



Economic Assessment of the Lower Waitaki River Control Scheme

Report to Otago Regional Council

**February
2017**

Acronyms and Abbreviations

Cumecs	Cubic metres per second
ECan	Environment Canterbury
NPV	Net Present Value
NZTA	New Zealand Transport Agency
ORC	Otago Regional Council

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Executive Summary

The Otago Regional Council (ORC) has engaged Castalia to undertake an economic assessment of the Lower Waitaki River Control Scheme. This assessment includes:

- An assessment of the benefit split between those inside the control scheme zone, and those outside.
- A review of the allocation of costs between Canterbury and Otago

The scheme is operated and maintained by Environment Canterbury (ECan), but the costs are split between ECan and the ORC because the scheme sits across both regional boundaries. ECan advise ORC of the Otago share of costs, which ORC collect via a targeted rate in their defined scheme area. Currently, the ORC does not collect revenue from ratepayers outside of the scheme area.

This report provides an economic assessment of the benefit share for the scheme.

Most benefits accrue to Canterbury

The proportion of benefits of the river control scheme accruing to Otago is 23.6 percent, while 76.4 percent accrues to Canterbury. The main driver for the difference is that Canterbury accounts for nearly double the amount of production from land in the scheme compared with Otago. This means more houses and farm land that would incur costs through greater levels of flooding and erosion if the scheme were not in place.

Most benefits accrue to those inside the scheme

We included both the Otago and Canterbury sides of the scheme area when calculating the in-scheme/out-of-scheme benefit ratio. This is because it is illogical to consider the in-scheme/out-of-scheme benefits for Otago alone, because the out-of-scheme benefits include national benefits, which cannot be split between Otago and Canterbury. This ratio remains just as relevant to Otago, because it fully captures out-of-scheme benefits, and provides a firm basis for considering cost allocation between in-scheme and out-of-scheme ratepayers.

The share of benefits to those inside the scheme area is 90 percent, with 10 percent of benefits accruing outside of the scheme area.

We used a counterfactual test to assess the benefit ratios

We used a counterfactual approach to determine benefits of the scheme, where we consider the hypothetical situation if the infrastructure were not to exist and flooding and erosion events were to occur as they naturally would. The costs that would be faced in those circumstances are assumed to be proportional to the benefit received from the scheme.

All costs were assessed qualitatively to determine material costs. Material costs were then quantified by calculating their net present value from expected flood and erosion events over a 100-year sample period. The regional costs were then split as a ratio between those accruing to Canterbury and Otago. We also split the benefits between those accruing to people inside the scheme zone, versus those out of the scheme.

There are some key reasons for the in-scheme/out-of-scheme benefit split

Most benefits accrue to residents and businesses inside the scheme, because the scheme reduces the impact of flood and erosion events and the zone encompasses those who are immediately at risk. However, several out-of-scheme benefits exist because:

- There is important regional infrastructure within them including state highways, a railway line, and an 18km Transpower transmission line; disruption or maintenance would have impacts that are widely felt by people and businesses throughout the region
- The farms and businesses within the scheme support wider regional economic activity. Productive losses to farms and businesses inside the scheme therefore negatively impact the regional economy
- Public services such as emergency services and highway operations benefit from a reduction in flood events, which lowers their costs. This is felt both at the Territorial Local Authority level, regional level, and the national level.

We tested the sensitivity of the results

The sensitivity range of benefit splits was tested by varying key assumptions including the discount rate and the proportion of lost business inside the scheme. The benefit shares do not alter substantially when these key variables are changed.

Table E.1: Sensitivity Ranges for Public-Private Benefit Ratios

Ratio	Public-private benefit ratio	Sensitivity range	
		Low end	High end
Canterbury: Otago	76.4 : 23.6	75.5 : 24.5	76.5 : 23.5
In-scheme: Out-of-scheme	10 : 90	9.4 : 90.6	18.8 : 81.2

Benefits accrue to the district, the region, and the country

The ORC may wish to consider how to distribute the out-of-scheme benefits across the region. To give an initial sense of the spread, the benefits are grouped in Table E.2 by district, region and country according to where the majority of benefits would fall.

Table E.2: Distribution of Benefits

Public benefit category	Allocated to			Comment
	District	Region	Country	
Damage to non-commercial property	✓			Would accrue to properties in the scheme
Lost businesses because of impacts on farms	✓	✓		Significant proportion of economic activity likely to be in district and region because of proximity to farm businesses
The cost of the emergency response and repairs		✓	✓	Local authorities bearing these costs can apply for central government financial

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				assistance (such as, benefit higher than district level)
Reduced access via roads			✓	State highways are paid for by NZTA
Reduced access via rail			✓	Part of the national rail network
Transpower Transmission line damages			✓	Costs to protect lines from erosion would be absorbed by Transpower and dissipated nationally
Irrigation intakes	✓			Costs to replace intake infrastructure would be spread amongst farmers in irrigation cooperatives across the district. (Approximately 20 percent of the recipients of the irrigation are in the Scheme and 80 percent out of Scheme in the district)

1 Introduction

The Otago Regional Council (ORC) has engaged Castalia to undertake an economic assessment of the Lower Waitaki River Control Scheme. This assessment includes:

- A review of the allocation of costs between Canterbury and Otago
- An assessment of the benefit split between those inside the control scheme zone, and those outside

The scheme manages water channels and erosion impacts to protect local communities and enhance the productive use of land.

The scheme is operated and maintained by Environment Canterbury (ECan), but the costs are split between ECan and the ORC because the scheme sits across both regional boundaries. ECan advises ORC of the Otago share of costs, which ORC collect via a targeted rate in their defined scheme area. Currently, it does not collect revenue from ratepayers outside the scheme area.

In this section, we describe the purpose and structure of this paper and then provide some background on the scheme.

Purpose of this paper

In this study, we assess the economic benefits of the scheme. This requires an understanding of the economic benefits from the scheme's erosion mitigation role, in addition to the scheme's flood protection role and any other benefits. This assessment enables cost ratios to be described for: public to private costs; in scheme costs to out of scheme costs; and ORC costs to Ecan costs.

