ACTION FOR
HEALTHY WATERWAYS
NGĀ MAHI MŌ
TE WHAKAORA WAI

TE MANA O TE WAI

Overview of the impact analysis undertaken to inform decisions on freshwater policy, with a focus on monetised costs

Ministry for the Environment
Manatū Mō Te Taiao

New Zealand Government

This document may be cited as: Ministry for the Environment. 2020. *Action for healthy waterways: Overview of the impact analysis undertaken to inform decisions on freshwater policy, with a focus on monetised costs*. Wellington: Ministry for the Environment.

Published in May 2020 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10362, Wellington 6143, New Zealand

ISBN: 978-1-98-857989-4 (online)

Publication number: ME 1502

This document is available on the Ministry for the Environment website: www.mfe.govt.nz.

Making Aotearoa New Zealand
the most liveable place in the world

Contents

Tables

Figure

Introduction

The purpose of this paper is to provide a high-level outline of the impact assessment of the Action for healthy waterways proposals (and subsequent final package), providing information about the objectives and scope of the impact assessment, the findings, the parties involved, the methodologies applied and the limitations and constraints to the analysis. As well, high-level information about the calculation of monetised costs is provided, with a particular focus on the impact assessment of the nutrient-related policies.

Background

In October 2019, the Action for healthy waterways policy proposals (the 'proposals') were released for public consultation. These proposals consisted of a suite of policies including new bottom lines for nutrients and sediment; a moratorium on the further loss of wetlands, fish passages and streams; stock exclusion requirements and mandatory freshwater modules in farm plans.

Extensive analysis of the likely costs and benefits had been undertaken prior to arriving at the proposals, and this analysis was released publicly when consultation began in the interim regulatory impact analysis for consultation. In many cases the findings from this analysis were summarised in the discussion document released in September 2019.

The key nutrient policies (related to nitrogen and dissolved reactive phosphorous or DRP) were introduced late into the proposals and this prevented detailed impact analysis being done prior to consultation. A detailed assessment of the administrative impact on regional councils had also not been done. These latter two factors led some submitters to complain that they could not assess the proposals, or provide informed feedback, because insufficient impact assessment information had been provided.

The need for an environmental and economic impact assessment of the nutrient policies was particularly important as estimates provided by DairyNZ suggested the cost to the dairy sector upon full compliance could be in the billions of dollars a year. Given this feedback, it was important to arrive at monetised estimates of the impact of the nutrient policies, in particular, on the agricultural sector prior to making final decisions.

In May 2020, final decisions on the Action for healthy waterways proposals were made (the 'final package'). The final package departed from the proposals in several key areas including nutrient bottom lines and stock exclusion.

All the impact analysis undertaken before and after September 2019 considered the *marginal* impact of the proposals and the final package – the additional impact that are beyond existing policies when those are fully complied with. This is important because the current (2017) National Policy Statement Freshwater Management (2017 NPS-FM) is yet to be reflected in regional council plans. The 2017 NPS-FM is expected to require significant reductions in pollution, from both urban and rural land uses, bringing sizeable benefits and costs. However, because the requirements are not yet implemented the likely impacts are yet to be seen. The impacts of the proposals and the final package have been assessed assuming full compliance with the (2017) NPS-FM has been achieved. Only in this way, can the contribution of the proposals and final package be clearly seen.

In addition, new legislation with the objective of reducing greenhouse gas emissions was passed early in 2020. The long-term implications of this legislation are likely to include a change in land use from agriculture to forestry on erosion-prone land. This changing context meant the costs and benefits of the sediment bottom line policy, while able to be identified and monetised, could not be confidently described as marginal contributions. Hence, unlike other components of the proposals and final package the estimated impacts of the sediment bottom line have not been included in reported aggregate 'net benefits' (instead they are reported on a standalone basis).

