

between flood-prone and non-flood-prone areas with the price difference dependent on the frequency of flooding and the actual experience of the hazard.

The benefit of introducing natural hazard management options is a likely reduction in the loss of property values if a natural hazard occurs. There may also be impacts from the identification of the properties as being hazard prone. For many households, their home will be their biggest financial asset and viewed as security or retirement savings, any negative effects on the income that can be generated from this asset will have significant adverse effects. For this reason, we have classified property values and capital gain as an effect that will have a 'high impact'.

Insurance

One of the questions asked by Queenstown-Lakes District Council was what would the likely effects on households and businesses be in terms of accessing home, property and contents insurance? We have undertaken a literature review to answer this question.

Research undertaken within the Deep South Challenge highlighted that there are two likely insurance responses to higher likelihoods of natural hazard events:

1. Insurance Retreat: international evidence from the insurance industry indicates that insurers become reluctant to insure properties at around 2% Annual Exceedance Probability ("AEP")[73] and by 5% AEP insurance is completely unavailable[74]. Therefore, it is likely that insurance companies will withdraw insurance from an area when natural events begin to occur between every 50 to 20 years. (Insurance retreat)

2. Partial Retreat: if the probability of the hazard increases five-fold, from 1% to 5% AEP, it is likely that the premium or excess will increase, and it will become increasingly difficult to renew insurance for that property and that hazard. (Partial retreat)

Storey et al (2020)[75] explain the mechanisms of insurance, whereby insurance companies generate income by charging premiums in exchange for insurance coverage. Insurance companies reinvest those premiums into other income-generating assets to create a reserve of capital ready to pay out to policy holders if a natural hazard event occurs. Thus, to remain solvent, the premiums collected over time must, on average, equal more than the total amount paid out in claims.[76] As the probability of a hazard increases, or the value of the exposed asset increases, the likely losses also increase.

A range of factors are assessed to base underwriting decisions on, including soil types, date of construction, the building materials used and the height of the buildings. Additionally, the state of adjacent properties may also be considered as the failure of less resilient buildings will have an impact on more resilient buildings located nearby.

[73] A 1% AEP event occurs on average once every 100 years, a 2% AEP event occurs on average once every 50 years and a 5% AEP event occurs approximately once every 20 years.

[74] https://deepsouthchallenge.co.nz/insurance-retreat-and-climate-change-much-anticipated-research-released/

[75] Storey, B., Owen, S., Noy, I. & Zammit, C. (2020). Insurance Retreat: Sea level rise and the withdrawal of residential insurance in Aotearoa New Zealand. Report for the Deep South National Science Challenge, December 2020.

[76] Generally, the expected value of the loss in any one year must be lower than the premium collected in that year.

Insurance retreat occurs when an insurer declines coverage or stops offering renewal of existing coverage, based on the property's exposure and vulnerability to a hazard[77]. Partial retreat occurs when an insurer introduces terms that transfer a major proportion of the property's risk back onto the property owner, through financial caps in coverage, hazard related excesses, and policy exclusions related to the hazard[78].

There are a range of impacts that may arise from insurance retreat and partial retreat, including:

- Residential Mortgages – insurance is a requirement for residential mortgages and failing to secure insurance can trigger default. Property purchasers will find it difficult to borrow money to purchase a hazard prone property[79].
- Expensive Modifications – Existing owners may be required to undertake costly modifications to their homes to mitigate the impacts of natural hazards.
- The re-sale value of houses will be impacted if information about risks is made available or insurance is unable to be gained. As the costs associated with insuring or protecting properties in the hazard path increases, homeowners may seek to block the transmission of information about potential risk to possible future home purchasers by seeking court approval to remove information from LIM reports for example.
- A larger proportion of household income will be invested in insurance for likely hazard damage, meaning that other spending will be foregone, for instance on recreation activities.

Already in the New Zealand context, there is evidence of some insurance providers choosing to not operate in certain markets, as has been the case with IAG choosing not to take on new clients in the Wellington Region[808182]. For some earthquake prone buildings in Wellington, property owners who undertook significant work to earthquake strengthen their buildings found that high insurance premiums were unaffected by that remediation work[83]. Examples of premium hikes include a Christchurch owner having premiums go from $2,300 to $12,000, and another property going from $6,000 to $27,000 on renewal[84].

The NZ Insurance Council maintain that insurance is a good mechanism for informing people about risk levels, while also providing protection and affordability to a wide number of clients. They maintain that charging lower risk properties more to subsidise higher risks ones would be unfair[85].

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[77] Storey, B, Noy, I, Owen, S, Townsend, W, Kerr, S, Salmon, R, Middleton, D, Filippova, O, and James, V (2017). Insurance, Housing and Climate Adaptation: Current Knowledge and Future Research. Motu Economic and Public Policy Research.

[78] Storey, B., Owen, S., Noy, I. & Zammit, C. (2020). Insurance Retreat: Sea level rise and the withdrawal of residential insurance in Aotearoa New Zealand. Report for the Deep South National Science Challenge, December 2020.

[79] https://i.stuff.co.nz/environment/climate-news/123550542/flood-risk-worse-than-council-inundation-maps-suggest-lobbyists-say

[80] https://www.rnz.co.nz/news/national/384657/no-secret-about-wellington-insurance-risk-insurance-council

[81] https://i.stuff.co.nz/business/money/111245823/state-and-ami-deny-wellington-home-and-contents-insurance-retreat

[82] https://i.stuff.co.nz/business/106365880/what-does-it-mean-for-homeowners-faced-with-new-riskbased-insurance

[83]https://www.nzherald.co.nz/business/insurance-council-defends-skyrocketing-wellington-premiums/2RTP5KFVLFUZ3ZDUXZLTHS2Q4Q/

[84] https://i.stuff.co.nz/business/106365880/what-does-it-mean-for-homeowners-faced-with-new-riskbased-insurance

[85]https://www.nzherald.co.nz/business/insurance-council-defends-skyrocketing-wellington-premiums/2RTP5KFVLFUZ3ZDUXZLTHS2Q4Q/

However, for individual households, property purchasing and renting decisions may not be made based on natural hazard risk, unless insurance costs are prohibitive. Storey et al (2017) highlight that individuals can over-react when risks are small and act optimistically when the risks are higher than perceived, especially if hazards are considered based on long-term probabilities.

In the Reavers Fan context, the likelihood of significant events occurring is not currently within the twenty year or fifty-year timeframe, so it is unlikely that homeowners' insurances will be impacted. There is some probability that properties that are within the small event hazard area in Brewery Creek may start to experience a partial retreat with potential changes in insurance in the medium term. It is also possible that insurances may be increased at some stage in the medium term if more events occur in line with climate change within the wider Gorge Road area.

The benefit of introducing natural hazard management options is a likely reduction in the insurance costs required both in anticipation and after a natural hazard occurs. However, there may also be impacts from the identification of the properties as being hazard prone. Households have a finite amount of money to spend on day-to-day costs and increases or reductions in the costs for insurance can make a significant difference to the amount of disposable income available for other expenses. For this reason, we have classified property values and capital gain as an effect that will have a 'high impact'.

Implications for Queenstown-Lakes District Council and Central Government

The Earthquake Commission ("EQC") protects private residential property and contents from damage by earthquake, volcanic eruption, hydrothermal activity, landslip, tsunami, or fire caused by natural disasters. EQC land cover extends to include storm and flood hazards but does not cover damage to residential structures or contents on that land. Currently EQC covers the first $150,000 of building damage before private insurers cover the remaining costs. The Public Inquiry into the Earthquake Commission noted the average cost of building a house in NZ was about $400,000, and there are recommendations to increase EQC cover to this amount[86].

Once building developments have been permitted on a property, the land use is likely to extend well beyond the existing life of a building (50 years). Due to climate change, the risks from some natural hazards are likely to worsen over this timeframe, and for this reason it is important that territorial authorities give due consideration to the likely consequences of permitting land use activities in areas likely to be subject to natural hazards in the future.

Storey et al (2020) advocate that local authorities should deny building consent applications when the longer-term outlook will see the risk from natural hazards increasing to high levels. The Insurance Council has called for consideration to be given to avoid development in areas prone to other climate change impacts such as areas vulnerable to flooding, rising sea levels and coastal erosion[87].

[86] https://www.interest.co.nz/insurance/106817/govt-accepts-public-inquiry-recommendation-consider-increasing-eqc-cap-so-more-risk

[87] https://www.nzherald.co.nz/nz/insurance-council-issues-stark-warning-over-wellingtons-spatial-plan/G3ECARWRZGALNKL4INGKIJECNA/

Storey et al (2017)[88] state that local and central government could face relatively high costs from protective engineering measures and continued provision of infrastructure when abandoning residential land uses may have more efficient outcomes. Additionally, local authorities, and their insurers, could find themselves holding unexpected liabilities if future courts rule that councils are liable for resource consents provided to homes threatened by climate change related hazards. At this stage it is unclear whether local government will become liable for property damage, however there is evidence in the NZ context of some local authorities purchasing at-risk properties (with respect to coastal inundation), there are also examples where other local authorities have refused to undertake this course of action.

In the event of a natural hazard, if local authorities are not in a financial position to aid affected communities and insurance cover is not affordable/available, then central government may be expected to pick up the costs for those people who have ignored the likely risk.

The 2011 Christchurch earthquake has highlighted that agencies cannot afford to downplay the likelihood of a 1:100 year event happening, given that the earthquake had a probability of 1:2,500 years and caused long-term impacts for a range of households, businesses, emergency response organisations, local authorities, and central government[89]. This is an important consideration in the Queenstown context, because some of the probabilities are for very long timeframes, but the Christchurch example is an important reminder that unexpected events can occur and cause widespread damage and have unanticipated socio-economic impacts.

Storey et al (2020) posit that insurance is not a substitute for risk management nor does it reduce risk. The risk is transferred to the insurer for a price, which increases as the risk gets greater, and can become unavailable if the risks get too high. There are high levels of insurance in New Zealand, however, as was shown in the case of the Christchurch earthquakes, not everyone chose to insure properties and the government was expected to provide assistance for those cases after the event.

3.3.4 Loss of, and interruption to, business activity

Operational vulnerability arises from businesses proximity to the natural hazard impacts and the structural vulnerability of the building where they operate from. Loss of access to services which enable the business to operate safely and functionally include electricity, telecommunications, three waters, and fuel. Other impacts to businesses and the wider economy that are measurable include the number of working days lost and the volume of production that is lost[90] and loss of jobs and retention of employees[91]. Other sources of vulnerability arise from loss of customers and distribution base after the event has occurred[92]. If the health (physical and mental) of the workers is impacted, then this could impact their productivity levels as well.

[88] Storey, B, Noy, I, Owen, S, Townsend, W, Kerr, S, Salmon, R, Middleton, D, Filippova, O, and James, V (2017). Insurance, Housing and Climate Adaptation: Current Knowledge and Future Research. Motu Economic and Public Policy Research.

[89] Storey, B., Owen, S., Noy, I. & Zammit, C. (2020). Insurance Retreat: Sea level rise and the withdrawal of residential insurance in Aotearoa New Zealand. Report for the Deep South National Science Challenge, December 2020.

[90] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[91] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[92] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

The benefit of introducing natural hazard management options is a likely reduction in the loss of, and interruption to, business activity after a natural hazard occurs. However, businesses have insurance and are much more likely to find new business premises or be able to adapt to new operating conditions than households, and therefore the disruptions are likely to be short term. For this reason, we have classified the loss of, and interruption to, business activity as an effect that will have a 'moderate impact'.

3.3.5 Displacement of Businesses

Temporary displacement of businesses at the time of a hazard event, and during the recovery period. This outcome is key to the local economy as well as the livelihoods of business owners, however, business activity is likely to resume (albeit slowly) following a natural hazard. The benefit of introducing natural hazard management options is a likely reduction in the displacement of businesses after a natural hazard occurs. However, businesses have insurance and are much more likely to find new business premises and therefore the displacements are likely to be short term. Although this is likely to be a temporary effect, there will be some impacts on the livelihood of businesses, and for this reason we have classified displacement of businesses as an effect that will have a 'moderate impact'.

There could potentially be displacement of businesses that is a cost of the proposed management options in some cases, and due to the impact that this would have on business' operations we have classified the displacement of businesses as a 'moderate impact'.

3.3.6 Network Resilience to disruption caused by natural hazards

Natural hazards can disrupt regular activity when roading, electricity lines, telecommunications, and three waters infrastructure is damaged or destroyed. It is important to protect these types of infrastructure from the effects of natural hazards to ensure daily life can continue as much as possible, as highlighted in the Otago RPS.

As with the loss of, and damage to, public property, if network resilience to disruption is poor following a natural hazard and causes interruption to peoples' everyday lives and personal movements, a greater level of importance would be placed on this outcome. The benefit of introducing natural hazard management options is a likely reduction in the disruption of business as usual for households and businesses after a natural hazard occurs. We have classified network resilience as an effect that will have a 'moderate impact'.

3.3.7 Additional Employment opportunities

After a natural hazard event, there is likely to be an increase in demand for services such as construction, which can be provided by local companies and generate additional employment opportunities. Alternatively, skilled workforces may be attracted to the region. The effect of that impact will be increased spending in local businesses, and added richness in social interactions, however it may also place pressure on housing stocks, which may already be experiencing significant pressure.

In the case of Christchurch after the earthquakes, significant temporary accommodation was required to accommodate the increased workforce attracted to the region to construct new homes and repair damage. Some of these workers were attracted from outside the region and from overseas and eventually chose to remain in the Christchurch community long-term.

The benefit of introducing natural hazard management options is a likely reduction in the numbers of people who would be required to re-build homes and businesses after a natural hazard. There are a range of positive and negative benefits that will arise from this element.

The construction of the engineering structures to avoid damage from potential natural hazard events is also likely to create some additional jobs or attract skilled workers from outside of the district. Though this would be on a small-scale and would be temporary. For this reason, we have classified additional employment opportunities as a 'low impact' element.

3.3.8 Loss of Tourist numbers and expenditure (Indirect)

Loss of tourist revenue is an indirect impact of natural hazards that results from damage to popular tourist facilities (campgrounds, walking tracks, accommodation, attractions), increased risk perception and interruption of roading and transport networks[93]. Furthermore, if tourists feel unsafe or threatened at the destination, they are less likely to visit again or recommend it to others[94].

Weber (2006) uses the example of rock falls, landslides, debris flows and avalanches impacting the number of tourists present in the Swiss Alps, which in turn impacts the revenue made by tourism companies. In the medium term (more than three years), the hazard events did not continue to affect the popularity of a tourist destination.

Looking at earthquakes as the most representative example of a natural hazard, it was found that the frequency of earthquakes had a greater impact on tourism than the scale and intensity of earthquakes[95]. This suggests areas with a known history of natural hazards occurring are more likely to be impacted by a decline in tourist numbers.

Day trippers usually reacted a little more strongly, but also recovered faster than overnight visitors. Domestic tourism was found to decrease less dramatically and more briefly than inbound tourism. Individual tourists tended to come back sooner than group tours. Examples of past events showed that tourist streams usually dropped immediately after an event, but that tourist numbers normally recovered quite quickly. Larger events can lead to falsified pictures and stronger reactions with tour operators that are based far away from the hazard event, while smaller and closer tour operators usually react more flexibly. And small events tended to be barely noticed by large international tourist organisations.

According to tour operators, reservations and bookings normally resumed as soon as the media interest declined. Regular guests are more resistant to medium reports and normally abide by their destinations advice also after the event occurs. Adventure tourists get less discouraged by medium events.

After the Boxing Day tsunamis, guests in higher price segments came back faster, but this must also be viewed in conjunction with the faster reconstruction efforts of the luxury hotels compared to low-budget places.

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[93] Kjekstad, O., & Highland, L. (2009). Economic and social impacts of landslides. In Landslides–disaster risk reduction (pp. 573-587). Springer, Berlin, Heidelberg.

[94] Ma, H., Chiu, Y. H., Tian, X., Zhang, J., & Guo, Q. (2020). Safety or Travel: Which Is More Important? The Impact of Disaster Events on Tourism. Sustainability, 12(7), 3038.

[95] Ma, H., Chiu, Y. H., Tian, X., Zhang, J., & Guo, Q. (2020). Safety or Travel: Which Is More Important? The Impact of Disaster Events on Tourism. Sustainability, 12(7), 3038.

Reduced visitor numbers were reported as the most disruptive factor affecting tourism operators following the Christchurch earthquakes[96]. Survey respondents reported a change in the type of tourists with 70% of tourism operators seeing reduced numbers of international visitors.

Loss of tourist numbers and tourism spending is an indirect impact and therefore of lesser importance in the event of a natural hazard occurring. The benefit of introducing natural hazard management options is a likely reduction in the disruption to the number of tourists after a natural hazard occurs. We have classified loss of tourist numbers and expenditure as an effect that will have a 'low impact' in the Queenstown-Lakes context because there are lots of alternative places for tourists to stay in the district.

One of the costs of the proposed management options will be a reduction in the number of tourists that will stay in the communities under some of the options, which will in turn impact the available spending in local retailers from tourists.

3.3.9 Flow on impacts into other industry sectors (indirect)

Tourism consists of a service chain, into which several providers are involved; those companies are likely to be negatively impacted if tourism companies experience a downturn. The benefit of introducing natural hazard management options is greater certainty and less disruption to businesses after a natural hazard. We have classified flow-on impacts into other industry sectors as an effect that will have a 'low impact' due to the relatively small scale of change in the localised fans.

One of the costs of the proposed management options will be a reduction in the number of people that will live, work and play in the communities under some of the options, which will impact the turnover of local businesses directly and have negative impacts on the industries further downstream.

3.4 Social Capital

This describes the norms and values that underpin society. It includes things like trust, the rule of law, the Crown-Maori relationship, cultural identity and the connections between people and communities. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely outcomes if natural hazards were to occur in a do-minimum scenario.

3.4.1 Fears and Aspirations – Public acceptability of Proposals

Public perceptions of proposals will vary over time and with experiences. There are likely to be instances of particular groups, and communities, having specific responses. Communication and engagement will be essential to limit tension and provide assurances.

One of the costs of the proposed management options will be increased uncertainty about what the proposed management options mean for households and businesses. That uncertainty may lead to high

[96] Orchiston, C., Vargo, J., & Seville, E. (2012). Outcomes of the Canterbury earthquake sequence for tourism businesses.

levels of emotional stress by those parties and for this reason we have classified this element as having a 'high impact'.

3.4.2 Perceptions about Safety and Security

Perceptions of safety will depend on actual safety performance and will also be based on the advice that is communicated to the public by local authorities. While perceptions may be unfounded in fact, it is important to recognise that they still influence behaviour regarding the natural hazard. This outcome is important in determining how individuals, households and tourists view the risk of a potential hazard in the community, and their level of preparedness before, during and after a hazard event.

The costs of the proposed hazard management options are likely to relate to increased fear about loss of life, injuries and building damage that will arise from public consultation. The presence of visible engineering structures will have both a positive effect of reassuring people that they are safer from risks, but also a negative effect from the constant reminder of the likely threat of danger. People will respond differently and for some people the threat will create significant stress, while for others, there will be less stress. After a natural hazard event has occurred people will be grateful to have avoided harm or feel unsafe because some properties were affected that potentially were not anticipated to be by the general public. For these reasons we have classified perceptions about safety and security as 'high impact'.

3.4.3 Displacement of Residents

Temporary displacement of residents at the time of a hazard event, and during recovery from the event. The number of displaced residents is a good measure for social disruption. One of the benefits of the hazard management options is that in the event of a natural hazard, in some cases fewer people will be impacted, meaning fewer people need to move their households. One of the costs of the hazard management options is that some residents will be permanently displaced. Due to the small scale of relocations both for the management options and in the event of a natural hazard, we have classified this element as 'medium impact'.

3.4.4 Community Cohesion, stability and character

Deloitte (2016)[97] identified that strong social capital correlates with more effective recovery and resilience[98] from natural disasters and identified that funding of disaster mitigation measures should include funding for social measures. Such measures would include community awareness, education and engagement programmes that enhance social capital by building social networks and connections. There is a role of facilitating the connections between communities, not for profits, emergency management agencies, businesses, and governments to collaborate, design and deliver preparedness campaigns, while fostering a culture of connectedness and resilience.

Natural hazards can shape communities through shared experiences, creating support networks and community cohesion. However, as Miller (2006) discovered, community experiences following natural hazards are not all positive with reports of increasing distrust among residents and looting after Hurricane

[97] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[98] Albrecht, F. (2018). Natural hazard events and social capital: the social impact of natural disasters. Disasters, 42(2), 336-360.

Katrina. The challenge of involving citizens in recovery-related decision-making was highlighted as a learning from the Christchurch post-earthquake recovery, especially given the significance of decisions, and the impact they have on the affected community, people's lives and livelihoods.

Fostering and maintaining community cohesion, stability and character should be given significant importance in the event of a natural hazard as this form of social capital is key to overcoming the adverse impacts of such disasters.

One of the benefits of the community consultation and engagement that will be undertaken as part of identifying which hazard management options are progressed is that in the event of a natural hazard, people will be more aware of their neighbours and potentially more responsive to those in need. One of the costs of the hazard management options is that some residents will be permanently displaced, and the built character of the communities is likely to change. Due to the small scale of people impacted by the management options and in the event of a natural hazard, we have classified this element as 'medium impact'.

3.4.5 Sense of Place

After a natural hazard event, community dislocation in the immediate recovery from the natural hazard, and long-term re-construction of buildings and infrastructure can change the ease of getting around and sense of place for the community[99]. Homes are often no longer a place of refuge.

The sense of place for a neighbourhood can change if developers seize the opportunity to acquire damaged properties and seek to develop more intensive housing developments, which is out of keeping with other non-damaged properties remaining in the neighbourhood[100]. A potential area for conflict is how residents see the goals for recovery from a natural hazard event. A large proportion of the community will seek to restore the community to the way that it was prior to the damage, while others might have more aspirational goals for urban renewal[101]. We have not assessed this element for the post natural hazard context because there are similarities with the community character element and it is difficult predict how the community would react.

