Narrative for Ruamāhanga Whaitua Scenarios
Economic impact on the agricultural sector

19 November 2017

The economic impacts were estimated based on land use, farm system and mitigation data specified in the GIS layers provided by Jacobs, waste water treatment plant upgrade costs provided by the Carterton District Council, irrigation reliability estimates provided by Aqualinc and GWRC, and areas currently consented for irrigation by GWRC. The data used and assumptions for this analysis are outlined at the end of the document. Accompanying spreadsheets provide more detailed information on the analysis and figures that can be used to show the findings graphically (the parenthetical reference to a tab in the findings below relates to the spreadsheet).

Summary of scenarios

Mitigation option	BAU	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Retirement of steep slopes	retire rate		X	X	X	X	X
Space planting on steep slopes	Planting rate	X	X	X	X	X	X
Additional riparian planting (+5m)					X	X	X
Stock exclusion	X	X	X	X	X	X	X
WWTP discharge to land	Staggered	60%	100%	100%	100%	100%	100%
Minimum flow and allocation set	X	X	X	X	X	X	X
On-farm mitigation options	Tier 1	Tier 1	Tier 2	Tier 3	Tier 2	Tier 3	Tier 3

Findings

Total Impacts

- On-farm mitigation is estimated to cost between $20.5 and $46.8 million per year for the Silver and Gold scenarios, equivalent to a 11 to 24% reduction from baseline net farm revenue.
- Sheep and Beef (S&B) has the largest percent reduction in net revenue and bares the largest total mitigation cost. Dairy farms typically face the largest per hectare mitigation cost.
- Wastewater treatment plant upgrades are estimated to have an annualized cost of $10.4 to $14.8 million/yr depending on the scenario.
- Regional output could be reduced by $19.0 to $44.6 million per year, while regional employment could be reduced by 88 – 206 FTEs.
- Changes in irrigation reliability because of the changes in minimum flows in the sub-catchments of particular concern are estimated to reduce farm profits by $57k-400k per annum
- There is little difference between the Silver and Gold scenarios in terms of reductions in sediment losses, P losses and N losses.

On-farm Mitigation Impacts *(Tables 1-4; File: Ruamhanga_OnFarmMitigation_15Nov17_v1.4)*

Some of the key findings from the on-farm economic analysis are:

- The impact on net agricultural revenue is greater under the Gold scenario than the Silver scenario with the negative impact increasing over time as more mitigation options are implemented (Table 1 and NetRev-LandUse tab).
- Approximately 69% of the baseline agricultural net revenue (i.e., profits) in the catchment comes from dairy (~31%) and sheep and beef (S&B; ~39%) farming
    - S&B experience a greater reduction in revenue (percent and total) than dairy in both the Silver and Gold scenarios (Table 1 and NetRev-LandUse tab).
- Approximately 66% of the baseline agricultural net revenue comes from 3 FMUs – Eastern Hill Rivers (23%), Valley Floor Streams (23%) and Western Hill Rivers (20%)
    - The Eastern Hill Rivers FMU has the biggest reduction in net agricultural revenue compared to the other 2 high revenue FMUs (Table 1 and NetRev-FMU tab)
    - The Valley Floor Streams FMU has the lowest reduction in net agricultural revenue compared to the other 2 high revenue FMUs (Table 1 and NetRev-FMU tab)
- As per the Jacobs maps which outline where mitigation options are implemented
    - A majority of up to about 36,000 ha of pole planting is undertaken on S&B farms (up to 29,495 ha). The land use with the next largest amount of pole planning is dairy (up to 2,208 ha).
    - Similarly, most of the land that is retired is on S&B farms (up to 11,000 ha).

- The mitigation costs are higher for the Gold scenario than the Silver scenario (Table 1 and MitigationCost tab)
    - The on-farm mitigation bundles have the highest cost followed by land retirement (Table 1 and MitigationCost tab)
    - S&B farms have the highest total mitigation costs with dairy mitigation costs being less than half those of S&B farms for nearly all scenarios (Table 1 and MitigationCost tab)
    - On a per hectare basis, dairy has the highest mitigation costs, followed by S&B (Table 1 and MitigationCost tab).
- Three environmental parameters were estimated for each scenario (Table 2)
    - There were marked reductions in sediment losses in the Silver (~37%) and Gold (~33%) scenarios by 2080. The biggest reductions are on S&B farms which is expected given these farms are in steeper areas and a number of the mitigation options target sediment losses (Table 2 and Env Outputs tab)
    - There is an even larger percent reduction in P losses with reductions of just over 50% for the Silver and Gold scenarios by 2080. Again most reductions are associated with S&B farming areas (Table 2 and Env Outputs tab)
    - There were only modest decreases of about 9 % in N losses with both Silver and Gold scenarios (Table 2 and Env Outputs tab)