We informed our assessment with feedback from the public in Oamaru. A summary of their feedback is attached in 6Appendix A.

We carry out the economic assessment in three steps (Section 2 describes these in greater detail):

- Determine a counterfactual to the scheme's existence, and identify the types of costs (that is the benefits of the scheme) that would be incurred (Section 3)
- Qualitatively assess the benefits to find material benefits (Section 4)
- Quantify the material benefits for the scheme (Section 5).

We are then able to identify the ratio of Canterbury to Otago benefits and the ratio of in-scheme to out-of-scheme benefits. We then discuss if the current rating policy reflects those benefits (Section 6).

Background

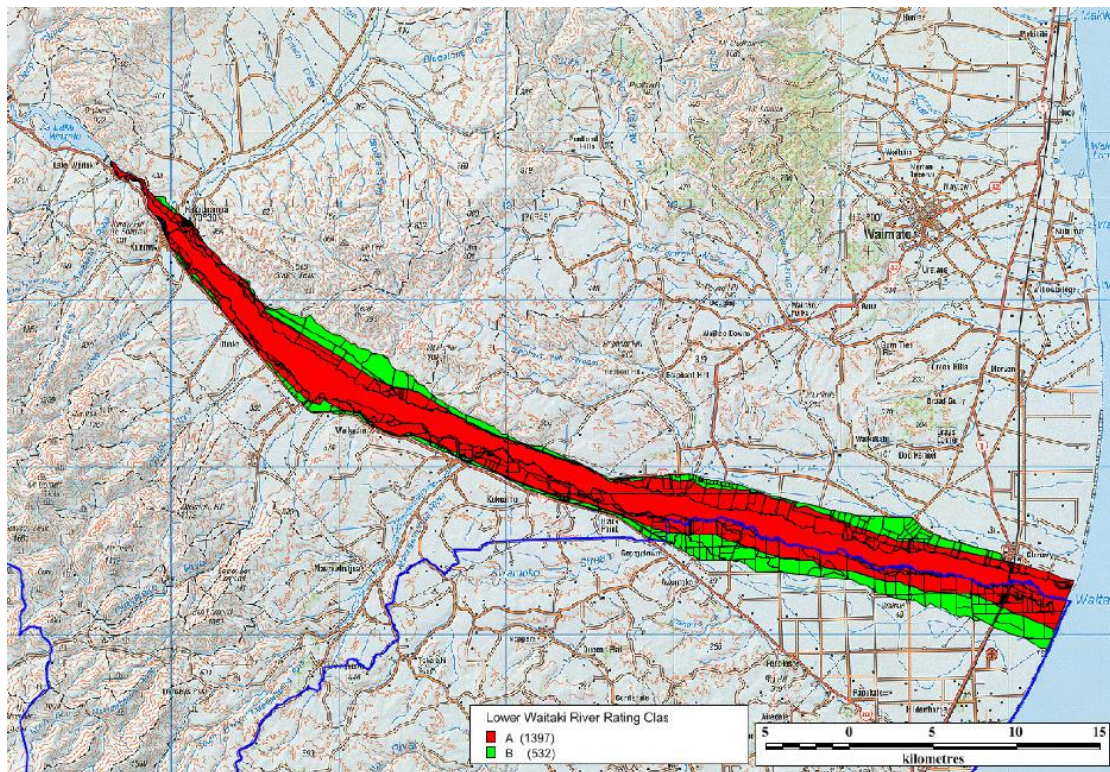
The Lower Waitaki River Control Scheme involves a 65km length of river extending from downstream of the Waitaki Dam (near Kurow) to the Pacific Ocean at Glenavy. It controls water flow and erosion levels by maintaining a cleared fairway and an active riverbed, limiting the erosion of active bed vegetated margins, containing river flows and minimising lateral erosion that affects farmland.

The areas protected by the scheme are mainly freehold farm land and Department of Conservation land. The scheme area also covers important infrastructure including State Highway bridges, a South Island Main Trunk rail bridge, lengths of two State Highways (82 and 83), a Transpower transmission line and various irrigation intakes. Several towns and communities exist within the scheme servicing surrounding farming businesses

including Kurow, Otekaieke, and Duntroon on the ORC side and Hakataramea and Glenavy on the Canterbury side.

ECan is responsible for managing the scheme. They recover around 40 percent of the cost of the scheme from Meridian Energy, who operate the Waitaki dam further upriver. A review of the benefits to Meridian Energy was outside of the scope of this report. The remaining 60 percent of the costs are split between ECan and the ORC because the scheme sits across regional boundaries. ECan pay approximately 33 percent of the costs and the ORC pay 27 percent. The ORC collect and pass on their share of the revenue to ECan. The scheme area and the split between Otago and Canterbury can be seen in Figure 1.1.

Figure 1.1: The Lower Waitaki River Control Scheme Area



The blue line is the boundary between Otago and Canterbury. The targeted rate is collected from the red and green areas.

Source: ECan, Lower Waitaki River Control Scheme Review: Options Report, March 2015

The ORC recovers costs through a targeted rate on ratepayers in the scheme area, which is intended to reflect the benefits accrued to those in the scheme area. ECan recover costs through three rates: a targeted rate on ratepayers in the scheme area; a Works and Services Rate; and a General Rate targeting ratepayers within and beyond the scheme area. The two latter rates are intended to reflect the broader benefits of the scheme accrued to individuals both inside and outside of the scheme area. This is summarised in Table 1.1.

Table 1.1: Otago and Canterbury Funding Policy Ratios (%)

Funding source	ORC	ECan
Differential targeted rate	27	23
Works and services rate	-	5
General rate	-	5
Meridian energy contribution	40	

Source: ECan, Lower Waitaki River Control Scheme Review: Options Report, March 2015, p.15

2 Methodology

The three steps in our economic assessment of the benefits from the scheme are:

- Determine the counterfactual
- Qualitatively assess the benefits to identify the material benefits of the scheme
- Quantify the material costs and determine the benefit ratios.