Impact assessment objectives

Beginning in October 2019, further impact assessment analysis was undertaken. The purpose of this work was to assess the potential impacts of the proposed nutrient bottom lines (analysis not done at that stage) and to review and/or revise estimates of the likely impacts of the other policy elements in light of feedback provided in submissions and by advisory groups. As well, further policy options emerged post-consultation and the impact assessment workstream provided information about the potential impacts of these options.

Reflecting statutory requirements relating to the development of regulations, the impact assessment has aimed to provide both monetised estimates of benefits and costs where possible, and qualitative assessments of likely impacts otherwise.

The key objectives of the work initiated in October 2019 were therefore to:

- provide monetised estimates of costs and benefits where possible, but not to be constrained to report *only* monetised impacts
- provide estimates of the likely impacts of nutrient limits (nitrogen and phosphorous) and, in particular, arriving at monetised estimates of the costs of these policies to the agricultural sector
- review impact assessments done prior to October 2019, referring to feedback provided by submitters and others.

In many areas, there were significant data limitations, and in particular a lack of publicly available data about farm-level nutrient losses, farm management practices and farm finances for different types of farms. Hence, the above objectives were to be achieved subject to data availability.

The data availability issue highlights the importance and value of considering non-quantified, qualified impacts as well as monetised impacts when appraising policies. If reliance was placed entirely on monetised impacts, important benefits and costs would be overlooked when decisions are made.

High-level findings

Benefits and costs were estimated for both the initial proposals and the final package presented to Cabinet. The latter omitted the phosphorous bottom line, achieved nitrogen-related objectives through more stringent toxicity requirements rather than the proposed nitrogen bottom line, and eased the stock exclusion policy. These amendments were judged to reduce the estimated costs of the policy without forfeiting key environmental gains (for example, the post-consultation review determined that the DRP bottom line was unlikely to achieve its objectives yet introduced significant costs to the agricultural sector).

Monetised estimates could be provided for some but not all benefits (swimming-related human health, water clarity, ecosystem health, and wetland ecosystem services) and for some but not all costs (impacts on farm profits and administrative costs for regional councils).

Benefits that could only be assessed qualitatively included the value of giving effect to cultural values, enhanced recreational opportunities and avoided risks due to nitrogen toxicity of water aquifers. While some estimates were provided for preserving the economic value of New Zealand's 'green premium', uncertainty about the value meant this item was not included in aggregate monetised benefits. These are all considered to be very important benefits from the package.

Costs that could not be monetised included the opportunity cost of slowing the intensification of agriculture, the impact on the value of new housing developments in Greenfield sites and the opportunity cost of the moratorium on wetlands.

The monetised benefits were estimated to exceed the monetised costs by approximately $190 million a year (in current dollars). In addition, the non-monetised benefits were considered to outweigh the non-monetised costs.[1]

Analysis of costs attributable to nutrient bottom lines

A key area of analysis related to the economic impact of the nutrient bottom lines.

A multi-agency governance group was established to oversee this analysis. It consisted of officials from the Ministry for the Environment, Ministry for Primary Industries and the New Zealand Treasury. A technical working group with representatives from the same agencies undertook responsibility for technical matters and reported to the governance group. Key decisions for the impact assessment were made at the governance group level with advice from the technical working group – for example, the use of a three per cent discount rate for reporting (with ranges used for sensitivity analysis) and assumptions about technology change. These decisions were taken as inputs for the economic modelling.

The approach taken in the analysis was, as a first step, to estimate the extent to which nutrient pollution loads would need to reduce (for example, nitrogen losses measured as kg per hectare per year). This was done for each sea-draining catchment in New Zealand, with the analysis undertaken by NIWA. The analysis distinguished between the pollution load reductions that will need to occur for catchments to comply with the (2017) NPS-FM, as well as the proposals (or final package), thus enabling marginal impacts to be assessed.