- Regional economic impact (Tables 3 and 4 and Reg Economy tab)
    - Implementing mitigation bundles and retiring land could reduce on-farm revenue from pastoral land uses by $12 to $28.4 million/yr (4 – 8%) for the Silver and Gold scenarios (Table 3)
    - Using a multiplier approach, regional output could be reduced by $19.0 to $44.6 million per year for the same scenarios (Table 3)
    - Regional employment could be reduced by 88 to 206 full time equivalents (FTE) (Table 3)
    - Revenues are affected by both the implementation of mitigation bundles and land retirement (Table 4)
    - Sheep, beef and dairy support farm revenues are affected more by land retirement, while dairy farms are affected more by the implementation of mitigation bundles that have an effect on their productivity (Table 4)

Wastewater Treatment Plant Upgrade Impacts *(Table 5; File: Ruamhanga_WWTP_19Nov17_v1.5)*

- Wastewater treatment plant upgrades are estimated to have an annualized cost of $10.4 to $14.8 million/yr depending on the scenario.
- 55-64% of total costs are incurred in the Masterton District, which has the largest number of residents, businesses, and households.
- Approximately 20% of the costs are estimated to be in Carterton, the next most populated district in the Ruamāhanga catchment.
- The estimates for wastewater treatment plant mitigation costs equate to $230-319 per person per year for the Gold and Silver scenarios (based on estimated wastewater treatment plant costs and projected population growth for each town).

Irrigation Reliability Change Impacts *(Table 6; File: Ruamhanga_IrrigationReliability_19Nov17_v1.5)*

- Upper Ruamāhanga and Waipoua sub-catchments were identified as areas of concern. Collectively, they currently have 965ha of irrigated land, mostly in sheep-beef.
- As we don't know what type of farms are being irrigated we have estimated the impacts based on those farms being 'average farm systems' (which is an average of all farm systems within a given sector based on the AgResearch report) and also 'most intensive farm system'.
- Impacts to irrigation reliability because of the changes in minimum flows in the sub-catchments are estimated to reduce farm profits by $57k-400k per annum (based on the projected future reliability).
- Greatest impacts estimated to occur if all irrigation is done on most intensive farm systems with the highest revenue potential and reliability reduced to 90th percentile of summer annual estimate.

Table 1. Summary of on-farm economic analysis

Parameter	Base	BAU	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Net agricultural revenue (% change)								
Total agricultural net revenue	$192,504,691	-0.6%	-11%	-21%	-22%	-19%	-24%	-24%
Total dairy net revenue	$59,452,530	-1.3%	-13%	-15%	-16%	-16%	-18%	-18%
Total S&B net revenue	$74,721,075	-0.4%	-16%	-39%	-43%	-34%	-46%	-46%
Total other land use net revenue	$58,330,085	0.0%	-2%	-3%	-3%	-2%	-3%	-3%
Eastern Hill Rivers FMU	$43,489,735	-1.3%	-11%	-29%	-33%	-25%	-35%	-35%
Valley Floor Streams FMU	$44,296,246	-0.7%	-11%	-13%	-13%	-13%	-14%	-14%
Western Hill Rivers FMU	$39,053,737	-0.8%	-12%	-21%	-23%	-20%	-25%	-25%
Mitigation costs ('000 $/yr)								
Total cost		1,516	20,528	39,848	42,971	36,188	46,806	46,806
Cost of mitigation bundles		863	15,732	29,359	32,483	27,231	32,267	32,267
Cost of 10m riparian planting		0	0	0	0	1,546	4,051	4,051
Cost of pole planting		588	1,976	5,054	5,054	1,977	5,054	5,054
Cost of retirement		65	2,820	5,434	5,434	5,434	5,434	5,434
Dairy mitigation costs		799	7,488	9,136	9,382	9,505	10,506	10,506
S&B mitigation costs		715	12,196	29,191	32,065	25,608	34,735	34,735
Other land use mitigation costs		2	844	1,521	1,524	1,075	1,565	1,565
Mitigation costs ($/ha/yr)								
Dairy mitigation costs		27	249	304	312	316	349	349
S&B mitigation costs		4	74	177	194	155	210	210
Other land use mitigation costs		0	5	9	9	7	10	10

Table 2: Summary of the environmental response to the different scenarios.

