Economic Assessment of the Healthy Catchments Project Proposed Zone Implementation Programme Addendum (ZIPA)

MEMORANDUM Prepared for Environment Canterbury

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1 Background

The Orari – Temuka – Opihi – Pareora (OTOP) Zone Implementation Programme Addendum (ZIPA), was finalised in December 2018. The ZIPA includes recommendations on a number of areas, including flow regimes, nutrient management zones, changes to Permitted Activity (PA) rules and additional riparian management requirements above recreational swimming locations. This report assesses the economic impacts of the recommendations in these four areas relative to the current state of the catchment.

The assessments utilise outputs from ECan's other technical assessments of land use, nutrient loss and water availability. It should be noted that many bio-physical effects have economic consequences, for instance, ecological effects are important for the consequences they have for industries using water and for tourist activity. Similarly, economic effects are interconnected with social ones. For instance, employment growth affects population levels which in turn affect community vitality. These other impacts are not discussed in this assessment, but are valid considerations in the decision-making process and are in part discussed in the social assessment (Kaine, 2019).

2 Assessment of changes to the flow regime

2.1 Method

The Agribusiness Group (TAG) undertook an assessment of the impact of various flow regime options for the OTOP zone (TAG, 2018), and *Economic Assessment of the Healthy Catchments Project Proposed Flow Regimes for the Temuka catchment* (Harris, 2018) assessed the impact of further flow regimes for the Temuka catchment.

The approach used here draws on some of the financial data used by TAG for their assessment of impacts together with models developed in conjunction with a group of farmer stakeholders. The Farmer Reference Group was established as an informal committee providing input to the zone committee and did not have formal mandate or standing but was used as a targeted consultation mechanism to provide input on specific issues of concern to the farming community. The group met with ECan and LWP staff through the second half of 2017, and provided information on typical production systems in the zone, potential nutrient mitigations (Fietje & Carmichael, 2018), and confirmed a set of irrigated and dryland financial models. The financial models used are common with those used for the nutrient mitigation modelling and are shown in Appendix A.

The assessment method uses a modelling approach that relies on estimating pasture growth losses in restriction events[1]. Data were supplied by ECan on the daily availability of irrigation water for the 1991/92 – 2014/15 irrigation seasons (Temuka) and 1998/99 – 2014/15 (other catchments), and daily rainfall and PET (a measure of daily Potential Evapotranspiration or plant water use) over the same period[2]. This data includes both surface water and

[1] For the Harris (2018) assessment of the Temuka an attempt was made to replicate the process undertaken by TAG for other catchments in the OTOP zone which utilised modelling from Aqualinc Research on pasture growth under different irrigation scenarios. Unfortunately, the various datasets and outputs could not be reconciled, so replicating the TAG approach was abandoned and the pasture loss method was adopted.

[2] There were some missing days in the rainfall/PET database, and these were filled in using the average of the preceding 11 days.

stream-depleting groundwater. The flow data were used to indicate restriction events during the irrigation season, which was assumed to run from 15 September to 30 April.

A model was constructed that estimates whether a restriction is likely to have an impact using an indicator of likely demand at that time. The demand indicator is relatively simple and is based on whether the PET exceeds rainfall and irrigation over the previous 6 days, based on 2 rotations of 3 days for a centre pivot applying 4mm per day. If demand was likely to have occurred, the model records a restriction event and the magnitude of that event based on the availability of water, categorised into <10% available (full restriction), 10 – 50% available, 50 - 90% available, and > 90% available (no restriction). Thus, the reliability figures reported here are a measure of supply/demand reliability, not simply supply reliability and may differ from figures that report only supply reliability.

Where a water supply shortage exists, this is assumed to translate directly into lost production (depending on the farm type) for that period, using a pasture growth curve from reported data for Lincoln[3]. The conversion into reduced production is likely to overestimate the actual losses because losses in production are not linearly related to days of moisture deficit but have a more complex relationship to soil moisture deficit. However extensive consultation with farmers on the impacts of poor reliability suggest that there are substantial difficulties in addition to the direct loss in pasture production that are associated with negative events in farming such as irrigation restrictions. These may include managing feed curves, sourcing replacement feed, feeding out costs and transitioning difficulties, pasture re-establishment, animal health, stress and cashflow difficulties. It is considered therefore that the overestimate of losses is to an extent compensated for by the other difficulties that climatic variability can create for farm management that cannot be accounted for in this type of modelling.

Estimates of regional outcomes from changes in agricultural land use were derived from a regional model developed by Butcher Partners Ltd but updated for the Waimakariri zone project[4]. This input/output (IO) model was developed using standard methodologies for developing IO tables (Jensen, 1990), and the sectors included in the model were customised to include detailed sectors covering irrigated and dryland arable, dairy, dairy support, sheep and beef, and horticulture. Regional IO modelling involves a description of the input (expenditure) and output (revenue) structures of sectors in the economy of the area being described. These are collated into a table that describes the interrelationships between all the sectors – because the inputs of one sector are outputs from another sector in the economy. The table is used to estimate the degree to which a change in output from one sector will result in further changes in other sectors of the economy. The magnitude of these relationships is estimated as a ratio between the direct output and total output, household income, and employment changes (including various flow-on impacts). This effectively results in a set of "multipliers" for each sector and each indicator, which describes the relationship between output of a sector and the flow-on impacts for the rest of the economy. Regional IO modelling tends to overestimate the total impact of land use change because it does not include

[3] Source of data: Lincoln dairy farm 2006 - 2010 irrigated farm cited in DairyNZ SI pasture growth data http://www.dairynz.co.nz/feed/pasture/pasture-growth-data/. Accessed 2 March 20218. The translation is as follows: Full restriction = 100% loss of growth, 10 – 50% restriction = 70% loss of growth, and 50 – 90% restriction = 30% loss of growth.

[4] The use of the IO models based on Waimakariri farm models is not ideal, but insufficient time was available to develop a regional IO model specific for the farming activities in this zone. The adapted approach allows for separate irrigated and dryland models, and for a degree of customisation to region specific circumstances. The Waimakariri models tend to be slightly lower in revenue and expenses than the OTOP farm models, but the overall differences are not significant given the errors within the regional IO model.

feedback effects[5], but is computationally simpler and less reliant on estimated functions in the absence of reliable data[6].

The results are reported as operating profit per ha which is the revenue less expenses including depreciation, but excluding tax, interest and rent, and development expenditure, aggregated operating profit for the band, contribution from the affected area to regional GDP[7], regional household income (wages, salaries, profits etc), and regional employment in Full Time Equivalent (FTE) employees.

2.2 Land use

The land use mix used by scenario is shown in Table 1 below. TAG estimated a land use mix and irrigated areas for their original work, and their relative proportions of different land uses in the Temuka catchment were adopted. However, it was not clear how their aggregated information on irrigated area was comparable with the data ECan supplied on allocation. Furthermore, the stream-depleting groundwater allocations need to be adjusted because it is not just the stream-depleting component that is subject to the minimum flows, but the whole allocation.

The process adopted therefore was as follows.

- The land use mix for the Temuka catchment was adopted based on TAG information on land use associated with allocations in the catchment[8]. For other catchments the land use is based on data provided by ECan on the irrigated areas for each land use in the relevant surface water allocation zone (SWAZ).
- Water allocated for irrigation is divided into bands for each SWAZ, with each band having a specific set of minimum flows and other management tools, and an allocation. The total allocation for each band was estimated from ECan's resource consent inventory. The allocation reported here includes only irrigation water and excludes industrial, drinking water and stockwater consents. The impact of changes in reliability for these other users will need to be estimated separately. It also excludes any takes related to KIL[9], and any consents which were specified in the ECan inventory as being excluded from the allocation[10]. The figures do include the whole consent for stream-depleting groundwater irrigators. Where no economic impacts are noted for a band there is no current allocation.
- For all areas other than the Opihi above Rockwood, the total area potentially irrigated was calculated from an application rate of 4mm/day (0.463l/s/ha), which gave a total area of 5040 ha for the A block, and 3045 ha for the B block. The 4mm/day was provided by the Farmer Reference Group as an appropriate figure reflecting typical

[5] For example where a change increases demand for labour in an area, which results in higher wages, which in turn impacts on demand for labour across a range of sectors.
[6] There are computable general equilibrium models (CGE) that incorporate feedback for use at the regional levels, but for the New Zealand situation this requires some somewhat tenuous closure and regional import/export assumptions that do not necessarily improve the accuracy of the modelling. The model used here focuses only on the Canterbury region, and treats interactions with the rest of New Zealand and overseas as exports or imports.
[7] GDP estimates the value added, which is the value of outputs minus the inputs excluding labour and capital.
[8] The TAG information was generated by intersecting the consent points by farm, land use and irrigation area, using the existing Environment Canterbury GIS shapefiles.
[9] Kakahu Irrigation Ltd.
[10] The reasons why they were excluded from the allocation were not provided.

consented allowances for irrigation. This will overestimate the irrigated area because not all the allocation will be used[11], but is a useful starting point for estimating the potential impacts.

- For the Opihi above Rockwood, the irrigated area is calculated using a rate of 0.23l/s/ha based on feedback to the zone committee from irrigators[12] in that area, because this area has higher rainfall than more coastal locations[13].
- If restrictions are applied, irrigation land area will be reduced, and replaced with dryland sheep and beef.

The final estimated land use areas and total allocation by catchment are shown in Table 1 below.

Table 1: Estimated irrigated area by land use, reliability band and catchment

Catchment and scenario assessed	Dairy (ha)	Arable (ha)	Irrigated Sheep and Beef (ha)	Vegetable (ha)	Dryland (ha)	Total irrigated (ha)	Consented Water Allocation for irrigation (l/s)
Temuka Current A	4153	803	451	0		5406	2503
Temuka Current B	906	346	441	0		1693	784
Temuka 2035 A	2655	513	288	0	1950	3456	1600
Temuka 2035 B	462	177	225	0	829	864	400
Opihi SH1 AN	922	304	1038	95		2359	1092
Opihi SH1 BN	167	55	188	17		428	198
Opihi Sale AA + BA	4772	1571	5368	491		12202	5649
N Opuha AA + BA	57	19	65	6		147	68
N Opuha AN	148	49	166	15		378	175
N Opuha BN	422	139	475	43		1080	500
S Opuha BA	262	322	741	44		1369	634
S Opuha BN	330	406	935	56		1728	800
Opihi Rockwood BA	1246	157	658	0		2061	474
Opihi Rockwood AN	2871	361	1515	0		4748	1092
Opihi Rockwood BN	2104	265	1110	0		3478	800
Te Ana Wai AA + BA	378	0	198	0		577	267
Te Ana Wai AN	24	0	13	0		37	17
Te Ana Wai BN	1134	0	593	1		1728	800

Note: A band is typically higher priority (lower minimum flow) than B band. The use of N after the band letter defines water that is not released from the Opuha dam, while the A after the band letter is water that is associated with dam releases.

[11] Data on actual use relative to consented allocations was not available.
[12] This feedback was provided separately from the farmer stakeholder group.
[13] For example rainfall at Fairlie averages 913mm/year compared with 587mm/year at Timaru.

2.3 Results

The results are reported as levels of restriction on average over all irrigation seasons, and for the worst year event (2014-15) reported by TAG. In addition, the 1-in-4 years and 1-in-10 years restriction events are also reported here to give an indication of a moderate but not uncommon restriction year and a highly restricted (i.e. drought) year respectively. The financial impacts at a farm level, as well as the impacts aggregated for the catchment and region are provided for the average, 1-in-4 and drought years[14].

The modelling of the water resource uses estimated flows and reliability, and an allocation that does not reflect actual current use, so the results may not be entirely reflective of the outcomes that will occur under these regimes. They are best used in a relative way to provide comparative information for decision making on the regimes.

2.3.1 Reliability

The reliability of the irrigation takes is described in this report in a number of ways:

- severity of restrictions;
- frequency of restrictions; and
- timing of restrictions.

These are discussed below.

Severity is described by the number of days on restriction and the restriction in total volume. In order to ease the assessment of the changes across the large number of catchments and bands analysed, reliability is given an overall class from S-A to S-D and Non-viable based on its volume restriction. These grades have been developed for this analysis only, are indicative only, and the terminology has no meaning outside the definitions provided here. The grades are shown in Table 2, Where the grade changes between Current and ZIPA it is indicative of a change to the flow regime having an impact on reliability.

Table 2: Classification of severity of restrictions

Reliability Class	Volume restriction	Days of restriction
S-A	0 – 10% restriction	Very few full days and only a moderate number of partial days.
S-B	10% - 20% volume restriction	Some full-day restrictions and many partial restrictions.
S-C	20% - 30% volume restriction	Numerous full and partial restrictions.
S-D	30% - 50% volume restriction.	Numerous full and partial restrictions.
Non-viable (for run of river irrigation)	>50% volume restrictions.	Numerous full and partial restrictions.

[14] For many catchments the flow record was too short for the 1 in 10 year event to be meaningful.

Table 3: Classification of reliability by catchment and scenario

	Reliability (based on severity of restriction)	
Catchment	**Current**	**ZIPA**
Temuka A	S-B	S-B
Temuka B	S-C	S-D /S-C
Temuka Harvest B[15]		Non-Viable
Opihi SH1 AN	S-B	S-B
Opihi SH1 BN	Non-Viable	Non-Viable
Opihi Sale AA + BA	S-A	S-A
N Opuha AA + BA	S-A	S-A
N Opuha AN	S-B	S-B
N Opuha BN	Non-Viable	Non-Viable
S Opuha BA	S-A	S-B
S Opuha BN	Non-Viable	Non-Viable
Opihi Rockwood BA	S-A	S-B
Opihi Rockwood AN	S-C	S-C
Opihi Rockwood BN	Non-Viable	Non-Viable
Te Ana Wai AA + BA	S-A	S-B
Te Ana Wai AN	S-B- S-C[16]	S-C
Te Ana Wai BN	Non-Viable	Non-Viable

The frequency of restrictions is shown in the second set of tables per catchment in Appendix B. The change in frequency of full restrictions is most useful, because partial restrictions did not occur in the Current scenario for some catchments. The terminology for the description of frequency is shown in Table 4, and the classification by catchment is shown in Table 5.