The environmental modelling was a static analysis. In other words, a simple before and after comparison assuming full compliance was assumed. Static analysis was necessary because it was not possible to identify the rate of soil transfer of nutrients and of water quality improvement for each individual catchment, or to generate a 'no policy' forecast for pollution loads in the future, which could be used as a baseline for comparison purposes.

The use of static analysis was continued into the economic impact work.

---

[1] Assessments of the net benefits of the individual components of the package are available on the Ministry for the Environment's website at http://www.mfe.govt.nz/action-for-healthy-waterways.

The second step was to create core data sets. This data related to:

- the spatial location of different farm or land use types
- the climate and terrain characteristics of these spatial locations
- the effectiveness of different categories of on-farm actions at reducing pollution loads, for different land use types
- the costs of different on-farm actions
- profits from different land uses.

While data like this is collected in surveys administered by industry groups DairyNZ and Beef and Lamb New Zealand, in the case of DairyNZ, the data is self-reported, and in both cases the data has the status of private intellectual property. Industry-owned data was not available to officials for the purpose of the impact assessment.

Three consulting firms were contracted to work towards developing these data sets. Sapere and Resource Economics were contracted to undertake an economic impact assessment more generally, whilst agricultural consulting firm, Perrin Ag, was engaged to provide mitigation cost advice. As well, advice was provided by Professor Richard McDowell from AgResearch, who was a member of the Freshwater Leader's advisory group, and Manaaki Whenua Landcare Research. Manaaki Whenua Landcare Research also provided an in-depth impact assessment of the sediment proposals.

Combining publicly available data on land use with NIWA's assumptions, Sapere generated estimates of the spatial location of different types of farms. These farm 'typologies' were distinguished by sector (dairy versus sheep and beef), slope, drainage, climate and whether or not irrigation was used.

Professor McDowell provided advice regarding the likely efficiency of different on-farm actions aimed at reducing nutrient pollution, for different types of farms. This was supplemented by information provided in a report published by the Ministry for Primary Industries in 2017 and prepared by Landcare Research, Motu Economic and Public Policy Research and NIWA.[2] Agricultural advisors Perrin Ag Consultants provided estimates of the costs of different types of on-farm actions. This was supplemented by a horticulture-focused survey prepared by Sapere.

Ultimately, various information sources were combined to arrive at efficiency and cost estimates deemed to be representative of the range of options likely to be available to farms in the coming 30 years (full compliance is assumed to occur in 2050). Data limitations meant it was necessary to rely on assumptions about an 'average' farm. This meant the impact analysis itself produced generalised estimates – the analysis could not capture differences between individual farms within a typology (for dairy, or sheep and beef) or sector (for horticulture, or arable). This limited the ability to carry out sensitivity analysis but did not undermine the overall conclusions.

While the efficiency and cost estimates were based in particular mitigations, they should be interpreted as efficiency-cost combinations likely to be available to the associated type of farm through time. They should not to be interpreted as applying only to the actions used

[2] Ministry for Primary Industries (2017) *Modelling the potential impact of New Zealand's freshwater reforms on land-based Greenhouse Gas emissions.* MPI Technical Paper No. 2017/22. Cost estimates in this report were updated by officials for the purpose of the impact work to 2019 values using the GDP deflator.

to estimate those values today. The nitrogen mitigation 'bundles' M1, M2 and M3 are distinguished by capital intensity, for example, with M1 reflecting on-farm actions that require little if any capital expenditure. Efficiency and cost estimates associated with M1 reflect what is deemed likely for low capital expenditure options (for a given type of farm) going forward in time. The estimates are not limited to the specific actions used to calculate those values today. Ongoing innovation is to be expected and what constitutes a 'low cap ex' bundle will change through time. However, the relative efficiency and cost of M1 relative to M2 and M3 is expected to remain the same.[3]

Given the challenges presented by data limitations, assumptions about mitigation efficiencies and costs were discussed between officials and consultants and ultimately decided by the cross-agency technical working group. Before making final decisions, the technical working group hosted a workshop, with attendance from officials, Sapere and Resource Economics.