	BAU 2040	BAU 2080	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Environmental parameters (% change)								
Sediment loss[1]	-9.3%	-15.3%	N/A	-26.9%	-36.8%[2]	N/A	-30.1%	-32.9%
N losses	0%	0%	-8.1%	-8.7%	-8.7%	-9.0%	-9.1%	-9.1%
P losses	0%	0%	-18.1%	-43.4%	-52.1%	-32.4%	-52.6%	-52.6%

[1] There was no information on sediment loss provided for 2025.

[2] Note that the reduction in sediment losses under the Silver scenario was greater than the Gold scenario. This may have been due to rounding errors when the raster GIS layer provided by Jacobs was converted to a shapefile or it may also be due to differences in the actual layers provided by Jacobs.

Table 3: Summary of regional economic impacts from different mitigation scenarios

Land Use	BAU	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Change Farm Gate Revenue from Baseline (mil $/yr)							
Dairy	$0.00	-$4.25	-$6.67	-$7.36	-$7.54	-$9.56	-$9.56
Sheep, Beef & Dairy Support	-$0.84	-$7.82	-$15.97	-$16.75	-$16.85	-$18.81	-$18.81
Total	-$0.85	-$12.08	-$22.64	-$24.11	-$24.39	-$28.37	-$28.37
Change in Regional Economic Output from Baseline (mil $/yr)							
Dairy	-$0.01	-$6.80	-$10.65	-$11.75	-$12.04	-$15.27	-$15.27
Sheep, Beef & Dairy Support	-$1.32	-$12.21	-$24.93	-$26.16	-$26.31	-$29.38	-$29.38
Total	-$1.32	-$19.01	-$35.58	-$37.91	-$38.36	-$44.64	-$44.64
Change in Regional Employment from Baseline (FTE)							
Dairy	0.0	-33.0	-51.6	-56.9	-58.4	-74.0	-74.0
Sheep, Beef & Dairy Support	-5.9	-54.8	-111.9	-117.5	-118.1	-132.0	-132.0
Total	-5.9	-87.8	-163.5	-174.4	-176.5	-206.0	-206.0

Table 4: Summary of breakdown of lost farm gate revenue by mitigation bundles and retired land

Land Use	BAU	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Change Farm Gate Revenue From Baseline due to Mitigation Bundles (Mil $/yr)							
Dairy	$0.00	-$3.57	-$5.37	-$6.07	-$6.24	-$8.27	-$8.27
Sheep, Beef & Dairy Support	$0.00	-$3.00	-$6.57	-$7.35	-$7.46	-$9.42	-$9.42
Total	$0.00	-$6.57	-$11.94	-$13.42	-$13.70	-$17.68	-$17.68
Change Farm Gate Revenue From Baseline due to Retired Land (Mil $/yr)							
Dairy	$0.00	-$0.69	-$1.30	-$1.30	-$1.30	-$1.30	-$1.30
Sheep, Beef & Dairy Support	-$0.84	-$4.82	-$9.40	-$9.40	-$9.40	-$9.40	-$9.40
Total	-$0.85	-$5.51	-$10.69	-$10.69	-$10.69	-$10.69	-$10.69
Total Change Farm Gate Revenue from Baseline (Mil $/yr)							
Dairy	$0.00	-$4.25	-$6.67	-$7.36	-$7.54	-$9.56	-$9.56
Sheep, Beef & Dairy Support	-$0.84	-$7.82	-$15.97	-$16.75	-$16.85	-$18.81	-$18.81
Total	-$0.85	-$12.08	-$22.64	-$24.11	-$24.39	-$28.37	-$28.37

Table 5: Summary of wastewater treatment plant mitigation costs ('000 $/yr)

District	BAU 2080	Silver 2025	Silver 2040	Silver 2080	Gold 2025	Gold 2040	Gold 2080
Masterton	8,178	5,873	8,241	8,178	8,146	8,241	8,178
Carterton	2,243	2,149	3,105	3,111	2,980	3,105	3,111
Martinborough	1,202	839	1,202	1,202	1,164	1,202	1,202
Greytown	1,181	824	1,181	1,181	1,143	1,181	1,181
Featherston	0	758	1,086	1,086	1,051	1,086	1,086
Total	12,805	10,443	14,816	14,758	14,483	14,816	14,758