The costs of hazard management options include relocation of buildings and erection of some highly visible engineering solutions which is likely to change the sense of place in the fans. Due to the relatively small scale of relocations and changes to the built and physical landscape, we have classified this element as 'medium impact'.

3.4.6 Way of Life and Reverse Sensitivity

After a natural hazard event victims often experience negative impacts to their quality of life, predominantly associated with available housing options. For example, in the initial stages, availability of temporary shelter and housing units will be an issue. Temporary homes are often located outside of a victims' usual neighbourhood, and this makes travel to work, school, shopping and friends and neighbours more difficult and costly. In addition, due to the limited availability of properties, building characteristics

[99] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[100] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[101] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

can be problematic due to the lack of affordability, inadequate size, poor quality and designs that do not suit household's requirements[102].

Victims of damaged properties and buildings typically try to occupy temporary homes on their own lots while waiting for the completion of permanent housing replacements and repairs, as a way of reducing costs and integrating back into their neighbourhoods and ways of life. This can create tensions with neighbours if the homes are perceived as a blight on the neighbourhood[103].

Owners of holiday homes will have limited opportunity to stay in their properties until they are replaced or repaired and will experience the associated stresses of organising the replacement and repair work.

These factors all impact on residents and businesses way of life. The benefits of some of the natural hazard management options are that fewer people will be impacted by natural hazards and therefore residents and workers will have less disruption to their way of life.

The costs of the management options relate to the loss of people from the community which may impact the way of life of residents and the reverse sensitivity for properties which are located adjacent to the engineering structures. Due to the relatively small scale of changes in the fans, we have classified this element as 'low impact'.

3.4.7 Culture and identity, including community aspirations, heritage and cultural values

Natural hazards can destroy places with important heritage and cultural values, as was demonstrated in the Christchurch community with the loss of many heritage buildings and churches[104]. There are no significant heritage places or sites of significant cultural values that we are aware of within the areas of high-risk. Nevertheless, this element needs to be recognised, but has been classified as 'low impact' in the Gorge Road context and has not been assessed in the SIA.

The costs of the management options relate to the loss of sites and buildings with heritage and cultural values. Due to the relatively small scale of changes in the fans and the absence of heritage or culturally significant sites or buildings, we have classified this element as 'low impact'.

3.4.8 Impacts on Te Ao Maori

Planners should communicate and engage with Maori regionally and locally and recognise Treaty partnerships in planning, design features, safety and creating social places. While significant in the New Zealand context, Te Ao Maori outcomes that could occur from a natural hazard risk in the Gorge Road area may be of limited importance.

The costs of the management options relate to the impacts on Te Ao Maori. Due to the relatively small scale of changes in the fans and the absence of culturally significant sites, we have classified this element

[102] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[103] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[104] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

as 'low impact'. This is an area that needs further consultation with iwi groups to ensure that the preferred management options do not adversely impact this element.

3.4.9 Grassroots Community Organisations (indirect)

New and existing community groups can emerge or increase their visibility by trying to support some goals and undermine others[105]. This is an indirect outcome and therefore less important. This is an effect that will arise due to the management options, but is a positive effect, rather than a cost. Due to the relatively small scale of changes in the fans, we have classified this element as 'low impact'.

3.5 Natural Capital

Refers to all aspects of the natural environment needed to support life and human activity. It includes soil, water, plants and animals, as well as minerals and energy resources. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely outcomes if natural hazards were to occur in a do-minimum scenario.

3.5.1 Environmental and Landscape Effects

Landscape damages are inevitable from natural hazards and the scale and severity are tangible measures of the environmental impact[106]. This SIA does not assess the impacts on landscape damages due to natural hazards because it is an inevitable and unavoidable consequence of natural hazards.

The costs of the management options relate to the impacts on the natural environment. Some of the engineering options will change the natural course of the streams and creeks and will have visually dominant landscape effects. For those reasons, we have classified this element as 'moderate impact'.

3.6 Council Costs

While the costs that will accrue to Council fall into each of the LSF Capital stocks, Council has requested that we assess the costs to Council in a separate report section in order to maintain consistency with the CBA methodology. This section provides context about the benefits that will accrue after a natural hazard event and outlines the costs likely to be generated by the proposed hazard management options.

3.6.1 Communication and Public Safety Management

A region's ability to minimise the negative impacts from a natural hazard can be directly related to the preparedness for crisis management and communication[107]. The reaction potential depends on the

[105] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[106] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

[107] Weber, F (2006). Natural Hazards: Increasing Challenges for Tourism Destinations. Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

following factors: experience and preparation for a natural hazard, organisation and structure of natural hazard management, implemented measures (organisational, technical etc), existence of danger maps, effectiveness of a disaster plan, insurances, the level of co-operation with authorities, the degree and sensitisation of the population, existence and condition of protection forests, event analyses, adaptability and learning aptitude of the responsible authorities[108]. Communities that are more likely to be impacted by natural hazards are much more likely to be engaged in hazard mitigation and emergency preparedness to reduce their vulnerability than for those that are less likely to be impacted.

Planning to be prepared when disaster strikes, by identifying specific segments of the community that are likely to be disproportionately impacted (i.e., low-income households, ethnic minorities, or specific types of businesses) can help local authorities and planners to develop strategies to help those communities. It is also useful to understand where those communities are located when developing approaches for managing hazards[109].

Restoring damage and enabling a community to return to normal daily life after an event is a crucial way of minimising the long-term effects to communities.

Tangible costs include preparedness in emergency response capability and mobilisation costs[110]. Close co-operation between public authorities and tourism entities is required prior to an event, during the event, and in the final stages of cleaning up after the event. Resilient and prepared communities are more likely to withstand the negative impacts of natural disasters[111].

The Deloitte (2016) report emphasises that investment in resilience and mitigation measures such as community awareness, education and engagement programmes can have a significant impact in the reduction of social and psychological impacts. There are two types of approaches. Firstly, preparedness and mitigation strategies reduce the exposure and vulnerability of individuals and communities by shifting the mindset to proactive preparedness and prevention. Secondly, community recovery efforts boost social connectedness and support individuals and empower them to adapt and improve post-disaster. The ability for individuals and communities to be prepared, and resilience through communication and public safety management, is especially important when weathering the negative impacts of a natural disaster.

These are costs to Council that will incur irrespective of the hazard management options, however some of the management options will affect the numbers of people that need to be engaged with and potentially impacted during a natural hazard event. This element has been classified as 'high impact' because the Deloitte Access Economics Report (2016) highlighted that if done well, it can generate positive impacts for the community.

[108] Weber, F (2006). Natural Hazards: Increasing Challenges for Tourism Destinations.

[109] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[110] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[111] Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities (2016). The economic cost of social impact of natural disasters.

3.6.2 Additional expenditure by public authorities

Natural hazards have important implications for public finance and expenditure, especially immediately following an event, during the recovery as well as long-term mitigation and planning[112]. Initially costs can be measured for emergency operations in terms of volume of labour, workdays employed, costs of equipment and resources[113]. Costs must be incurred for damage assessment, emergency demolition, debris removal, clean-up costs, temporary housing relief, infrastructure restoration and replanning for redevelopment of impacted areas. In addition to these costs, there will be decreased revenues due to loss or deferral of sales taxes, business taxes, property taxes, personal income taxes, and user fees[114].

Following the 2016 Kaikoura earthquake, critical government functions such as health services, civil defence protection and social benefit payments saw an increase in demand compared to non-critical government functions[115].

The CBA and SIA in this assessment has concentrated on the following additional costs of hazard management options:

- Community engagement
- Capital Costs
- Maintenance of hazard management schemes, and
- Costs for funding the engineering structures.

There are also benefits after a natural hazard event has occurred including effects on clean-up costs, disruption to revenue collection from ratepayers and community engagement.

These elements have been classified as 'high impact', as the costs to Council will likely flow onto ratepayers, or potentially taxpayers if central government is required to provide assistance.

3.7 Summary

There are a wide range of social impacts that may arise from natural hazards and the time taken to recover from the impact of disasters, is usually a function of preparedness. Individuals and households with some form of contingency plan in place, are likely to recover more quickly than those without any such plans.

The direct and indirect socio-economic impacts of the proposed land use and engineering management options are likely to represent the reduction in the costs and increases in the benefits associated with natural hazards. Section 5 explores the likely socio-economic impacts that will arise from the proposed

[112] World Bank. 2005. Natural Disaster Risk Management in the Philippines: Enhancing Poverty Alleviation Through Disaster Reduction. Washington, DC. https://openknowledge.worldbank.org/handle/10986/8748

[113] Ademola, A., Adebukola, D, Adeola, C, Cajetan, A and Christiana, U (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria in International Journal of Disaster Risk Reduction (17) 1-12.

[114] Lindell, M.K. and Prater, C.S. (2003). Assessing Community Impacts of Natural Disasters in Natural Hazards Review Vol 4(4).

[115] Brown, C. O., Horspool, N., Sampson, K., MacDonald, G. A., Seville, E., Smith, N., & Stevenson, J. R. (2018). Lessons from the 2016 Kaikoura Earthquake: Understanding the Impacts of a Potential Alpine Fault Earthquake on Government Productivity in Wellington. Resilient Organisations.

land use and engineering management options using the wellbeing outcomes discussed in this section as a framework for assessment.

4 Community Situation

A key input into socio-economic impact assessments is the nature and range of people, households and businesses that live, work, visit, operate or own property in the area that will be impacted by a natural hazard event or a change of policies. It is also important to understand what those communities are likely to look like in the future - without interventions or natural hazard events. This section describes the socio-demographic structure of the communities residing and working in Brewery Creek and Reavers Fan to provide a baseline for assessing the likely socio-economic impacts.

4.1 Datasets and Geographic Scope

This section relies on secondary datasets to describe the scale and composition of residential, business and tourism activity within Brewery Creek and Reavers Lane fans. The most detailed geographic level at which Statistics New Zealand publishes population, household and business demographic data is Statistical Area 1 (SA1) geographies. SA1s are much larger (approximately 1.5-2 x larger) than the specific alluvial fan study areas (see Figure 4.1 and Figure 4.2), meaning that data presented in this section is for the wider statistical area, rather than for the alluvial fan extents.

Figure 4.1: Brewery Creek Statistical Boundary Definition.

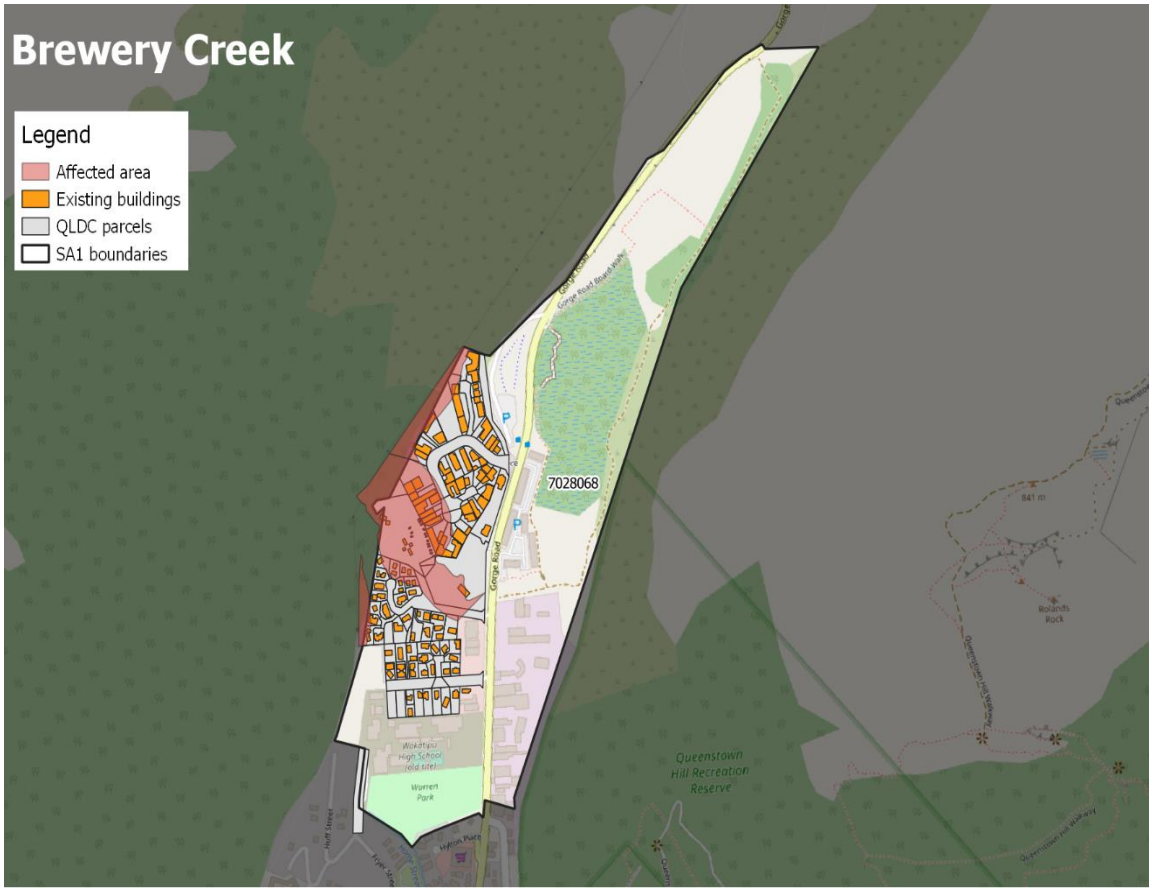

Figure 4.2: Reavers Lane Statistical Boundary Definition.

The data presented is from the latest Census (2018). Although it is likely that Covid19 may have had some impact on the number and types of people living in households within the area, the level of change has not been estimated. For this study, we have assumed that similar people and households are likely to choose to live in the area once the economy recovers and adapts to the impacts of Covid19.

4.2 Population Demographics

4.2.1 Population and Households

In 2018, there were 330 people living in 95 households, with an average household size of 3.5 people in the SA1 that include Brewery Creek. In Reavers Lane, there were 590 people living in 155 households, with a larger average household size of 3.9 people.

Approximately 2.3% of Queenstown's total population live in the two study areas. Population growth since 2013 has been slower in the study areas than for the entire district (38.7%), though Brewery Creek has been only slightly slower (37.5%) in comparison to Reavers Lane (21.6%).

4.2.2 Demographics

Age

The majority of population of both study areas in the working aged cohorts, 47% are aged 15-29 years and a further 42% aged 30-64 years. In Brewery Creek, approximately 14% of the population were children (<15 years), compared with 6% in Reavers Fan. For both locations, there were significantly lower shares of retirement aged people in comparison to the district overall.

Ethnic Profile

The ethnic profile was predominantly European (56%), which is much lower than the share in the District population. There were also much higher shares of Asian (22%) and MELAA[116] (16%) populations than for the district overall (9% and 4% respectively).

Personal Income

The median personal income in Queenstown-Lakes district was $40,600. Approximately 40% of people living in the study areas earnt between $30,001 to $50,000. When compared to the wider district, there were lower shares of individuals earning more than $70,000, with 7% in Brewery Creek and 9% in Reavers Lane in comparison to 20% district wide.

Source of Income and Employment Status

Reflecting the high shares of working aged residents, there are much higher shares of residents who are engaged in paid employment in the two study areas (75%) than for the district (50%). There are commensurately lower proportions of people earning incomes from self-employment, investments, and benefits. Residents are much more likely to be employed full time (84%) than for the district (66%).

Education Qualifications

Reflecting the high shares of Asian and MELAA residents, residents are much more likely to have obtained overseas educational qualifications (23%) than the average Queenstown resident (10%).

Home Ownership

There were low rates of home ownership, with 80% of households in occupied private dwellings not owning their own home or holding it in a family trust.

[116] Middle Eastern, Latin American and African

Figure 4.3: Brewery Creek and Reavers Lane Demographic Profile, 2018

Demographic Variable		Brewery Creek	Reavers Lane	Queenstown
Age	Children	14%	6%	17%
	Working Aged	85%	92%	73%
	>65+ years	1%	2%	11%
Ethnicity	NZ European	47%	62%	78%
	Asian	25%	20%	9%
	MELAA	20%	14%	4%
	Maori	4%	2%	5%
	Other	3%	2%	3%
Home Ownership Rates		20%	21%	39%
Personal Income	$0-$30,000	38%	41%	34%
	$30,001-$50,000	39%	41%	29%
	$50,001-$70,000	15%	10%	18%
	>$70,001	7%	9%	20%
Source of Income	Paid Employment	70%	77%	50%
	Self Employment	11%	7%	18%
	Private Investments	4%	4%	15%
	Benefits and Allowances	12%	11%	15%
	No Source	3%	1%	2%
Employment Status	Employed Full-time	84%	84%	66%
	Employed Part-time	6%	7%	14%
	Unemployed or Not in Workforce	10%	9%	19%
Educational Quals	Secondary School	39%	34%	49%
	University Undergraduate	19%	23%	19%
	University Postgraduate	12%	9%	13%
	Overseas	19%	26%	10%
	None	11%	9%	9%

4.2.3 Household Profiles

We have examined customised data from Statistics New Zealand from the Census, which characterises households according to family types, age and income to understand the range of household types (294 household types) living in the catchments of Brewery Creek and Reavers Lane. This assessment shows that there is a relatively high intensity of non-family with young working age households and higher incomes in the area compared to the rest of the District (See Appendix 1).

The key patterns were:

- There is a high proportion of working aged couples with high incomes (>$70,001).
- There are very high shares of non-family households (29%) compared with 9% for the district.
- Of the non-family households, all of the households are under retirement age, and there are very low shares of households earning less than $70,001.
- There is a higher prevalence of working aged single person households for all incomes than for the district overall.

- The location does not appear to be attractive to families with children for most incomes, except for young middle-income families.
- There were 23 multi-family households in the study area.

4.2.4 Natural Hazard Risk Considerations for the Resident Population

The demographic assessment has highlighted that the population living in both areas are more likely to be able to escape in a natural hazard event, with lower shares of children and elderly people (100 people in 2018), provided there is sufficient warning time.

Based on the census data, our site visit and discussions with council officers, it is considered that many of the households living in the area are transient in nature. Specifically, a large share of dwellings will be likely to be occupied by seasonal, tourism and hospitality workers, with multiple young working aged people living together. This is shown in the high rates of rental properties, low rates of children and older cohorts, lower than average individual incomes, and the ethnic diversity. Those people are more likely to be physically capable of responding to a natural hazard risk, but less likely to be able to cope with the financial outcomes. They are likely to be more mobile and less connected to the local area, so will potentially find it easier to relocate to other locations in Queenstown than homeowners, families and older generations.

The demographic analysis has also highlighted some key areas of concern for public safety and emergency management. Regular and consistent communication of information to households about the natural hazard risks and what to do in the event of an emergency will be required because there is likely to be significant household churn. That information will need to be published in a range of Asian and MELAA languages for residents to be able to clearly understand the natural hazard risks and emergency procedures.

4.3 Business and Tourism Activity

4.3.1 Business Activity

In 2020, there were 210 businesses located in the study areas, providing employment for 1,330 people[117] (MECs)[118]. Approximately 62% of jobs, and 64% of businesses, were located in Brewery Creek study area. This information is used in the Social Impact Assessment, to provide an understanding of the nature of the community in the "study area", which is much wider than the fans or the area affected by the hazard. Unfortunately there is no detailed data on who lives or works in the areas affected by the hazard.

The industry profile of employment differs across the two areas, with administrative and support services (130 jobs), retail trade (95 jobs), education and training (85 jobs) and accommodation and food services (85 jobs) being the most dominant employers for Reavers Lane (Figure 4.4). In Brewery Creek, the main employment was in the following sectors: construction (130 jobs), retail trade (90 jobs), transport, postal and warehousing (85 jobs), and manufacturing (70 jobs). Brewery Creek is an important location for

[117] Statistics NZ Business Directory, 2020, modified by Market Economics.

[118] Modified Employment Count, which includes an estimate of working proprietors as well as employees.

employment in other services and wholesale trade sectors accounting for 11% and 9% respectively of Queenstown's urban area employment in these industries.

Figure 4.4: Industry Sector Businesses and Employment in Brewery Creek and Reavers Fan, 2020

Industry Sector	Brewery Creek		Reavers Lane		Queenstown Lakes	
	Businesses	Jobs	Businesses	Jobs	Businesses	Jobs
Agriculture, Forestry and Fishing	2	1	1	1	330	750
Mining	-	-	-	-	20	20
Manufacturing	9	71	-	-	270	1,060
Electricity, Gas, Water and Waste Services	-	-	-	-	30	160
Construction	21	128	9	26	1,600	4,750
Wholesale Trade	10	60	-	-	170	660
Retail Trade	13	89	7	96	550	3,770
Accommodation and Food Services	7	60	6	87	750	7,770
Transport, Postal and Warehousing	8	85	6	5	350	1,610
Information Media and Telecommunications	2	17	-	-	160	410
Financial and Insurance Services	2	0	4	1	630	400
Rental, Hiring and Real Estate Services	16	12	12	24	1,890	1,370
Professional, Scientific and Technical Services	8	45	5	24	930	2,340
Administrative and Support Services	9	52	9	128	440	2,560
Public Administration and Safety	1	60	-	-	50	760
Education and Training	2	13	8	87	120	1,140
Health Care and Social Assistance	2	6	3	22	260	1,120
Arts and Recreation Services	5	24	3	4	310	1,870
Other Services	15	97	4	8	280	890
Total	**133**	**821**	**76**	**512**	**9,140**	**33,410**

4.3.2 Tourism Activity

There are a number of tourism businesses located in the study areas. The key concern regarding tourism is the ability to communicate danger and evacuation procedures to tourists, as well as their needs after a natural hazard event occurs.