As well as absolute impacts, of key interest were likely regional differences in impact, the relative impact on sectors, identifying what role if any land-use change might play and the relative impact of different policy settings.

The third step was to translate NIWA's estimates of pollution reductions into estimated (and monetised) farm profit impacts using the agreed assumptions about mitigation efficiencies and costs. The focus of the reports provided by the consultants reflects the timing of their work. Sapere's reports focus on the proposals, as published in October 2019, whilst Resource Economics reported on both the initial proposals and the final package.

The conclusions from this analysis reflected closely the findings from environmental modelling, namely considerable reductions in nitrogen pollution loads are likely to occur as a result of the 2017 NPS-FM, bringing sizeable costs. Very small reductions in pollution, in addition, are due to the package (meaning very little further new costs). Quite large additional reductions would have occurred had the initial proposals for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorous (DRP) been enacted. The marginal impact of the nitrogen toxicity bottom line in the final package was an annual reduction in farm profits of $30 million per annum (once full compliance is achieved).[4]

The close relationship between the marginal pollution load reductions and marginal impacts on farm profits is illustrated in figure 1 below. Figure 1 shows the marginal impact of three nitrogen-related policies – the 2017 NPS-FM, the final package toxicity policy (defined as a DIN bottom line of 2.4 mg per litre) and the initial proposal (a DIN bottom line of 1.0 mg per litre).

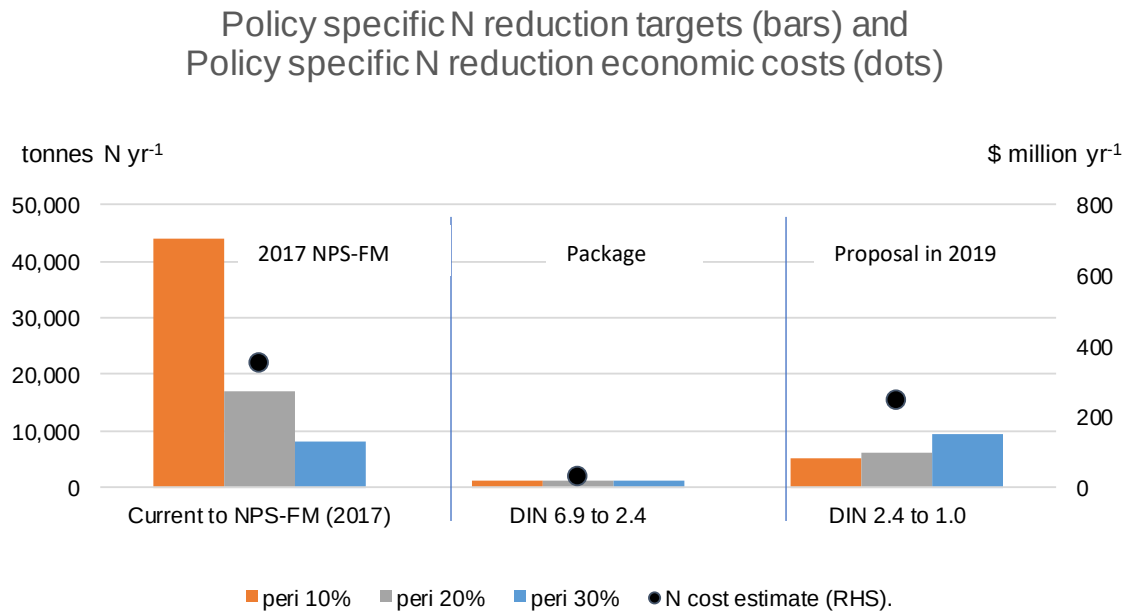
Each policy is represented by three bars, each bar representing a variation of council risk aversion. '10 per cent peri" refers to the case where councils are assumed to accept that any randomly selected point in a stream or river may exceed the 2017 NPS-FM periphyton bottom line (ie, the standard may be breached) 10 per cent of the time. '20 per cent peri" refers to acceptance of the 2017 NPS-FM standard being breached 20 per cent of the time. '30

[3] In practice, when calculating the PV of the nutrient bottom lines, technology change was assumed to reduce the absolute costs of M1, M2 and M3 through time as well, with technology gains of 1.75 per cent per annum for the base case.