Table 4: Classification of frequency of restrictions

Frequency Class	Frequency
F-A	0 – 1/5 years
F-B	1/5 – 2/5 years
F-C	2/5 – 3/5 years
F-D	3/5 – 9/10 years
Always	>9/10 years

[15] This is a new flow regime introduced by the ZIPA that is not included in Table 1. It has no associated land use as it is available for harvest and storage.
[16] This scenario is on the boundary (19% volume restriction)

Table 5: Classification of reliability based on frequency of restrictions by catchment and scenario

	Frequency full restriction		Frequency partial restriction	
Catchment	**Current**	**ZIPA**	**Current**	**ZIPA**
Temuka A	Always	F-C	F-D	F-D
Temuka B	Always	Always	S-A	Always
Temuka Harvest B		Always		F-D
Opihi SH1 AN	F-D	Always	Always	Always
Opihi SH1 BN	Always	Always	Always	F-D
Opihi Sale AA + BA	S-B	S-B	S-A	S-A
N Opuha AA + BA	F-C	F-C	S-A	S-B
N Opuha AN	Always	Always	F-D	F-D
N Opuha BN		Always		S-A
S Opuha BA	Always	Always	S-A	Always
S Opuha BN		Always		F-D
Opihi Rockwood BA	F-D	F-D	F-D	F-D
Opihi Rockwood AN	Always	Always	Always	Always
Opihi Rockwood BN	Always	Always	S-A	F-D
Te Ana Wai AA + BA	F-D	F-D	F-D	Always
Te Ana Wai AN	Always	Always	Always	Always
Te Ana Wai BN	Always	Always	S-A	F-D

The timing of restrictions is shown in the third set of tables for each catchment in Appendix B. They are denoted as early season (September – December), late season (January – April). For those scenarios where the reliability is S-A or S-B the restrictions tend to be more frequent in late season, whereas where reliability is S-C to S-D and Non-Viable the restrictions occur more evenly spread throughout the irrigation season. The impact for growth and production will vary by farm system – for example irrigated pasture production in the irrigation season is a fairly even curve with a peak of 80kgDM/ha/day in January, and a low of ~50kgDM/day in September and April, and milk production will peak in September – November then decline through to the end of the season. But for arable the impact of restrictions in late January and February are lower because crops are maturing, but later in the season when greenfeed is being established water availability may also be important.

2.3.2 Financial Outcomes

The financial outcomes are shown on a per hectare (ha) basis and in terms of contribution by the affected irrigators to regional GDP, household income and employment. Because of the large number of results in the per ha category these are not discussed in detail but are shown in Appendix B. It should be noted that the outcomes shown in those tables exclude capital and management costs, so the potential for a net negative outcome with significant reductions in reliability is greater than has been shown in those tables, and even small changes can have an important impact for highly indebted landholders.

The regional outcomes are shown in Table 6. The situations where there is significant change in regional outcomes from Current to ZIPA have been highlighted, with the darker the colour the greater the change. The analysis suggests that the only areas where very significant

decrease in economic indicators (>15 - 20%) will occur are in Temuka catchment, particularly with respect to the B block. Smaller decreases in economic indicators in the order of 5 – 10% will occur in the South Opuha BA block and the Te Ana Wai AA+BA block.

The reliability for the Temuka Harvest block and the BN blocks for other catchments was so low as to render them non-viable for run-of-river irrigation. No financial analysis or regional analysis was undertaken for these scenarios because the modelling does not adequately represent the financial outcomes in situations with very low reliability.

Table 6: Aggregate operating profit and contribution to regional outcomes by catchment and scenario

Catchment	Scenario	Allocation Band	On farm Operating profit ($m/annum)	Contribution to Regional GDP ($m/annum)	Contribution to Regional Household Income ($m/annum)	Contribution to Regional Employment (FTE)
Temuka	**Current**	**A**	$7.20	$39.40	$18.80	287
Temuka	**Solutions Package (2035)**	**A**	$6.0	$30.0	$14.6	232
Temuka	**Current**	**B**	$1.50	$9.60	$4.60	73
Temuka	**Solutions Package (2035)**	**B**	$0.9	$5.6	$2.8	48
Opihi	**Current**	**AN**	-$0.2	$4.6	$2.2	35
Opihi	**Solutions Package**	**AN**	$0.0	$0.0	$0.0	-
Opihi Saleyard	**Current**	**AA+BA**	$13.8	$80.3	$40.7	715
Opihi Saleyard	**Solutions Package**	**AA+BA**	$13.8	$80.3	$40.7	715
North Opuha	**Current**	**AA+BA**	$0.2	$1.0	$0.5	9
North Opuha	**Solutions Package**	**AA+BA**	$0.2	$0.9	$0.5	8
North Opuha	**Current**	**AN**	$0.3	$2.1	$1.1	19
North Opuha	**Solutions Package**	**AN**	$0.3	$2.1	$1.1	19
South Opuha	**Current**	**BA**	$1.2	$7.0	$3.6	66
South Opuha	**Solutions Package**		$1.0	$6.5	$3.3	61
Opihi Rockwood	**Current**	**BA**	$2.2	$14.2	$6.9	108
Opihi Rockwood	**Solutions Package**	**BA**	$2.0	$13.5	$6.6	103
Opihi Rockwood	**Current**	**AN**	$3.9	$28.8	$14.1	220
Opihi Rockwood	**Solutions Package**	**AN**	$3.8	$28.5	$13.9	218
Te Ana Wai	**Current**	**AA+BA**	$0.6	$4.0	$2.0	31
Te Ana Wai	**Solutions Package**	**AA+BA**	$0.5	$3.8	$1.9	29
Te Ana Wai	**Current**	**AN**	$0.0	$0.2	$0.1	2
Te Ana Wai	**Solutions Package**	**AN**	$0.0	$0.2	$0.1	2
Total Current			**$30.70**	**$191.20**	**$94.60**	**1565**
Total ZIPA 2035			**$28.48**	**$171.44**	**$85.50**	**1435**
Difference			**$2.22**	**$19.76**	**$9.10**	**130**
Difference %			**7%**	**10%**	**10%**	**8%**

2.4 Discussion

Reliability and regional outcomes are affected by minimum flows and allocation. Changes in minimum flow affect both reliability and regional outcomes in the same way – i.e. higher minimum flows decrease reliability and regional outcomes. However, allocation affects reliability and regional outcomes in different ways. A lower allocation will increase reliability because of fewer partial restrictions, but potentially also decrease regional outcomes because

it allows for less irrigation. An increasing allocation operates in reverse, although there is a point where the decrease in reliability from larger allocation, which affects both existing and new irrigators, outweighs the larger irrigated area and regional outcomes also decrease.

2.4.1 Temuka

The Temuka has changes to both minimum flows and reliability.

- For the A block, reliability increases, which appears to occur despite the higher minimum flow, and appears to be associated with a move away from a stepped reduction regime under the current and the reduced allocation block. As a result, the on-farm outcomes for the remaining irrigators are improved. However, the reduced allocation leads to lower regional outcomes, including less aggregate operating profit, GDP and employment.
- For the B block, reliability decreases. There is an increase in minimum flow and decrease in allocation, and regional outcomes decrease significantly. The B block under the new regime is a very marginal resource for run-of-river irrigation. In aggregate, there will be a significant reduction in contribution to the regional economy from the Temuka economy, although this may be mitigated if alternative sources of water or storage can be found.

2.4.2 South Opuha

The South Opuha BA block also has reasonably large changes to reliability associated with an increase in minimum flow and a decrease in volume available in the order of 10% both on average and across all event types. Because this is currently a good irrigation resource and will change to one that is only moderately reliable, the impacts on irrigators will be significant. In the drought year, there is a doubling of the number of days on full restriction, and there are 87 days of consecutive partial restriction. Events of this magnitude are difficult to manage and are likely to require significant changes to farm systems and possibly capital structure in order to improve resilience.

2.4.3 Other

In the majority of other catchments, the changes to flow regimes have smaller scale impacts on reliability. These are less than 10% changes in overall reliability, which will have an impact on farm operating profit but will be within the resilience of most irrigators given time to adjust. Those with high levels of debt and high fixed costs may be more significantly affected. Farms which have previously used groundwater and are now deemed stream-depleting will experience more severe impacts because they have not previously experienced irrigation restrictions.

The regional results presented are average levels of change, but it should be noted that in addition to a general decrease in activity the variability of economic activity will also increase. This presents difficulties for businesses and households that are not adequately described by the statistics presented here, but should be noted by decision makers. These impacts are non-linear and can be both positive and negative depending on the year and the services being provided to farm businesses, and can be spread out over a number of years. The aggregate of the impacts across all catchments represents approximately 7% of the current operating profit and 8–10% of current contribution to regional GDP, household income and regional employment from the affected properties.

The results in this study should be taken with some caution, since they rely on a limited number of farm models that must cover a wide range of complex and diverse farm situations. There will also be a range of different potential responses, and a conservatively large estimate of the impact of restrictions has been used. The regional impact models are also reasonably simple relative to the true complexity of the local and regional economy. The results should be seen as providing indicative estimates of the potential impacts on farm and in the wider community, and the relative scale of impacts between different catchments and flow regimes.

3 Impact of nutrient mitigations

The ZIPA introduces three areas within the OTOP zone where nitrate concentrations are considered too high in receiving environments, and there is a requirement for a reduction in N losses from upstream land uses. This section summarises the implications of adopting a requirement to reduce N losses for the Ashwick Flat, Levels Plains and Rangitata-Orton Nutrient Priority Zones. There are different levels of reduction in each priority zone:

- In Ashwick Flat, consented properties are required by the ZIPA to reduce their nutrient losses beyond Good Management Practice (GMP) defined in the Land and Water Regional Plan (LWRP) by 10% for dairy and 5% for other land uses.
- In Levels Plains and Rangitata-Orton Priority Zones, the reductions beyond GMP for consented properties are 20% for dairy and 10% for other land uses.

The analysis estimates the costs of different levels of reductions for operating profit on different land uses, and the aggregate impact of the proposed reductions for properties in those areas. The wider regional economic implications from these changes are also reported.

3.1 Method

The modelling of the impacts of requirement for reductions in nutrient losses uses operating profit as an indicator of the economic outcomes but extends this by signalling how such reductions could impact regional indicators including GDP, household income and employment, as well as how it will impact on farm values and on the viability of businesses in the zone.

3.1.1 Cost of mitigations

The costs of mitigation are estimated in terms of operating profit, which is revenue minus farm working expenses including depreciation, but taking no account of costs of capital, taxation or returns to owners and unpaid labour. The costs of mitigation in N losses were estimated from information:

- generated with the Farmer Reference Group utilising mitigations considered feasible the group; and
- information provided by DairyNZ.

Generally, the mitigations investigated by the Farmer Reference Group fall into the category of changes that can be made to existing farm systems, without making major adjustments involving significant changes to the farm system. These mitigations are described in Farmer Engagement in Farming Within Limits (Fietje L. C., 2018), and achieved up to ~10% reduction in N losses. The impacts on profitability are based on the estimates for similar mitigations in the Waimakariri zone and are in the order of increases of up to 10% and decreases of up to 5%. The DairyNZ work on mitigations extended the farmer stakeholder group's work and

investigated reductions in N losses for dairy farms of 10%, 20% and 30% beyond GMP and associated costs.

The data used to estimate the costs of mitigation, and the curve generated and included in the modelling are shown in Figure 1. The figures used here exclude some of the DairyNZ mitigations which included the use of irrigation efficiency improvements to mitigate N loss below GMP. Under the LWRP this would not be possible as the irrigation efficiency requirements are included in the definition of GMP that defines baseline. The DairyNZ work includes mitigations based on adjustments to N losses that may not be available to farmers depending on the way in which the ECan PC5 proxy for nitrogen requirements works in their situation, and some caution with the estimates is therefore warranted.