In Brewery Creek, there is a campground, QBox Motorhome Queenstown, which has been identified as being in the highest risk area, especially from floods and associated debris flows. There are 17 powered, and 40 non-powered sites, and a further three cabins, one studios and chalets operated by QBox, which would enable approximately 130 visitors (at peak).

Reavers Lane contains five accommodation providers, comprising of motels, lodges, and a holiday park, including:

- Coronet View Apartments: 11 smaller sized apartments/studios and B&Bs, and 6 larger sized apartments.
- Reavers Lodge: 94 rooms.
- Pinewood Lodge: 27 rooms.
- Bella Vista: 24 smaller sized rooms, and 4 larger sized rooms.
- Queenstown Holiday Park and Motels Creeksyde: 92 powered sites, 2 electric vehicle sites, 18 apartments, and 5 lodge rooms.

The Coronet View Apartment, Reavers Lodge and Pinewood Lodge are located in the areas with the highest natural hazard risk.

4.3.3 Natural Hazard Risk Considerations for Businesses and Tourism

The businesses that are most likely to be directly affected by a natural hazard event are all accommodation providers. Though there are also risks to some of the established industrial premises on the edge of Brewery Creek. Tourists are vulnerable to natural hazard events. Businesses also provide employment, income and access to goods and services which people in the wider community utilise. Impacts on businesses could have flow-on impacts into households' responses to any natural hazard event.

4.4 Future Activity

4.4.1 Development Pressure

Queenstown-Lakes District is one of the fastest growing territorial areas in New Zealand, and the zoning policies and objectives designed in the PDP attempt to make provision for residential and business growth near to the Queenstown CBD. To understand how much development has occurred recently, and what is planned, we have drawn on a secondary dataset from Pacifecon. They collect information from planners, consent authorities, industry bodies and commercial developers to form a comprehensive dataset showing an overview of recent market activity.

Recent consented activity in Brewery Creek includes:

- A commercial extension of an industrial building (2018)
- A change of use to a commercial property to a gym (2019)
- Two new houses (<$1 million) (2019 and 2020)
- Q Box Accommodation has large scale redevelopment plans for their site including three new buildings for high intensity tourism accommodation activity. Currently the resource consent is in a holding pattern.

For Reavers Lane, the most recent consented activity includes:

- One four-bedroom house (2018)
- Six residential unit or apartment consents, providing over 60 new dwellings or visitor accommodation units.

This data shows that there is currently market pressure for additional tourism accommodation in the area to capitalise on the closeness of the Queenstown CBD. There has also been pressure for new residential developments. At the time of our site visit, there was evidence of older properties being replaced with multi-unit developments. It is likely that without the presence of the natural hazard risks there would be residential growth pressure in this wider location. This pressure is concerning given the natural hazard, and more intensive land use would increase the scale of risk to households, businesses and tourists.

4.4.2 Future Land Use

Currently there is 19,660 m^2 in Reavers Lane and 10,970 m^2 in the Brewery Creek of floorspace in the hazard area (Figure 4.5).[119] Under the Status Quo scenario the total floorspace area for both areas may increase by 30,100m^2 to 2051.[120] The number of people present in the fans may almost double by 2051.

Figure 4.5: Development Path Built out and Community Activity - Status Quo Scenario

	2021	2031	2041	2051
Built Floorspace (sqm)				
Reavers Fan	19,660	24,510	29,360	34,210
Brewery Creek	10,970	16,150	21,320	26,500
Total	30,630	40,660	50,680	60,710
Community (Live, Work and Visit)				
Reavers Fan	630	790	940	1,100
Brewery Creek	330	450	580	700
Total	960	1,240	1,520	1,800

4.5 Summary

While there are fewer vulnerable people living in both locations (in terms of children and older ages), the demographic analysis has highlighted some key areas of concern for public safety and emergency management. The key considerations are that the populations and households living in this area are likely to be transient and moving more frequently than those habited by homeowners. These people are likely to have fewer local connections or resources to draw on in the event of natural hazards, which means they will face greater burdens than other communities in more stable suburbs.

This means that there will need to be regular and consistent sharing of information to households and visitors about the natural hazard risks, the probability of natural hazards occurring and what to do in the event of an emergency. There will need to be published information that is in languages other than English, specifically a range of Asian and MELAA languages, and it is also likely that tourists will need information in a wider variety of languages.

The Pacifecon information demonstrates that both locations have been identified as being suitable for tourist accommodation, and due to the presence of other tourism providers and the relatively short distance to the Queenstown CBD that there will be pressure in coming years for more developments of this nature. Section 3.2.4 discusses the range of social impact issues that tourists may experience in relation to a natural hazard in more detail.

Based on our site visit it is clear that the area mostly consists of older dwellings and commercial buildings. There have been some recent developments on the edge of the hazard areas of each fan. There has been limited new development within the hazard areas. However, some of the sites within the hazard area have

[119] Queenstown Lakes District Council (2020) Gorge Road Hazard Build Environment Modelling – 2020 Current Buildings.

[120] Queenstown Lakes District Council (2020) Gorge Road Hazard Build Environment Modelling – 2120 Uncontrolled. For this report the development is assumed to be taken up over the coming 100 years.

relatively low intensity of use and may become more intensively developed in the future. The wider location is viewed as a highly strategic location for development and business within the district, due to its accessibility to Queenstown's CBD and the area of flat land which is at the bottom of the foothills. Given the high growth pressures in Queenstown, up until the natural hazard risks were identified, the area was viewed as providing important levels of capacity for growth and redevelopment.

5 Socio-Economic Impacts

This section describes the range of socio-economic impacts likely to arise from the four proposed land use and engineering management options assessed for this research. The social wellbeing outcomes are described under the Living Standards Framework capitals and are primarily ordered in terms of the relative weighting of the likely impacts. Each section is separated into the costs of the management options and the benefits arising during and after a natural hazard event.

An economic consequence of increasing urbanisation identified by Ademola et al (2016) is that the consequences of natural hazard disasters impacting large cities can have a bigger impact than if they occur in lower density areas, due to the higher concentrations of people, infrastructure, assets, and economic activity. High density urban areas can complicate the ability of the population to evacuate out of harm's way in a natural hazard event. However, there is the potential for urbanisation to improve the resilience of communities to recover from natural hazards due to improved building standards and planning mechanisms that can be achieved by clustering people together and planning for emergency situations.

The key message for QLDC is that the more people living, working, and visiting a location, the more likely that the socio-economic impacts arising from a natural hazard event would be higher than if lower density land uses were present in the hazard risk zones.

5.1 Human Capital

This section describes the likely effects of the proposed management options on people's physical and mental health and skills and knowledge. These are the elements which enable people to participate fully in work, study, recreation and in society more broadly. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. This section describes the likely costs of the management options firstly, before describing the benefits that will accrue after a natural hazard event.

Costs of Hazard Management Options

5.1.1 Uncertainty while awaiting planning decisions

There is likely to be a high level of emotional stress experienced by property owners and people residing and working in the area about the what ifs related to the uncertainty around natural hazard risks and management options.

Prior to PDP changes being made, and after community consultation, there may be some members of the community that will fast-track consent applications to achieve a higher density before they are prevented from maximising the capital value from their properties. These actions will be contrary to the management objectives and could potentially be risky if land values and insurance rates are impacted by the PDP decisions.

Most property owners will be concerned about what the proposed changes mean for their ability to increase their personal wealth through the development potential of their land. This uncertainty and the likely financial impact on property owners is likely to create bad sentiments, frustration, and mistrust with the Council. Such sentiments have been expressed in other New Zealand locations, such as at Matata, with residents feeling disillusioned by decisions made to retreat from landholdings[121].

Under the Manage Risk option, there will be some businesses (tourism accommodation providers) and property owners who will face uncertainty about the future income generating potential of their land.

There will be more certainty for property owners whose properties will be acquired by Council under the Reduce Risk, and Engineering A options, at least in terms of securing a fair market value for the property. Those households and businesses will still face uncertainty and new decisions about where to relocate to. There will also be a sense of loss and having control taken away for landowners not anticipating the loss of their homes and land.

Under the Status Quo and Engineering B option, there is likely to be a positive response from property owners towards Council by enabling property owners to achieve higher land use intensities. Those residents will also have greater awareness about the potential threats, and under Engineering B option will have more protection from small natural hazard risks.

This plan change, the community consultation and associated informal discussions and media coverage may increase awareness generally within the wider community about natural hazard risks which may create undue stress on other property owners located in areas that may also potentially be affected by natural hazard risks that have not yet been investigated by council. Conversely, increased information about the hazard can assist with preparedness.

We have classified the effects of uncertainty while awaiting planning decisions as 'moderate-impact' due to high levels of stress that will be created for individuals which can often be difficult to measure, even if they are experienced only over a short timeframe.

5.1.2 Disruption during construction of engineering options and removal of structures

The effects of disruption during construction of engineering options and removal of structures are likely to be felt across a short timeframe. For this reason, we have rated the social wellbeing outcome as having a 'low impact'.

There will be no disruptions under the Status Quo and Manage Risk options.

Under the Reduce Risk option there may be some limited disruptions (e.g., noise, dust, heavy traffic movements, traffic delays) due to the removal of existing buildings in areas of significant and intolerable risk. This management option will be the most disruptive, as it will result in some businesses being required to leave their premises. This will include some commercial accommodation providers and some industrial tenants.

[121] https://i.stuff.co.nz/environment/123216408/moving-day-at-matat--the-end-of-one-familys-fight-against-managed-retreat

The Engineering A option is most likely to cause short term disruption to the community through the construction of the debris flow channels, and removal of properties along the channel path in Reavers Lane.

The Engineering B option is likely to cause lower levels of disruption to the community than the Reduce Risk option, though with most activity occurring away from residents and businesses.

5.1.3 Daily Travel Movements

There are unlikely to be any significant changes to daily travel movements under all land use management and Engineering B options, though with fewer people, workers and visitors under the Manage Risk and Reduce Risk options it will be easier to move around the alluvial fans.

Once the debris flow channel is constructed in Reavers Lane, there will be significant changes to cross catchment daily travel movements due to the physical barrier that it will create. We have classified these effects as 'low-impact' due to the short-term and temporary nature.

5.1.4 Summary of Human Capital Costs of Management Options

The likely outcomes for each of the human capital costs are ranked in Figure 5.1, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Status Quo option has the least costs, and that the Engineering A option has the greatest costs, especially in the Reavers Lane location. It is important to recognise that these costs are ranked to be of low-medium importance in terms of human capital effects.

Figure 5.1: Rating of Human Capital Socio-economic Costs

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
Moderate Impact										
Uncertainty while awaiting planning decisions										
Low Impact										
Disruption during construction of engineering options and removal of structures										
Daily travel movements										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

Benefits of Hazard Management Options in a Natural Hazard

5.1.5 Loss of Life

In general terms, the greater the number of people that live, work or visit the natural hazard risk zones, the greater the likelihood that people may suffer fatal injuries in the event of a debris flow or rockfall. Experts agree that people who are struck by debris are much more likely to die than become injured. For this reason, loss of life is one of the most important social wellbeing outcomes for this project and has been classified as 'high impact'.

Each of the land use management options will impact population growth in the alluvial fans, with the Status Quo option enabling more people to live in the natural hazard risk zone, and the Reduce Risk option enabling the fewest people in the risk zones (Figure 5.2).

Figure 5.2: Brewery Creek and Reavers Lane People in Hazard area for Land Use Management Options

		2051		
	2021	Status Quo	Manage Risk	Reduce Risk
Reavers	630	1,100	780	330
Brewery Creek	330	700	440	230

For this assessment it is assumed that any person that lives, visits or works within the area are part of the local community. This is a wide definition, which is designed to provide an understanding of the total numbers of people that may be at risk from the hazard events. Every person that is in the area will face similar chances of harm while they are present, regardless of their purpose for being there. However, as outlined in the Beca assessment, the quantity of time spent in the area has an influence on the level of risk faced by an individual. This means the risk can be different for each person depending on the time they spend in the area.

To estimate the potential risks to the local community, this report has estimated the amount of built space that is at risk from the hazard, the numbers of people that could be present in/near those buildings, the risk of fatality for those people and the economic value of preventing potential fatalities.

In any given year, the built space is divided by an assumed average space ratio for each floorspace type – residential (one person per 30m^2), business (one person per 50m^2) and tourists (occupancy of 62%[122] and capacity[123]). This provides an estimate of the local community in any given year.

For example, currently there is expected to be approximately 630 people living, working, or visiting the buildings within Brewery Creek hazard area and 330 people within Reavers Lane. Based on the midpoint probability in each AIFR contour[124] and the number of people within the area, there is an expected fatality rate of approximately 0.3 per annum within both fans.

As more floorspace is developed, the number of people within the fans increases and the expected fatalities increase commensurately. Under the Status Quo option, the annualised number of expected fatalities increases to almost 1 for Brewery Creek and 0.4 for Reavers. This compares to Reduce Risk, which will see the number of people within the higher risk areas decline as buildings are removed. Under this option the expected fatality decreases substantially to 0.02 for Brewery Creek and 0.01 for Reavers.

The final step is then to establish the economic value of preventing the potential fatalities. This report utilises the official Value of Statistical Life (VOSL) which is developed by Waka Kotahi NZ Transport Agency for the assessment of transport projects. The VOSL is not a value of an identified individual life. It is simply a planning statistic which indicates society's preparedness to pay (Willingness to Pay) for projects that will

[122] Statistics New Zealand (2019) Commercial Accommodation Survey.

[123] Market Economics (2021) Accommodation Providers Capacity, Reavers and Brewery Creek Study areas.

[124] Refer to Beca report for a discussion of AIFR contours and midpoint probabilities.

reduce premature fatalities. The VOSL is measured using primary research that elicits values which include a wide range of social costs associated with preventable fatality, i.e., market and non-market values.

There is no particular reason why the VOSL in the present context should differ drastically from VOSL estimated from the traffic crash risk changes. However, there is a possibility for lower values due to a comparatively quick death, with brief pain and suffering caused by this type of hazard. Also, it is not practical to estimate the VOSL for every risk environment due to the high cost of conducting primary research required to establish the value of VOSL. Therefore, this report adopts Waka Kotahi NZTA current VOSL estimate, which is $4.56 million per preventable fatality.

Figure 5.3 shows the annual expected costs of preventable fatality for each management option and each fan. The preventable fatality costs show that in the future Reavers fan is likely to have significantly lower expected costs (i.e., around a million dollars per annum) than Brewery Creek (i.e., mostly above two million dollars per annum) under most of the management options. This difference in costs is primarily driven by the difference in return periods on each fan, with Brewery Creek being much higher than Reavers Lane (that is the probability of the events occurring are greater), rather than there being greater development potential or human activity. This is not unsurprising, as the probability of an event in Reavers[125] is much lower than Brewery Creek[126].

Figure 5.3: Reavers and Brewery Creek Preventable Fatality Costs, (annual, $ million) 2021-2051.

Preventable Fatality Costs ($m)		2021	2051	Change
Reavers Fan				
A	Status Quo	$1.20	$1.60	33%
B	Managed		$1.20	3%
C	Reduced		$0.10	-95%
D	Engineering (rockfall fences & channels)		$1.10	-9%
E	Engineering (rockfall fences and debris flow fences/mesh)		$1.10	-5%
Brewery Creek Fan				
A	Status Quo	$1.70	$4.10	137%
B	Managed		$2.10	22%
C	Reduced		$0.10	-94%
D	Engineering (rockfall fences & channels)		$2.80	61%
E	Engineering (rockfall fences and debris flow fences/mesh)		$2.70	57%

For Reavers fan the value of preventable fatalities could increase from $1.2 million today to $1.6 million per annum by 2051 if the Status Quo development pattern is permitted to continue (up 33%). This compares to $1.1 million for each of the Engineering options and $1.2 for the Managed Risk option. The

[125] Beca report suggests that the small event occurs every 1300 years, moderate event every 4,600 years and large event every 13,350 years. This is an annual probability of an event occurring of 0.1%.

[126] Beca report suggests that the small event occurs every 125 years, moderate event every 1,300 years and large event every 6,250 years. This is an annual probability of an event occurring of 0.9%.

Reduced Risk option is the only management option where the value of preventable fatalities decreases significantly, reaching $0.1 million by 2051 (down 95%).

For Brewery Creek fan, the value of preventable fatalities could increase from $1.7 million today to $4.1 million per annum by 2051 if the Status Quo pattern persists (up 137%). This compares to $2.7-2.8 million for each of the Engineering options (up approx. 60%) and $2.1m for the Managed Risk option (up 22%). The Reduced Risk option is the only management option where the value of preventable fatalities decreases, reaching $0.1 million by 2031 (down 94%).

When compared to the preventable fatality costs in 2021, for Reavers Fan, the Reduce and Engineering options lower risk below what currently exists. For Brewery Creek, only the Reduce option lowers risk. Both the Status Quo and the Managed option allow risk to increase over time on both fans, and on Brewery Creek, the risk also increases from today's levels under the Engineering options.

5.1.6 Number of Injuries

As discussed in relation to Loss of Life, the greater the number of people living in the natural hazard risk zones, the greater the likelihood that people may suffer injuries in the event of a debris flow. The number of injuries is likely linked to the scale of loss of life, though in this case we have been advised by GNS that people are more likely to lose their life as a result of debris flows, rather than become injured. For these reasons, we have classified loss of life as an effect that has a 'high impact'.

Under the Status Quo option, the greatest number of people (households, workers, and tourists) will be in the fans, and consequently there is more likelihood of injuries[127] for small, moderate, and large events. For this reason, this option is likely to lead to the most significant costs associated with hospitalisation, medical and ambulance costs. For those people injured, there are likely to be on-going medical costs which will be felt through lost productivity and costs of medical care for individuals, and wider society will pay for treatment through ACC costs.

Under the Manage Risk option, there will be fewer households, workers, and vulnerable communities (tourists, children, and elderly), especially in areas with hazard risks that are not tolerable, so the rates of injury and associated costs are likely to be lower than for the Status Quo option.

Under the Reduce Risk option, there will be the least number of households, workers, and vulnerable people living in the fans, so the rate of injuries and costs associated with them will be commensurately lower. Of the land use management options, this option will produce the least costs.

Under the Engineering A option, there will be the same number of residents, workers, and tourists in the fans as the Status Quo option, however the rockfall fences and debris flow channels will reduce the risk of injuries from small debris flow events significantly. There will be injuries in moderate and large events because the engineering structures have not been designed to be effective for those scales. The costs associated with injuries will be lower than for the Status Quo, Manage and Reduce risks options, under small events. For moderate and large events, the costs are likely to be higher.

[127] Our understanding is that for major rockfall and debris flow events, the risk to individuals is more likely to result in death than injury.

Under the Engineering B option, there will be the same number of residents, workers, and tourists in the fans as the Status Quo option, however the rockfall fences and debris flow fences will reduce the risk of injuries from small debris flow events. There will be injuries in moderate and large events because the engineering structures have not been designed to be effective for those scales. The costs associated with injuries will be lower than for the Status Quo, Manage and Reduce risks option, under small events. For moderate and large events, the costs are likely to be similar to the Engineering A option.

5.1.7 Health and Wellbeing

There will be an increase in the long-term levels of anxiety relating to the likelihood of a natural hazard event occurring. As was the case with injuries and loss of life, the fewer people living, working, and visiting the fans, the fewer people that will be subject to anxiety and stress.

The key health and wellbeing effects that would result when a natural hazard event occurs, would be that health and wellbeing costs are reduced if fewer people are living in the areas of significant risk or are better protected by engineering structures. On this basis, the Reduce Risk option will have the most positive effects. For small events, the Engineering A and B options would provide better outcomes than the Status Quo option. For large events, greater numbers of people would be impacted, even under the Engineering A and B options.

5.1.8 Impacts for Vulnerable Populations

One of the key research questions that was asked for this project was to identify the likely impacts on vulnerable populations and consider whether tourists can be included in this category, which the literature review confirmed can be done. For this reason, we have weighted this social wellbeing outcome as being weighted as 'high impact'.

As is the case for loss of life, injuries, and health and wellbeing outcomes, the more people living, working, and visiting an area that is subject to a natural hazard, the higher the risk of impacts to that population.

Under the Status Quo option there would be the greatest number of vulnerable located in the fans. There would be slightly more tourists in Reavers Lane (400) than Brewery Creek (375).

Under the Manage Risk option, vulnerable populations would be discouraged from living and working in certain locations impacting their choices of living environments, but also protecting them from loss of life and injuries. Community consultation highlighted that placing greater restrictions on more vulnerable groups (such as elderly, younger people, and tourists) would not be well received by the community. Conversely, there is an argument that fatalities and injuries to those communities in the event of a natural hazard would also be less well received. The Reduce Risk option would result in less fatalities and injuries to vulnerable communities by preventing tourism activities from locating in the areas of the fans with significant natural hazard risks. There would be very few tourists present in Brewery Creek (less than 30) in 2051, and approximately 60 tourists in Reavers Lane.

The Engineering A and B options would provide more choice for living environments for vulnerable people, but at the cost of more chance of death and injuries if moderate and large natural hazard events occur. Providing for more choice for these people would be better aligned with the community's expressed desires

on not restricting vulnerable people's living choices. Under small events, the communities would be reasonably well protected by both engineering options.

5.1.9 Daily Travel Movements

After natural hazard events, there will be some benefits from having roads protected from debris flows, though the scale of the area that is likely to be affected will be small, and the disruptions are likely to be limited. We have classified these effects as 'low-impact' due to the short-term and temporary nature of effects.

There is unlikely to be any change under any of the land use management options. There are likely to be some positive impacts to roading resilience from each of the Engineering options, though there is more potential that the debris flow channel in Brewery Creek will direct the debris flow towards Gorge Road in moderate and large events which may lead to overtopping and blocking of culverts.