This section describes these three steps in more detail.

1. Determine a counterfactual

We pose a counterfactual whereby the scheme does not exist and flooding and erosion occur as they naturally would, with flooding more severe and erosion more widespread. The economic benefits of the scheme are the avoidance of the costs that would be incurred in the absence of the scheme. This requires knowing:

- Expected rainfall, flooding inundation levels and frequencies (for flooding)
- Rate and direction of natural erosion processes (for erosion).

We obtained data on the frequency and severity of a flood event in the Waitaki River, expressed as an expected event every set number of years (for example, a ‘1 in 5’ year event, a ‘1 in 20’ year event, and so forth).¹ The data also describes the accelerated change to the course of the river during such events, and the associated land loss, which provides a measure of material changes to rates of erosion.

We would expect several types of costs in the counterfactual scenario, some of which will result from natural flooding events and some which will result from river course change. We identify and describe the direct and indirect costs faced by those inside and outside the scheme in the counterfactual (which are the benefits of the scheme). These are described in Table 2.1.

Table 2.1: Benefit Categories

Impact	Description
Loss of life	Deaths that occur because of the flood event
Impaired health	Injuries and illnesses caused by the flood event
Damage to non-commercial property	Structural and contents damage to residential homes because of flooding and/or river course change
Loss of Amenity	The disruption to recreational activities
Loss of land or output on farms or businesses	Damage to farm infrastructure and lost productive output on farmland, and the flow-on impacts on local and regional businesses
The cost of the emergency response and repairs	The costs of evacuation, immediate welfare needs for those affected by the event, support and advisory services
Reduced access via roads	The disruption to users of road infrastructure (individuals and businesses) and increased maintenance costs from erosion
Reduced access via rail	The disruption to users of rail infrastructure (individuals

¹ Data obtained through personal communications from River Engineers and Asset Management Engineers at Environment Canterbury, January 2017.

	and businesses) and increased maintenance costs from erosion
Damages to Transpower transmission line	The cost of unserved energy from the line being down due to flooding and increased maintenance costs from erosion
Increased costs of irrigation intake	Higher infrastructure costs to repair/replace river intake infrastructure more regularly due to accelerated river course change.

2. Qualitatively assess the benefits to identify the material benefits of the scheme

We assessed the costs using a qualitative assessment framework over four levels: negligible, low, moderate and high. These assessments consider the likelihood of the impact, the number of parties affected, and the scale of the impact to those parties. The definitions are described in Table 2.2:

Table 2.2: Qualitative Cost Assessment Guide

Assessment	Description
Negligible	The impact is managed by a small number of residents, farms or businesses without noticeable flow-on effects
Low	The impact is noticeable through the community where the event occurred but not beyond
Moderate	The impact is felt throughout the community including those not directly affected by flood waters and erosion, and there is a detectable impact within the region
High	Significant impacts are detected across the region and/or beyond the region and the effects of the event are felt for some time after

3. Quantify the material costs and determine the benefit ratios

We quantified those costs that were assessed as ‘moderate’ or ‘high’ to focus on the most material impacts. Some material costs result from flood events and some result from river course change.

The model uses appropriate methods for each specific cost; these methods are summarised in :

Table 2.3: Quantification Methods

Impact	Quantification Methods
Damage to non-commercial property	For flooding, apply damage-depth curves for different levels of flood inundation for non-commercial properties For river course change, calculate total capital value of properties lost to erosion
Loss of land or output on farms or businesses	<ul style="list-style-type: none"> ▪ Estimate infrastructure losses on farms ▪ Estimate production losses on farms by assessing the extent of effective hectares lost, and multiply by the average value per effective hectare ▪ Assume the amount of farms’ expenses no longer spent in service towns, with losses inside and outside of the scheme
The cost of the emergency response	Apply evacuation costs based on past flood events by the number of people evacuated

and repairs	
Loss of access: Road	For flooding, apply costs of additional journey time and fuel cost from having to take alternative routes when roads are inaccessible, or the wider implications to the regional economy when roads are inaccessible and no alternatives are available For river course change, estimate the capital costs of rebuilding road sections lost to erosion
Loss of access: Rail	Estimate the lost value of products crossing the Waitaki rail bridge due to delays
Transpower transmission line	Estimate the cost of moving or rebuilding the original line lost to erosion
Irrigation intakes	Estimate the increased infrastructure costs to irrigation companies suffered from land lost to river course change

For each expected flood event, impacts are measured for severity and frequency over a 100-year sample period. The benefits of the scheme are, therefore, the avoided costs of flood events, multiplied by each event's expected frequency without the scheme.

For river course change, we have estimated how long it would take until the river reaches key infrastructure. At that point, we assume that the capital value of the infrastructure is lost.

Total costs are measured using a net present value (NPV) analysis of the costs over the 100-year period. The NPV model is set with a discount rate of 7.5 percent. Other rates are also tested for sensitivity.

These assessments are uncertain

The assessment of costs and the resulting ratios are subject to a degree of uncertainty that is a result of several factors. These factors include:

- Predicting the timing, severity and coverage of flooding events and river course change
- Predicting the costs of flooding events and river course change.

This economic assessment deals with this uncertainty in two ways:

- While the total amount of expected cost remains uncertain, this uncertainty would be expected to affect both sides of the ratio (Canterbury: Otago or in-scheme : out-of-scheme). This means that while the overall cost of an event might be uncertain, the ratio is less uncertain
- Remaining uncertainty is dealt with by altering assumptions made in our quantitative assessment, using different scenarios of expected outcomes to understand a range of possibilities.

3 Categories of Benefits

Without the scheme in place, flooding and river course change would be much more severe which would lead to a range of costs. This section provides an estimate of how much more severe flooding and course change would be without the scheme in place.