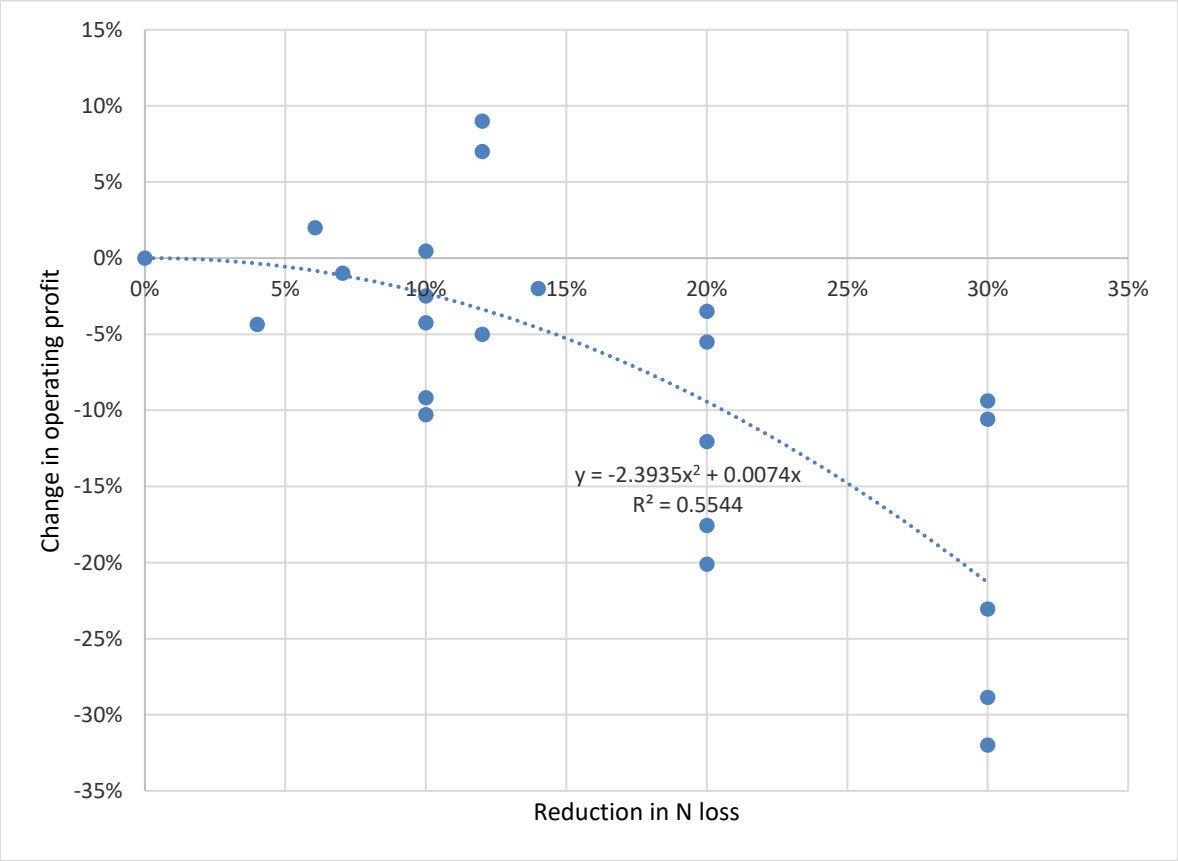

Figure 1: Reduction in operating profit for reduction in N losses, dairy operation

The implications for profitability of dairy were calculated using the fitted curve, but it should be noted that the modelled curve only accounts for about half of the variability in the cost of achieving a given reduction in N loss, and there is a range of possible costs for different operations that should be taken into account. The modelled, high and low range of costs are shown in Table 7 below.

Table 7: Range of operating profit implications for reduction in N losses from dairy operations

Reduction in N	Change in operating profit		
	Low	Modelled	High
5%	9%	-1%	-4%
10%	9%	-2%	-10%
20%	-3%	-9%	-20%
30%	-9%	-21%	-32%

The Farmer Reference Group also investigated potential mitigations for sheep and beef and arable. No specific mitigations were found for reducing N losses beyond GMP for these land uses, which is generally typical of exercises of this nature and reflects the fact that:

- Sheep and beef land uses tend to be lower intensity and have lower levels of inputs, which provides fewer opportunities for mitigation. GMP as defined in the PC5 already includes the major sets of mitigations available.
- Arable farms that are run at GMP reflect a very efficient system where nutrients are captured by product, and any reduction in losses will tend to have a direct reduction in yield because they require a reduction in inputs. Because of the high levels of fixed costs, and the small margins in cropping, it is not likely to be worthwhile to take this approach[17].

For this reason, the sheep and beef, dairy support and arable mitigation curves were generated by reducing revenue and variable costs directly in relation to the reduction in N losses required, while the fixed costs were left the same. This approach reflects a reduction in area utilised or intensity of operation. In terms of removal of area from production, forestry is used as a substitute land use because it generates a profit (over the long term) but has very low N losses. In the short term, this would not provide any additional cashflow, and therefore the ability to service debt is reduced. In the longer-term forestry does generate cashflow and has a non-zero land value. The analysis therefore uses two approaches. For impacts on operating profit over the short term, the fixed costs of the existing land use are left the same, and no substitution with an alternate land use is utilised – the low-leaching alternate land use of forestry may not be appropriate, and from a cashflow perspective will not generate returns within a -30-year period and so is not relevant to the immediate returns for farm operations. In the longer term the value of land for forestry is included in the analysis. The treatment of forestry may change once the status of the ETS (New Zealand Emissions Trading Scheme) has been settled and it is clearer how carbon absorption is able to be taken into account for production forestry and pasture.

The analyses adopted assume that all farms are currently at a standard GMP for N loss that is represented by the LWRP definition of GMP (irrigation efficiency, N application etc). However, a consequence of Plan Change 5 (PC5) to the LWRP has been that the Baseline (2009 – 2013) N loss is represented by the actual N loss including GMP for a farming operation[18]. Under PC5 farms which had undertaken mitigations or practices that reduced their

[17] Ideally this would be modelled to prove the assumption correct, but that was not possible within the scope of this project.
[18] The costs of farms achieving GMP has not been included because that requirement was introduced before the ZIPA, and so would occur regardless of what the ZIPA introduced. However it will have an impact on the economics of the area and will have some impact on the financial feasibility for businesses of achieving further reductions.

N loss below standard GMP at the time of Baseline have a lower N loss allowance than farms which had not undertaken those mitigations.

The implications are that farms which had undertaken mitigations during or prior to the Baseline period no longer have those mitigations available to them to undertake further reductions. This will have implications for the costings of mitigation on dairy land uses, and there is potential that the costs for mitigation on these farms will be higher, and in some cases substantially higher, than for farms that did not undertake mitigation during or prior to the Baseline period.

3.1.2 Implications for contribution to regional economic indicators

The change resulting from the requirement to reduce nutrient losses will have different impacts for the contribution to regional outcomes from different industries. For non-dairy and non-forestry operations the impact is taken directly from the reduction in revenue, since it is assumed that the landholder is taking some land out and replacing it with forestry. For dairy operations, the modelled mitigations up to 10% typically involve increases in expenditure rather than decreases in revenue, which will not have as much impact on the regional. economic performance. Above 10%, decreases in revenue are modelled in alignment with the reduction in operating profit[19]. For forestry that is used to substitute for higher leaching land uses, because there will be no revenue in the short term an allowance has been made only for the proportion of first and second round impacts that are associated with services to agriculture and forestry (9%) on the basis that only planting and release spraying will occur in the 10-year period of the proposed plan.

3.1.3 Implications for farm value

Generally, the value of a productive asset reflects its ability to generate a profit, although this is not always true because some of the returns (e.g. capital value gains) may not be reflected in the annual operating profit. However, in a stable situation where demand for land and product are in equilibrium, and product prices are not increasing, there is a reasonable expectation of a relationship between operating profit and asset value. The analysis here uses this relationship to provide an indicative estimate of the likely implications for asset values from requirements to reduce N leaching. The reduction in asset value is estimated as directly proportional to the decrease in operating profit, with the proviso that the asset value does not decrease below that of an alternate land use (sheep and beef for dairy and dairy support, and forestry for sheep and beef and arable).

The value of forestry land is included in the analysis, since even though it is not producing a profit over the period of the plan it retains value as land for forestry, but no value is assigned to the trees which may underestimate the total value.

Current land and building asset values are estimated from national and regional statistics based on survey data of asset prices per kgMS (dairy), per stock unit (SU) (sheep and beef) and per ha (arable). These were checked against REINZ three-monthly average median property sales prices to April 2018[20] to ensure no major discrepancies were occurring. This information is summarised in Table 8 below.

[19] Taking into account the reduction in expenses – i.e. the reduction in revenue is greater than the reduction in profit, with the adjustment reflecting the proportion of revenue that is expenses.
[20] The REINZ figures are not reliable enough to use directly because of the relatively low number of sales, and because it is not possible to identify other factors (such as location) that are influencing sale price.

Table 8: Farm value estimates

Land use	Unit	Metric	Farm value ($/ha)	REINZ Canterbury sales median 3 months April 2018 ($/ha)	Note
Dairy	$41	$/kgMS	$55,000	$45,000	Light dairy land, average of last five years national sales price/kgMS.
Sheep and beef irrigated	$1900	$/SU	$30,000	$33,000	
Sheep and beef dryland	$1900	$/SU	$12,000	$10,000	
Arable	$28,000	$/ha	$27,000	$38,000	Based on Mixed finishing land use
Forestry	$1000	$/SU	$4,000	$11,000	Uses hill country sheep and beef as the most likely alternate land use. Sales price may include forests

3.1.4 Farm indebtedness and vulnerability

Farm indebtedness is one of the primary determinants of the farm business vulnerability to changes in profitability, because the requirement to pay interest and debt cannot be deferred for any length of time[21], and because of the bank requirements to maintain adequate debt-asset ratios. There are a number of potential sources of information on dairy farm indebtedness and vulnerability.

- Statistics NZ (Statistics New Zealand, 2014) estimated that the total equity-to-asset ratio for the dairy industry was 30% in Canterbury.
- DairyNZ' s estimate of average assets is $12-$13 m for a 240-hectare farm (210 effective) with liabilities/debt around 50%[22]. The DairyNZ data indicates that Canterbury farms carry higher total debt on average, as a result of them being larger than the New Zealand average, but on a per kg milk solids[23] (MS) basis they are similar to national debt levels.
- DairyNZ estimate for the average of 2016/17 and 2017/18 average debt was $23/kg MS for Marlborough/Canterbury, and a debt/asset ratio of 50%.
- Debt servicing and rent costs nationally were estimated to average $1.36/kgMS for 2014/15 and 2015/16. For the model irrigated dairy farm on light land this amounts to $1,864/ha or 75% of operating profit. This correlates closely with data provided by DairyNZ for that period on Marlborough/Canterbury dairy farm debt levels, which showed median and average debt servicing costs of $1,835/ha and $1,869/ha respectively.
- The Reserve Bank (Reserve Bank NZ, 2015) undertook stress testing of the potential impact of the low farmgate milk price through to 2018/19. Under a base scenario with

[21] In past downturns there has been an increase in off-farm work in order to pay for household items and provide additional income, but the extent to which this can be used to cover debt servicing requirements for heavily indebted farms is limited.
[22] Source: Matthew Newman, 2018 DairyNZ, pers.comm. Also for later information regarding debt loadings for Canterbury relative to the national figures.
[23] Milk solids is the measure by which dairy farmers are paid. The total milk solids are also adjusted for the ratio of milk solids and milk fats present in each suppliers product.

the milk price recovering[24] to $5.50/kgMS in 2016/17 and subsequently to $6.50 in 2018/19, non-performing loans (where cashflow is negative and equity is less than 10%) increase to 7.8% of debt. In a scenario where the milk price is $4/kgMS in 2015/16 and increases at 50c/kgMS annually through to 2018/19, 25% of farms and 44% of debt is in non-performing loans. This indicates that a small proportion of farms (<10%) are vulnerable to any decrease in operating profit, and a larger proportion (~25%) are vulnerable to a sustained decrease in operating profit.

Beef + Lamb New Zealand statistics on the debt to asset ratios for Marlborough/Canterbury sheep and beef farms are shown in Figure 2. They indicate that sheep and beef, and mixed cropping properties have a lower average level of debt as a proportion of assets than dairy properties.

- On average, mixed cropping and finishing farms (Farm Class 8) had a debt/asset ratio of 23% from 2012/13 - 2016/17, and debt servicing and rent costs of $444/ha or 59% (range 48% - 81% over that period, on a quintile basis the range for 2016/17 is 37% to -380%) of operating profit for the farm class.

- Debt/asset ratio for finishing-breeding sheep and beef properties (Farm Class 6) was only 16% on average from 2012/13 to 2016/17, although this covers a mix of irrigated and dryland properties. It is likely that irrigated properties will have a higher debt ratio because of greater capital demands with irrigation. Debt servicing costs and rent averaged $13.44/SU over the five years from 2012/13 to 2016/17, with a range from $11.86 to $15.20/SU (ranges from 23% to -590% for 2016/17 of operating profit on a quintile basis).

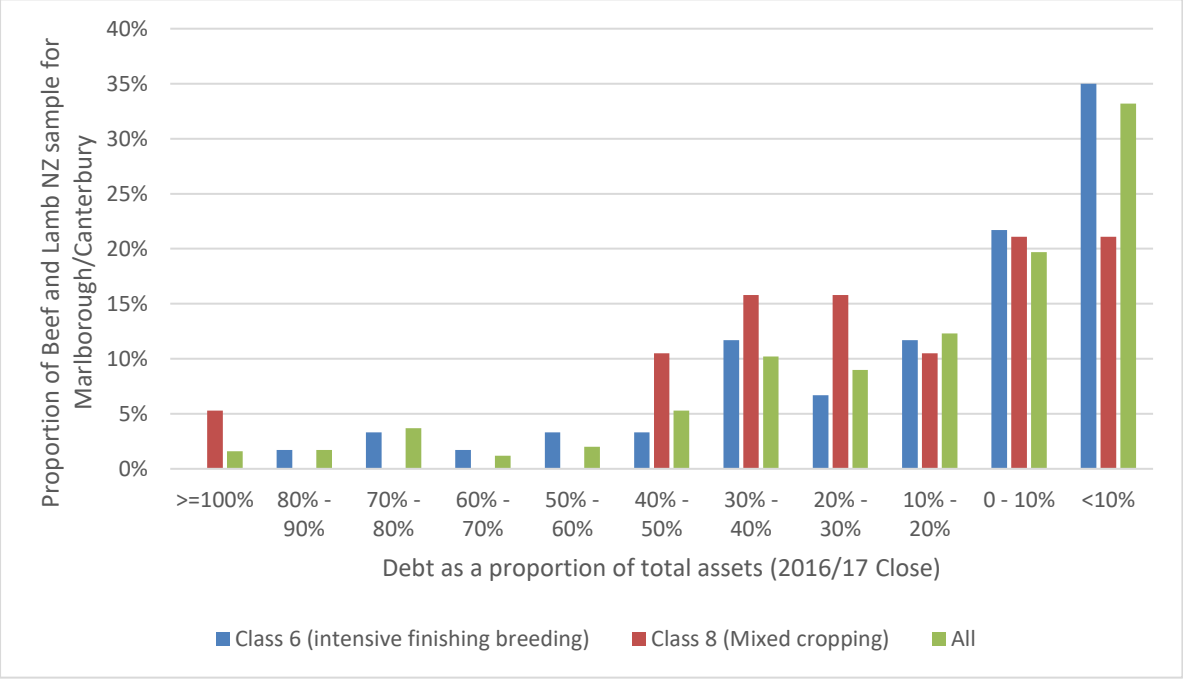

Figure 2: Proportion of sheep and beef, cropping farms with different levels of debt as a proportion of total assets (Source: Beef and Lamb NZ Sheep and Beef Farm Survey)

[24] The payout for the 2014/15 year was $4.40/kg MS (excl dividend), and the Reserve Bank used prices of $4 to $4.15 in their scenarios of 2015/16 payout.