5.1.10 Summary of Human Capital Benefits After a Natural Hazard

The likely outcomes for each of the human capital social benefits are ranked in Figure 5.4, where red are the worst outcomes and green are the best relative outcomes for each option. This shows clearly that the Status Quo option has the least desirable results for human capital social wellbeings for Brewery Creek and in some cases for Reavers Lane, and the Reduce Risk option has the most desirable outcomes. Each of the engineering options have reasonable outcomes if small events occur in Reavers Lane, but the impacts increase as the extent and severity of natural hazard impacts arises.

Figure 5.4: Rating of Human Capital Socio-Economic Benefits

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Loss of life										
Number of injuries										
Health and wellbeing										
Impacts for vulnerable populations										
Low Impact										
Daily travel movements										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

5.2 Financial and Physical Capital

This section describes the likely effects of the proposed management options on things which make up the district's produced assets which have a direct role in supporting incomes and material living, such as houses, roads, buildings, factories, equipment, and investments. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely costs of the management options firstly, before describing the benefits that will accrue after a natural hazard event.

5.2.1 Material Wellbeing

Effects on Property Values and Capital Gain

Property purchases are one of the largest assets that the average New Zealand family makes in their lifetime, so any impact on their ability to increase capital gains from their properties will have a negative impact on their material wellbeing. For this reason, we have classified property values and capital gains as an effect that will have a 'high impact'.

Property owners will still be able to maximise capital gains and profit from their land under the Status Quo and Engineering A and Engineering B options. This is an outcome that was favoured by landowners in the community consultation. Under both the engineering options house sales prices in the impacted area may be reduced due to the market perception that the area is subject to significant risk or alternatively buyers may view the debris flow and rock fences as added protection.

Under the Manage Risk option, some property owners in the high-risk contours will be unable to develop their land further. Those properties may also become more difficult to sell in the future, due to information about hazard risk being recorded against the property, signalling some loss of potential income. Being unable to develop further, or only in a limited way, may lead owners to not invest in their properties and/or lower socio-economic property owners to move into the houses, either in a renting or ownership capacity.

For some of the hazard management options, some property owners may be required to sell their land and buildings to the Council or other government organisations. For example, under the Reduce Risk option, property owners will be compensated for the loss of their land, and there is likely to be some loss of income for property owners who are unable to find equivalent properties to redevelop elsewhere in the district.

In this report, it is assumed that the purchase price paid by Council (as estimated in Figure 5.5) is a market value which is sufficient to offset the value of the land and existing buildings to the property owners. Therefore, property owners are assumed to be net neutral, i.e., the purchase price is equal to the value of the existing property.

However, under some of the management options, the future potential use of the land will be different from what is currently enabled. This means that property owners may lose some benefits in terms of use potential, and they will find it harder to acquire an equivalent property elsewhere in the region if properties were purchased some time ago. For example, under the Status Quo option, the property owners in the area could (in theory) build over 100,000m^2 of new floorspace space within both fans. This compares to the Managed Risk option which would allow over 40,000m^2 and the Reduced Risk option which would allow very little additional space. This additional space would generate benefits (e.g., rents) to the property owners. For this assessment we have applied an average yield of 3.59% to the value of the new floorspace that is developed in each management option.[128] Figure 5.5 shows the potential revenue of future development, which was estimated using the development path outlined in Appendix Two.

[128] Real Estate Institute of New Zealand (2020) Residential Investment Property Rental Yield Indicator - Queenstown.

While these values will be important to the property owners in the area, for the most part this value cannot be viewed as net additional from the wider community perspective. The scale of activity enabled within the fans is relatively small compared to the rest of the district. Therefore, any difference in activity between the management options is likely to be offset by changes in development outside of the fans. Hence, the differences in revenue in Figure 5.5will be offset by values that flow to other properties in the district. That is from a community perspective the differences in development potential are not likely to be material.

Figure 5.5: Reavers and Brewery Creek Development Potential, 2021-2051 (annual, $ million).

Development Potential Revenue ($m)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$ -	$ 0.6	$ 1.3	$ 1.9
B	Managed		$ 0.2	$ 0.4	$ 0.6
C	Reduced		-$ 1.2	-$ 1.2	-$ 1.2
D	Engineering (rockfall fences & channels)		$ 0.6	$ 1.3	$ 1.9
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 0.6	$ 1.3	$ 1.9
Brewery Creek Fan					
A	Status Quo	$ -	$ 0.6	$ 1.2	$ 1.9
B	Managed		$ 0.2	$ 0.3	$ 0.5
C	Reduced		-$ 0.4	-$ 0.4	-$ 0.4
D	Engineering (rockfall fences & channels)		$ 0.6	$ 1.2	$ 1.9
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 0.6	$ 1.2	$ 1.9

For Reavers Lane, the value of development potential revenue could increase to $1.9 million per annum by 2051, under the Status Quo option and the engineering management options. This compares to $0.5 million per annum for Manage Risk and -$0.4 million for Reduced Risk per annum by 2051.

For Brewery Creek fan the value of potential revenue could increase to $1.9 million per annum by 2051, if the Status Quo option persists or the engineering management options are pursued. This compares to $0.6 million per annum for the Manage Risk option and -$1.2 million for the Reduced Risk option per annum by 2051.

Additional Property Costs

There are likely to be some additional costs for all property owners in areas that have been defined as at higher risk levels related to new building developments. These will apply to additional design features required to strengthen and protect buildings from natural hazards.

In addition to these impacts, property owners that choose to undertake a redevelopment will need to apply for building consent and in some cases resource consent. The Council considers that the application cost will remain the same as current costs for the Status Quo and two Engineering options.

Conversely, the costs are expected to be smaller for Managed and Reduced options, as there would be no need for technical assessments in some areas. Also, the number of consent applications is likely to be lower for these two management options, as there are restrictions on new builds in some of the higher risk areas within each fan.

In this report, it is assumed that there are no additional consenting costs for property owners under the Status Quo and two Engineering options. The changes in policy suggested in the Managed and Reduced options relate to a small number of properties. In any given year, the number of consents in each fan is

likely to be small. Therefore, nominal savings are likely to be small (i.e., less than $10,000 per annum). For this report, it is assumed that there are nominal savings of less than $10,000 per annum in each fan.

Effects on Property Insurance

One of the potential costs that may arise due to the hazard management options is that properties which were previously not identified by insurers as being vulnerable to natural hazards may have increased insurance costs associated with them. In our opinion, it is unlikely that property owners in Reavers Lane would be charged increased insurance costs based on the long recurrence intervals for the hazard events. There is some chance that property owners in Brewery Creek may begin to face increased insurance costs in the medium term because the likelihood of small events is much higher than Reavers events. It is also possible that insurances may be increased at some stage in the medium term if more events occur in line with climate change within the wider Gorge Road area.

The Reduce Risk option will remove the likelihood that property owners would be charged an increased insurance cost related to the likelihood of natural hazards because buildings will not be permitted in the areas of most risk.

5.2.2 Displacement of Businesses

There could potentially be displacement of businesses that is a cost of the proposed management options. This would have a short-term unanticipated impact on business' operations, and therefore we have classified this element as having a 'moderate impact'.

Business intensification will continue throughout both fans under the Status Quo and Engineering options. Intensification will also be enabled outside the areas of significant risk under the Manage Risk option, and no businesses will be displaced.

The most significant displacement of business will occur under the Reduce Risk option when some businesses are relocated from areas of significant and intolerable risk (Q Box, Coronet View Apartments, Reavers Lodge and Pinewood Lodge). Businesses will not be allowed to establish throughout the wider location also.

The scale of businesses that will be relocated under each of these options is small as a proportion of the district's total activity, though the relocation process is likely to have operational impacts on those affected businesses.

5.2.3 Additional Employment opportunities

There is some potential for additional employment opportunities to be created through the construction of engineering structures, though this would be on a small-scale and would be a temporary addition to the local economy. Due to the small scale and temporary nature, we have classified this element as 'low-impact'.

There will be more employment opportunities in the fans under the Status Quo option, with slightly fewer under the Manage Risk option due to restrictions on the properties where businesses can establish and intensify. Those jobs would not be net additional to the district economy but would impact the provision of localised employment.

There will be significantly fewer employment opportunities in the fans under the Reduce Risk options. Employment losses will arise from tourism operators that are forced to close, though there is a chance that these businesses will re-locate within the district.

There will be the same level of employment opportunities under the Engineering A and B options as the Status Quo options. Some employment activity will be created within the region, or alternatively skilled workers will be attracted to the region while the rock fall and debris flow fences and debris flow channels are constructed. These are likely to be relatively short-term projects, however they may generate some additional spending on accommodation, hospitality, and groceries (living costs) while workers stay in Queenstown. There may be new opportunities for apprenticeship and training to be provided to locals to improve their professional skills.

Ongoing maintenance will be required for the engineering structures under both options. This work may be undertaken by someone employed by Council or contracted to an external agency.

5.2.4 Loss of Tourist numbers and expenditure

One of the costs of the proposed management options will be a reduction in the number of tourists that will be staying in the Gorge Road area, which will have some impacts on the available spending in local retailers. We have classified this as a 'low impact' because regionally, the same number of tourists will stay in Queenstown, however there will be localised impacts.

On a regional basis, there are unlikely to be impacts on the tourist numbers and expenditure, the main impacts will be the loss of tourists in the fans according to the restrictions placed on tourism accommodation providers, with Status Quo being more liberal and Reduce Risk curtailing this activity. The presence of the debris flow channels will increase tourist's awareness of the risks, but it is unlikely to cause them to choose other places to book accommodation on a first time visit basis.

5.2.5 Flow on impacts into other industry sectors

One of the costs of the proposed management options will be a reduction in the number of people that are living, working and staying in the communities under some of the options. This will effect the turnover of local businesses directly and generate negative downstream impacts. Due to the small-scale nature of the changes to the daily population, we have classified this element as 'low impact'.

There are unlikely to be any significant flow-on impacts into other industry sectors under the Status Quo and Manage Risk options. Under the Reduce Risk option, there is likely to be reduced spending from tourists within the immediate area, and this will have some impact on local retailers.

Under each of the engineering options, there will be some short-term spending generated by workers constructing the engineering structures which will benefit local retail and service providers.

5.2.6 Summary of Financial and Physical Capital Costs of Management Options

The likely outcomes for each of the financial and physical capital costs are ranked in Figure 5.6, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Status Quo option has no costs associated with the management options for both fans. There are positive benefits from the Engineering B option. The Reduce Risk options has the greatest range of costs of any of the proposed hazard management options.

Figure 5.6: Rating of Financial and Physical Capital Socio-economic Costs

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Material Wellbeing										
Effects on property values and capital gain										
Effects on property insurance										
Moderate Impact										
Displacement of businesses										
Low Impact										
Additional employment opportunities										
Loss of tourist numbers and expenditure										
Flow-on impacts into other industry sectors										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

Benefits of Hazard Management Options in a Natural Hazard

5.2.7 Loss of, and damage to, private property

The benefit of introducing natural hazard management options is a likely reduction in the loss of, and damage to, private property if a natural hazard occurs. While the loss of, and damage to property can often be replaced through insurance pay-outs, the inconvenience of finding alternative accommodation or business premises while buildings are repaired or replaced can take a considerable amount of time for individuals, households and businesses. For many households, their homes will be their largest financial asset, and there will be considerable stress involved in organising new homes. For this reason, we have classified loss of, and damage to, private property as an effect that will have a 'high impact'.

The greater the quantity of residential and commercial activity within the fans, the more property damage is likely to occur in the case of a natural hazard event. GNS has modelled the property losses for debris flow and rock fall hazards, for the current activity and three potential futures.

Currently the value of damages associated with a debris flow event in Brewery Creek event are estimated to range from $1.1 million (small debris flow) to $14.1 million (large debris flow). While Reavers Lane ranges from $13.6 million (small debris) to $39.2 million (large debris flow). There are also potential damages from rockfall events of $0.7 million in Brewery Creek and $11.8 million in Reavers.[129]

Based on the mean return periods of each event, the annual expected risk of building damage would be around $20,000 per annum for Brewery Creek and $18,000 per annum for Reavers Lane.[130] While events on Reavers will cause more property damage than Brewery Creek, the probability of an event in Reavers

[129] GNS Sciences (2021) Queenstown debris flow and rockfall loss modelling for land-use planning policy options.

[130] GNS has provided 'annualised (mean)' damage, which reflect the midpoint of return periods defined by Beca.

Lane is lower which means that the expected risk of building damage in any one year is currently almost the same in each fan.

In the future the use of some properties will change, which will influence the potential impacts of the hazards on buildings and the risks associated with the hazards. Broadly, if more buildings are constructed within the hazard areas, then the impacts will increase if an event occurs, which would result in greater risks. Figure 5.7 shows the future building damage costs for the management options, which were estimated using the development path that is outlined in Appendix Two.

Under the Status Quo option there will be the most built activity, and consequently there will be more property damage impacts from small, moderate, and large events, relative to any of the other management options.

Under both the Manage Risk and Reduced Risk options there will be fewer residential and commercial properties and the rate of damage is likely to be lower than the Status Quo option.

Figure 5.7: Reavers and Brewery Creek Building Damage Costs, 2021-2051 (annual, $000)

	Building Damage Costs ($000)	2021	2051	Change
Reavers Fan				
A	Status Quo	$18.0	$22.8	27%
B	Managed		$17.8	-1%
C	Reduced		$2.0	-89%
D	Engineering (rockfall fences & channels)		$17.2	-4%
E	Engineering (rockfall fences and debris flow fences/mesh)		$17.2	-4%
Brewery Creek Fan				
A	Status Quo	$20.0	$113.0	464%
B	Managed		$25.2	26%
C	Reduced		$8.1	-60%
D	Engineering (rockfall fences & channels)		$31.7	58%
E	Engineering (rockfall fences and debris flow fences/mesh)		$31.7	58%

For Reavers Lane, the value of building damage could increase from $18,000 today to $23,000 per annum by 2051 if the Status Quo pattern persists. This compares to $17,000 per annum by 2051 for each of the Engineering options and the Managed Risk option. The Reduced Risk option is the only option where the value of building damage decreases, reaching $2,000 per annum by 2051.

For Brewery Creek, the value of building damage could increase from $12,000 today to $113,000 per annum by 2051 if the Status Quo pattern is enabled to continue. This compares with $32,000 per annum by 2051 for each of the Engineering options and $25,000 per annum for the Managed Risk option. The Reduced Risk option is the only option where the value of building damage decreases, reaching $8,000 per annum by 2051.

When compared to the building damage costs in 2021, only the Reduce option lowers property risk below current levels. For Reavers Fan, the risk will be maintained at current levels under the Managed and

Engineering options. For Brewery Creek, all options except Reduce will increase property risk above current levels.

5.2.8 Loss of, and damage to, public property

The benefit of introducing natural hazard management options is a likely reduction in the loss of, and damage to, public property if a natural hazard occurs. While the loss of, and damage to property can often be replaced through insurance pay-outs, the inconvenience of having roads, power lines and telephone lines damaged can be disruptive. For this reason, we have classified loss of, and damage to, public property as an effect that will have a 'high impact'.

There will be no further significant public infrastructure developed under any of the land use management options. Existing infrastructure that may be damaged in a natural hazard event includes electricity lines, culverts, bridges, and roads. The cost to repair this infrastructure will be the same under all land use management options.

Under the Reduce Risk option it is possible that some of the acquired properties will be converted into public recreation land, though we have assumed that there would be limited public investment due to the high levels of risk..

Under the engineering options, the rockfall fence will provide protection to the regionally significant power lines. The debris flow channel proposed under Engineering A option will provide increased protection to other infrastructure for small events, but there is likely to be some impacts on culverts, bridges and roads for medium and high events. Under the Engineering B option, the debris flow fences will provide increased protection but to a lesser extent than for the Engineering A option. Under the Engineering B option, there may be some reduced impact on culverts, bridges and roads towards the end of the flow extent because the flow will not be channelled in a particular direction and is more likely to flow overland earlier.

5.2.9 Effects on Material Wellbeing if a Natural Hazard Occurs

As is the case with loss of life and property damage, the more households and businesses in the fans, the greater the impacts that are likely to occur for material wellbeing. There are three aspects to material wellbeing that will be impacted if a natural hazard occurs: impacts to household income and unemployment, effects on property values and capital gain, and effects on property insurance. Material wellbeing is very important, both in the short-term and long-term and is directly related to a households' ability to live day to day. Therefore, we have classified this element as a 'high-impact'.

Household Income and Unemployment

Workers may lose their ability to earn incomes when the businesses they work for are affected by damage from natural hazards. There may also be lost productivity from residents in the area unable to go to work, or only being able to work partial days while co-ordinating repair work and finding new accommodation. Some rental properties and Air BNBs will lose income potential if they are directly damaged.

The greatest number of workers, households and property owners will be present under the Status Quo option, and this has the most likely potential for damage and disruption to working patterns. The Manage Risk option reduces the number of people present in the fans and has a commensurate reduction in the likely disruption and rates of unemployment or loss of incomes.

Each of the Engineering options will have similar numbers of people present in the fans as the Status Quo option, but there will be added protections to mitigate the level of damage likely to occur after small events. After a moderate or large event, the disruption to household incomes is likely to be more closely aligned with the Status Quo option.

The Reduce Risk option has the greatest benefits after a natural hazard event mainly due to the smaller number of people and properties present in the fans.

Effects on property values and capital gain

Property prices are likely to decrease after a natural hazard occurs due to the perceived threat of other hazards occurring. The greatest number of properties that can be affected by reductions in property values will be under the Status Quo option. The Reduce Risk option will have the least number of homes and businesses within the fans, and this will generate the greatest benefits if a natural hazard event were to occur. While there will be a reduction in the number of properties which are in the areas of highest risk under the Manage Risk option, there will still be widespread loss in property values if a natural hazard occurred.

The Engineering options are likely to protect properties in small events but are unlikely to protect all properties in moderate and large events, so it is likely that there will be some loss of property value after a natural hazard event.

Effects on Property Insurance

The main benefit of introducing hazard management options is a likely reduction in the insurance costs both in anticipation of, and after, a natural hazard occurs. As is the case, with the other Material Wellbeing elements, the more properties present in the fans at the time of a natural hazard, the greater the impact on households and businesses in terms of paying for increased insurance premiums or perhaps not being able to gain insurance for their properties moving forward. The least number of households and businesses that will be impacted by increased insurance costs will be under the Reduce Risk option, and the greatest impacts will be felt under the Status Quo option.

5.2.10 Loss of, and interruption to, business activity

The benefit of introducing land use management options is a likely reduction in the loss of, and interruption to, business activity after a natural hazard occurs. However, businesses have insurance and are much more likely to find new business premises or be able to adapt to new operating conditions than households, and therefore the disruptions are likely to be short term. For this reason, we have classified the loss of, and interruption to, business activity as an effect that will have a 'moderate impact'.

The greater the number of businesses located in the fans, the greater the scale of business interruption that will occur for natural hazard events. For the tourism accommodation businesses located in the areas with the highest levels of risk, the interruption is likely to be very significant, while for businesses located elsewhere on the fans, the scale of business interruption is likely to be much smaller. For all land use management options, it is important that commercial activity that is likely to generate high customer volumes is deterred from developing in the natural hazard paths, for example, supermarkets and large format retail stores.

There is likely to be some impact on the client base and number of visitors choosing to use businesses in the hazard zones in the aftermath of an event. Over the short term, productivity, employment, and overall profitability is likely to be impacted.

Rockfalls and debris flows could potentially damage the regionally significant electricity lines located up slope of the built-up areas of both fans, which could impact the operation of businesses for a much wider catchment.

A significant share of the properties currently located in Brewery Creek (27%) and Reavers Lane (36%) are holiday homes, and property damage may impact the earning potential of those homes, both in the short and medium terms.

The disruption costs have been valued in the CBA using the floorspace development scenarios under each of the management options, a workspace ratio which reflects a midpoint of use for commercial activity[131], the average productivity for the district[132] and an assumed disruption period of one month. In summary, it is assumed that businesses cannot operate for one month and that the output of the impacted businesses is lost.

Figure 5.8 shows the estimated value of lost business activity for both fans. The key outputs are:

- Reavers Lane: the expected value of lost business activity could remain at around $1,000 per annum by 2051 under the Status Quo option. This compares to a reduction from 2021 loss levels under all other options, to around $800 per annum for the Managed Risk and Engineering options and $100 for the Reduced Risk option per annum.
- Brewery Creek: the expected value of lost business activity increases from 2021 loss levels under the Status Quo and Managed Risk options, to $16,000 per annum and $8,000 respectively by 2051. This compares with a reduction from 2021 loss levels under the Reduced Risk option to $2,500 per annum by 2051.

[131] The workspace ratio of industrial activities tends to be over 100m^2 per employee, while office activities can be as low as 20m^2 per employee, retail can be up to 50m^2 per employee and other uses (health, community facilities and commercial accommodation) can vary depending on the business model. For this report we adopt 50m^2 as a reasonable mid-point.

[132] Infometrics (2021) Queenstown Lakes District Economic Profile.

Figure 5.8: Reavers and Brewery Creek Lost Business Activity, 2021-2051 (annual, $000).

Business Activity ($000)		2021	2051	Change
Reavers Fan				
A	Status Quo	$1.0	$1.1	12%
B	Managed		$0.9	-5%
C	Reduced		$0.1	-92%
D	Engineering (rockfall fences & channels)		$0.8	-15%
E	Engineering (rockfall fences and debris flow fences/mesh)		$0.8	-15%
Brewery Creek Fan				
A	Status Quo	$7.4	$16.0	117%
B	Managed		$8.3	12%
C	Reduced		$2.5	-66%
D	Engineering (rockfall fences & channels)		$7.5	2%
E	Engineering (rockfall fences and debris flow fences/mesh)		$7.5	2%

If an event occurs, the businesses will also lose assets such as machinery, furniture, materials, and stock. There is no information on the value of tangible business assets that could be lost within the hazard risk areas. However, an average small business in New Zealand has approximately $0.5 million of tangible assets.[133] For this assessment, it is assumed that the businesses in the hazard areas lose tangible assets which are worth $0.5 million.