Table 3.1 shows the size and return periods of flood events, and the land lost through river course change that would follow.²

The land lost through flooding and river course change in Table 3.1, is a percentage of the major Waitaki River flood that occurred in 1995. We have used the 1995 flood because it is estimated to be the biggest flood that has ever occurred in the river.³

Table 3.1: Floodplain Area Affected (As a Percentage of Area Bounded by Yellow Lines)

Flood Return Period (years)	Flood Flow (cumecs)	With Scheme		Without Scheme	
		Flooding	River course change	Flooding	River course change
2	1180	0	0	0	0
5	1520	0	0	20	5
20	2060	12	2	50	10
100	2660	20	5	80	20
200 (1995 Flood)	2920	25	6	100	25

Source: Data obtained from River Engineers and Asset Management Engineers at Environment Canterbury, January 2017.

3.1 Categories of Benefits from the River Control Scheme

The costs of flooding and river course change (which are the benefits of the scheme) are broken down into 10 categories. In this section, we describe these categories, identify the parties that would be affected, and determine whether they would be inside or outside the scheme area.

Loss of life

This includes the deaths expected to occur on average from flood events.

Those inside the scheme at the time of the event (residents and visitors) will be at risk. Those outside the scheme are not at risk of this impact.

Impaired health

This covers injuries and illness caused by the flood event. Illnesses can be caused where residents' health is impaired by:

- Lack of access to healthcare

² Matthew Surman, Asset Management Engineer, Environment Canterbury

³ Heslop, Palmer & Surman (2015) Lower Waitaki River Control Scheme Review – Options Report

- Farm drainage overflowing into residential areas, and contamination water/vegetable gardens
- Stagnant water
- Overflows in the storm water and wastewater systems.

Those inside the scheme will largely bear the costs of injuries. However, given that the costs of the storm water and wastewater systems are spread across the district, the costs from system overflows will be borne by the wider community as well.

Damage to non-commercial property

For flooding, this covers the structural damage to residential homes. For the land lost through the river course change of a flood event, this covers the total capital value of destroyed buildings.

These costs will be borne by landowners and residents in the scheme area.

Loss of amenity

Flooding costs include the inability to fish, camp or walk on the river bank during floods. For the land lost through river course change, it includes decreased quality of walking trails and camp sites making it a less desirable location.

There would be a mixture of recreational users from in and outside the scheme affected.

Loss of land or output on farms or businesses

This includes damage to farm infrastructure (fences, tracks etc.) and the lower production value from the loss (or reduced health) of stock or crops, or ability to support stock or crops. These damages can result from flooding or permanent land loss through river course change.

These impacts are felt by those farmers inside the scheme that suffer damage and revenue losses. There are also flow-on effects as businesses that service the affected area would suffer from reduced economic activity; these can be inside or outside of the scheme.

Costs of the emergency response and repairs

This includes the costs of evacuation, immediate welfare needs for those affected by the storm, and support and advisory services.

Those outside the scheme would bear these costs where co-ordinated emergency management is called on. The groups bearing these costs may be at a local, regional or national level.⁴

Reduced access via roads

Flooding would result in costs from increased travel times via alternative routes. River course change would result in capital costs to build new roads as land loss eventually reached the current roads.

The travel time costs will be to residents using roads and to businesses using road for freight. Costs to businesses can be through either lost or delayed business, or the

⁴ In accordance with the National Civil Defence Emergency Management Plan, local authorities can request government financial assistance for response and recovery costs for civil defence emergencies. See <http://www.civildefence.govt.nz/cdem-sector/cdem-framework/guide-to-the-national-civil-defence-emergency-management-plan/>.

additional cost using alternative route. These costs are borne by those who would normally use the roads in the scheme. These users can be from inside or outside the scheme.

The capital cost of a new state highway will be received on a national level as the New Zealand Transport Agency (NZTA) pays for state highways.

Reduced access via rail

Flooding would result in lost or delayed business to rail users. There are also costs to the rail company from the delays.

As the rail track intersects the river by running north-south through Glenavy, erosion from river course change would require capital expenditure from KiwiRail to maintain or rebuild track or bridge infrastructure.

Like roads, these costs are borne by the users of the rail for flooding. Given the small size of the scheme areas, we assume that rail users are from outside of the scheme. For river course change, the costs would accrue to KiwiRail.

Transmission line failure

The cost of this impact is the unserved energy from when the line is down from flooding. The threat of erosion from river course change would require capital expenditure from Transpower to rebuild the line further from the encroaching river.

The flooding costs will be to the recipients of the power. This includes the towns of Oamaru, Studholme, and Timaru, as well as two large irrigation schemes.

Increased costs for irrigation intakes

Bank erosion through river course change will result in damage to, or the stranding of, intake infrastructure. Though river course change might mean the river moving further away from irrigators, it is more likely to move closer because, without the scheme, the river is likely to widen by reclaiming the adjacent floodplains. This will require capital expenditure to replace intake infrastructure.

These costs would be to the irrigation companies, whose members are both inside and outside of the scheme. These companies are Maraewhenua, North Otago Irrigation, Morven-Glenavy-Ikawai Irrigation, and Lower Waitaki Irrigation.

4 Identifying Material Benefits

Using the categories identified under Section 3, we identify which benefits are material to the scheme. These assessments consider the likelihood of the impact, the number of parties affected, and the size of impacts to those parties.

We rank the materiality of benefits using a four-point scale:

- **Negligible:** The impact is managed by a small number of residents, farms or businesses without noticeable flow on effects
- **Low:** The impact is noticeable throughout the community where the event occurred but not beyond
- **Moderate:** The impact is felt throughout the community, not just those directly affected by the flooding or erosion, and there is a detectable impact within the region
- **High:** Significant impacts are detected across the region and/or beyond the region and the effects of flooding or erosion are felt for some time after.

4.1 River Control Scheme

We have combined the benefits from preventing flooding and erosion and assessed them together in Table 4.1.