3.2 Results – impact of nutrient reduction requirements

Three sets of results are shown:

- The implications for operating profit and regional indicators of different levels of requirement for reduction in N loss;
- The aggregate reduction in operating profit, regional indicators and land values under the ZIPA N reduction measures for each of the priority areas; and
- A qualitative interpretation of the likely implications for farm viability within the next 10 years for the N reduction targets set.

These results utilise the best available information, but this information is limited and primarily based on averages and case studies. The impacts of different soil types, climates and individuals is not represented in detail, and it is likely that there will be a range of cases where the impacts are greater or less than has been estimated here. As a result, caution in utilising the results is warranted.

This section discusses the implications for the primary sector economic outcomes of different targets for catchment N reduction. The analysis produced 6 graphs per priority area, with two sets each for all land uses aggregated, and specifically for dairy and forestry.

One set of graphs details the change in operating profit, household income and value added/GDP implications. The other set describes the changes to direct (on-farm) and regional employment for each reduction in N loss.

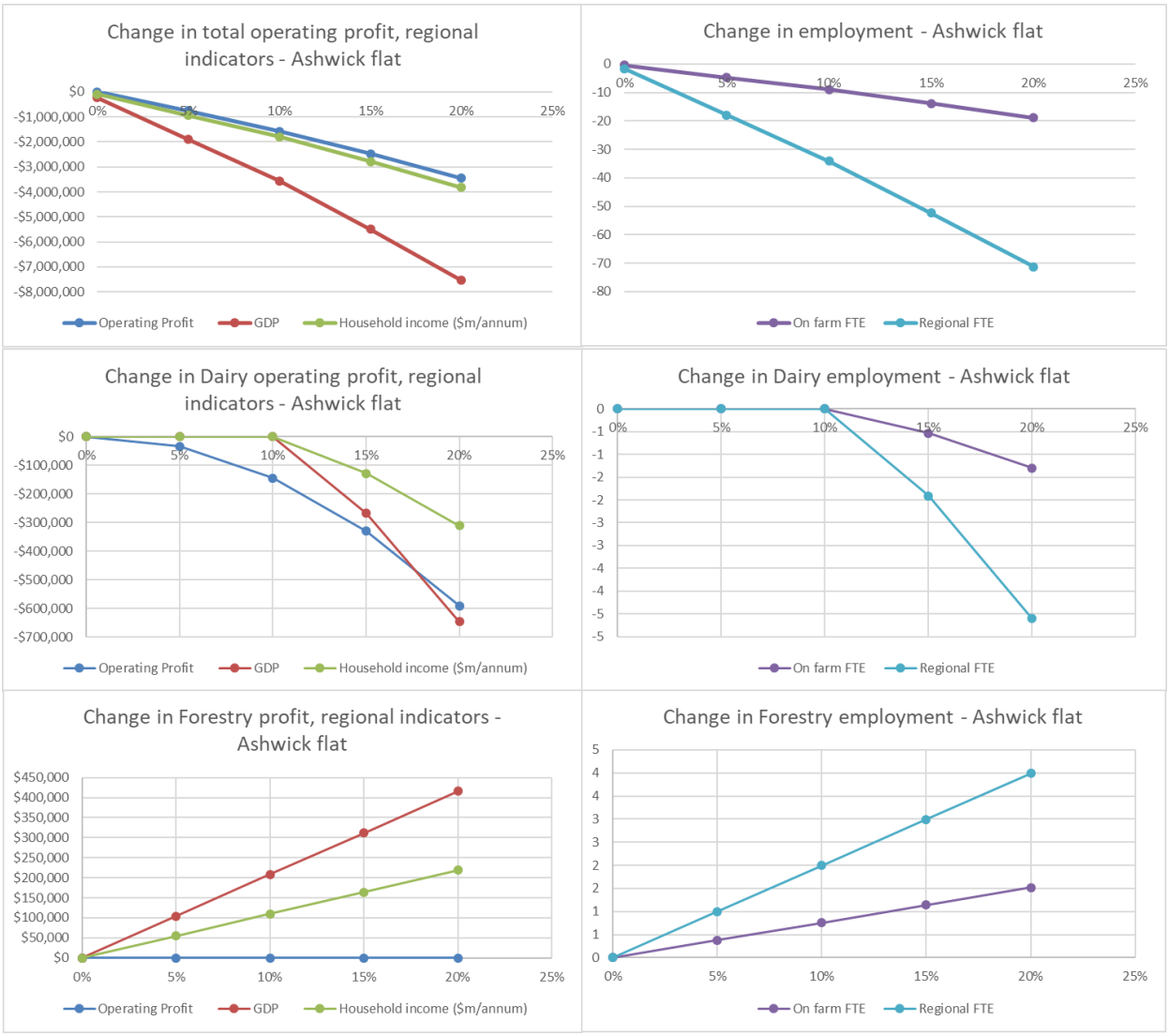

Figure 3: Implications of N mitigation requirements by land use - Ashwick flat

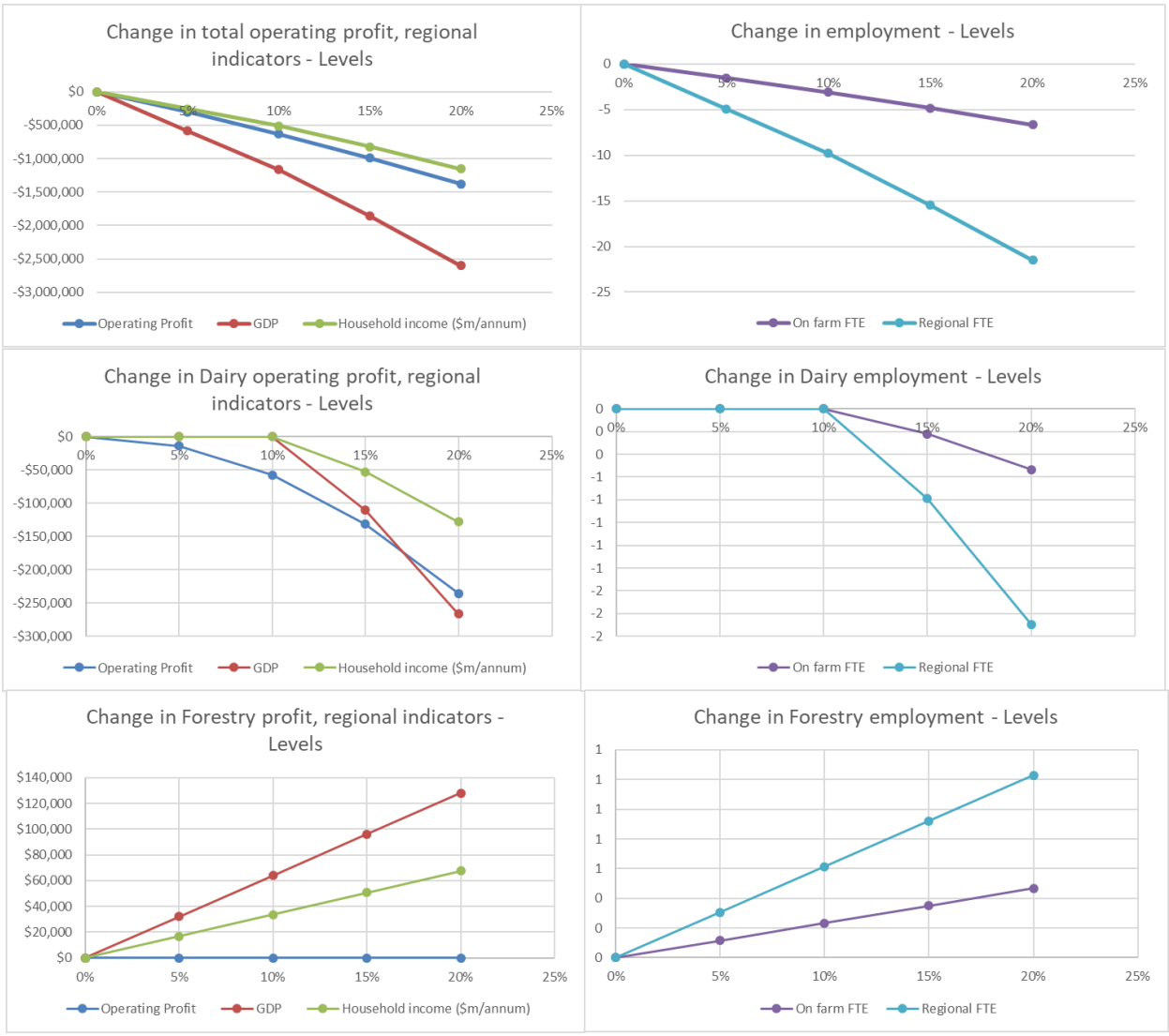

Figure 4: Implications of N mitigation requirements by land use - Levels Plains

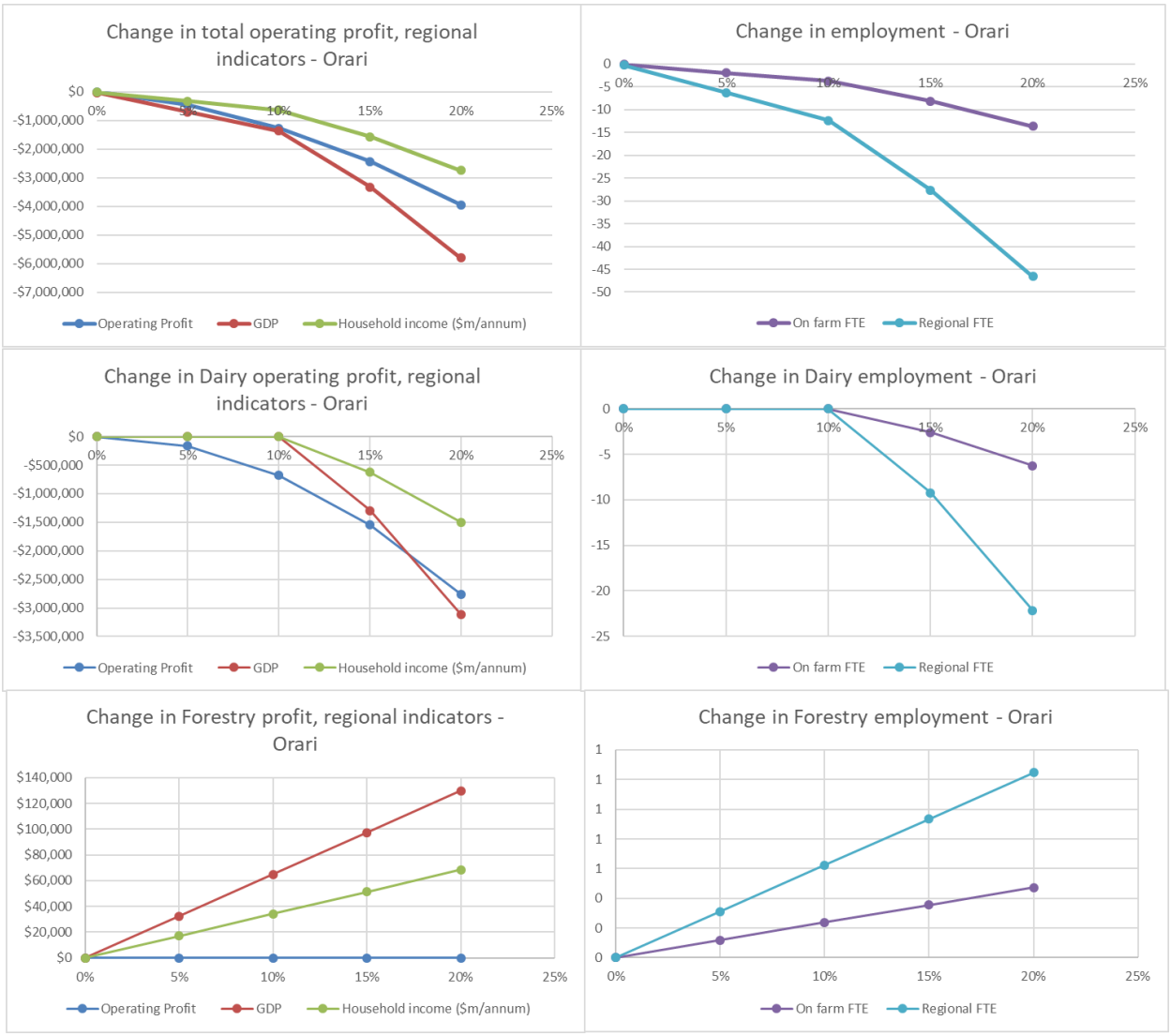

Figure 5: Land use source, reduction target, profit outcomes, and land use change - Rangitata-Orton

The changes in profit and a Net Present Value (NPV) at 6% discount rate over 25 years are shown in Table 9 to Table 11 below. The NPV gives an equivalent value in the present day terms to a future stream of cashflows. The stream of cashflows assumes that the impacts on profit occur linearly over 10 years and are held constant thereafter. A discount rate of 6% is the NZ Treasury default recommendation[25].