Table 6: Summary of estimated regional economic impacts from changes in irrigation reliability in Waipoua and Upper Ruamāhanga subcatchments

Reliability	Waipoua (104 ha)		Upper Ruamāhanga (861 ha)	
	Now	*Future*	*Now*	*Future*
Change in Regional Economic Output from Baseline - Most Intensive Systems Irrigated				
Average Annual Reliability	-$12,315	-$16,879	-$70,785	-$115,449
Average Summer Reliability	-$21,442	-$29,048	-$97,583	-$186,913
90th Percentile Summer Reliability	-$43,786	-$53,145	-$160,114	-$347,705
Change in Regional Economic Output from Baseline - Average System Irrigated				
Average Annual Reliability	-$8,140	-$11,557	-$28,096	-$45,824
Average Summer Reliability	-$14,974	-$20,668	-$38,733	-$74,189
90th Percentile Summer Reliability	-$31,584	-$37,503	-$63,552	-$138,010
Change in Regional Employment from Baseline (FTE) – Average Systems Irrigated				
Average Annual Reliability	-0.1	-0.1	-0.5	-0.8
Average Summer Reliability	-0.1	-0.2	-0.7	-1.3
90th Percentile Summer Reliability	-0.3	-0.4	-1.1	-2.4
Change in Regional Employment from Baseline (FTE) – Average System Irrigated				
Average Annual Reliability	-0.1	-0.1	-0.2	-0.3
Average Summer Reliability	-0.1	-0.1	-0.3	-0.5
90th Percentile Summer Reliability	-0.2	-0.3	-0.4	-1.0

Economic Impact Modelling Data and Assumptions

- Baseline net farm revenue
    - Pastoral and arable farm systems: MPI/Parminter report
    - All other land uses: Values from Daigneault et al (2017)
- 5 mitigation cost components
    - Mitigation bundle: based on June 2016 AgResearch report
    - Land retirement: Full loss of baseline net farm revenue (opportunity cost)
    - Space planting: $1,500/ha, annualised over 25 years at rate of 8%
    - Additional riparian planting: extending from 5 to 10m in Gold scenarios accounts for additional planting and lost production (opportunity) costs of 5m of new buffer along 26m stream/ha
    - Waste water treatment plant upgrades: based on cost estimates provided by Carterton District Council (CDC), annualized over 25 years at rate of 8%. Costs for WWTP mitigation in other districts were estimated by scaling the CDC estimates based on relative population.
- Mitigation imposed
    - All mitigation imposed on each farm parcel/land use in catchment is exactly as specified by Jacobs GIS layers (i.e., mitigation bundle, pole planting, retirement)
    - Mitigation bundles: only applied on MPI farm systems[3]
    - Land retirement: applied on all areas specified by Jacobs, including non-MPI farm system land uses (e.g. deer, lifestyle)
    - Pole planting: applied on all areas specified by Jacobs, including non-MPI farm systems (e.g. mixed, native bush)
    - Additional riparian planting: applied in Gold scenarios on MPI farm systems where M3 bundle costs were estimated and applied
- Irrigation reliability
    - Changes in water availability: based on three different reliability scenarios (average annual, average summer, and 90th percentile summer).
    - Current irrigated area: consented irrigation are by land use and sub-catchment from GWRC
    - Net farm revenue under alternative water availability: estimated using figures on Dairy, Arable, and Sheep-Beef profit curves from Aqualinc
    - Sub-catchments of particular interest: List provided by GWRC
- Regional Economic Impacts
    - Use a multiplier approach that takes into account changes in on-farm revenue as a result of implementing mitigation bundles and retiring land
    - Pole planting does not affect regional output or employment as there is no effect on farm income/revenue or production, just the cost of planting
    - Baseline revenues: based on MPI/Parminter report
    - Mitigation revenues: based on June 2016 AgResearch report (Tables 7-22)

[3] Note that the Jacobs N+P GIS layers have mitigation bundles imposed on almost all land uses for Silver and Gold scenarios, but as there is minimal impact on environmental outputs. It was assumed that there would not be any mitigation bundles applied on those land uses in actuality, and hence they would not face a cost for this option.

- Includes direct, indirect and induced effects on regional economy
- Multipliers provided by Geoff Butcher