Figure 5.9 shows the estimated value of lost business assets for both fans, the key conclusions are:

- Reavers Lane: the value of lost business assets could increase from $1,600 per annum in 2021 to $1,800 per annum by 2051 under the Status Quo option. This compares with a small decline under the Managed Risk option, with a reduction to $1,500, and a larger reduction to $100 per annum for the Reduced Risk option.
- Brewery Creek: the value of lost business assets could increase from $46,100 per annum in 2021 to $98,000 per annum by 2051 (Status Quo). This compares to an increase to $49,300 per annum for Managed Risk. The Engineering option results in a reduction to $41,000 p.a., while the Reduced Risk option results in a reduction to $9,700 per annum by 2051.

[133] Stats NZ (2020) Annual Enterprise Survey 2019 financial year.

Figure 5.9: Reavers and Brewery Creek Lost Business Assets, 2021-2051 (annual, $000).

Business Assets ($000)		2021	2051	Change
Reavers Fan				
A	Status Quo	$1.6	$1.8	10%
B	Managed		$1.5	-7%
C	Reduced		$0.1	-94%
D	Engineering (rockfall fences & channels)		$1.3	-20%
E	Engineering (rockfall fences and debris flow fences/mesh)		$1.3	-20%
Brewery Creek Fan				
A	Status Quo	$46.1	$98.0	113%
B	Managed		$49.3	7%
C	Reduced		$9.7	-79%
D	Engineering (rockfall fences & channels)		$41.2	-11%
E	Engineering (rockfall fences and debris flow fences/mesh)		$41.2	-11%

5.2.11 Displacement of Businesses

The benefit of introducing hazard management options is a likely reduction in the displacement of businesses after a natural hazard occurs. However, businesses have insurance and are much more likely to find new business premises and therefore the displacements are likely to have a temporary effect. Despite this, there will still be some impacts on the turnover of businesses, and for this reason we have classified this element as a 'moderate impact'.

Under the Status Quo option there will be the greatest number of businesses in both Brewery Creek and Reavers Lane. The consequence of a natural hazard will be the greatest likelihood of displacement of businesses. There will be slightly fewer businesses in the fans under the Manage Risk option, meaning slightly lower impacts on businesses. The Reduce Risk option will have the least number of businesses present, and therefore the fewest number of businesses will be impacted in a natural hazard event.

The Engineering options will provide protection for the businesses in small events but will not perform well in moderate and large events, and due to the presence of similar numbers of businesses as the Status Quo option will experience higher negative effects in natural hazards than the Manage Risk and Reduce Risk options.

5.2.12 Network Resilience to disruption caused by natural hazards

Natural hazards can disrupt regular activity when roading, electricity lines, telecommunications, and three waters infrastructure is damaged or destroyed. It is important to protect these types of infrastructure from the effects of natural hazards to ensure daily life can continue as much as possible, as highlighted in the Otago RPS. The benefit of introducing hazard management options is a likely reduction in the disruption of business as usual for households and businesses after a natural hazard occurs. We have classified network resilience as a 'moderate impact'.

There will be no significant changes to the network resilience under each of the land use management options, so in the event of a natural hazard there are likely to be impacts on the infrastructure networks.

The rockfall fences proposed under each of the engineering options will protect the regionally significant electricity lines from rockfall. For large debris flow events in Brewery Creek, the culvert at Gorge Road is likely to become blocked and the road may become damaged by over-topping under the Engineering A option. There is also potential for blockages and over-topping for Engineering option B for medium and large debris flow events.

5.2.13 Loss of tourist numbers and expenditure

Loss of tourist numbers and tourism spending is an indirect impact and therefore of lesser importance in the event of a natural hazard occurring. The benefit of introducing natural hazard management options is a likely reduction in the disruption to the number of tourists after a natural hazard occurs. We have classified loss of tourist numbers and expenditure as an effect that has a 'low impact' in the Queenstown-Lakes context because there are lots of alternative places for tourists to stay in the district.

Under the Status Quo scenario there will be the greatest number of tourists impacted by a natural hazard event. There will be lower numbers of tourists affected after a hazard event under the Manage Risk option. The least number of tourists will be impacted under the Reduce Risk option.

The Engineering options will help prevent disruption to tourism accommodation in small events, but there is likely to be some disruption to tourists in moderate and large events. Fortunately, there are many locations where tourists will be able to find alternate accommodation, though there will be issues if their property is damaged.

5.2.14 Flow-on impacts into other industry sectors

The benefit of introducing natural hazard management options is greater certainty and less disruption to businesses after a natural hazard occurs. We have classified flow-on impacts into other industry sectors as an effect that will have a 'low impact' due to the relatively small scale of change in the localised fans.

As with many of the other elements, the greater the number of people living, working and staying in the fans, the greater the likely impacts. Therefore the Status Quo option will have the least benefits, followed by the Manage Risk option. The Reduce Risk option will have the greatest benefits. Each of the engineering options will afford some benefits in small events but are unlikely to perform well in moderate and large events.

5.2.15 Summary of Financial and Physical Capital Benefits After a Natural Hazard

The likely outcomes for each of the financial and physical capital social benefits are ranked in Figure 5.10, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Status Quo option has the most negative impacts for financial and physical capital social benefits, and the Manage Risk option has the next least benefits in natural hazard events. The Reduce Risk option has the best outcomes. Each of the engineering options have reasonable outcomes if small events occur, but the impacts increase to undesirable levels as the extent and severity of natural hazard impacts arises.

Figure 5.10: Rating of Financial and Physical Capital Socio-Economic Benefits

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Loss of, and damage to, private property										
Loss of, and damage to, public property										
Material Wellbeing										
Household Income and Unemployment										
Effects on property values and capital gain										
Effects on property insurance										
Moderate Impact										
Loss of, and interruption to, business activity										
Displacement of businesses										
Network resilience to disruption caused by natural hazards										
Low Impact										
Loss of tourist numbers and expenditure										
Flow-on impacts into other industry sectors										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

5.3 Social Capital

This section describes the likely effects of the proposed management options on norms and values that underpin the community in the fans. These are elements such as trust, iwi, ways of life, cultural identity, and the connections between people and communities. The management options will produce a range of benefits that may accrue only after a natural hazard event has occurred. Correspondingly, there will be a range of costs that may arise from the management options. The weighting of the costs and benefits are unlikely to be even. This section describes the likely costs of the management options firstly, before describing the benefits that will accrue after a natural hazard event.

Costs of Hazard Management Options

5.3.1 Fears and Aspirations – Public acceptability of Proposals

Aspirations for outcomes from proposals

The community consultation already undertaken highlighted that property owners wish to be able to maximise the value from developing their properties while working with Council to understand and manage natural hazard risks. These aspirations are likely to have significant importance to locals, and for this reason we have classified this element as 'high impact'.

The Status Quo, Engineering A and Engineering B options provide the best opportunity for property owners to fulfil aspirations about having autonomy over their ability to re-develop properties. The Manage Risk option will enable some property owners to fulfil their aspirations of autonomy, while others in the areas of the highest levels of risks will not have the same levels of freedom.

The Reduce Risk option will have the highest negative impacts on the choices that property owners can make about developing to higher land use intensities, and the impact that restrictions will have on material wellbeing, and even though they will be compensated for the acquisition of their properties, they may find

it difficult to achieve the same outcomes elsewhere in the district, especially if they have been property owners for a long time i.e., more than ten years.

Fears for outcomes from Proposals

One of the costs of the proposed management options will be increased uncertainty about what the proposed management options mean for households and businesses. That uncertainty may lead to high levels of emotional stress by those parties and for this reason we have classified this element as having a 'high impact'.

Property owners will be more aware of the natural hazard risks and the likely impact on their properties. Fears will be focussed on the likely loss of life, potential injuries and property damage, as well as the impacts on material wellbeing. It is possible that a proportion of landowners will downplay the risks and wish to continue as though the danger is not present due to the long timeframes described in the hazard risk event likelihoods. Public investment in engineering structures may help allay people's fears about the likelihood of damage and loss of life/injuries, even though the risks will still be present for moderate and large events.

Under the Manage Risk option there will be increased fear about the future of people's homes and properties, and the potential for uncertainty about securing insurance. The Reduce Risk option will compound these effects, and there will be significant uncertainty about people's material wellbeing and life choices.

5.3.2 Perceptions about Safety and Security

Good communication and engagement processes will be essential to inform residents of the risks and response plans under all management options. While perceptions may be unfounded in fact, it is important to recognise that they still influence behaviour regarding the natural hazard. This outcome is important in determining how individuals, households and tourists view the risk of a potential hazard in the community, and their level of preparedness before, during and after a hazard event.

The costs of the proposed hazard management options are likely to generate heightened fear about loss of life, injuries and building damage that will arise from public consultation. The presence of visible engineering structures will have both a positive effect of reassuring people that they are safer from risks, but also a negative effect from the constant reminder of the likely threat of danger. People will respond differently and for some people the threat will create significant stress, while for others, there will be a low level of concern. For these reasons we have classified perceptions about safety and security as 'high impact'.

The public consultation already undertaken highlighted that residents, business owners and workers were concerned about the dangers present, and especially that lives were at risk. The greater the number of people present in the zone, the more concern there will be about safety and security.

The Status Quo and Engineering options will have the greatest number of people living, working, and visiting the fans. The more people present in the fans, the more concern there will be about safety and security. Public consultation has already been undertaken to alert current populations about the possibility of natural hazard risks, however it is likely that some people are still not aware, and some people may choose to ignore or disagree with the potential risks. The erection of management structures will help to significantly allay the fears of many residents, workers, and visitors, though there will be significant risks

for moderate and large events, as the engineering structures only address most of the natural hazard risks for small events.

There will be less people in the areas of significant risk under the Manage Risk option and significantly fewer people in the fans under the Reduce Risk option helping to reduce the overall rate of risk to people, but the reduction in people located in the fans may not help to ease people's fears about hazard risks. The community consultation identified that both childcare centres and visitor accommodation, new businesses and other development would not be deemed appropriate in the hazard zone. The Manage Risk option moves part way towards ensuring vulnerable activities are less likely to be at risk from natural hazards, and the Reduce Risk option moves towards prohibiting vulnerable activities in high-risk zones, which will help to allay the community's fears.

Erection of significant debris flow channels on the fans will help to significantly allay fears of many residents, workers, and visitors. It is possible that some residents will become relatively complacent about risks given the inherent faith in engineering options. However, the mere physical presence of intrusive structures may alternatively make people constantly more aware of the natural hazard risks. It is important to recognise that the structures will mainly help in small events, rather than moderate and large debris flow events, and there are good grounds for concern. In addition, some property owners in Reavers Lane are likely to become more aware of the risks due to the likelihood that debris flows will be directed to their properties when they wouldn't have originally been exposed.

5.3.3 Displacement of Residents

One of the costs of the hazard management options is that some residents will be permanently displaced. Due to the small scale of relocations, we have classified this element as 'medium impact'.

Residential intensification will continue throughout both fans under the Status Quo and Engineering B options. Intensification will also be enabled to occur outside the areas of significant risk and no residents will be displaced under the Manage Risk option.

The most significant displacement of residents occurs under the Reduce Risk option when residents are relocated from areas of significant and intolerable risk. In total, approximately 10 dwellings may be removed in Reavers and one in Brewery Creek. The Engineering A option also requires the displacement of some residents from homes that will need to be acquired to create the debris flow channels. The scale of relocations under each option is small as a proportion of the district's total population, though the relocation process is likely to have significant impacts on those households.

5.3.4 Community Cohesion, Stability, and Character

It is likely that if community engagement is undertaken well, local resident groups may be established that will help form a sense of community and provide for resilience should a natural hazard event occur. One of the biggest costs will be that some residents will be permanently displaced, and the built character of the communities is likely to change. Due to the small scale of people impacted, we have classified this element as 'medium impact'.

Under the Status Quo, Engineering A and Engineering B options, the community will continue to develop in line with anticipated residential and business growth.

Under the Manage Risk option the community will continue to grow in line with anticipated residential and business growth, though there will be no further development in areas that are subject to high risk. That will have a limited impact on the community cohesion and character.

Under the Reduce Risk option the community will become an area that does not change within the wider area, with no further growth and some homes and businesses removed from the areas with highest risk. This will be a significant change from the high land use intensities that were originally envisaged for the area. There will be a loss of some of the long-standing residents and local businesses which will change the character of the community.

The Engineering A option will create significant changes to the layout of the community with extreme severance through the central part of Reavers Lane. There will also be a limited loss of some of the long-standing residents and local businesses which will change the character of the community.

5.3.5 Sense of Place

The costs of hazard management options include relocation of buildings and erection of some highly visible engineering solutions which is likely to change sense of place in the fans. Due to the relatively small scale of relocations and changes to the physical landscape, we have classified this element as 'medium impact'.

Under the Status Quo and Engineering B options there are unlikely to be any significant impacts on sense of place. For the Manage Risk option, it may become evident where intensive development stops, and levels of more intensive land use are enabled.

Under the Reduce Risk option there will be significant changes to the sense of place of the Reavers Lane fan especially with fewer tourism accommodation providers in the area, and largely undeveloped areas that are subject to higher risk.

There will be significant changes to the sense of place of the Reavers Fan especially with large debris flow channels bisecting the community and drawing attention to the potential hazard risks (Engineering A).

5.3.6 Way of Life and Reverse Sensitivity

The costs of management options relate to the loss of people from the community which may impact the way of life of residents and the reverse sensitivity for properties which are located adjacent to the engineering structures. Due to the relatively small scale of changes in the fans, we have classified this element as 'low impact'.

There are unlikely to be any negative impacts on the community's way of life under the Status Quo, Manage Risk, and Engineering B options. Property owners will be able to continue to act as they currently do. Under the Manage Risk option some of those living in areas of significant risk will experience slight differences to their ways of life.

Under the Reduce Risk option, the only risks to the community's way of life will result from the reduction of the number of people living in the fans. The removal of buildings from the areas of significant risk will change the surrounding environment, but not in a manner that would create reverse sensitivities.

There will be some significant changes to residents' way of life in the Reavers Lane fan with a large channel bisecting the community under the Engineering A option. There may also be increased sensitivity for properties adjacent to the rockfall and debris flow fences due to their appearance, and the increased attention drawn to the hazard risks.

5.3.7 Culture and identity, including community aspirations, heritage and cultural values

The costs relate to the loss of sites and buildings with heritage and cultural values. Due to the relatively small scale of changes in the fans and the absence of heritage or culturally significant sites and buildings, we have classified this element as 'low impact'.

There are unlikely to be any significant impacts on cultural values, identity and heritage for all management options. Further community consultation needs to be undertaken to understand what the community aspirations are for the fans.

5.3.8 Impacts on Te Ao Maori

Due to the relatively small scale of changes in the fans and the absence of culturally significant sites, we have classified this element as 'low impact'.

There are unlikely to be any significant impacts on te ao Maori for the fans under the land use management options. It is possible that there may be some concerns about diversion of waterways and protection of flora and fauna for both engineering options. Further engagement needs to be undertaken by Council with iwi to understand any issues.

5.3.9 Grassroots Community Organisations

Grassroots community organisations can emerge due to a shared connection, issues and concerns within the community. This is an indirect outcome but can create a positive effect, rather than a cost. Due to the relatively small scale of changes in the fans, this element has been classified as 'low impact'.

There is the potential for grassroots community organisations to be established by members of affected property owners. The greater the number of people impacted by land use and engineering options, the more likelihood that community organisations will form and have wider memberships. This is an indirect effect of the proposed management options and is likely to have many positive effects relating to building social connections and giving residents a sense of empowerment.

5.3.10 Summary of Social Capital Costs of Management Options

The likely outcomes for each of the social capital costs are ranked in Figure 5.11, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Reduce Risk and Engineering A option have the most costs for Reavers Lane in particular, but also for Brewery Creek. The Status Quo, and Engineering B are likely to produce the best outcomes in social capital terms, with the exception of concerns about safety and security.

Figure 5.11: Rating of Social Capital Socio-economic Costs

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Fears and aspirations - public acceptability of proposals										
Aspirations for outcomes from proposals										
Fears for outcomes from proposals										
Perceptions about safety and security										
Medium Impact										
Displacement of residents										
Community cohesion, stability and character										
Sense of place										
Low Impact										
Way of life and reverse sensitivity										
Culture and identity, including community aspirations, heritage and cultural values										
Impacts on te ao Maori										
Grassroots community organisations										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

Benefits of Hazard Management Options in a Natural Hazard

5.3.11 Perceptions about Safety and Security

This outcome is important in determining how individuals, households and tourists view the risk of a potential hazard in the community, and their level of preparedness before, during and after a hazard event. After a natural hazard event has occurred people will be grateful to have avoided harm, or alternatively feel unsafe because properties were affected that weren't anticipated to be affected by the general public. For these reasons we have classified perceptions about safety and security as 'high impact'.

Under the Status Quo option there will be heightened fears about future events and frustration and despair experienced due to the damages and loss of life and injuries caused by the lack of protection. Property and lives are the least likely to be impacted under the Reduce Risk option, and this will lead to an overwhelming sense of relief that the community has been protected. Under the Manage Risk option, some of the community are likely to be impacted by natural hazards and there will be heightened fears about future events, as well as frustration and despair experienced due to the damages caused and loss of life.

For small events, the Engineering options will help protect the communities and there will be a sense of relief that the community has been protected from impacts to life and property, however for moderate and large events, there will be damage to property and loss of life and injuries which will lead to frustration and despair.

5.3.12 Displacement of Residents

The scale of displaced residents is a good measure for social disruption. The likely benefits of the hazard management options are that after a natural hazard, in some cases, fewer households will need to be relocated. Due to the relatively small scale of relocations, this element has been classified as 'medium impact'. It is important to recognise that those households which are directly impacted will have significant amounts of stress related to both the impacts of the natural hazards and on finding a suitable place to move to temporarily.

The Status Quo option will have the greatest levels of displacement. Conversely the Reduce Risk option will have the least levels of displacement. Under the Manage Risk option there are likely to be more people needing to be relocated than for the Engineering options in a small event, though for a moderate and large event, all of those options will displace residents.

5.3.13 Community Cohesion, Stability, and Character

One of the benefits of community consultation and engagement is that in the event of a natural hazard, people will be more aware of their neighbours and potentially more responsive to those in need. Due to the small scale of people impacted in the event of a natural hazard, we have classified this element as 'medium impact'.

It is difficult to foresee which of the options that will create the greatest likelihood for community cohesion that may arise from the community engagement and consultation exercises. All residents will be equally available to attend workshops and meetings, and therefore there is an equal opportunity for community and neighbourhood groups to establish. The greater the severity of a natural hazard event, the greater the likelihood that neighbours will pitch in to help each other out. In terms of stability, the more residents that are displaced from the fans, the more unstable the community will be. This means that the Status Quo option is likely to have the greatest impacts, with the least impacts being accrued in the Reduce Risk option. There will also be stability issues that arise in a natural hazard event under the Mange Risk option. The engineering options will help to perpetuate stability in a small event but are unlikely to be helpful in moderate and large events.

The character of the communities will change after a natural hazard event. The Reduce Risk option is the most likely to have the least impacts to character after a natural event, followed by the engineering options in small events. The most significant impacts will occur in the Status Quo option, with less impacts under the Manage Risk, and engineering options in moderate and large events.

5.3.14 Way of Life and Reverse Sensitivity

The benefits of the natural hazard management options are that under some scenarios fewer people will be impacted by natural hazards meaning that residents and workers will have less disruption to their way of life. Due to the relatively small area impacted by the natural hazards, this element has been classified as 'low impact'.

The greater the number of people living and working in the fans, the greater the likely impacts to people's way of life. Therefore the Status Quo option is likely to have the greatest impacts and the Reduce Risk option is likely to have the least impacts. There will be limited impacts for each of the engineering options

for small events, but more significant impacts in moderate and large events. There is likely to be greater impacts for the Manage Risk option, but they will be lower than for the Status Quo option.

5.3.15 Summary of Social Capital Benefits After a Natural Hazard

The likely outcomes for each of the social capital benefits are ranked in Figure 5.12, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Reduce Risk option has the greatest benefits, and the Status Quo option will have the most negative outcomes. Each of the engineering options have reasonable outcomes if small events occur, but the impacts increase as the extent and severity of natural hazard impacts arises. The Manage Risk, Engineering A and Engineering B options are equally weighted, with negative impacts for the communities.

Figure 5.12: Rating of Social Capital Socio-Economic Outcomes

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Perceptions about safety and security										
Medium Impact										
Displacement of residents										
Community cohesion, stability and character										
Low Impact										
Way of life and reverse sensitivity										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

5.4 Natural Capital

This section describes the likely effects of the proposed management options on the natural environment needed to support life and human activity. Landscape damages are inevitable from natural hazards and this SIA does not assess the impacts on landscape damages due to them being inevitable and unavoidable.

Costs of Hazard Management Options

5.4.1 Environmental and Landscape Effects

The costs of the management options relate to the impacts on the natural environment. Some of the engineering options will change the natural course of the streams and creeks and will have visually dominant landscape effects. For those reasons, we have classified this element as 'moderate impact'.

The environmental and landscape impacts that will result from each of the land use management options will result in varying intensities of land use across the entire fan (Status Quo), restricted to the lower slopes

(Manage Risk), and lower uses (Reduce Risk). These uses are envisaged by the PDP and are a necessary change due to the growth pressures currently being experienced in Queenstown.

The removal of properties from the upper slopes of the fans under the Reduce Risk option will revert the land use pattern from a built landscape back to a more natural landscape, though it may take time for this to occur.