[25] https://treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates. Accessed 21 September 2018.

Table 9: Modelled total change in indicators under ZIPA reductions, Ashwick Flat

Indicator	Dairy	Sheep and beef	Arable	Dairy Support	Forestry	Total
Operating profit (on farm)	-$140,000	-$550,000	-$150,000	-$10,000	$0	-$860,000
NPV (6%) operating profit	-$1,850,000	-$7,080,000	-$1,920,000	-$160,000	$0	-$11,010,000
Contribution to Regional GDP	$0	-$1,390,000	-$340,000	-$40,000	$100,000	-$1,660,000
Contribution to Regional Household Income ($m/annum)	$0	-$750,000	-$140,000	-$20,000	$50,000	-$850,000
On-farm employment (FTE)	0	-4	-1	0	0	-4
Contribution to Regional employment (FTE)	0	-14	-3	0	1	-16
Land value	-$2,670,000	-$12,640,000	-$2,580,000	-$470,000	$3,000,000	-$15,370,000
Change in indicator value						
Indicator	**Dairy**	**Sheep and beef**	**Arable**	**Dairy Support**	**Forestry**	**Total**
Contribution to Regional GDP	-2%	-7%	-8%	-7%	0%	-5%
Contribution to Regional Household Income ($m/annum)	-1%[26]	-5%	-5%	-5%	44%	-2%
On-farm employment (FTE)	-1%	-5%	-5%	-5%	60%	-2%
Contribution to Regional employment (FTE)	-1%	-5%	-5%	-5%	105%	-3%
Contribution to Regional GDP	-1%	-5%	-5%	-5%	61%	-3%
Land Value	-2%	-8%	-8%	-7%	229%	-4%

Table 10: Modelled total change in indicators under ZIPA reductions, Levels Plains

Indicator	Dairy	Sheep and beef	Arable	Dairy Support	Forestry	Total
Operating profit (on farm)	-$240,000	-$140,000	-$420,000	-$10,000	$0	-$810,000
NPV (6%) operating profit	-$3,010,000	-$1,760,000	-$5,420,000	-$130,000	$0	-$10,320,000
Contribution to Regional GDP	$0	-$350,000	-$850,000	-$30,000	$60,000	-$1,170,000
Contribution to Regional Household Income ($m/annum)	$0	-$190,000	-$340,000	-$10,000	$30,000	-$510,000
On-farm employment (FTE)	0	-1	-2	0	0	-3
Contribution to Regional employment (FTE)	0	-4	-7	0	1	-10
Land value	-$6,870,000	-$4,470,000	-$7,370,000	-$550,000	$1,840,000	-$17,400,000
Change in indicator value						
Indicator	**Dairy**	**Sheep and beef**	**Arable**	**Dairy Support**	**Forestry**	**Total**
Operating profit (on farm)	-9%	-17%	-15%	-14%		-13%
Contribution to Regional GDP	-1%	-10%	-10%	-10%		-5%
Contribution to Regional Household Income ($m/annum)	-1%	-10%	-10%	-10%		-4%
On-farm employment (FTE)	-1%	-10%	-10%	-10%		-5%
Contribution to Regional employment (FTE)	-1%	-10%	-10%	-10%		-5%
Land Value	-9%	-18%	-14%	-14%		-11%

Table 11: Modelled total change in indicators under ZIPA reductions, Rangitata-Orton

Indicator	Dairy	Sheep and beef	Arable	Dairy Support	Forestry	Total
Operating profit (on farm)	-$2,760,000	-$200,000	-$280,000	-$110,000	$0	-$3,350,000
NPV (6%) operating profit	-$35,280,000	-$2,600,000	-$3,560,000	-$1,450,000	$0	-$42,890,000
Contribution to Regional GDP	$0	-$520,000	-$520,000	-$350,000	$60,000	-$1,330,000
Contribution to Regional Household Income ($m/annum)	$0	-$280,000	-$210,000	-$160,000	$30,000	-$620,000
On-farm employment (FTE)	0	-1	-1	-1	0	-4
Contribution to Regional employment (FTE)	0	-5	-4	-3	1	-12
Land value	-$73,810,000	-$7,930,000	-$4,850,000	-$5,790,000	$1,870,000	-$90,510,000
Change in indicator value						
Indicator	**Dairy**	**Sheep and beef**	**Arable**	**Dairy Support**	**Forestry**	**Total**
Contribution to Regional GDP	-9%	-19%	-14%	-14%	0%	-10%
Contribution to Regional Household Income ($m/annum)	-1%	-10%	-10%	-10%	195%	-1%
On-farm employment (FTE)	-1%	-10%	-10%	-10%	264%	-1%
Contribution to Regional employment (FTE)	-1%	-10%	-10%	-10%	464%	-1%
Contribution to Regional GDP	-1%	-10%	-10%	-10%	271%	-1%
Land Value	-9%	-20%	-14%	-14%	1015%	-10%

3.3 Implications of nutrient mitigation requirements for farm viability

Threats to farm viability have implications for economic disruption, but also have negative social consequences for individuals and their families which should be taken into account. The implications for farm viability are difficult to determine, because debt levels are not fixed, and changes to ownership and ownership structures can alter over time. However, if a short term (<10 years) perspective is taken, the ability to repay significant amounts of debt is reasonably limited, so the implications can be seen to be more directly related to the current circumstances of the properties.

The issue of farm viability is greatly complicated by the range of indebtedness of different farming operations, with some properties having little debt, while others can be heavily indebted. This relates to appetite for risk, and where in the cycle of farm ownership the property is, with younger owners and more recent purchases/conversions typically having higher debt while older and more established properties having lower debt levels.

The relative profitability of farming operations also affects their ability to service debt, with higher profit operations both within and between land uses being more resilient than low profit operations. The status of dairy and meat product markets will also have a significant impact,

[26] Note that rounding will cause apparent differences between % changes and absolute values.

with high product prices greatly increasing the ability of farms to cope with reductions, while the converse is also true. There is little data available at a regional level that allows detailed understanding of the spread of debt and debt servicing obligations[27], so the analysis here is provided as qualitative and should be seen as indicative only. They are based on expert assessment rather than data and should be viewed with caution, and takes into account the resilience required to cope with other price and climate shocks. The indicative impacts on farm viability for different levels of N reduction are shown in Table 12.

Table 12: Qualitative assessment of likely impacts to farm viability over 10 years (indicative only)

Reduction in N loss	**Impact of required reduction in N loss for viability of different land uses**		
	Dairy	**Sheep and Beef**	**Arable**
5% (Applies sheep and beef and arable in Ashwick flat)	Low impact	Most farms able to cope but impacts for cashflow.	Most farms able to cope but impacts for cashflow.
10% (applies to dairy in Ashwick flat, and sheep and beef and Arable for Levels Plains and Rangitata-Orton)	Low impact for most farms depending on baseline.	Significant impacts	Significant impacts
20% (applies to dairy for Ashwick flat)	Heavily indebted farms non-viable[28] (applies for Levels Plains and Rangitata-Orton)	Farms with average performance and debt loadings threatened.	Farms with average performance and debt loadings threatened
30%	Farms with average performance and debt loadings non-viable[29]	Farms with average performance and debt loadings non-viable	Farms with average performance and debt loadings non-viable

4 Stock Exclusion for Recreational Swimming sites

The ZIPA adds a number of recreational swimming sites to Schedule 6 of the LWRP. These sites will require all farmed cattle, deer and pigs to be excluded within 1000m upstream of the swimming site. The sites and upstream land uses are shown in Table 13. The analysis assumes 1000m of stream will require fencing on both sides, with fencing required for all sheep and beef and deer land uses. It is assumed that dairy will already be fenced, and that arable land uses do not require fencing, or where they do this will be for temporary grazing and this can be accommodated by electric fencing. Where multiple land uses are shown, they are assumed to be evenly distributed in the upstream area. This provides an approximate estimate of 6.8 km of stream requiring sheep and beef fencing, and 1 km requiring deer fencing. It is likely that there will be some overestimation because some of the streams will already be fenced for management purposes.

[27] Although Beef and Lamb NZ provides information on the spread of debt for properties at the quintile level for properties ranked by earnings before interest, tax and rent at the Marlborough/Canterbury level
[28] Based on Reserve Bank stress testing 2014
[29] While interest costs could be just be serviced for most farms there would be no profit available for drawings, debt repayment or farm development. This is not sustainable over the long term.

Fencing costs are based on data from an MPI study on the costs of stock exclusion (The Agribusiness Group, 2016), using the Canterbury-specific data and updated to 2018 using the producer price index ("PPI") data from Statistics NZ. Costs used are $16.20/m for deer fencing and $11.60/m for fencing on sheep and beef properties, with both sides of the stream requiring fencing.

The total cost of stock exclusion on this basis is $80,000, and if spread equally over 10 years and discounted at a 6% discount rate this amounts to an NPV of $60,000.

Table 13: Schedule 6 swimming sites to be added

Site	High level land use 1km upstream
Orari River Gorge	Dryland sheep farm, native.
Waihi River Gorge	Dryland sheep & beef, native.
Waihi River at Geraldine	Urban.
Hae Te Moana River Gorge	Exotic forestry, sheep.
Lake Opuha at Recreation Reserve	Dryland sheep
Lake Opuha at Ewarts Corner Boat Ramp	Irrigated deer, arable.
Opihi River at Raincliff Scout Camp	Deer, dairy
Opihi River at Allandale Bridge	Dryland sheep & beef, lifestyle
Opihi River at Saleyards Bridge	Arable, dairy
Opihi River at State Highway One	Arable, sheep & beef
Opihi River at Waipopo Huts	Arable, dairy
Te Ana Wai River at Belmont Bridge	Sheep & beef, settlement, forestry
Temuka River at State Highway One	Lifestyle blocks, peri-urban
Pareora River at Evans Crossing	Dryland sheep & beef
Pareora River at Pareora Huts	Dryland sheep & beef
Upper Pareora River at Lindisfarne	Dryland sheep & beef

5 Changes to PA rules

The ZIPA proposes some changes to the permitted activity (PA) rules contained in LWRP for land use. The ZIPA recommends in the High Runoff Risk Phosphorus Risk Zone (HRRPRZ) that for any property that has more than 20 hectares of winter grazing by deer or cattle, a resource consent is required and is to be accompanied by a Farm Environment Plan, but is not required to undertake OVERSEER modelling or be tied to a Baseline or Baseline GMP Loss Rate.

ECan estimates there are 91 properties in the HRRPRZ that will be affected by this requirement. The analysis allows $1250 per Farm Environment Plan (FEP), $3850 per consent for consultant time ($1500) and council processing costs ($2350), and $1000 for auditing[30]. In addition there will be costs for the property owner which are not accounted for in this analysis. It is assumed that consents would be granted for 10 years and thus require replacement every

[30] Based on discussions with the two major consultancies undertaking farm plan and nutrient budgeting work (The Agribusiness Group, David Lucock; Nicole Phillips, Irricon. Pers comm. March 2019). Costs for auditing within irrigation schemes may be lower, but those properties will not be affected by the changes to PA rules.

10 years. The majority of properties are obtaining B grades on audit, with limited A and C grades, so an allowance was made for audits every 2 years at a cost of $1000 per audit.

The results are shown in Table 14. They show an additional cost per property of $5000 initially and $1000 per year on average thereafter. This amounts to an NPV over 25 years of $19,000 per property affected and $950,000 for the zone.

It is likely that some of these costs will not be incurred directly, because landholders will change the amount of land in winter grazing rather than be subject to the additional cost and complexity of acquiring a resource consent. However if this were to occur there is likely to be a cost associated with reducing the amount of winter grazing available, either directly, in terms of management flexibility and complexity, or for alternate feed supplies and impacts for farmers purchasing winter feed, but these costs have not been calculated.

Table 14: Costs of PA rule changes in the HRRPRZ

Costing approach	Per affected property	Total (91 properties)
Initial cost	$5,000	$460,000
Annual average	$1,000	$90,000
NPV (6%, 25 years)	$19,000	$1,720,000
NPV cost with uptake over 10 years	$14,000	$1,270,000

6 Summary

The ZIPA will incur costs across a range of areas. The largest of these are in the changes to minimum flows, where operating profit is estimated to reduce from $31 million per annum under the Current scenario, to $28 million per annum in the Solutions Package (Table 15), contribution to regional GDP is forecast to decrease by ~$20 million per annum, and employment by ~130 FTEs. While the changes are relatively minor for most sub catchments, in the Temuka catchment the impacts will be substantial and may cause significant problems for irrigators. It is likely that there will be significant impacts on farm viability, particularly for those irrigated properties with high debt loadings.

Table 15: Changes to aggregate operating profit and contribution to regional outcomes for landholders affected by changes to the flow regimes, by scenario

Scenario	Operating profit ($m/annum)	Contribution to Regional GDP ($m/annum)	Contribution to Regional Household Income ($m/annum)	Contribution to Regional Employment (FTE)
Current	$30.70	$191.20	$94.60	1565
Solutions Pack 2035	$28.48	$171.44	$85.50	1435
Change ($, FTE)	-$2.22	-$19.76	-$9.10	-130
Change from Current %	7%	10%	10%	8%

The impacts associated with changes to the nutrient management regime are next most important, since these will impact across a range of land uses including dryland. The total

calculated reduction for calculated items is estimated to be approximately $5.0 million per annum in operating profit, $4.2 million per annum in regional GDP, $2.0 million per annum in regional household income, and 38 full time equivalent jobs.

The additional costs for stock exclusion above swimming sites were calculated as a capital cost, while the costs for a lower PA threshold were calculated as NPV based on the costs over time. These costs are $0.08 million for stock exclusion and $1.7 million for additional compliance costs for the altered PA threshold in the HRRPRZ. If the costs are incurred evenly over the period of the plan (10 years), then converted to an equivalent annual value over 25 years, the equivalent costs are $0.005 million per annum for stock exclusion and $0.1 million per annum for compliance costs with the PA threshold.