Table 4.1: Assessment of Impacts of Flood Events Without Existing Infrastructure

Type of Impact	Lower Waitaki River Scheme
Loss of life	<p>Net impact assessment: Low</p> <ul style="list-style-type: none"> ▪ The risk to lives is low in the event of a small flood ▪ The risk to lives is higher in the event of a large flood. For instance, in a recent flood in Wellington (a 1 in 50-year event), there was one fatality ▪ While the cost of losing lives is high, its low probability means the overall impact is low
Impaired health	<p>Net impact assessment: Low</p> <ul style="list-style-type: none"> ▪ Injuries and illness from flooding events are likely to affect several people in the scheme, which will increase the longer the flooding persists
Damage to non-commercial property	<p>Net impact assessment: High</p> <ul style="list-style-type: none"> ▪ May suffer aesthetic damage ▪ Given the extent of property (residential and farms) in the area, damage to this property is likely to be widespread (and severe in a large event) ▪ River course change will destroy property on affected land
Loss of Amenity	<p>Net impact assessment: Negligible</p> <ul style="list-style-type: none"> ▪ Less recreational users in a flooding event (This includes campers, trampers, people fishing etc.) ▪ Little or no effect on recreational users from erosion as they would move with the river bed
Loss of land or output on farms or businesses	<p>Net impact assessment: High</p> <ul style="list-style-type: none"> ▪ Damage to stock and ability to support them for several weeks (possibly longer, if the recovery time after the event is considered)

Type of Impact	Lower Waitaki River Scheme
	<ul style="list-style-type: none"> ▪ Lost business to those reliant on expenditure by farms. Significant impact given multiple service towns in schemes
The cost of the emergency response and repairs	<p>Net impact assessment: Moderate</p> <ul style="list-style-type: none"> ▪ A large flooding event would be more damaging than without the scheme because water would breach the river banks earlier. This would lead to higher cost of response and subsequent reparation works. ▪ Direct costs would be moderate in low level events as they require relatively little response (partly due to the ability to give some warning about the likelihood of flooding) and some reparation costs ▪ Cost to evacuate, house and provide welfare for residents in major event would be higher than with the scheme
Loss of road access	<p>Net impact assessment: Moderate</p> <ul style="list-style-type: none"> ▪ The areas of State Highway 1, 82, and 83 that receive greater protection from the scheme will face higher delays and greater loss of access in large events without the scheme ▪ Residents and businesses (in-and out-of-scheme) using road infrastructure in scheme would face greater delays and costs from taking alternative routes ▪ There would be increased road maintenance costs from greater erosion
Loss of rail access	<p>Net impact assessment: Moderate</p> <ul style="list-style-type: none"> ▪ Businesses using rail infrastructure in scheme (Main South Trunk Line) would face delays and costs from lost business in the event of a flood. ▪ There would be higher cost in repairing or maintaining the rail line with higher levels of erosion. ▪ Given unique characteristics of rail freight, businesses are more likely to bear cost of delays than use more expensive alternatives, such as road freight
Transpower Transmission line damages	<p>Net impact assessment: Moderate</p> <ul style="list-style-type: none"> ▪ 18km transmission that runs from Hakataramea to Penticotico Stream on the Canterbury side of the river. ▪ Flood impact likely to be low. Line redundancies allow the line to deal with some malfunctions from flooding and continue to operate. A more severe flood impact, such as the loss of line towers, would lead to power outages for up to three days in Oamaru, Studholme, and Timaru, and for two large irrigation schemes. However, the 1995 Waitaki river flood event (a 1-in-100-year event) did not lead to power outages in these regions, showing that the line's towers remained intact in severe floods. ▪ Impact from river course change would be high. River course change without the scheme is expected to lead to land loss that would require Transpower to move the lines, incurring significant expense.
Irrigation intakes	<p>Net impact assessment: Moderate</p> <ul style="list-style-type: none"> ▪ The irrigation companies taking water from the river will have increased costs of infrastructure.

5 Quantifying Material Benefits

The material benefits of the scheme are quantified below, and used to determine their geographic distribution. This enables an assessment of ratios between Otago and Canterbury, and between those in and out of the scheme. The material benefits are the 'moderate' and 'high' impacts from Section 4.

We quantify impacts every 2 years, 5 years, 20 years, and 100 years. For each of these events, there is a flood impact and a course change impact, which we model separately using different techniques. The model captures the cumulative effect of the course change impact over time, because each time the river changes course, there is permanent damage to buildings and long-lasting damage to land (in the absence of a Scheme).

The material benefits of the river control scheme are the avoidance of:

- Damages to non-commercial property
- Losses to farms or businesses
- The cost of the emergency response and repairs
- Reduced access via roads
- Reduced access via rail
- Damage to Transpower transmission lines
- Damage to irrigation intake infrastructure.

5.1 Damages to non-commercial property

In this section, we describe the flood and river course change impacts on non-commercial properties inside the scheme area.

Flood impact

Flood damage to non-commercial property was determined by applying the expected damage per property (based on flood inundation levels) to the number of properties.

The expected damage per property was based on the depth-damage curves developed for the Macquarie floodplain in New South Wales, Australia. These curves calculate the cost per individual residence for flooding level above floor level (ranging from 5 metres under the floor level to 5 metres above floor level).⁵ Given the differences in residential homes built in Australia and New Zealand, we have only applied the costs associated with single-storey slab/low set properties to non-commercial properties in the Taieri Plain.

We assumed that for moderate events (5-year events) the flood level was assumed to be at floor level. For 20 year events, we have assumed that the flood levels get up to 0.5 metres above floor level and for large 100 year events we have assumed that the flood levels will get up to 1 metres above floor level. We have then multiplied the costs for these levels of flooding by the percentage of land in the scheme that each flood effects.

Course change impact

Course change damage to non-commercial property was measured by multiplying the expected percentage of land loss in the scheme area by the capital value of the total

⁵ Bewsher Consulting Pty Ltd, Macquarie Park FRMS&P Final Report, February 2011. The costs for each level of flooding were converted from 2007 Australia dollars using the exchange rate for 1 September 2007 and adjusted for inflation.

number of properties within the scheme area. We assume that, as the land loss is more permanent than flooding, the property loss is also permanent.