There will be significant environmental and landscape effects from the creation of a new wide channel through Reavers Lane, changing the character and landscape, as well as the natural creek flow (Engineering A option). The debris flow fences proposed under Engineering B option are likely to impact the character, landscape, soil, water, plants, and animals to a lesser extent than the Engineering A option.

The rockfall fences proposed under both Engineering options will be a visual reminder of the presence of rockfall risk. The erection of the rockfall fences will require access routes, though there are already routes for the power lines, so environmental effects should be relatively minor.

5.4.2 Summary of Natural Capital Costs of Management Options

The likely outcomes for the one natural capital outcome are ranked in Figure 5.12, where red are the worst outcomes and green are the best relative outcomes for each option. This shows clearly that the Engineering A option has the least desirable results for natural capital wellbeings, and the Reduce Risk option has the most desirable outcomes.

Figure 5.13: Rating of Natural Capital Socio-economic Costs

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
Moderate Impact										
Environmental and landscape effects										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

5.5 All Council Costs

While the costs that will accrue to Council fall into each of the LSF Capital stocks, Council has requested that we assess the costs to Council in a separate section in order to maintain consistency with the CBA methodology. This section provides context about the benefits that will accrue after a natural hazard event and outlines the costs likely to be generated by the proposed hazard management options. This section describes the likely costs of the management options firstly, before describing the benefits that will accrue after a natural hazard event.

Costs of Hazard Management Options

5.5.1 Communication and Public Safety Management

As outlined in the Deloitte (2016) report, investment in resilience and mitigation measures such as community awareness, education and engagement programmes can result in significant cost savings and benefits when natural hazards occur. This element has been classified as 'high impact' because the Deloitte Access Economics Report (2016) highlighted that if done well, it can generate positive impacts for the community. It was highlighted in the Community Consultation exercise that there is an expectation that Council will play a role in educating the residents and businesses about the hazard risks.

There will be an initial cost to Council for preparing this information and advice, and the costs to disseminate the information will vary based on the number of people needing to be kept informed. Those costs depend on whether information is disseminated through written material and site visits. There will also need to be active discussions with tourism accommodation providers about the best approaches for communicating information to tourists about evacuation procedures.

Under the Status Quo option, there will be the greatest number of household and businesses that need to be regularly informed and reminded of the public safety risks and management procedures. There will be more tourism providers in the area under the Status Quo option than for other land use management options, meaning greater time costs involved in communicating information.

Under the Manage Risk option, there will be fewer households, workers and tourist accommodation providers that need to be regularly kept informed. This means that there will be some time and cost savings to Council depending on the means in which information is disseminated.

Under the Reduce Risk option, there will be much less people activity in the fans, and there will be commensurate time and cost savings to Council.

Under each of the Engineering options, it is likely that similar time and financial costs will be incurred as the Status Quo option, due to the presence of the same number of impacted people if a moderate or large event were to occur.

5.5.2 Community Engagement

Property owners indicated in the community consultation that they believe Council should work with them to manage risks posed by natural hazards on their land. The more property owners that are likely to be impacted, the more people that Council will need to engage with, which will increase the associated time and financial costs for these activities. We have classified this element as 'high impact', as the costs to Council will likely flow onto ratepayers, or potentially taxpayers if central government is required to provide assistance. The size of the monetary contribution is likely to be small, however.

The Status Quo, Engineering A and Engineering B options will have the greatest number of affected households and businesses, though the engineering options will help reduce the number of impacted properties. There will be fewer people to engage with under the Manage Risk option, and even fewer under the Reduce Risk option, representing commensurate costs savings for Council (and ratepayers).

5.5.3 Capital Costs

Council will need to acquire properties and demolish them under both the Reduce Risk and Engineering A management options. One of the benefits to Council of undertaking this exercise is that they will be taking onboard the natural hazard risks and removing the need to consult with property owners regularly. There will be no on-going insurance costs associated with those buildings that are demolished. There will also be additional capital costs invested in constructing the engineering structures.

For capital costs, the Reduce Risk option has the most significant costs ($33.9m for Reavers Lane and $19.7m for Brewery Creek), followed by the Engineering A option ($11.5m for Reavers Lane and $6.2m for Brewery Creek) and the Engineering B option ($2.2m for Reavers Lane and $2.3m Brewery Creek) (Figure 5.14). There will be no capital costs for the Status Quo and Manage Risk options.

Figure 5.14: Council Capital Costs Brewery Creek and Reavers Management Options (decade, $ million)

	Council Capital Costs ($m)	Engineering Protection	Acquired Land & Buildings	Demolition	Total
	Reavers Lane				
A	Status Quo	$ -	$ -	$ -	$ -
B	Managed	$ -	$ -	$ -	$ -
C	Reduced	$ -	$ 33.7	$ 0.2	$ 33.9
D	Engineering (rockfall fences & channels)	$ 4.7	$ 6.7	$ 0.1	$ 11.5
E	Engineering (rockfall fences and debris flow fences/mesh)	$ 2.2	$ -	$ -	$ 2.2
	Brewery Creek				
A	Status Quo	$ -	$ -	$ -	$ -
B	Managed	$ -	$ -	$ -	$ -
C	Reduced	$ -	$ 19.6	$ 0.2	$ 19.7
D	Engineering (rockfall fences & channels)	$ 2.7	$ 3.6	$ 0.0	$ 6.2
E	Engineering (rockfall fences and debris flow fences/mesh)	$ 2.3	$ -	$ -	$ 2.3

The mechanisms for funding the engineering structures are uncertain, the costs could be covered by Council (through a rate spread across the district or targeted to those households living in the fans), or alternatively the Regional Council or the Crown may help pay the costs. If households are expected to pay the costs of this infrastructure it will have negative impacts on their material wellbeing.

5.5.4 Maintenance of Hazard Management Schemes

Under each of the engineering options there will be additional maintenance costs involving checking the rockfall fences, debris flow channels and debris flow fences to remove any built-up debris on an annual basis. The operational costs are likely to be highest for the Engineering B option ($61,500 p.a.), followed by the Engineering A option ($24,700 p.a.), with all other options not incurring costs to Council.

5.5.5 Summary of All Council Costs of Management Options

The likely outcomes for the council costs are ranked in Figure 5.13, where red are the worst outcomes and green are the best relative outcomes for each option. This shows clearly that both Engineering options will incur the greatest costs. The Manage Risk option has the most positive outcomes of all the management options.

Figure 5.15: Rating of Council Socio-economic Costs

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Communication and public safety management										
Community engagement										
Capital costs										
Operational Costs										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

Benefits of Hazard Management Options in a Natural Hazard

We have classified the following three elements as 'high impact', as the costs to Council will likely flow onto ratepayers, or potentially taxpayers if central government is required to provide assistance. The size of the monetary contribution is likely to be small, however.

5.5.6 Community Engagement

Property owners indicated in the community consultation that they believe Council should work with them to manage risks posed by natural hazards on their land. The greater the number of property owners that are likely to be impacted, the more people that Council will need to engage with, which will increase the associated time and financial costs for these activities.

The Status Quo, Engineering A and Engineering B options will have the greatest number of affected households and businesses, though the engineering options will help reduce the number of impacted properties. There will be fewer people to engage with under the Manage Risk option, and even fewer under the Reduce Risk option, representing commensurate costs savings for Council (and ratepayers).

5.5.7 Clean Up Costs

In a natural hazard event, there will be more costs to Council for providing temporary housing relief, clean-up costs, damage assessment, emergency demolition, and land-use planning for redevelopment after the event based on the number of people located in the fans. The Status Quo option will have the highest associated costs, with lower costs for each of the engineering options even though the scale of land use will be the same. There will be fewer people to assist under the Manage Risk option, and even fewer under the Reduce Risk option, representing commensurate costs savings for Council (and ratepayers).

Modelling shows the clean-up costs are likely to be the highest under the Status Quo and Manage Risk options (Figure 5.16) of $6,200 p.a. for Brewery Creek and $500 p.a. for Reavers Lane. The clean-up costs are likely to be $1,900 p.a. for both engineering options in Brewery Creek and $400 p.a. for Reavers Lane. The clean-up costs will be the lowest for the Reduce Risk option, at $300 p.a. for Brewery Creek and $100 p.a. for Reavers.

Figure 5.16: Council Operational Costs Brewery Creek and Reavers Management Options (annual, $000)

Council Operational Costs ($000)		Event Clean Up
Reavers Fan		
A	Status Quo	$0.5
B	Managed	$0.5
C	Reduced	$0.1
D	Engineering (rockfall fences & channels)	$0.4
E	Engineering (rockfall fences and debris flow fences/mesh)	$0.4
Brewery Creek Fan		
A	Status Quo	$6.2
B	Managed	$6.2
C	Reduced	$0.3
D	Engineering (rockfall fences & channels)	$1.9
E	Engineering (rockfall fences and debris flow fences/mesh)	$1.9

5.5.8 Disruption to Ratepayers Revenue Collection

If there are a significant number of households and businesses impacted by a natural hazard event, there will be a reduction in their ability to contribute to rates payments, and there may be requirements for financial assistance through grants and rates rebates. The greater the number of impacted households and businesses, the more likelihood of rates relief being required. The Status Quo option would have the highest impacts, with lower impacts for Engineering A and Engineering B and Manage Risk options, and the least disruption for the Reduce Risk option.

5.5.9 Summary of Council Benefits After a Natural Hazard

The likely outcomes for each of the council benefits are ranked in Figure 5.17, where red are the worst outcomes and green are the best relative outcomes for each option.

This shows clearly that the Status Quo option has the highest council costs, and the Reduce Risk option has greatest benefits after natural hazard events.

Figure 5.17: Rating of Council Socio-Economic Benefits

Socio-economic Outcome	Brewery Creek					Reavers Lane				
	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact										
Community engagement										
Clean-up costs										
Disruption to ratepayers revenue collection										
Legend										
No Change										
Most Positive										
Positive										
Negative										
Most Negative										

5.6 CBA Outcomes

The social impacts described above play out across the entire community and for impacted households and businesses more directly. In the Cost Benefit Assessment (CBA) summarised below, those costs and benefits that are able to be monetised have been assessed against each other over time to determine which management option achieves the highest benefit to cost ratio. This is an important metric and should be viewed alongside the social and environmental impacts discussed above.

The Status Quo is used as the baseline, or counterfactual, from which the alternative management options are tested. Simply, the resulting value of doing nothing (Status Quo) is subtracted from each management option to establish the marginal value of implementing the management option. Specifically, a positive number in the tables below shows the instances where the management option is beneficial compared to the Status Quo.

Figure 5.18 shows the estimated Net Present Value of the tangible costs over the evaluation period for the four alternative scenarios and each of the fans separately, for Council, local community (and businesses) and property owners. The positive numbers in the table show the instances where the management option is beneficial compared to the Status Quo. For example, the positive numbers in the local community and business column show that each of the management options will result in net benefits to the local community relative to the Status Quo, which relates to the reduction in hazard risk (i.e., prevention of death). Conversely, the negative numbers in the Council/wider community column shows that each of the management options result in net costs to the wider community relative to the Status Quo, which relates to the increased expenditure on engineering protections and property acquisition.

Figure 5.18: Reavers and Brewery Creek CBA Net Present Value, 2021-2051.

NPV 2021 - 2051 ($m)		Council/Wider Community	Local Community and Business	Property Owners	Total
Reavers Fan					
B	Managed	$0	$2	-$8	-$6
C	Reduced	-$26	$15	-$25	-$36
D	Engineering (rockfall fences & channels)	-$10	$3	$0	-$7
E	Engineering (rockfall fences and debris flow fences/mesh)	-$2	$3	$0	$0
Brewery Creek Fan					
B	Managed	$0	$12	-$9	$3
C	Reduced	-$15	$33	-$15	$2
D	Engineering (rockfall fences & channels)	-$6	$8	$0	$2
E	Engineering (rockfall fences and debris flow fences/mesh)	-$2	$8	$0	$6

Key results are:

- For Reavers Fan, all management options except for the Engineering B option result in negative economic outcomes compared to the Status Quo. The Reduce Risk option has the largest negative economic outcome (-$36 million). This means the Status Quo is preferred over the management options, broadly the reduction in harm from this hazard do not generate enough benefits to offset the costs of management.

- The Engineering B option has a small positive economic outcome compared to the Status Quo on Reavers Fan (+$0 million). It is therefore the favoured option on Reavers Fan, from an economic point of view. The results show that the benefit cost ratio from investing money in protection under Engineering B on Reavers Fan is 1.1:1.
- There are no negative economic outcomes for any of the management options on Brewery Creek – all options result in positive economic outcomes.
- The Engineering B option has the best economic outcome compared to the Status Quo on Brewery Creek. The CBA shows this option has the largest positive economic outcome for Brewery Creek (+$6 million). The results show that the benefit cost ratio from investing money in protection under Engineering B for Brewery Creek is approximately 3.6:1.
- The Managed option has the second-best management option in terms of economic outcomes when compared to the Status Quo, for both fans. The CBA shows a negative economic outcome for Reavers Lane (-$6 million) and positive economic outcome for Brewery Creek (+$3 million).

The difference between the cost benefit ratios for the Engineering B option on the two fans is mainly a function of the return periods of the events, as Reavers Lane has a much lower probability of an event occurring relative to Brewery Creek. Specifically, the costs of protection in Engineering B are broadly similar for each fan, but the benefits of avoided risk to the local community are smaller for Reavers than for Brewery Creek.

Based on the indicative CBA, the Status Quo, Reduced and Engineering A management options are not preferred over the other management options, from an economic point of view.

These results must be viewed in the wider context of the Social Impacts described in detail in the preceding sections and in relation to the findings of international literature which indicates that the intangible impacts are often more important than the tangible costs, though this study has taken a different approach and provided estimates of economic impact for a wide range of costs and benefits. The above results are purely economic. They allow consideration of how much value is placed on managing the physical and social outcomes that the hazard may generate under the Status Quo. A negative economic outcome indicates the net cost of implementing that option – it is the cost of achieving the risk management outcomes offered by that particular option. For example, on Reavers Fan it would cost $36 million to achieve a reduction in risk, whereas it would cost $6 million to hold the highest levels of risk at current levels while allowing risk to increase in a controlled manner in areas of lower risk.

5.7 Interpretation of the Results

There are a range of impacts across each of the wellbeings for the four management options. The key result is that the Manage Risk option has the best generalised outcomes for all four capitals. The Reduce Risk option is the second-place runner, though with the most negative outcomes for social capital of the four management options. While some of the engineering options would rate better if their ability to manage natural hazard risks for small events was only taken into consideration, it needs to be acknowledged that these options do not have good outcomes for moderate and high events.

6 Summary

This report provides an assessment of the social and economic costs and benefits of four proposed management options for addressing natural hazard risks present in two discrete locations on the western side of Gorge Road, near the Queenstown CBD. The assessment has been separated into the costs of undertaking hazard management options and the benefits that are likely to arise when a natural hazard event occurs.

The Manage Risk option has the least costs associated with implementing the new land use patterns. The Status Quo option has some negative impacts for some of the high impact elements but has the least change from the current situation for most other elements. The Reduce Risk and Engineering A option in Reavers Lane has the greatest costs. After Status Quo, Manage Risk is the next best option, followed by Engineering B.

In terms of benefits when a natural hazard event occurs, the Reduce Risk option has the greatest benefits across all capital stocks. The Status Quo management option has the least benefits. The Engineering A and B options have a range of negative and positive outcomes, while the Manage Risk option has mainly negative impacts.

This report addresses the key socio-economic impacts likely to arise from the proposed land use and engineering mitigation options proposed to address the potential natural hazards in the Brewery Creek and Reavers Lane as required for a Section 32 assessment.

One of the critical concepts to reconcile is what do the technical time periods provided for the small, moderate, and large events mean in real world terms? Many property owners will be thinking that the likelihood of a small event happening over the next 50-200 years for Brewery Creek and 100-2,500 years for Reavers Lane is low. For moderate events (200-2,500 years for Brewery Creek and 2,500-6,700 years for Reavers Lane) and large events (2,500-10,000 years for Brewery Creek and 6,700-10,000 years for Reavers Lane), these timeframes seem way too long to warrant giving any consideration to.

It is important to compare these timeframes with recent New Zealand natural hazard events to put the likely social outcomes in perspective. The largest event in recent history was the 2011 Christchurch earthquake which had a probability of 1:2,500 years and caused widespread impacts to a large urban area over a medium timeframe for a range of households, businesses, emergency response organisations, local authorities and central government. Other examples include the Kaikoura earthquake (2016), White Island eruption (2019), and Matata debris flow (2005).

This Social Impact Assessment has provided a comprehensive understanding of the following aspects:

- What will happen if a proposed action were to be implemented – why, when, and where?
- Who will be affected?
- Who will benefit and who will lose?

- What will change under different alternatives?
- How can adverse impacts be avoided or mitigated, and benefits enhanced?

The Deloitte Access Economics (2009) report that was undertaken for the Australian Business Roundtable identified that the value of social impacts from natural hazards are often underestimated, mainly due to the difficulties associated with quantifying intangible costs. That report concluded that social impacts may be 2.4 times the value of property damage insurance claims. The intangible costs (social outcomes) are likely to persist over a person's lifetime and will have profound effects on communities as they recover. For this reason, it is important to consider social costs as being equally as important as the costs that are more easily able to be quantified.

There are a wide range of social impacts that may occur if natural hazard events, especially large-scale ones, occur in this location. It is important to recognise that as the climate changes, the incidence and scale of natural hazard events will be more likely. The most significant costs to the community will be loss of life and significant property damage. The four management options proposed by QLDC attempt to minimise and mitigate these costs by addressing them before a catastrophic event occurs.

What are the likely social impacts of the proposed management options?

We have assessed the social outcomes (including economic impacts) of the proposed management options for the four Treasury Living Standards Capitals and separated out costs that the Council will incur.

Summary of Costs of Management Options

For high impact elements, the Manage Risk options have the least costs for the four management options for both fans (Figure 6.1). The Reduce Risk option has the greatest costs for Brewery Creek and Reavers Lane.

The pattern of costs is different for moderate impact elements, with the Status Quo and Engineering B options having the least negative costs. The Reduce Risk option has the greatest costs in Brewery Creek, followed closely by the Engineering A option. In Reavers Lane, both the Reduce Risk and the Engineering Options have the greatest costs. That means the Manage Risk option is the middle of the road option for moderate impact elements.

For the low impact social wellbeing elements, the Status Quo option has no changes from the present situation. The Reduce Risk and Engineering A options have the greatest costs for Brewery Creek, while the Engineering A option has the greatest costs in Reavers Lane. The Engineering B option has the second least costs, followed by the Manage Risk option.

In summary, the Status Quo option has some negative impacts for some of the high impact elements but has the least change from the current situation for most other elements. The Reduce Risk and Engineering A option in Reavers Lane has the greatest costs. The Engineering A option in Brewery Creek has lower negative costs than for Reavers Lane. After Status Quo, Manage Risk is the next best option, followed by Engineering B.

Figure 6.1: Rating of All Socio-Economic Costs

Capital Stock	Socio-economic Outcome	Brewery Creek					Reavers Lane				
		Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact											
Financial and Physical	*Material Wellbeing*										
	Effects on property values and capital gain										
	Effects on property insurance										
Social	*Fears and aspirations - public acceptability of proposals*										
	Aspirations for outcomes from proposals										
	Fears for outcomes from proposals										
	Perceptions about safety and security										
All Council	Communication and public safety management										
	Community engagement										
	Capital costs										
	Operational Costs										
Moderate Impact											
Human	Uncertainty while awaiting planning decisions										
Financial and Physical	Displacement of businesses										
Social	Displacement of residents										
	Community cohesion, stability and character										
	Sense of place										
Natural	Environmental and landscape effects										
Low Impact											
Human	Disruption during construction of engineering options and removal of structures										
	Daily travel movements										
Financial and Physical	Additional employment opportunities										
	Loss of tourist numbers and expenditure										
	Flow-on impacts into other industry sectors										
Social	Way of life and reverse sensitivity										
	Culture and identity, including community aspirations, heritage and cultural values										
	Impacts on te ao Maori										
	Grassroots community organisations										
	Legend										
	No Change										
	Most Positive										
	Positive										
	Negative										
	Most Negative										

Figure 6.2: Rating of All Socio-Economic Benefits

Capital Stock	Socio-economic Outcome	Brewery Creek					Reavers Lane				
		Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B	Status Quo	Manage Risk	Reduce Risk	Engineering A	Engineering B
High Impact											
Human	Loss of life										
	Number of injuries										
	Health and wellbeing										
	Impacts for vulnerable populations										
Financial and Physical	Loss of, and damage to, private property										
	Loss of, and damage to, public property										
	Material Wellbeing										
	Household Income and Unemployment										
	Effects on property values and capital gain										
	Effects on property insurance										
Social	Perceptions about safety and security										
Council Benefits	Community engagement										
	Clean-up costs										
	Disruption to ratepayers revenue collection										
Moderate Impact											
Financial and Physical	Loss of, and interruption to, business activity										
	Displacement of businesses										
	Network resilience to disruption caused by natural hazards										
Social	Displacement of residents										
	Community cohesion, stability and character										
Low Impact											
Human	Daily travel movements										
Financial and Physical	Loss of tourist numbers and expenditure										
	Flow-on impacts into other industry sectors										
Social	Way of life and reverse sensitivity										
	Legend										
	No Change										
	Most Positive										
	Positive										
	Negative										
	Most Negative										

Summary of All Benefits After a Natural Hazard

For high impact social wellbeings, the Reduce Risk option has the greatest benefits of the four management options for both fans (Figure 6.2). The Status Quo option has the least benefits for Brewery Creek especially, but also for Reavers Lane.

The pattern of benefits for moderate and low impact elements is much the same as the high impact elements.

In summary, the Reduce Risk option has the greatest benefits in, and after, a natural hazard event across all capital stocks. The Status Quo option has the least benefits. On balance, there are fewer benefits arising from the Manage Risk option than for the engineering options.