Table 16: Summary impacts of OTOP ZIPA relative to Current scenario ($million/annum, FTE)

Item	Change in Operating profit (or equivalent annual sum, $m/annum)	Change in Regional GDP ($m/annum)	Change in Regional Household Income ($m/annum)	Change in Regional Employment (FTE)
Flow management regime	-$2.22	-$19.80	-$9.10	-130
Nutrient mitigation impact on operating profit	-$5.02	-$4.16	-$1.98	-38
Stock exclusion (Swimming sites)	-$0.005			
Change to PA rule in HRRPRZ	-$0.10			
Total	**-$7.34**	**-$23.96**	**-$11.08**	**-168**
Current state operating profit and contribution to regional indicators for landholders affected by ZIPA measures	$85.74	$441.70	$215.74	3500

These costs are significant for the landholders affected, particularly those with high debt loadings and with limited flexibility. The most severe costs will occur for landholders in the Temuka catchment from the reduction in allocation and for the B block, reductions in reliability. For most other situations the viability of farmers with average debt loadings and farming situations should not be jeopardised, particularly with a 10-year implementation period. However there are landholders with high debt loadings or specific situations which cause impacts to be higher, the threat to viability may be greater.

There are likely to be few situations where the impacts are additive – in most cases the reduction in reliability will also cause some reduction in production, which should also cause a reduction in nutrient losses. The PA rule's impacts will primarily occur for dryland farmers, because properties with substantial irrigation will already require consents. However, there may be some properties with partial irrigation, which are caught by this requirement. This may require some additional cost, and there are potentially some properties near swimming sites, which need to undertake additional fencing of streams.

Because estimates of the contribution from the primary sector to the zone and regional economy have not been made it is difficult to estimate the relative magnitude of these impacts.

The last row in Table 16 provides some estimates of the aggregate operating profit and contribution to the regional economy from the properties affected by changes to the flow regimes and nutrient mitigation requirements. The changes are approximately 9% of the aggregate current operating profit, and 5% of the current contribution to regional GDP, household income and regional employment from the affected properties.

Placing the impacts in terms of the zone economy, BERL (2016) estimated approximately 24,000 FTEs employed in the zone in total, and ~2400 FTEs in the zone's primary sector. They estimated that the primary sector generated $250 million directly in GDP in 2016[31]. The direct employment for the properties affected by the changes to flow regimes and nutrient mitigation requirements are in the order of 1100, suggesting that the affected landholders form in the order of 45% of the zone primary sector employment. In this context the impacts are approximately 7.5% of the primary sector employment by the affected properties, 3.4% of the primary sector employment for the zone, and 0.3% of the total employment for the zone. In terms of the zone economy the direct impacts are approximately 0.4% of the zone GDP, but the actual impact will be greater than this because it does not take into account the flow-on impacts, many of which will be experienced within the zone, particularly with processing facilities for dairy, meat and vegetables located within the zone (see Table 17).

Table 17: Direct impacts in the context of the affected properties, zone primary sector and zone economy

Impacts:	**On farm (direct) Employment (FTE)**	**On farm (direct) GDP ($million per annum)**
– As a proportion of affected properties	7.5%	6.6%
– As a proportion of zone primary sector	3.4%	4.1%
– As a proportion of the zone	0.34%	0.4%

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[31] These primary sector employment and GDP figures are 'direct' estimates in that they represent the employment and GDP on farms. The regional figures cited elsewhere here are the contribution to regional employment and GDP from the affected properties, which includes flow-on impacts associated with resulting changes for suppliers and processors, and from changes in household spending.

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Appendix A Financial modelling

The modelling for impacts of changes to the flow management regime (reliability of irrigation) and the impacts of mitigation requirement in the Nutrient Priority Zones uses the same financial dataset which is shown in Table 18. This is based on an amalgam of information provided by a Farmer Reference Group in 2016/17 and the modelling used by TAG in their previous reporting on reliability impacts and described in their report.

- For arable and vegetable systems the variable expenses are adjusted for change in average reliability to reflect the lower intensity that would be associated with lower reliability systems. For irrigated Arable systems the financials are taken from TAG Arable 2 (Cereal rotation)[32]. Vegetable system returns are taken from TAG Arable 1 (Root vegetable rotation) and are only used in the reliability modelling. For the reliability analysis production was varied in proportion to the reduction from pasture, and this is likely to overestimate the revenue implications because typically an arable property manager would direct available water to higher value crops and sacrifice the lower value ones.
- The TAG arable model appears to contain some revenue that is not crop, given the difference between the reported revenue sources in Table 29 of the TAG report and the total arable revenue in the unrestricted regime reported in Table 22. This is assumed to be revenue from grazing sheep and dairy cattle but is adjusted on the same basis as the arable revenue.
- The arable dryland model was based on the information for Farm Class 8 (mixed cropping) from the Beef + Lamb New Zealand Sheep and Beef Farm Survey, which the Farmers Reference Group indicated was an appropriate source of data. The average of the five years data to 2017/18 was used.
- The dairy model work undertaken with the Farmer Reference Group in the OTOP zone to estimate production of 1400kgMS/ha for a light soil, 1232kgMS/ha for a heavy soil, and 1026kgMS/ha for dryland dairy was used as indicated by the farmer stakeholder group. A farmgate milk price of $5.9/kgMS was used, which is the average from 2013/14 to 2017/18, with an additional $0.3/kgMS in livestock and other sales. The expenses were based on the figures used in the TAG dairy model as more recent information, on the basis that this would better reflect the impact of the low payout years on the expenditure than the Farmer Reference Group models which were developed earlier. The TAG expenses were adjusted for differences in production between the TAG models and the Farmer Reference Group models.
- The sheep and beef dryland model was based on work with the farmer stakeholder group, updated using the PPI for inputs. The revenue was updated using the TAG model production per stock unit to reflect more recent product prices than that developed by the Farmers Reference Group, but the stocking rate was based on the information from the Farmers Reference Group.
- The dairy support unit model (Nutrient Priority only) was based on the Farmer Reference Group models, updated using the PPI for inputs and outputs.

[32] There are varying revenue figures reported in the TAG report. This model uses the reported unrestricted figure from Table 21 of their report.

- The flow-on impacts for Canterbury are based on those estimated by Butcher Partners for the Waimakariri zone. These will not reflect the OTOP situation entirely, because they were based on Waimakariri models, but because the Waimakariri work adjusted the tables to incorporate more specific production systems they are likely to be more closely related to the OTOP situation than the generic Insight tables used by TAG. This approach to estimating impacts is only applicable to the average outcomes, because in severe restriction events the responses from landholders will not necessarily conform to the business structures estimated for the average – for example revenue may decrease while expenses increase in a drought event, because feed has to be purchased and resowing of pastures may be needed. These need to be modelled specifically for an event to be reliably translated into wider economic impacts.

Table 18: Financial models by land use for reliability and nutrient modelling

Land use	Unit	Irrigated dairy light soil	Irrigated dairy heavy soil	Dryland dairy	Irrigated sheep and beef	Dryland sheep and beef	Irrigated arable cereal	Irrigated arable vegetable	Dryland arable	Irrigated dairy support	Dryland dairy support
Revenue	**$/ha**	$8,680	$7,640	$6,360	$2,570	$1,610	$5,090	$12,290	$2,970	$2,650	$1,690
Variable expenses	**$/SU or $/cow**	$3.84	$3.84	$3.84	$72.09	$69.19	$0.00	$0.00	$0.00	$0.00	$0.00
Variable expenses	**$/ha**	$5,380	$4,730	$3,940	$1,150	$690	$2,750	$7,690	$1,970	$1,870	$1,180
Fixed expenses	**$/ha**	$1,300	$1,170	$1,040	$750	$260	$600	$600	$460	$230	$170
Total expenses	**$/ha**	$6,680	$5,900	$4,980	$1,910	$950	$3,350	$8,300	$2,420	$2,100	$1,350
Operating profit	**$/ha**	$2,000	$1,740	$1,380	$670	$660	$1,740	$3,990	$550	$560	$340

Notes
Revenue: Cash sales
Variable: Wages, animal health, weed and pest control, shearing and dairy shed expenses, fertiliser, seeds, vehicle, fuel, electricity, feed and grazing, cultivation and sowing, cash crop expenses, repairs and maintenance, cartage.
Fixed expenses: irrigation charges, administration expenses, rates, acc levies, insurance, depreciation.
Operating profit: revenue minus variable and fixed expenses.

Appendix B Detailed results

B1 Temuka

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Temuka Current A	**Average**	27	3	0	2	2	13%
	1 in 4 year event	48	9	0	1	1	23%
	1 in 10 year event	68	3	0	3	5	30%
	Drought year (2014/15	75	9	0	16	16	35%
Temuka Current B	**Average**	47	0	0	6	6	21%
	1 in 4 year event	69	0	0	14	14	30%
	1 in 10 year event	90	0	0	15	15	37%
	Drought year (2014/15	108	0	0	25	25	47%
Temuka 2035A	**Average**	8	18	19	3	10	11%
	1 in 4 year event	4	52	31	1	29	21%
	1 in 10 year event	18	62	6	8	37	26%
	Drought year (2014/15	62	53	45	19	38	51%
Temuka 2035 B	**Average**	96	9	4	37	42	45%
	1 in 4 year event	137	7	1	42	48	63%
	1 in 10 year event	159	8	4	55	56	73%
	Drought year (2014/15	187	0	0	106	106	82%
Temuka Harvest B	**Average**	162	2	1	57	57	72%
	1 in 4 year event	193	0	0	68	68	85%
	1 in 10 year event	193	0	0	79	79	85%
	Drought year (2014/15	193	0	0	157	157	85%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Temuka Current A	1	5/6	0			
Temuka Current B	1	0	0			
Temuka 2035A	3/7	2/3	1			
Temuka 2035 B	1	1	1			
Temuka Harvest B	1	3/4	1/2			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Temuka Current A	**First half season (Sept - Dec)**	9%	2%	0%
	Second half season (January - April)	14%	1%	0%
Temuka Current B	**First half season (Sept - Dec)**	17%	0%	0%
	Second half season (January - April)	24%	0%	0%
Temuka 2035A	**First half season (Sept - Dec)**	0%	3%	8%
	Second half season (January - April)	6%	12%	9%
Temuka 2035 B	**First half season (Sept - Dec)**	34%	5%	3%
	Second half season (January - April)	49%	3%	1%
Temuka Harvest B	**First half season (Sept - Dec)**	71%	1%	0%
	Second half season (January - April)	71%	1%	0%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Temuka Current A	Revenue	$7,300	$4,300	$2,300		$1,609	$6,400
	Expenses	$5,800	$2,900	$2,500		$948	$5,100
	Operating Profit	$1,500	$1,400	-$200		$661	$1,300
Temuka Current B	Revenue	$6,800	$3,900	$2,100		$1,609	$5,000
	Expenses	$5,500	$2,700	$2,400		$948	$4,100
	Operating Profit	$1,300	$1,200	-$300		$661	$900
Temuka 2035A	Revenue	$7,400	$4,400	$2,300		$1,609	$6,500
	Expenses	$5,900	$3,000	$2,500		$948	$5,200
	Operating Profit	$1,500	$1,400	-$200		$661	$1,400
Temuka 2035 B	Revenue	$5,300	$2,500	$1,600		$1,609	$3,700
	Expenses	$4,600	$1,900	$2,000		$948	$3,300
	Operating Profit	$700	$500	-$400		$661	$400

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Temuka Current A	Revenue	$6,600	$3,700	$2,100			$5,800
	Expenses	$5,800	$2,900	$2,500			$5,100
	Operating Profit	$800	$800	-$500			$700
Temuka Current B	Revenue	$5,900	$3,100	$1,800			$4,300

	Expenses	$5,500	$2,700	$2,400			$4,100
	Operating Profit	$400	$400	-$500			$200
Temuka 2035A	Revenue	$7,200	$4,300	$2,300			$6,400
	Expenses	$5,900	$3,000	$2,500			$5,200
	Operating Profit	$1,400	$1,300	-$300			$1,200
Temuka 2035 B	Revenue	$3,500	$900	$1,000			$2,300
	Expenses	$4,600	$1,900	$2,000			$3,300
	Operating Profit	-$1,000	-$1,100	-$1,000			-$1,000

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Temuka Current A	Revenue	$5,800	$3,000	$1,800			$5,100
	Expenses	$5,800	$2,900	$2,500			$5,100
	Operating Profit	$0	$100	-$700			-$100
Temuka Current B	Revenue	$5,000	$2,300	$1,500			$3,600
	Expenses	$5,500	$2,700	$2,400			$4,100
	Operating Profit	-$500	-$400	-$800			-$500
Temuka 2035A	Revenue	$5,000	$2,200	$1,500			$4,300
	Expenses	$5,900	$3,000	$2,500			$5,200
	Operating Profit	-$900	-$800	-$1,000			-$900
Temuka 2035 B	Revenue	$2,900	$300	$800			$1,900
	Expenses	$4,600	$1,900	$2,000			$3,300
	Operating Profit	-$1,600	-$1,600	-$1,100			-$1,500