Table 5.1 summarises the split of benefits between Otago and Canterbury, based on the avoided costs of damages to non-commercial property. All the benefits from this section accrue inside the scheme.

Table 5.1: NPV of Benefits from Avoided Damage to Non-Commercial Property

	In-scheme	Out of scheme
Otago	\$2,408,086	-
Canterbury	\$8,179,541	-

5.2 Losses to farms or businesses

In this section, we describe the flood and river course change impacts on farms and businesses inside and outside the scheme area.

Flood impact

We calculated the flood impact by quantifying:

- The direct infrastructure cost
- The production loss on farmland
- The losses to businesses supporting farming businesses (both inside and outside of the scheme).

The direct infrastructure costs included stock transport, silt removal, pasture renewal, fence repairs, repairs to tracks/culverts/troughs/buildings, and minor damage repairs. This was based on a quantified assessment of damage to the primary sector following a flood in the Taranaki and Horizons Regions in 2015, which provides the best benchmark.⁶

The production loss on farmland was calculated by multiplying the expected loss of productive hectares by their productive value. We assume that 90 percent of the land within the scheme area is productive. The productive value was calculated based on the average value of dairy output per effective hectare from 2003 to 2015.⁷ We then adjusted this to take account of other farming activities that are less productive than dairy.

Losses to farm productivity mean that farms reduce their expenditure in the local economy. We assume that 50 percent of losses to farming businesses would have been spent on farm inputs, meaning that money would be passed on to the wider economy. In accordance with our previous assessments of flood schemes, we assume 70 percent would have gone to businesses inside the scheme area and 30 percent would have gone to businesses outside the area. We alter these assumptions in our sensitivity analysis in section 6.

⁶ Ministry for Primary Industries, June 2015 Taranaki and Horizons Regions Storm: Primary Sector Impact Assessment. MPI Technical Paper No. 2015/28, 31 August 2015.

⁷ The value of dairy output per effective hectare was calculated by multiplying the average dairy company payout over 10 years by the average milksolids per effective hectare produced in the Dunedin City district. See p. 19 <http://www.dairynz.co.nz/media/1327583/nz-dairy-statistics-2013-2014-web.pdf>.

Course change impact

To quantify course change impacts, we multiply the expected percentage of land loss in the scheme area by the total number of productive hectares within the scheme area. We assume this loss to be permanent over the 100 years of our modelling.

Table 5.2 shows the split of benefits between Otago and Canterbury, based on the avoided costs of damages to farms and businesses.

Table 5.2: NPV of Benefits from Avoided Losses to Farms and Businesses

	In-scheme	Out of scheme
Otago	\$47,534,565	\$3,969,064
Canterbury	\$156,157,422	\$13,453,270

5.3 The cost of the emergency response and repairs

In this section, we describe the emergency response costs from flood events and river course change, inside and outside the scheme area.

Flood impact

The costs of the emergency response and repairs are based on the costs (\$90 million) to the government during the 2004 floods in Manawatu-Whanganui.⁸ This was approximately \$97,000 per person evacuated during those floods. We apply this rate to the total number of people that would be evacuated in each flood event. To work out the number of people evacuated in each flood event, we used a proportion of the number of people evacuated from the scheme area in the 1995 flood event (which was a 1-in-200 year event). This proportion was based on the relative size of each flood event in relation to the 1995 flood event (in cubic metres). This resulted in a range from 0 to 7.59.

While not all of these costs will be tied to evacuation costs, applying costs based on the number of evacuees helps link the costs with the magnitude of the event.

Course change impact

We assume that there are no emergency response and repairs associated with river course change that are not captured under 'flood impact' above.

Table 5.3 shows the benefits that accrue at the national level, based on the avoided costs of emergency response and repairs. No benefits are assumed to accrue inside the scheme, or at the regional level.

Table 5.3: NPV of Benefits from Avoided Emergency Response and Repairs

	In-scheme	Out of scheme
Wider NZ	-	\$652,985

⁸ Horizons Regional Council, 'Storm', Civil Emergency, Storm and Flood Report, February 2004. Available at <https://www.horizons.govt.nz/assets/publications/keeping-people-safe-publications/Civil-Emergency-Storm-and-Flood-Report-February-2004.pdf>.

5.4 Reduced Road Access

In this section, we describe the flood and river course change impacts on road access and repair.

Flood impact

A flood event can render a road unusable for a period, which has economic costs, such as lost time from using an alternative route or extra fuel costs. We focus on the region's state highways for the purposes of understanding the most material scheme benefits.

We have assumed that 20 percent of the delay costs would fall to those inside the scheme and 80 percent would fall to those outside the scheme. This was based on the amount of properties and farms inside the scheme and their expected vehicle use, compared to the total number of vehicles that use these roads daily.

State Highway 1 crosses the Waitaki river and we assume it would not be able to be used when 5-yearly or greater floods occur.

State Highway 82 starts at the Kurow bridge and runs along the Canterbury side of the river, with 18km of road going into the scheme area. If there is flooding at any part of this road, then we assume the whole section from Kurow to Ikawai would be closed as there is no alternative route.

State Highway 83 runs along the south side of the river, in Otago, with 5 km in the scheme. We have assumed that only the 5km section would get wiped out in a 5-year flood and it would be possible to drive around that section using an alternative road. For bigger floods, we have assumed more of the highway will be affected, rendering the entire section along the river unusable.⁹

Course change impact

We assume that the NZTA would relocate a road that was at risk of being destroyed through river course change, and as such would incur the capital cost of a new road. We assume 18 km of State Highway 82 from Kurow and 5km of State Highway 83 between Duntroon and Georgetown would need replacing.

Table 5.4 shows the benefits between Otago, Canterbury and wider New Zealand, based on the avoided costs of reduced access to roads and road repair.

Table 5.4: NPV of Benefits from Avoiding Reduced Road Access

	In-scheme	Out of scheme
Otago	\$67,806	\$158,213
Canterbury	\$244,100	\$569,568
Wider NZ		\$3,943,827

5.5 Reduced rail access

In this section, we describe the impacts of flood events and river course change on rail access and rail maintenance.