Cost Benefit Analysis

A key part of this research was to identify and understand the full range of the economic benefits and costs associated with the different management options. The economic assessment in this report applies a standard Cost Benefit Analysis (CBA), which assesses values of the costs and benefits that may arise, to whom they accrue and when they may occur. The results of the CBA are designed to provide an understanding of which management options are preferred from an economic point of view, but these findings must be viewed in relation to the outcome of the overall SIA.

Based on the indicative CBA, the Status Quo, Reduce Risk and Engineering A management options are not preferred over the other management options. The CBA shows the Engineering B option is the best option, relative to the Status Quo this option provides positive outcomes for both Brewery Creek (+$6 million) and Reavers Lane (+$0 million). The Manage Risk option is the second-best management option when compared to the Status Quo this option shows positive impacts for Brewery Creek (+$4 million), but negative outcomes for Reavers Lane (-$6 million).

These results must be viewed in relation to the findings of SIA and international literature which indicates that the intangible impacts are often more important than the tangible costs. Also, the impacts of the hazard events are significant, with loss of life and destruction of many buildings, which would generate significant social impacts (as discussed in the SIA).

Findings of Socio-economic Assessment

In summary, both the SIA and CBA indicate that the QLDC should actively undertake management of the risks associated with rockfall and debris flow in the Gorge Road area. Specifically, the Status Quo option of doing nothing would not improve wellbeing or economic outcomes in, and after, a natural hazard event. This report has shown that the socio-economic issues associated with the different management options would suggest that the Manage Risk management option is preferred, followed closely by the Engineering B option. The Reduce Risk option has the greatest benefits in, and after, a natural hazard, but it also has the greatest costs. The Engineering A option has the most significant costs, especially for Reavers Lane, and while there will be benefits for small events, the option will not create significant benefits for moderate and large events.

Appendix One: Baseline Community Data

Figure 6.3: Household Profile for Brewery Creek and Reavers Study Area, 2018

Household Type	Study Area (n)	Queenstown (n)	Study Area (%)	Queenstown (%)	Study Area LQ
One-Person Household Young Low Income	10	126	2.6%	0.3%	9.19
One-Person Household Young Mid Income	22	298	5.9%	0.7%	8.73
One-Person Household Young Upper Income	6	126	1.5%	0.3%	5.27
One-Person Household Middle Low Income	5	300	1.3%	0.7%	1.85
One-Person Household Middle Mid Income	11	423	3.0%	1.0%	3.11
One-Person Household Middle Upper Income	7	186	1.8%	0.4%	4.15
One-Person Household Retirement Low Income	1	300	0.3%	0.7%	0.45
One-Person Household Retirement Mid Income	1	186	0.3%	0.4%	0.75
One-Person Household Retirement Upper Income	-	300	0.0%	0.7%	-
Couple Only Household Young Low Income	-	95	0.0%	0.2%	-
Couple Only Household Young Mid Income	6	300	1.7%	0.7%	2.55
Couple Only Household Young Upper Income	81	186	21.8%	0.4%	51.60
Couple Only Household Middle Low Income	-	186	0.0%	0.4%	-
Couple Only Household Middle Mid Income	2	300	0.6%	0.7%	0.93
Couple Only Household Middle Upper Income	28	95	7.6%	0.2%	35.39
Couple Only Household Retirement Low Income	-	297	0.0%	0.7%	-
Couple Only Household Retirement Mid Income	1	95	0.4%	0.2%	1.76
Couple Only Household Retirement Upper Income	5	384	1.2%	0.9%	1.41
2 Parents with 1 to 2 Children Young Low Income	-	297	0.0%	0.7%	-
2 Parents with 1 to 2 Children Young Mid Income	9	384	2.4%	0.9%	2.74
2 Parents with 1 to 2 Children Young Upper Income	14	1,400	3.8%	3.2%	1.19
2 Parents with 1 to 2 Children Middle Low Income	-	1,400	0.0%	3.2%	-
2 Parents with 1 to 2 Children Middle Mid Income	3	1,400	0.9%	3.2%	0.27
2 Parents with 1 to 2 Children Middle Upper Income	9	1,400	2.5%	3.2%	0.79
2 Parents with 1 to 2 Children Retirement Low Income	-	1,400	0.0%	3.2%	-
2 Parents with 1 to 2 Children Retirement Mid Income	1	1,400	0.2%	3.2%	0.06
2 Parents with 1 to 2 Children Retirement Upper Income	1	1,523	0.3%	3.5%	0.10
2 Parents with 3 or more Children Young Low Income	-	1,523	0.0%	3.5%	-
2 Parents with 3 or more Children Young Mid Income	-	1,523	0.0%	3.5%	-
2 Parents with 3 or more Children Young Upper Income	4	1,523	1.0%	3.5%	0.28
2 Parents with 3 or more Children Middle Low Income	-	1,523	0.0%	3.5%	-
2 Parents with 3 or more Children Middle Mid Income	-	171	0.0%	0.4%	-
2 Parents with 3 or more Children Middle Upper Income	5	1,523	1.4%	3.5%	0.41
2 Parents with 3 or more Children Retirement Low Income	-	171	0.0%	0.4%	-
2 Parents with 3 or more Children Retirement Mid Income	-	720	0.0%	1.6%	-
2 Parents with 3 or more Children Retirement Upper Income	-	281	0.0%	0.6%	-
One Parent Families Young Low Income	-	720	0.0%	1.6%	-
One Parent Families Young Mid Income	-	720	0.0%	1.6%	-
One Parent Families Young Upper Income	5	541	1.4%	1.2%	1.12
One Parent Families Middle Low Income	-	281	0.0%	0.6%	-
One Parent Families Middle Mid Income	-	720	0.0%	1.6%	-
One Parent Families Middle Upper Income	4	171	1.2%	0.4%	3.08
One Parent Families Retirement Low Income	-	541	0.0%	1.2%	-
One Parent Families Retirement Mid Income	-	1,047	0.0%	2.4%	-
One Parent Families Retirement Upper Income	-	198	0.0%	0.4%	-
Multi-Family Households Young Low Income	-	1,047	0.0%	2.4%	-
Multi-Family Households Young Mid Income	-	1,777	0.0%	4.0%	-
Multi-Family Households Young Upper Income	16	177	4.3%	0.4%	10.71
Multi-Family Households Middle Low Income	-	1,047	0.0%	2.4%	-
Multi-Family Households Middle Mid Income	-	1,777	0.0%	4.0%	-
Multi-Family Households Middle Upper Income	7	1,777	1.9%	4.0%	0.47
Multi-Family Households Retirement Low Income	-	1,777	0.0%	4.0%	-
Multi-Family Households Retirement Mid	-	1,777	0.0%	4.0%	-
Multi-Family Households Retirement Upper	-	198	0.0%	0.4%	-
Non-Family Households Young Low	-	177	0.0%	0.4%	-
Non-Family Households Young Mid Income	18	1,047	4.8%	2.4%	2.03
Non-Family Households Young Upper Income	71	69	18.9%	0.2%	120.62
Non-Family Households Middle Low Income	-	198	0.0%	0.4%	-
Non-Family Households Middle Mid Income	3	1,777	0.8%	4.0%	0.21
Non-Family Households Middle Upper Income	15	12	4.1%	0.0%	154.47
Non-Family Households Retirement Low Income	-	69	0.0%	0.2%	-
Non-Family Households Retirement Mid Income	-	196	0.0%	0.4%	-
Non-Family Households Retirement Upper Income	-	403	0.0%	0.9%	-
Total Households	**374**	**43,982**	**100.0%**	**100.0%**	**1.00**

Appendix Two: CBA Technical Information and Sensitivity Analysis

The following Appendix outlines the technical details for the CBA and the sensitivity analysis. The following discussion presents the development path and community assumptions, assumptions, then outlines the valuation methods to assess the costs and benefits for the key groups – Council, Property Owners, Local Businesses, Local Community and the wider community. The appendix then presents sensitivity analysis.

Development Path and Community Assumptions

The table below shows the development path in terms of built space or floorspace (m^2) for each of the management options. The development path for Status Quo and the two engineered options are the same, reaching 34,200m^2 of floorspace in Reavers by 2051 and 26,500 m^2 of floorspace in Brewery Creek by 2051. The development path for Managed is around two-third to a half that of these three management options. The development under the Reduced management option is 24,000m^2 lower in Reavers and 18,600m^2 lower in Brewery Creek in 2051 than the Status Quo.

Figure 6.4: Development Path build out numbers in Hazard Area

Builtspace (floorspace m^2)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	19,663	24,511	29,359	34,207
B	Managed		21,207	22,751	24,294
C	Reduced		10,248	10,248	10,248
D	Engineering (rockfall fences & channels)		24,511	29,359	34,207
E	Engineering (rockfall fences and debris flow fences/mesh)		24,511	29,359	34,207
Brewery Creek Fan					
A	Status Quo	10,972	16,147	21,323	26,498
B	Managed		12,291	13,611	14,930
C	Reduced		7,883	7,883	7,883
D	Engineering (rockfall fences & channels)		16,147	21,323	26,498
E	Engineering (rockfall fences and debris flow fences/mesh)		16,147	21,323	26,498

The table below shows the estimated number of people living, working or visiting the area for each of the management options. Again, Status Quo and the two engineered options are the same, reaching 1,101 people in Reavers by 2051 and 703 people in Brewery Creek by 2051. The Managed reaches 779 people in Reavers by 2051 and 438 people in Brewery Creek by 2051. While under the Reduced management option the number of people declines to 331 in Reavers and 235 in Brewery Creek in 2051.

Figure 6.5: Number of People in Hazard Area

Community (Live, Work and Visit)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	627	785	943	1,101
B	Managed		678	728	779
C	Reduced		331	331	331
D	Engineering (rockfall fences & channels)		785	943	1,101
E	Engineering (rockfall fences and debris flow fences/mesh)		785	943	1,101
Brewery Creek Fan					
A	Status Quo	330	454	579	703
B	Managed		366	402	438
C	Reduced		235	235	235
D	Engineering (rockfall fences & channels)		454	579	703
E	Engineering (rockfall fences and debris flow fences/mesh)		454	579	703

Queenstown-Lakes District Council Costs

QLDC will incur upfront capital costs and ongoing operational costs to implement the risk management options. While others will be ongoing costs, which may be required on an annual basis, including assessing consenting applications[134], maintenance, event clean-up costs, hazard risk education, and civil defence.

The following discussion outlines the approach that has been adopted to establish the value of the costs that QLDC will incur over the next three decades.

Council Capital Costs

QLDC will incur upfront capital costs, which includes the resources used in the planning process to develop management options and capital investment required to implement some of the management options.

The planning process that has been conducted by QLDC has included detailed research of the hazard risk, capital costs of engineering options, stakeholder engagement, internal time of council officers and this socio-economic assessment. However, the costs incurred in the planning process are not relevant to this CBA, as this cost will be the same for all options. We have treated this cost as a sunk cost, as it is a cost that has already been incurred and cannot be recovered. Therefore, this cost was assumed to be not relevant to the CBA of the management options.

The capital investment required to implement some of the management options is significant. This includes engineering protection, land purchases and building purchases.

QLDC commissioned Beca to develop indicative design and capital works costings for engineering protections that will reduce the impacts of both debris flow and rock fall events.[135] Beca's design and costing has been conducted at a high level, although more detailed assessment will be required if either option is selected by QLDC for further investigation. The costs outlined in the Beca report are capital costs of the engineering works only and make no provision for contingencies and may be higher than indicated.

For this report, it is assumed that the Beca costings are sufficiently accurate and that there are two engineering management options. The first engineering protection management option (Engineering A)

[134] Although this cost may be entirely recoverable from applicant.

[135] Beca Ltd (2021). Gorge Road Natural Hazards – Engineering Options Report – DRAFT.

will include rockfall fences and channels, which cost $4.7 million for Reavers Lane and $2.7 million for Brewery Creek. There may also be costs associated with infrastructure (roads, underground pipes, etc) that will need to be moved or reinstated and other Consenting costs that maybe required to enable the construction of the channels. The second engineering protection management option (Engineering B) will include rockfall fences and debris flow fences, which cost $2.2 million for Reavers Lane and $2.3 million for Brewery Creek. It is assumed that in each management option the engineering capital costs are spread evenly over the next five years.

Next, for some of the management options QLDC will need to buy land, buildings and remove some buildings. For this report, the assessment has combined QLDC rates information with information from Beca's assessments to establish the potential cost of land and buildings that may need to be acquired and the cost of demolition.

The Reduced Risk management option requires that all buildings from within the AIFR contour of $1x10^{-4}$ be removed. To implement this, QLDC and other government agencies may need to purchase land and buildings within the identified area and demolish the existing buildings. Based on the existing rateable values of land and buildings that may need to be purchased could be in the order of $47 million for Reavers and $32 million for Brewery Creek. The demolition cost would be in the order of $200,000 for both Reavers and Brewery Creek.[136]

The Engineering A option includes the widening and development of debris flow channels. To implement this management option, QLDC will need to buy some land and buildings from the landholders. For this report, the amount of private land and buildings that are within the path of the proposed channels was estimated using QLDC rating layers and Beca channel pathways. In total approximately 5,100m^2 of land and 112m^2 of buildings within Brewery Creek. The Reavers channel covers approximately 2,600m^2 of land and 600m^2 of buildings. The value of land and buildings that would need to be purchased would be in the order of $6.7 million for Reavers and $3.6 million for Brewery Creek. The demolition cost would be less than $10,000 for Brewery Creek and in the order of $100,000 for Reavers.

It is assumed that in each management option, the land and building purchases and demolition are spread evenly across the next decade.

Figure 6.6 shows the total capital costs that QLDC is expected to incur over the next decade. These values are used within the CBA. The capital costs for QLDC are minimised under the Status Quo and Managed outcomes, which is unsurprising as both these management options use planning mechanisms to manage land use and risk. At the other end of the scale, the Reduced Risk management option would require the largest investment, most of which relates to the investment required to acquire private properties within the hazard areas (in total approximately $53.6 million for both fans). This is followed by the Engineering A option, with significant investments in the channels and the need to acquire land over which the channels traverse (in total approximately $17.7 million for both fans). Finally, the Engineering B option would require $4.5 million to cover the construction of rockfall fences and debris flow fences and mesh in both fans. The management options that have been suggested by QLDC represent a wide range of potential capital costs to be funded by QLDC (and recovered from ratepayers and landowners), from being negligible to significant ($53.6m).

[136] Quotable Value (2021) Cost builder – Demolition (m2) – Dunedin.

Figure 6.6: Council Capital Costs Brewery Creek and Reavers Management Options (decade, $ million)

	Council Capital Costs ($m)	Engineering Protection	Acquired Land & Buildings	Demolition	Total
	Reavers Lane				
A	Status Quo	$ -	$ -	$ -	$ -
B	Managed	$ -	$ -	$ -	$ -
C	Reduced	$ -	$ 33.7	$ 0.2	$ 33.9
D	Engineering (rockfall fences & channels)	$ 4.7	$ 6.7	$ 0.1	$ 11.5
E	Engineering (rockfall fences and debris flow fences/mesh)	$ 2.2	$ -	$ -	$ 2.2
	Brewery Creek				
A	Status Quo	$ -	$ -	$ -	$ -
B	Managed	$ -	$ -	$ -	$ -
C	Reduced	$ -	$ 19.6	$ 0.2	$ 19.7
D	Engineering (rockfall fences & channels)	$ 2.7	$ 3.6	$ 0.0	$ 6.2
E	Engineering (rockfall fences and debris flow fences/mesh)	$ 2.3	$ -	$ -	$ 2.3

Finally, the Council has identified that there will be no difference in community infrastructure costs across the management options. It is possible that there may be less maintenance for infrastructure under Reduce and Managed. These options result in less intense development than might arise under other options, but it is not possible to estimate the differences.

Council Operational Costs

QLDC will also incur ongoing operational costs associated with the implementation of the management options. This will include costs associated with assessing consenting applications, hazard risk education, civil defence, clean-up costs if hazards occur and maintenance of engineering protections.

The following assumptions have been used to value the operational costs,

- Consenting Costs: the research and information that has been developed as part of the planning process for the management options, will allow council officers to assess each consent application more quickly. QLDC considers that the costs of assessing a consent will be similar under all the management options. However, the scale of development that could be enabled within the Managed Risk and Reduced Risk management options would be less than the three other options. The scale of potential activity implies that consenting costs maybe lower for Managed Risk and Reduced Risk – i.e., there will be fewer consent applications in these management options. We note that consenting costs are generally recoverable from the applicant.
- Hazard Education Costs: the council will provide information on the levels of risk as part of communication and consultation processes associated with the planning process. It is not anticipated that the public will be actively educated about the risks after the plan process is completed unless this forms part of the management response framework. However, it is considered likely that the QLDC and other government bodies (Ministry of Civil Defence and Emergency Management) will maintain information about the risk (i.e., GIS information). QLDC considers that the costs of hazard education will be similar under all the management options.

- Civil Defence Costs: if the hazard event occurs the council will work jointly with the Ministry of Civil Defence and Emergency Management to coordinate civil defence response. This may include emergency accommodation and food for the immediate period after the event. As with the other costs, the scale of potential activity maybe lower for Managed Risk and Reduced Risk options, therefore, the required Civil Defence response may be smaller – i.e., there will be fewer dwellings impacted, thus fewer residents will require help in these management options. However, we have not received any information about the potential differences in costs for Civil Defence, so it is assumed in this indicative CBA that Civil Defence costs are the same for all management options.
- Clean-up Costs: there will also be clean-up costs associated with hazard events. The cost has been estimated using the debris flow depth[137] and bulk excavation costs[138]. A large event may cost in the order of $3.6 million to clean up in either fan. The smaller events may cost $0.5 million for Brewery Creek and $0.2 million for Reavers. The return periods of the events mean that the expected cost of clean-up for any year is approximately $6,000 for Brewery Creek and $500 for Reavers. These costs are adopted for the Status Quo and Managed Risk management options. The clean-up costs are assumed to be smaller for the other three management options, where the small event flows are assumed to be contained by the engineering protection or impact land that no longer requires remediation (i.e., open space). For these three management options the expected cost of clean-up for any year is approximately $2,000 for Brewery Creek and $400 for Reavers.
- Maintenance of Engineering Protections: there will be ongoing maintenance and inspections required for the two engineering options. According to Beca, the rockfall fences and flow barriers may need to be inspected once or twice per annum. The protections will also need maintenance if an event occurs. For this report the inspection has been assumed to cost $10,000 per annum for each fan. The maintenance costs are assumed to be 20% of the capital costs, which will only be required if an event occurs. This means that the expected annual maintenance cost would $2,000 for Brewery Creek and be less than $500 for Reavers.

Figure 6.7: Council Operational Costs Reavers and Brewery Creek Management Options (annual, $000) shows the annual operational costs that QLDC is expected to incur over the coming decade. These values are used within the CBA. The operational costs are minimised under the Status Quo, Managed, and Reduced options. At the other end of the scale, the two engineering options would require the largest ongoing operational costs by QLDC, most of which relates to the costs required to maintain the engineering protections. The management options that have been suggested by QLDC have relatively small amounts of operational costs.

[137] Beca (2020) Hazard Event Flow Depths (layers).

[138] Quotable Value (2021) Cost builder – Excavation (m3) – Dunedin.

Figure 6.7: Council Operational Costs Reavers and Brewery Creek Management Options (annual, $000)

Council Operational Costs ($000)		Consenting, Hazard Education and Civil Defence	Event Clean Up	Maintenance Engineering Protection	Total
Reavers Fan					
A	Status Quo	No difference	$0.5	$0.0	$0.5
B	Managed		$0.5	$0.0	$0.5
C	Reduced		$0.1	$0.0	$0.1
D	Engineering (rockfall fences & channels)		$0.4	$10.5	$10.9
E	Engineering (rockfall fences and debris flow fences/mesh)		$0.4	$30.2	$30.6
Brewery Creek Fan					
A	Status Quo	No difference	$6.2	$0.0	$6.2
B	Managed		$6.2	$0.0	$6.2
C	Reduced		$0.3	$0.0	$0.3
D	Engineering (rockfall fences & channels)		$1.9	$14.2	$16.1
E	Engineering (rockfall fences and debris flow fences/mesh)		$1.9	$31.3	$33.2

Property Owners Costs

The owners of properties within the risk areas will be impacted under all of the management options. They will incur costs when hazard events occur, which will mainly relate to building damage and to a lesser extent, loss of income during the clean-up, but this cost will be considerably lower under all but the status quo options. Also, in some cases the land and buildings may be acquired by council and/or the development potential may be reduced.

The building damage costs that are expected to accrue to property owners was estimated in this report using GNS Riskscape model outputs. Riskscape assesses the losses as compared to the four building outcomes. The model provides an estimate of the damage to buildings and the replacement costs.

The model shows that currently the value of damages associated with a debris flow event in Brewery Creek event ranges from $1.1 million (small debris flow) to $14.1 million (large debris flow). While Reavers ranges from $13.6 million (small debris) to $39.2 million (large debris flow). There are also potential damages from rockfall events of $0.7 million in Brewery Creek and $11.8 million in Reavers.

Based on the return periods of each event, the annual expected building damage would be around $20,000 per annum for Brewery Creek and $18,000 per annum for Reavers. While events on Reavers will cause more property damage than Brewery Creek, the return period of an event in Reavers is longer which means that the expected damage in any one year is almost the same in each fan.

Figure 6.8 shows the future building damage costs, which were estimated using the development path that is outlined in the first part of this section.

For Reavers fan the value of building damage could increase from $18,000 today to $23,000 per annum by 2051, if the Status Quo pattern persists. This compares to $17,000 per annum for each of the Engineering

options and the Managed Risk. The Reduced Risk is the only option where the value of building damage decreases, reaching $2,000 per annum by 2051.