B2 Opihi SH1

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current Opihi SH1 AN	**Average**	162	2	1	57	57	72%
	1 in 4 year event	193	0	0	68	68	85%
	1 in 10 year event	193	0	0	79	79	85%
	Drought year (2014/15	193	0	0	157	157	85%
Current Opihi SH1 BN	**Average**	135	0	0	44	44	59%
	1 in 4 year event	165	0	0	49	49	72%
	1 in 10 year event	142	0	0	106	106	85%
	Drought year (2014/15	193	0	0	106	106	85%
SP Opihi SH1 AN	**Average**	29	17	7	15	22	19%
	1 in 4 year event	50	12	11	16	16	27%
	1 in 10 year event	56	43	6	40	40	40%
	Drought year (2014/15	77	41	8	38	87	47%
SP Opihi SH1 BN	**Average**	126	4	2	42	43	57%
	1 in 4 year event	160	1	1	47	47	71%
	1 in 10 year event	192	1	0	106	106	85%
	Drought year (2014/15	192	1	0	106	106	85%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current Opihi SH1 AN	1	3/4	1/2			
Current Opihi SH1 BN	1	0	0			
SP Opihi SH1 AN	1	7/8	1			
SP Opihi SH1 BN	1	7/8	3/4			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current Opihi SH1 AN	**First half season (Sept - Dec)**	71%	1%	0%
	Second half season (January - April)	71%	1%	0%
Current Opihi SH1 BN	**First half season (Sept - Dec)**	6%	4%	2%
	Second half season (January - April)	18%	11%	4%
SP Opihi SH1 AN	**First half season (Sept - Dec)**	58%	0%	0%
	Second half season (January - April)	60%	0%	0%
SP Opihi SH1 BN	**First half season (Sept - Dec)**	6%	4%	2%
	Second half season (January - April)	19%	10%	4%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi SH1 AN	Revenue	$3,500	$900	$1,000			$2,400
	Expenses	$3,500	$1,100	$1,600			$2,500
	Operating Profit	$0	-$200	-$500			-$100
Current Opihi SH1 BN	Revenue	$4,400	$1,700	$1,300	$7,400		$3,100
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,700
	Operating Profit	$400	$200	-$400	$4,300		$400
SP Opihi SH1 AN	Revenue	$6,900	$4,000	$2,200	$12,200		$5,100
	Expenses	$5,600	$2,800	$2,400	$6,600		$4,100
	Operating Profit	$1,300	$1,200	-$200	$5,600		$1,000
SP Opihi SH1 BN	Revenue	$4,500	$1,800	$1,400	$7,700		$3,200
	Expenses	$4,100	$1,600	$1,800	$3,300		$2,800
	Operating Profit	$400	$200	-$400	$4,400		$400

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi SH1 AN	Revenue	$6,400	$3,500	$2,000	$11,300		$4,700
	Expenses	$5,600	$2,800	$2,400	$6,700		$4,100
	Operating Profit	$800	$800	-$400	$4,700		$600
Current Opihi SH1 BN	Revenue	$3,300	$700	$1,000	$5,500		$2,300
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,700
	Operating Profit	-$700	-$800	-$800	$2,400		-$500
SP Opihi SH1 AN	Revenue	$6,400	$3,500	$2,000	$11,300		$4,700
	Expenses	$5,600	$2,800	$2,400	$6,600		$4,100
	Operating Profit	$800	$800	-$400	$4,600		$600
SP Opihi SH1 BN	Revenue	$3,400	$700	$1,000	$5,600		$2,300
	Expenses	$4,100	$1,600	$1,800	$3,300		$2,800
	Operating Profit	-$700	-$800	-$800	$2,200		-$500

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi SH1 AN	Revenue	$5,200	$2,400	$1,600	$8,900		$3,700
	Expenses	$5,600	$2,800	$2,400	$6,700		$4,100
	Operating Profit	-$400	-$400	-$800	$2,300		-$400
Current Opihi SH1 BN	Revenue	$2,700	$200	$800	$4,400		$1,800
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,700
	Operating Profit	-$1,300	-$1,300	-$1,000	$1,300		-$900
SP Opihi SH1 AN	Revenue	$5,100	$2,300	$1,600	$8,800		$3,700
	Expenses	$5,600	$2,800	$2,400	$6,600		$4,100
	Operating Profit	-$500	-$400	-$800	$2,200		-$400
SP Opihi SH1 BN	Revenue	$2,700	$200	$800	$4,400		$1,800
	Expenses	$4,100	$1,600	$1,800	$3,300		$2,800
	Operating Profit	-$1,400	-$1,400	-$1,000	$1,100		-$1,000

B3 Opihi Saleyards

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current Opihi Sale AA + BA	**Average**	4	0	0	1	1	2%
	1 in 4 year event	1	0	0	0	0	0%
	1 in 10 year event	3	0	0	2	2	1%
	Drought year (2014/15	58	0	0	15	15	25%
SP Opihi Sale AA + BA	**Average**	4	0	0	1	1	2%
	1 in 4 year event	1	0	0	1	1	0%
	1 in 10 year event	3	0	0	2	2	1%
	Drought year (2014/15	58	0	0	15	15	25%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current Opihi Sale AA + BA	1/4	0	0			
SP Opihi Sale AA + BA	1/4	0	0			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current Opihi Sale AA + BA	**First half season (Sept - Dec)**	1%	0%	0%
	Second half season (January - April)	2%	0%	0%
SP Opihi Sale AA + BA	**First half season (Sept - Dec)**	1%	0%	0%
	Second half season (January - April)	2%	0%	0%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Sale AA + BA	Revenue	$8,000	$5,000	$2,500	$12,300		$5,800
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$1,800	$1,700	-$200	$4,100		$1,100
SP Opihi Sale AA + BA	Revenue	$8,000	$5,000	$2,500	$12,300		$5,800
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$1,800	$1,700	-$200	$4,100		$1,100

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Sale AA + BA	Revenue	$8,100	$5,100	$2,600	$12,400		$5,800
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$1,800	$1,800	-$100	$4,300		$1,200
SP Opihi Sale AA + BA	Revenue	$8,100	$5,100	$2,600	$12,400		$5,800
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$1,800	$1,800	-$100	$4,300		$1,200

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Sale AA + BA	Revenue	$6,600	$3,600	$2,100	$10,000		$4,700
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$300	$300	-$600	$1,800		$0
SP Opihi Sale AA + BA	Revenue	$6,600	$3,600	$2,100	$10,000		$4,700
	Expenses	$6,300	$3,300	$2,700	$8,100		$4,700
	Operating Profit	$300	$300	-$600	$1,800		$0

B4 North Opuha

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current N Opuha AA + BA	**Average**	8	0	0	2	2	4%
	1 in 4 year event	3	0	0	2	2	1%
	1 in 10 year event	13	0	0	4	4	6%
	Drought year (2014/15	107	0	0	26	26	47%
Current N Opuha AN	**Average**	29	16	7	17	21	19%
	1 in 4 year event	50	10	12	16	16	27%
	1 in 10 year event	50	42	5	40	40	38%
	Drought year (2014/15	81	38	11	71	80	48%
SP N Opuha AA + BA	**Average**	9	2	1	3	6	5%
	1 in 4 year event	5	4	0	3	6	3%
	1 in 10 year event	30	2	0	14	14	14%
	Drought year (2014/15	105	15	4	26	68	51%
SP N Opuha AN	**Average**	30	17	7	17	22	19%
	1 in 4 year event	50	12	11	16	16	27%
	1 in 10 year event	56	43	6	40	40	40%
	Drought year (2014/15	83	39	9	72	87	49%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current N Opuha AA + BA	4/9	0	0			
Current N Opuha AN	1	7/8	1			
SP N Opuha AA + BA	4/9	1/3	1/3			
SP N Opuha AN	1	7/8	1			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current N Opuha AA + BA	**First half season (Sept - Dec)**	1%	0%	0%
	Second half season (January - April)	6%	0%	0%
Current N Opuha AN	**First half season (Sept - Dec)**	7%	3%	2%
	Second half season (January - April)	18%	10%	4%
SP N Opuha AA + BA	**First half season (Sept - Dec)**	1%	0%	0%
	Second half season (January - April)	6%	1%	0%
SP N Opuha AN	**First half season (Sept - Dec)**	6%	4%	2%
	Second half season (January - April)	19%	10%	4%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current N Opuha AA + BA	Revenue	$7,900	$4,900	$2,500	$12,300		$5,700
	Expenses	$6,200	$3,200	$2,700	$8,000		$4,600
	Operating Profit	$1,700	$1,600	-$200	$4,300		$1,100
Current N Opuha AN	Revenue	$6,900	$4,000	$2,200	$10,700		$5,000
	Expenses	$5,600	$2,800	$2,400	$6,700		$4,100
	Operating Profit	$1,300	$1,200	-$200	$4,100		$900
SP N Opuha AA + BA	Revenue	$7,800	$4,800	$2,500	$12,200		$5,700
	Expenses	$6,200	$3,200	$2,700	$7,900		$4,600
	Operating Profit	$1,700	$1,600	-$200	$4,300		$1,100
SP N Opuha AN	Revenue	$6,900	$4,000	$2,200	$10,700		$5,000
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,100
	Operating Profit	$1,300	$1,200	-$200	$4,100		$900

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current N Opuha AA + BA	Revenue	$8,100	$5,000	$2,500	$12,500		$5,800
	Expenses	$6,200	$3,200	$2,700	$8,000		$4,600
	Operating Profit	$1,900	$1,800	-$100	$4,500		$1,200
Current N Opuha AN	Revenue	$7,000	$4,100	$2,200	$10,800		$5,000
	Expenses	$5,600	$2,800	$2,400	$6,700		$4,100
	Operating Profit	$1,400	$1,300	-$200	$4,200		$1,000
SP N Opuha AA + BA	Revenue	$8,100	$5,000	$2,500	$12,500		$5,800
	Expenses	$6,200	$3,200	$2,700	$7,900		$4,600
	Operating Profit	$1,900	$1,800	-$100	$4,600		$1,300
SP N Opuha AN	Revenue	$7,000	$4,100	$2,200	$10,800		$5,000
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,100
	Operating Profit	$1,400	$1,300	-$200	$4,200		$1,000

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current N Opuha AA + BA	Revenue	$5,200	$2,400	$1,600	$7,800		$3,600
	Expenses	$6,200	$3,200	$2,700	$8,000		$4,600
	Operating Profit	-$1,000	-$900	-$1,100	-$200		-$1,000
Current N Opuha AN	Revenue	$5,000	$2,300	$1,500	$7,600		$3,500
	Expenses	$5,600	$2,800	$2,400	$6,700		$4,100
	Operating Profit	-$600	-$500	-$900	$1,000		-$500
SP N Opuha AA + BA	Revenue	$5,000	$2,100	$1,500	$7,500		$3,500
	Expenses	$6,200	$3,200	$2,700	$7,900		$4,600
	Operating Profit	-$1,200	-$1,100	-$1,100	-$400		-$1,100
SP N Opuha AN	Revenue	$5,000	$2,200	$1,500	$7,500		$3,500
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,100
	Operating Profit	-$600	-$500	-$900	$900		-$600

B5 South Opuha

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current S Opuha BA	**Average**	19	0	0	4	4	8%
	1 in 4 year event	32	0	0	5	5	14%
	1 in 10 year event	43	0	0	14	14	19%
	Drought year (2014/15	97	0	0	18	18	43%
Current S Opuha BN	**Average**	135	0	0	44	44	59%
	1 in 4 year event	165	0	0	49	49	72%
	1 in 10 year event	163	0	0	106	106	85%
	Drought year (2014/15	193	0	0	106	106	85%
SP S Opuha BA	**Average**	27	15	5	9	17	17%
	1 in 4 year event	49	10	5	16	16	25%
	1 in 10 year event	58	19	8	16	32	32%
	Drought year (2014/15	122	16	3	40	87	59%
SP S Opuha BN	**Average**	171	1	1	66	67	75%
	1 in 4 year event	195	0	0	106	106	86%
	1 in 10 year event	202	0	0	77	77	88%
	Drought year (2014/15	195	0	0	106	106	86%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current S Opuha BA	1	0	0			
Current S Opuha BN	1	0	0			
SP S Opuha BA	1	1	7/8			
SP S Opuha BN	1	4/9	1/3			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current S Opuha BA	**First half season (Sept - Dec)**	2%	0%	0%
	Second half season (January - April)	14%	0%	0%
Current S Opuha BN	**First half season (Sept - Dec)**	58%	0%	0%
	Second half season (January - April)	61%	0%	0%
SP S Opuha BA	**First half season (Sept - Dec)**	3%	3%	2%
	Second half season (January - April)	20%	9%	3%
SP S Opuha BN	**First half season (Sept - Dec)**	76%	1%	1%
	Second half season (January - April)	74%	0%	0%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current S Opuha BA	Revenue	$7,600	$4,600	$2,400	$12,300		$4,600
	Expenses	$6,000	$3,100	$2,600	$7,600		$3,700
	Operating Profit	$1,600	$1,500	-$200	$4,700		$900
Current S Opuha BN	Revenue	$4,300	$1,700	$1,300	$6,700		$2,400
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,200
	Operating Profit	$400	$200	-$400	$3,600		$100
SP S Opuha BA	Revenue	$7,100	$4,100	$2,200	$11,400		$4,200
	Expenses	$5,700	$2,800	$2,500	$6,800		$3,500
	Operating Profit	$1,400	$1,300	-$200	$4,600		$700
SP S Opuha BN	Revenue	$3,300	$700	$1,000	$5,000		$1,700
	Expenses	$3,400	$1,000	$1,500	$1,700		$1,800
	Operating Profit	$0	-$300	-$500	$3,300		-$100

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current S Opuha BA	Revenue	$7,200	$4,300	$2,300	$11,700		$4,300
	Expenses	$6,000	$3,100	$2,600	$7,600		$3,700
	Operating Profit	$1,200	$1,200	-$300	$4,100		$600
Current S Opuha BN	Revenue	$3,300	$700	$1,000	$5,000		$1,700
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,200
	Operating Profit	-$700	-$800	-$800	$1,900		-$600
SP S Opuha BA	Revenue	$6,600	$3,600	$2,100	$10,600		$3,900
	Expenses	$5,700	$2,800	$2,500	$6,800		$3,500
	Operating Profit	$900	$800	-$400	$3,800		$400
SP S Opuha BN	Revenue	$3,100	$500	$900	$4,600		$1,500
	Expenses	$3,400	$1,000	$1,500	$1,700		$1,800
	Operating Profit	-$300	-$500	-$600	$2,900		-$300