⁹ Information for alternative routes has been taken from Google Maps

Flood impact

The Main South Line runs over a rail bridge at Glenavy. The line carries freight only and is an important transport mode for agricultural businesses moving goods for export. The line running through Glenavy serves several ports including Dunedin Port to the south and Timaru and Christchurch ports to the north.

We assume that the value of freight on the line is equal to the daily exports from Dunedin port served by train. We assume 0.5 percent of the value of the freight load is lost for every day that the rail line is not in use as a result of flooding. The benefits are assumed to accrue at the national level – though a portion of these benefits are likely to accrue to the Otago/Canterbury regions, the split of benefits would be similar.¹⁰

Course change impact

As the rail line runs north-south over the Waitaki river, a river course change would mean necessary rail remediation work to ensure the line continues to function. The cost of rail bridge repair work was assumed to be \$1.2 million, incurred every 20 years. However, the cost of this work would accrue to Kiwirail and not directly to either the Canterbury or Otago regions, which is the focus of our analysis. As such, we have not included this cost.

Table 5.5 shows the benefits that accrue nationally, based on the avoided costs of reduced rail access.

Table 5.5: NPV of Benefits from Avoided Reduced Rail Access

	In-scheme	Out of scheme
Wider NZ	-	\$1,411,670

5.6 Damage to Transpower Transmission Lines

In this section, we describe the impacts of flood events and river course change on the 18km Transpower transmission line between Hakataramea and Penticotico Stream.

Flood impact

Our analysis in Section 4 shows the benefits associated with minimising flooding are unlikely to be material.

Course change impact

A river course change would lead to land loss requiring Transpower to move the lines. The cost used to calculate replacing a transmission line is \$320,000 per kilometre, based on actual project costs.¹¹ We calculated total costs by multiplying this figure by the length of the transmission line (18km). We have assumed it will be necessary for Transpower to pay to move the line after 40 years, at which point we calculate the course river change to reach the lines.

¹⁰ Line-hauled freight from Otago to Canterbury, and from Canterbury to Otago, is similar. For Otago, over 1 million tonnes of all regional freight was line-hauled north in 2012. For Canterbury, 1.65 million tonnes of all regional freight was line-hauled south in 2012. Source: NZTA (2015). Draft South Island Freight Plan. Available at: <https://www.nzta.govt.nz/assets/resources/draft-south-island-freight-plan/docs/draft-south-island-freight-plan.pdf>

¹¹ ElectroNet Services Ltd (2013). Waipori Generation Embedment Project (WGEP), Prepared for TrustPower. https://www.transpower.co.nz/sites/default/files/uncontrolled_docs/Waipori-PDA-External-Report.pdf

Table 5.6 shows the benefits that accrue nationally, based on the avoided costs of damage to transmission lines. Though the line services Oamaru, Studholme and irrigators in Otago and Canterbury, the costs of line maintenance fall to Transpower, who distribute the costs nationally.

Table 5.6: NPV of Benefits from Avoiding Transmission Line Damages

	In-scheme	Out of scheme
Wider NZ	-	\$ 374,936

5.7 Increasing irrigation intake costs

In this section, we describe the impacts of flood events and river course change on irrigation schemes along the Waitaki river.

Flood impact

Our analysis in Section 4 shows that the benefits associated with minimising flooding are unlikely to be material.

Course change impact

Irrigation intake infrastructure is responsible for moving water from the river to the irrigation scheme. By necessity, it must be located near the river. As the Waitaki river control scheme contains the river and prevents it from expanding widthways, the absence of the scheme would lead to river course change and the erosion of banks protecting intake infrastructure.

Irrigators would need to rebuild their intake infrastructure further from the expanding river, but still close to the river to continue extracting water. The average size of intake infrastructure was calculated for two schemes, one in Otago and one in Canterbury, based on aerial photographs of the region. Based on this, we calculated how long it would take for the river to erode land on which the intake infrastructure resides. We assumed that irrigators would need to fully replace their intake infrastructure once the underlying land fully erodes.

Table 5.7 shows the benefit split between Otago and Canterbury, based on the avoided increased irrigation costs of course change.

Table 5.7: NPV of Benefits from Avoiding Increased Irrigation Intake Costs

	In-scheme	Out of scheme
Otago	\$140,265	\$561,061
Canterbury	\$87,335	\$349,340

6 Benefit Ratios

We calculated that the proportion of benefits of the river control scheme accruing to Otago is 23.7 percent, while 76.3 percent accrues to Canterbury, as shown in Table 6.1. We found the main driver is that Canterbury accounts for nearly double the amount of land in the scheme compared with Otago. This means more houses and farm land that would incur costs if the scheme were not in place.

Table 6.1: Regional Benefit Split of the Lower Waitaki River Control Scheme

Region	Benefits
Otago	\$54,839,061
Canterbury	\$177,442,444
Ratio	23.6 %

We included both the Otago and Canterbury sides of the scheme area when calculating the in-scheme/out-of-scheme benefit ratio. This is because it is illogical to consider the in-scheme/out-of-scheme benefits for Otago alone, because the out-of-scheme benefits include national benefits, which cannot be split between Otago and Canterbury. This ratio remains just as relevant to Otago, because it fully captures out-of-scheme benefits, and provides a firm basis for considering cost allocation between in-scheme and out-of-scheme ratepayers.

The share of benefits to those inside the scheme area is 90 percent, with 10 percent of benefits accruing outside of the scheme area as shown in Table 6.2

Table 6.2: In-Scheme/Out-of-Scheme Benefit Split of the Lower Waitaki River Control Scheme

	Benefits
In-scheme	\$214,819,121
Out-of-scheme	\$23,845,801
Ratio	90%

The wider Otago region residents receive ten percent of the economic benefits of the Scheme. A reasonable share of costs is to allocate a similar proportion to that group. The benefits are received widely and in this case any charge should be spread as widely and as evenly as possible.