For Brewery Creek fan the value of building damage could increase from $20,000 today to $113,000 per annum by 2051, if the Status Quo pattern is enabled to continue. This compares with $32,000 per annum for each of the Engineering options and $25,000 per annum for the Managed Risk option. The Reduced Risk option is the only option where the value of building damage decreases, reaching $8,000 per annum by 2051.

Figure 6.8: Reavers and Brewery Creek Building Damage Costs, 2021-2051 (annual, $000).

Building Damage Costs ($000)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$18.0	$19.6	$21.2	$22.8
B	Managed		$17.9	$17.9	$17.8
C	Reduced		$2.0	$2.0	$2.0
D	Engineering (rockfall fences & channels)		$17.8	$17.5	$17.2
E	Engineering (rockfall fences and debris flow fences/mesh)		$17.8	$17.5	$17.2
Brewery Creek Fan					
A	Status Quo	$20.0	$51.0	$82.0	$113.0
B	Managed		$21.8	$23.5	$25.2
C	Reduced		$8.1	$8.1	$8.1
D	Engineering (rockfall fences & channels)		$23.9	$27.8	$31.7
E	Engineering (rockfall fences and debris flow fences/mesh)		$23.9	$27.8	$31.7

Some property owners may be required to sell their land and buildings to the Council or other government organisation. In this report, it is assumed that the purchase price paid by Council (as estimated in Figure 6.8) is a market value which is sufficient to offset the value of the land and existing buildings to the property owners. Therefore, property owners are assumed to be net neutral, i.e., the purchase price is equal to the value of the existing property.

However, under some of the management options the future potential use of the land will be different. This means that property owners may lose some benefits in terms of use potential. For example, under the Status Quo option, the property owners in the area could (in theory) build over 100,000m^2 of new floorspace space within both fans. This compares to the Managed Risk option which would allow over 40,000m^2 and the Reduced Risk option which would allow very little additional space. This additional space would generate benefits (e.g., rents) to the property owners. For this assessment we have applied an average yield of 3.59% to the value of the new floorspace that is developed in each management option.[139]

Figure 6.9 shows the potential revenue of future development, which was estimated using the development path outlined in the first part of this section.

[139] Real Estate Institute of New Zealand (2020) Residential Investment Property Rental Yield Indicator - Queenstown.

For Brewery Creek fan the value of potential revenue could increase to $1.9 million per annum by 2051, if the Status Quo option persists. This compares to $0.6 million per annum for the Managed Risk option and -$1.2 million for the Reduced Risk option per annum by 2051.

For Reavers fan, the value of development potential revenue could increase from $1.9 million per annum by 2051, under the Status Quo option. This compares $0.5 million per annum for Managed Risk and -$0.4 million for Reduced Risk per annum by 2051.

While this value is obviously important to the property owners in the area, for the most part this value cannot be viewed as net additional from the wider community perspective. The scale of activity enabled within the fans is relatively small compared to the rest of the district. Therefore, any difference in activity between the management options is likely to be offset by changes in development outside of the fans. Hence, the differences in revenue, noted in the table below will be more or less offset by values that flow to other property owned in the district. That is from a community perspective the differences in development potential are not likely to be material.

Figure 6.9: Reavers and Brewery Creek Development Potential, 2021-2051 (annual, $ million).

Development Potential Revenue ($m)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$ -	$ 0.6	$ 1.3	$ 1.9
B	Managed		$ 0.2	$ 0.4	$ 0.6
C	Reduced		-$ 1.2	-$ 1.2	-$ 1.2
D	Engineering (rockfall fences & channels)		$ 0.6	$ 1.3	$ 1.9
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 0.6	$ 1.3	$ 1.9
Brewery Creek Fan					
A	Status Quo	$ -	$ 0.6	$ 1.2	$ 1.9
B	Managed		$ 0.2	$ 0.3	$ 0.5
C	Reduced		-$ 0.4	-$ 0.4	-$ 0.4
D	Engineering (rockfall fences & channels)		$ 0.6	$ 1.2	$ 1.9
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 0.6	$ 1.2	$ 1.9

Additionally, property owners that choose to undertake a redevelopment will need to apply for building consent and in some cases resource consent. The Council considers that the application cost will remain the same as current costs for the Status Quo and two Engineering options.

Conversely, the costs are expected to be smaller for Managed and Reduced options, as there would be no need for technical assessments in some areas. Also, the number of consent applications is likely to be lower for these two management options, as there are restrictions on new builds in some of the higher risk areas within each fan.

In this report, it is assumed that there are no additional consenting costs for property owners under the Status Quo and two Engineering options. The changes in policy suggested in the Managed and Reduced options, relate to a small number of properties. In any given year, the number of consents in each fan is likely to be small. Therefore, nominal savings are likely to be small (i.e., less than $10,000 per annum). For this report, it is assumed that there are nominal savings of less than $10,000 per annum in each fan.

Local Businesses

There are businesses operating in both fans that will be impacted if an event occurs. As outlined in the community section, there are five commercial accommodation provides in Reavers hazard area. In Brewery Creek there are around 10 businesses operating in the industrial buildings on Industrial Place and one commercial accommodation provider within the hazard area.

If an event occurs there will be disruption to these businesses; during the event, the clean-up and the rebuild period. Also, the events are likely to destroy assets of the businesses and there is potential for employees to be lost through fatalities or unemployment. If an event does occur, then the businesses will be negatively impacted.

The disruption costs have been valued in the CBA using floorspace that could be developed under each of the management options, a workspace ratio which reflects a midpoint of use for commercial activity[140], the average productivity for the district[141] and an assumed disruption period of one month. In summary, it is assumed that businesses cannot operate for one month and that the output in the businesses is lost.

Figure 6.10 shows the estimated value of lost business activity for both fans. The key outputs are:

- Reavers Lane: the expected value of lost business activity could remain at around $1,000 per annum by 2051, under the Status Quo option. This compares to $900 per annum for the Managed Risk option and $100 for the Reduced Risk option per annum by 2051.
- Brewery Creek: the expected value of lost business activity could increase from $7,400 per annum to $16,000 per annum by 2051, under the Status Quo option. This compares with $8,300 per annum for the Managed Risk option and $2,500 for the Reduced Risk option per annum by 2051.

[140] The workspace ratio of industrial activities tends to be over 100m^2 per employee, while office activities can be as low as 20m^2 per employee, retail can be up to 50m^2 per employee and other uses (health, community facilities and commercial accommodation) can vary depending on the business model. For this report we adopt 50m^2 as a reasonable mid-point.

[141] Infometrics (2021) Queenstown Lakes District Economic Profile.

Figure 6.10: Reavers and Brewery Creek Lost Business Activity, 2021-2051 (annual, $000).

Business Activity ($000)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$1.0	$1.0	$1.0	$1.1
B	Managed		$0.9	$0.9	$0.9
C	Reduced		$0.1	$0.1	$0.1
D	Engineering (rockfall fences & channels)		$0.9	$0.9	$0.8
E	Engineering (rockfall fences and debris flow fences/mesh)		$0.9	$0.9	$0.8
Brewery Creek Fan					
A	Status Quo	$7.4	$10.3	$13.1	$16.0
B	Managed		$7.7	$8.0	$8.3
C	Reduced		$2.5	$2.5	$2.5
D	Engineering (rockfall fences & channels)		$7.4	$7.5	$7.5
E	Engineering (rockfall fences and debris flow fences/mesh)		$7.4	$7.5	$7.5

If an event occurs, the businesses will also lose assets such as machinery, furniture, materials, and stock. There is no information on the value of tangible business assets that could be lost within the hazard risk areas. However, the average small business in New Zealand has approximately $0.5 million of tangible assets.[142] For this assessment, it is assumed that the business in the hazard areas lose tangible assets which are worth $0.5 million.

Figure 5.13 shows the estimated value of lost business assets for both fans, the key conclusions are:

- Reavers Lane: the value of lost business assets could increase from $1,600 to $1,800 per annum by 2051, under the Status Quo option. This compares with $1,500 per annum for the Managed Risk option and $100 for the Reduced Risk option per annum by 2051.
- Brewery Creek: the value of lost business assets could increase from $46,100 per annum to $98,000 per annum by 2051 (Status Quo). This compares to $49,300 per annum for Managed Risk and $9,700 for Reduced Risk per annum by 2051.

[142] Stats NZ (2020) Annual Enterprise Survey 2019 financial year.

Figure 6.11: Reavers and Brewery Creek Lost Business Assets, 2021-2051 (annual, $000).

Business Assets ($000)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$1.6	$1.7	$1.7	$1.8
B	Managed		$1.6	$1.6	$1.5
C	Reduced		$0.1	$0.1	$0.1
D	Engineering (rockfall fences & channels)		$1.5	$1.4	$1.3
E	Engineering (rockfall fences and debris flow fences/mesh)		$1.5	$1.4	$1.3
Brewery Creek Fan					
A	Status Quo	$46.1	$63.4	$80.7	$98.0
B	Managed		$47.1	$48.2	$49.3
C	Reduced		$9.7	$9.7	$9.7
D	Engineering (rockfall fences & channels)		$44.4	$42.8	$41.2
E	Engineering (rockfall fences and debris flow fences/mesh)		$44.4	$42.8	$41.2

Local Community

As discussed above, much of the land in the hazard areas is currently used for either industrial or commercial accommodation. The remaining land is used by residents, most of whom are tenants in private rentals, and a number of owner occupiers.

For this assessment it is assumed that any person that lives, visits or works within the area are part of the local community. This is a wide definition, which is designed to provide an understanding of the total numbers of people that may be at risk from the hazard events. Every person that is in the area will face similar chances of harm while they are present in the area, regardless of their purpose for being there. However, as outlined in the Beca risk assessment, the time spent in the area is different for each group. This means the risk can be different for each person depending on their purpose for being in the area.

To estimate the potential risks to the local community, this report has estimated the amount of built space that is at risk from the hazard, the numbers of people that could be present in/near those buildings, the risk of fatality for those people and the economic value of preventing potential fatalities.

First, the quantity of built space at risk was estimated by applying the Annual Individual Fatality Risk (AIFR) contours[143] to the building areas that could be developed (both existing buildings and future building potential). This spatial assessment outputs an estimate of the amount of floorspace that could be within each area of risk. In any given year, the built space is divided by an assumed average space ratio for each floorspace type – Residential (one person per 30m^2) and business (one person per 50m^2). This provides an estimate of the local community in any given year, within each AIFR contour.

For example, currently there is expected to be approximately 600 people living, working or visiting the buildings within Brewery Creek and 300 people within Reavers. Based on the average risk and the number of people within the area, there is an expected fatality rate of approximately 0.3 per annum within both fans.

[143] Beca (2020) AIFR Contours.

As more floorspace is developed, the number of people within the fans increases and the expected fatalities increase commensurately. Under the Status Quo option, the annualised number of expected fatalities increases to almost 1 for Brewery Creek and 0.4 for Reavers. This compares to Reduce Risk, which will see the number of people within the higher risk areas decline as buildings are removed. Under this option the expected fatality decreases substantially to 0.02 for Brewery Creek and 0.01 for Reavers.

The final step is then to establish the economic value of preventing the potential fatalities. This report utilises the official Value of Statistical Life (VOSL) which is developed by NZ Transport Agency for the assessment of transport projects. The VOSL is not a value of an identified individual life. It is simply a planning statistic which indicates society's preparedness to pay (Willingness to Pay) for projects that will reduce premature fatalities. The VOSL is measured using primary research that elicits values which include a wide range of social costs associated with preventable fatality, i.e., market and non-market values.

There is no particular reason why the VOSL in the present context should differ drastically from VOSL estimated from the traffic crash risk changes. However, there is a possibility for lower values due to a comparatively quick death, with brief pain and suffering caused by this type of hazard. Also, it is not practical to estimate the VOSL for every risk environment due to the high cost of conducting primary research required to establish the value of VOSL. Therefore, the CBA in this report adopts NZTA current VOSL estimate, which is $4.56 million per preventable fatality.

For Reavers fan the value of preventable fatalities could increase from $1.2 million today to $1.6 million per annum by 2051, if the Status Quo development pattern is permitted to continue. This compares to $1.1 million for each of the Engineering options and $1.2 for the Managed Risk option. The Reduced Risk option is the only management option where the value of preventable fatalities decreases, reaching $0.1 million by 2051.

For Brewery Creek fan, the value of preventable fatalities could increase from $1.7 million today to $4.1 million per annum by 2051, if the Status Quo pattern persists. This compares to $2.8 million for each of the Engineering options and $2.1 for the Managed Risk option. The Reduced Risk option is the only management option where the value of preventable fatalities decreases, reaching $0.1 million by 2051.

Figure 6.12 shows the annual expected costs of preventable fatality for each management option and each fan. The preventable fatality costs show that Reavers fan is likely to have significantly lower expected costs (i.e., around a million per annum) than Brewery Creek (i.e., mostly above 2 million per annum) under most of the management options. This difference in costs is primarily driven by the difference in risks for each fan, with the return periods in Brewery Creek being much higher than Reavers (that is the probability of the events occurring are greater), rather than there being greater development potential or human activity.

For Reavers fan the value of preventable fatalities could increase from $1.2 million today to $1.6 million per annum by 2051, if the Status Quo development pattern is permitted to continue. This compares to $1.1 million for each of the Engineering options and $1.2 for the Managed Risk option. The Reduced Risk option is the only management option where the value of preventable fatalities decreases, reaching $0.1 million by 2051.

For Brewery Creek fan, the value of preventable fatalities could increase from $1.7 million today to $4.1 million per annum by 2051, if the Status Quo pattern persists. This compares to $2.8 million for each of the

Engineering options and $2.1 for the Managed Risk option. The Reduced Risk option is the only management option where the value of preventable fatalities decreases, reaching $0.1 million by 2051.

Figure 6.12: Reavers and Brewery Creek Preventable Fatality Costs, (annual, $ million) 2021-2051.

Preventable Fatality Costs ($m)		2021	2031	2041	2051
Reavers Fan					
A	Status Quo	$ 1.2	$ 1.3	$ 1.4	$ 1.6
B	Managed		$ 1.2	$ 1.2	$ 1.2
C	Reduced		$ 0.1	$ 0.1	$ 0.1
D	Engineering (rockfall fences & channels)		$ 1.2	$ 1.1	$ 1.1
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 1.2	$ 1.2	$ 1.1
Brewery Creek Fan					
A	Status Quo	$ 1.7	$ 2.5	$ 3.3	$ 4.1
B	Managed		$ 1.9	$ 2.0	$ 2.1
C	Reduced		$ 0.1	$ 0.1	$ 0.1
D	Engineering (rockfall fences & channels)		$ 2.1	$ 2.5	$ 2.8
E	Engineering (rockfall fences and debris flow fences/mesh)		$ 2.1	$ 2.4	$ 2.7

Wider Community

The wider community will also incur costs and benefits from the different management options. These will arise because there are differences in the management options in terms of Council expenditure and the land use outcomes.

Firstly, Council's expenditure will increase under some of the management options to cover new capital investments and operating costs. While this cost is already covered above in the Council section of the assessment, it is important to note that the wider community may be required to fund a share of the costs.

Secondly, the District is facing strong growth pressures which are expected to continue over the coming decade. There are issues in terms of the amount of residential housing and the affordability of the housing. Under some of the management options the amount of development potential in the area will be reduced, which means that housing and economic activity enabled in the area will be different depending on the management option.

However, while there are differences in development potential, these are relatively small in the context of the district (i.e., less than 1% of housing). Also, it is considered that most of the difference may simply be accommodated in other parts of the district. Therefore, the difference in development potential within the management options will have minimal impact on affordability or housing supply in the district over the evaluation period. For this CBA, the impacts on the wider community from affordability and housing supply is assumed to be the same under all the management options.

Cost Benefit Assessment Summary

The cost and benefits described in the previous subsections combined in this summary section to provide an understanding of the relative merit of each management option. The CBA combines the flow of costs and benefits over the evaluation period and converts into today's value to provide Net Present Value for the Status Quo and the four alternative management options.

The Status Quo is used as the baseline, or counterfactual, from which the alternative management options are tested. Simply, the resulting value of doing nothing (Status Quo) is subtracted from each management option to establish the marginal value of implementing the management option. Specifically, a positive number in the tables below shows the instances where the management option is beneficial compared to the Status Quo.

Figure 6.13 shows the estimated Net Present Value of the costs over the evaluation period for the four alternative scenarios and each of the fans separately, for Council, local community (and businesses) and property owners. The positive numbers in the table shows that the instances where the management option is beneficial compared to the Status Quo. For example, the positive numbers in the local community and business column show that each of the management options will result in net benefits to the local community relative to the Status Quo, which relates to the reduction in hazard risk (i.e., prevention of death). Conversely, the negative numbers in the Council/wider community column shows that each of the management options result in net costs to the wider community relative to the Status Quo, which relates to the increased expenditure on engineering protections and property acquisition.

Figure 6.13: Reavers and Brewery Creek CBA Net Present Value, 2021-2051.

NPV 2021 - 2051 ($m)		Council/Wider Community	Local Community and Business	Property Owners	Total
Reavers Fan					
B	Managed	$0	$2	-$8	-$6
C	Reduced	-$26	$15	-$25	-$36
D	Engineering (rockfall fences & channels)	-$10	$3	$0	-$7
E	Engineering (rockfall fences and debris flow fences/mesh)	-$2	$3	$0	$0
Brewery Creek Fan					
B	Managed	$0	$12	-$9	$3
C	Reduced	-$15	$33	-$15	$2
D	Engineering (rockfall fences & channels)	-$6	$8	$0	$2
E	Engineering (rockfall fences and debris flow fences/mesh)	-$2	$8	$0	$6

The key results are:

- The Reduced Risk option is the least favour option when compared to the Status Quo. There are significant costs to Council/wider community and property owners, which are not offset by the reduction in risks to the local community. The CBA shows negative outcome for both Reavers Lane (-$36 million) and marginally positive for Brewery Creek ($2 million).
- The Engineering B option is better than the Status Quo. The CBA shows positive outcomes for both Reavers Lane (+$0 million) and Brewery Creek (+$6 million).
- The Managed option is the second-best management option when compared to the Status Quo. The CBA shows negative outcomes for Reavers Lane (-$6 million) and positive for Brewery Creek (+$3 million).
- Comparing the two fans, the results shows that the benefit cost ratio from investing money in protection under Engineering B for Brewery Creek is approximately 3.5:1, while for Reavers it is 1.1:1. This is mainly a function of the return periods of the events, as Reavers

Lane has a much lower probability of an event occurring relative to Brewery Creek. Specifically, the costs of protection in Engineering B are broadly similar for each fan, but the benefits of avoided risk to the local community are smaller for Reavers than for Brewery Creek.

Based on the indicative CBA, the Status Quo, Reduced and Engineering A management options are not preferred over the other management options, from an economic point of view. The favoured options, from an economic point of view, are the Engineering B and Manage Risk options. If Council decides to take either of these options forward, it is recommended that more resources are put into understanding the costs and benefits of these two management options in greater detail to establish which of these options is best.

This indicative CBA is based on the best available information that QLDC holds. It is acknowledged that there may be future research commissioned by QLDC to refine certain elements of the management options. For example, QLDC may commission detailed capital costing of the Engineering Protections, loss of life modelling, development potential modelling or changes to the management options. As such we have designed the CBA model to enable new information to be readily imported and allow updated results to be provided.

Sensitivity Testing

The final step in this assessment was to undertake sensitivity analysis of the assumptions that have been applied in the indicated CBA. The sensitivity testing covered 22 assumptions within the model (see details below), which included a low and high run for each assumption.

The sensitivity testing shows that the model results are most sensitive to the following assumptions (listed in order of importance),

1) Evaluation Period: is always a key assumption in CBA. If the period is increased to 50 years, then both Engineering options become preferred. This is an understandable outcome as the additional benefits from reduced risk (preventable fatalities) in the future cumulate to offset the large upfront cost of the capital works that Council must fund.
2) Development Path: if the development path is quicker than is assumed in this report then the value of Managed option would be increased.
3) VOSL: the value of preventable fatalities is also important. The main benefit of the management options is to reduce risk of fatalities, if VOSL is higher or lower than the relative value of the management options would change.
4) Discount Rate: is always a key assumption in CBA. If the discount rate increased, then the value of future preventable fatalities would be reduced significantly. This would have implications for the comparison of the different options.
5) Capital Expenditure: this cost of capital is also important to the CBA. If the cost of constructing the protections increased significantly then the relativity between the options could change.

However, the sensitivity testing shows that the for the most part the findings of this report are not sensitive to the assumptions. That is the model outputs from the CBA show that Managed, and Engineering B are the preferred options for most runs of the sensitivity. Given the information currently available, the

indicative CBA and the sensitivity analysis, it is considered likely that either, Managed or Engineering B management option will be the best.

Figure 6.14: Indicative CBA Sensitivity Analysis – List of Assumption Ranges

Senstivity Anslysis - Assumption Settings	Low	Base	High
Evaluaiton Period	10	30	50
Discount Rate	3%	5%	7%
Development Path	75	100	125
Engineering Costs	-30%	0%	30%
Engineering Build time	3	5	10
Maintenance Costs	-50%	0%	50%
Resi persons per m2	20	30	40
Dwelling Size	120	150	180
VOSL	$ 3,000,000	$ 4,560,000	$ 6,000,000
Land Value	-30%	0%	30%
Building Value	-30%	0%	30%
Demolition Costs	$ 30	$ 43	$ 50
Acquistion	5	10	15
Building Damage	-30%	0%	30%
Clean up costs	$ 15	$ 27	$ 40
Economic Activity	$ 86,579	$ 108,224	$ 129,869
Workspace Ratio	40	50	60
Business Assets	$ 753,723	$ 1,076,748	$ 1,399,772
Business Assets - Insured	30%	50%	70%
Accomodation Occupancy	50%	62%	70%
Development Potential (costs)	2%	3.6%	5%
Landholder Consenting	$ 5,000	$ 10,000	$ 20,000