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current S Opuha BA	Revenue	$5,400	$2,600	$1,700	$8,600		$3,100
	Expenses	$6,000	$3,100	$2,600	$7,600		$3,700
	Operating Profit	-$600	-$500	-$900	$1,000		-$600
Current S Opuha BN	Revenue	$2,700	$200	$800	$4,000		$1,300
	Expenses	$4,000	$1,500	$1,800	$3,100		$2,200
	Operating Profit	-$1,300	-$1,300	-$1,000	$900		-$1,000
SP S Opuha BA	Revenue	$4,500	$1,700	$1,400	$7,100		$2,500
	Expenses	$5,700	$2,800	$2,500	$6,800		$3,500
	Operating Profit	-$1,100	-$1,100	-$1,100	$300		-$1,000
SP S Opuha BN	Revenue	$2,700	$100	$800	$3,900		$1,200
	Expenses	$3,400	$1,000	$1,500	$1,700		$1,800
	Operating Profit	-$700	-$900	-$700	$2,200		-$500

B6 Opihi Rockwood

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current Opihi Rockwood BA	**Average**	11	1	1	3	4	5%
	1 in 4 year event	10	1	5	3	6	5%
	1 in 10 year event	29	0	0	10	10	13%
	Drought year (2014/15	97	7	5	15	22	46%
Current Opihi Rockwood AN	**Average**	31	16	7	15	21	20%
	1 in 4 year event	50	10	12	16	16	27%
	1 in 10 year event	50	41	5	40	40	42%
	Drought year (2014/15	81	34	10	37	80	47%
SP Opihi Rockwood BA	**Average**	18	8	6	8	10	11%
	1 in 4 year event	17	25	13	10	17	17%
	1 in 10 year event	45	6	11	16	16	23%
	Drought year (2014/15	123	10	11	46	46	58%
SP Opihi Rockwood AN	**Average**	34	15	8	15	22	21%
	1 in 4 year event	50	13	11	16	16	28%
	1 in 10 year event	72	35	6	40	40	44%
	Drought year (2014/15	90	31	6	39	87	49%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current Opihi Rockwood BA	2/3	4/9	1/4			
Current Opihi Rockwood AN	1	1	1			
SP Opihi Rockwood BA	7/8	7/8	7/8			
SP Opihi Rockwood AN	1	1	1			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current Opihi Rockwood BA	**First half season (Sept - Dec)**	2%	0%	0%
	Second half season (January - April)	8%	1%	1%
Current Opihi Rockwood AN	**First half season (Sept - Dec)**	7%	3%	2%
	Second half season (January - April)	20%	10%	4%
SP Opihi Rockwood BA	**First half season (Sept - Dec)**	3%	2%	2%
	Second half season (January - April)	12%	5%	3%
SP Opihi Rockwood AN	**First half season (Sept - Dec)**	8%	3%	2%
	Second half season (January - April)	21%	9%	4%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Rockwood BA	Revenue	$7,800	$4,800	$2,500			$5,900
	Expenses	$6,100	$3,200	$2,600			$4,800
	Operating Profit	$1,700	$1,600	-$200			$1,100
Current Opihi Rockwood AN	Revenue	$6,900	$4,000	$2,200			$5,200
	Expenses	$5,600	$2,700	$2,400			$4,400
	Operating Profit	$1,300	$1,200	-$200			$800
SP Opihi Rockwood BA	Revenue	$7,400	$4,400	$2,300			$5,600
	Expenses	$5,900	$3,000	$2,500			$4,600
	Operating Profit	$1,500	$1,400	-$200			$1,000
SP Opihi Rockwood AN	Revenue	$6,800	$3,900	$2,100			$5,100
	Expenses	$5,500	$2,700	$2,400			$4,300
	Operating Profit	$1,300	$1,200	-$300			$800

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Rockwood BA	Revenue	$7,800	$4,800	$2,500			$5,900
	Expenses	$6,100	$3,200	$2,600			$4,800
	Operating Profit	$1,700	$1,600	-$200			$1,100
Current Opihi Rockwood AN	Revenue	$7,100	$4,100	$2,200			$5,300
	Expenses	$5,600	$2,700	$2,400			$4,400
	Operating Profit	$1,500	$1,400	-$200			$900
SP Opihi Rockwood BA	Revenue	$7,300	$4,300	$2,300			$5,500
	Expenses	$5,900	$3,000	$2,500			$4,600
	Operating Profit	$1,400	$1,300	-$300			$800
SP Opihi Rockwood AN	Revenue	$7,000	$4,000	$2,200			$5,200
	Expenses	$5,500	$2,700	$2,400			$4,300
	Operating Profit	$1,500	$1,300	-$200			$900

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Opihi Rockwood BA	Revenue	$5,300	$2,500	$1,600			$3,900
	Expenses	$6,100	$3,200	$2,600			$4,800
	Operating Profit	-$800	-$700	-$1,000			-$900
Current Opihi Rockwood AN	Revenue	$5,200	$2,300	$1,600			$3,800
	Expenses	$5,600	$2,700	$2,400			$4,400
	Operating Profit	-$400	-$400	-$800			-$600
SP Opihi Rockwood BA	Revenue	$4,500	$1,700	$1,400			$3,300
	Expenses	$5,900	$3,000	$2,500			$4,600
	Operating Profit	-$1,400	-$1,300	-$1,200			-$1,300
SP Opihi Rockwood AN	Revenue	$5,000	$2,200	$1,500			$3,700
	Expenses	$5,500	$2,700	$2,400			$4,300
	Operating Profit	-$500	-$500	-$900			-$600

B7 Te Ana Wai

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current Te Ana Wai AA + BA	**Average**	15	6	0	6	12	8%
	1 in 4 year event	26	10	0	7	12	14%
	1 in 10 year event	46	8	0	14	25	22%
	Drought year (2014/15	112	8	0	38	87	51%
Current Te Ana Wai AN	**Average**	31	17	6	15	21	19%
	1 in 4 year event	50	13	9	16	16	27%
	1 in 10 year event	50	22	1	40	40	41%
	Drought year (2014/15	77	40	8	39	80	47%
SP Te Ana Wai AA + BA	**Average**	27	11	6	14	16	16%
	1 in 4 year event	48	13	8	8	10	26%
	1 in 10 year event	41	31	14	15	15	30%
	Drought year (2014/15	118	16	5	87	87	57%
SP Te Ana Wai AN	**Average**	41	16	7	18	22	24%
	1 in 4 year event	63	15	7	9	29	33%
	1 in 10 year event	101	10	2	40	40	47%
	Drought year (2014/15	84	39	7	78	87	50%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current Te Ana Wai AA + BA	5/8	4/7	0			
Current Te Ana Wai AN	1	7/8	1			
SP Te Ana Wai AA + BA	7/8	1	4/5			
SP Te Ana Wai AN	1	1	1			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current Te Ana Wai AA + BA	**First half season (Sept - Dec)**	2%	1%	0%
	Second half season (January - April)	11%	4%	0%
Current Te Ana Wai AN	**First half season (Sept - Dec)**	7%	5%	2%
	Second half season (January - April)	20%	10%	3%
SP Te Ana Wai AA + BA	**First half season (Sept - Dec)**	4%	5%	3%
	Second half season (January - April)	19%	4%	2%
SP Te Ana Wai AN	**First half season (Sept - Dec)**	9%	7%	3%
	Second half season (January - April)	25%	8%	3%

Per ha outcomes by scenario

Average year

Per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Te Ana Wai AA + BA	Revenue	$7,600	$4,600	$2,400	$12,300		$5,800
	Expenses	$6,000	$3,100	$2,600	$7,500		$4,800
	Operating Profit	$1,600	$1,500	-$200	$4,700		$1,000
Current Te Ana Wai AN	Revenue	$6,900	$4,000	$2,200	$11,100		$5,300
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,500
	Operating Profit	$1,300	$1,200	-$200	$4,500		$800
SP Te Ana Wai AA + BA	Revenue	$7,100	$4,200	$2,200	$11,500		$5,500
	Expenses	$5,700	$2,900	$2,500	$6,900		$4,600
	Operating Profit	$1,400	$1,300	-$200	$4,600		$900
SP Te Ana Wai AN	Revenue	$6,600	$3,700	$2,100	$10,700		$5,100
	Expenses	$5,400	$2,600	$2,300	$6,200		$4,400
	Operating Profit	$1,200	$1,100	-$300	$4,500		$700

1 in 4 year event

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Te Ana Wai AA + BA	Revenue	$7,200	$4,300	$2,300	$11,600		$5,500
	Expenses	$6,000	$3,100	$2,600	$7,500		$4,800
	Operating Profit	$1,200	$1,200	-$300	$4,100		$700
Current Te Ana Wai AN	Revenue	$5,500	$2,700	$1,700	$8,700		$4,200
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,500
	Operating Profit	-$100	-$100	-$700	$2,100		-$300
SP Te Ana Wai AA + BA	Revenue	$6,700	$3,700	$2,100	$10,700		$5,100
	Expenses	$5,700	$2,900	$2,500	$6,900		$4,600
	Operating Profit	$900	$900	-$400	$3,800		$500
SP Te Ana Wai AN	Revenue	$5,100	$2,300	$1,600	$8,100		$3,900
	Expenses	$5,400	$2,600	$2,300	$6,200		$4,400
	Operating Profit	-$300	-$300	-$800	$1,900		-$400

Drought (2014/15) Year

per ha		Dairy	Arable	Sheep and Beef	Horticulture and Vegetables	Dryland	Weighted Average
Current Te Ana Wai AA + BA	Revenue	$4,700	$2,100	$1,400	$7,400		$3,600
	Expenses	$6,000	$3,100	$2,600	$7,500		$4,800
	Operating Profit	-$1,300	-$1,000	-$1,100	-$100		-$1,200
Current Te Ana Wai AN	Revenue	$5,100	$2,400	$1,600	$8,100		$3,900
	Expenses	$5,600	$2,700	$2,400	$6,600		$4,500
	Operating Profit	-$400	-$400	-$800	$1,500		-$600
SP Te Ana Wai AA + BA	Revenue	$4,500	$1,800	$1,400	$7,100		$3,500
	Expenses	$5,700	$2,900	$2,500	$6,900		$4,600
	Operating Profit	-$1,200	-$1,100	-$1,100	$200		-$1,200
SP Te Ana Wai AN	Revenue	$5,000	$2,200	$1,500	$7,900		$3,800
	Expenses	$5,400	$2,600	$2,300	$6,200		$4,400
	Operating Profit	-$400	-$400	-$800	$1,700		-$600

B8 BN Block Reliability Analysis

Severity of restrictions

		Full days lost (100% restriction)	50% restriction	25% restriction	Consecutive days of full restriction	Consecutive days of 50% restriction	Volume restriction
Current N Opuha BN	**Average**	186	0	0	79	79	82%
	1 in 4 year event	195	0	0	97	97	86%
	1 in 10 year event	202	0	0	104	104	89%
	Drought year (2014/15	195	0	0	108	108	86%
SP N Opuha BN	**Average**	168	0	0	65	65	74%
	1 in 4 year event	193	0	0	56	56	85%
	1 in 10 year event	193	0	0	77	77	88%
	Drought year (2014/15	195	0	0	106	106	86%
Current Opihi Rockwood BN	**Average**	135	0	0	44	44	59%
	1 in 4 year event	165	0	0	49	49	72%
	1 in 10 year event	193	0	0	106	106	85%
	Drought year (2014/15	193	0	0	106	106	85%
SP Opihi Rockwood BN	**Average**	149	3	1	50	51	66%
	1 in 4 year event	175	1	0	67	67	77%
	1 in 10 year event	193	0	0	106	106	85%
	Drought year (2014/15	193	0	0	106	106	85%
Current Te Ana Wai BN	**Average**	135	0	0	44	44	59%
	1 in 4 year event	166	0	0	53	53	73%
	1 in 10 year event	193	0	0	68	68	85%
	Drought year (2014/15	193	0	0	106	106	85%
SP Te Ana Wai BN	**Average**	142	3	1	49	49	63%
	1 in 4 year event	181	0	1	67	67	80%
	1 in 10 year event	193	0	0	106	106	85%
	Drought year (2014/15	193	0	0	106	106	85%

Frequency of restrictions

	Frequency of years with full days restriction	Frequency of years with 50% restriction	Frequency of years with 25% restriction			
Current N Opuha BN	1	0	0			
SP N Opuha BN	1	1/4	1/4			
Current Opihi Rockwood BN	1	0	0			
SP Opihi Rockwood BN	1	2/3	5/8			
Current Te Ana Wai BN	1	0	0			
SP Te Ana Wai BN	1	4/5	3/4			

Timing of restrictions

		100% restriction	50% restriction	25% restriction
Current N Opuha BN	**First half season (Sept - Dec)**	84%	0%	0%
	Second half season (January - April)	79%	0%	0%
SP N Opuha BN	**First half season (Sept - Dec)**	75%	0%	0%
	Second half season (January - April)	72%	0%	0%
Current Opihi Rockwood BN	**First half season (Sept - Dec)**	58%	0%	0%
	Second half season (January - April)	60%	0%	0%
SP Opihi Rockwood BN	**First half season (Sept - Dec)**	64%	2%	1%
	Second half season (January - April)	67%	0%	0%
Current Te Ana Wai BN	**First half season (Sept - Dec)**	58%	0%	0%
	Second half season (January - April)	60%	0%	0%
SP Te Ana Wai BN	**First half season (Sept - Dec)**	61%	2%	1%