Sensitivity analysis

We test some key assumptions to manage uncertainty. The key assumptions we have tested are the discount rate and the percentage of lost business for farmers losing productivity.

We ran a sensitivity analysis of the discount rate which was initially at 7.5 percent. We tested for nine percent and six percent to see how this would change the results. The

ratio split between Otago and Canterbury only varied by a maximum of 0.2 percent, while the ratio split between in-scheme and out-of-scheme benefits varied by 0.8 percent.

We also ran a sensitivity analysis on the percentage of lost business inside the scheme. We looked at how the ratios would change if 50 percent of farms' costs were outside the scheme and if 70% was outside the scheme, rather than the 30 percent originally assumed. The scheme area is reasonably small and so more inputs may come from the closest towns. The ratio split between Otago and Canterbury varied by a maximum of 0.8 percent, while the ratio split between in-scheme and out-of-scheme benefits in Otago varied by 8.8 percent.

Considerations when applying this assessment

The ORC may wish to consider how to distribute the out-of-scheme benefits across the region. To give an initial sense of the spread, the benefits are grouped in Table 6.3 by district, region and country.

Table 6.3: Allocation of Out-of-Scheme Benefits

Public benefit category	Allocated to			Comment
	District	Region	Country	
Damage to non-commercial property	✓			Would accrue to properties in the scheme
Lost businesses because of impacts on farms	✓	✓		Significant proportion of economic activity likely to be in district and region because of proximity to farm businesses
The cost of the emergency response and repairs		✓	✓	Local authorities bearing these costs can apply for central government financial assistance (such as, benefit higher than district level)
Reduced access via roads			✓	State highways are paid for by NZTA
Reduced access via rail			✓	Part of the national rail network
Transpower Transmission line damages			✓	Costs to protect lines from erosion would be absorbed by Transpower and dissipated nationally
Irrigation intakes	✓	✓		Costs to replace intake infrastructure would be spread amongst farmers in irrigation cooperatives across the region

Appendix A: Feedback from Public Consultation

January 2017

A.1 Introduction

Currently, Otago ratepayers living within the boundaries of the Lower Waitaki River Control Scheme bear all the scheme costs that are apportioned to the ORC. This differs from Canterbury, where the costs are split between those in the immediate scheme area, the wider Waimate District and the Canterbury region. The ORC's current targeted rates are based on an assessment of direct benefits received by those in the scheme area against flood protection and natural erosion.

The ORC has engaged Castalia to review the allocation of costs between the Canterbury and Otago areas, and for the Otago portion of costs, to assess the in-scheme and out-of-scheme benefit split. This review requires understanding the types of benefits the scheme provides and who these accrue to.

As part of this study, we consulted ratepayers through a public session held at the Waitaki Bridge Hall on 19 December 2016. We also invited written submissions from ratepayers afterwards. This note summarises the feedback we received, which we will use to help identify the benefits of the scheme, the Otago-Canterbury split and the public-private split.

A.2 Who Participated in the Consultation Process?

Approximately 30 residents from Otago attended the public session, including individuals from in- and out-of-scheme areas. We received five written submissions following the public session from residents, including two from local farm owners.

A.3 Key Themes from Public Consultation

We have grouped the feedback we received through the public session and written submissions into four themes:

- Mixed views on the benefits accrued to in-scheme residents
- Concerns with the way the scheme is managed currently
- Comments that individuals from outside the scheme area also benefited and that the current rating system used in Otago was too narrow
- Concerns that Meridian's activities are changing the nature of river erosion and queries as to whether Meridian's contribution reflects these impacts.

A.3.1 Mixed views on the benefits accrued to in-scheme residents

Several in-scheme residents queried whether the Lower Waitaki River Control Scheme conferred significant enough benefits to them in comparison to the rates they were paying. This included fairness concerns on the split of rating classes, with some residents suggesting some land owners received greater in-scheme protection from flooding and erosion while paying the same rate as neighbours receiving fewer benefits.

Several in-scheme ratepayers did recognise the advantages they received from the scheme. However, this was often qualified with concerns that the costs of the scheme should not fall entirely on in-scheme ratepayers because residents felt benefits were also conferred on individuals outside of the scheme area (this is discussed below).

A.3.2 Concerns with the way the scheme is managed currently

Some residents perceived that the scheme was not being managed efficiently and queried scheme costs.

A.3.3 Comments that individuals from outside the scheme area also benefited and the current rating system used in Otago was too narrow

Several residents stated that scheme benefits accrued to individuals outside of the scheme area, including:

- The wider Waitaki District who benefit from a reliable supply of water for domestic, industrial and irrigation usage
- New Zealand energy users who benefit from the power supplied by Meridian, at the perceived expense of accelerated river erosion through Meridian's activities
- Businesses outside the scheme which currently benefit from the economic activity within the scheme area
- Recreational river users who benefit from increased environmental amenity, including using the river for fishing, boating and for camping alongside.

We note that the benefits to Waitaki District water users of a reliable water supply are not directly due to the scheme, though the scheme's mitigation against periodic flood events and erosion may reduce some of the infrastructure costs of river water take. We also received comments from a representative of a local irrigation scheme that they do their own work to protect their intake, which is funded by the users of the irrigation scheme.

We note that the benefits conferred upon wider New Zealand energy users will already be accounted for in the current rating structure because Meridian pay for 40 percent of the scheme costs, which will be incorporated into their overall cost structure and passed on to their customers.

Many residents cited the rating structure adopted by ECan as fairer than the Otago one because it captures the broader scheme beneficiaries.

A.3.4 Concerns that Meridian's activities are changing the nature of river erosion and queries as to whether Meridian's contribution reflects these impacts

Several residents felt the upstream dam operated and owned by Meridian is speeding up the natural rate of river erosion because of its effects on river flow rates. One resident with land adjoining the river queried whether land lost to the river in the past was because of changes to natural river flows from the dam.

Residents accepted that Meridian already contribute 40 percent to the overall costs of the scheme, but several queried whether Meridian should pay more.

Meridian's contribution is not within scope of this report.



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