[4] The impact analysis estimated the cost of achieving the nitrogen reductions implied by the 2017 NPS-FM as $355 million per annum (if the phosphorous reductions are included the estimate increases to $394 million per annum). This is higher than the estimated impact reported in 2017 when the 2017 NPS-FM was released. New data and methodological improvements have occurred since 2017.

per cent peri' refers to acceptance of the standard being breached 30 per cent of the time.[5] The central cost estimates were based on an assumption of tolerance of a 20 per cent failure rate (hence the results are plotted above the '20 per cent peri' bar).The data in figure 1 was drawn from NIWA's environmental modelling (nitrogen load reductions) and Resource Economics' impact analysis (cost estimates).

Figure 1: Marginal impact of three nitrogen-related policies



The overall finding that the package has a very low cost differs from the reported findings of DairyNZ, provided in its submission, and from the subsequent modelling results it provided. The explanation for this appears to lie largely with assumptions DairyNZ makes regarding the 2017 NPS-FM. In its view, the 2017 NPS-FM implies minimal change in pollution loads going forward. Hence, to achieve the package nitrogen bottom line, most (or all) of the change required is attributed to the package. This means DairyNZ attributes, in effect, the marginal nitrogen pollution load reductions in the left panel of figure 1, and those in the middle panel, to the package. If, in addition, DairyNZ assumes councils are very risk averse, the estimated cost of achieving a given bottom line would be higher than otherwise.

DairyNZ has described where it envisages differences arising:

> We note that MfE [Ministry for the Environment] have applied a modelling approach to assess where the existing (2014) NPS national bottom line is being met or not, and subsequently the impact of DIN after periphyton has been accounted for. This model significantly over-predicts the proportion of sites that exceed the periphyton bottom line (by a factor of around 8) when compared to actual regional council monitoring data from all sites nationally (model assumes 62 per cent of sites exceed, actual data from the same sites shows only 8 per cent exceed). DairyNZ therefore believe the model is not fit for purpose to assess the impact of the existing NPS.
>
> DairyNZ believes the difference in economic results is likely due to the application of this uncertain periphyton model, which overestimates the impact of the old NPS, and

[5] This is discussed further in Ministry for the Environment. 2020. *Action for healthy waterways: Summary of modelling to inform environmental impact assessment of nutrient proposals.* Wellington: Ministry for the Environment.

underestimates the impact of the new DIN or nitrate protection scenarios. (Letter from DairyNZ to Ministry for Primary Industries and Ministry for the Environment 14 May 2020)

The modelling approach applied by NIWA and relied on by officials has been peer-reviewed and found to be appropriate.

In addition to differences with respect to the 2107 NPS-FM DairyNZ's modelling results were based on a stock exclusion policy which goes beyond the package: (Dairy NZ assumed existing non-compliant fences would have to be moved, small streams would have to be fenced and a setback of five metres would be required, not three metres); a nitrogen leaching cap for the worst 25 per cent of farms (a policy that was proposed but is not part of the final package); and whole farm plan costs which exceed those assumed by officials.

A further difference relates to new income from land-use change. Unlike the modelling done by Resource Economics, DairyNZ's modelling did not include income from land-use change.

Resource Economics' and Sapere's reports highlight differences in regional impacts. The region found to be most likely to be impacted by the nitrogen proposals is Canterbury, incurring $25 million of the $30 million nationwide impact estimated by Resource Economics.

The profit impacts, and land-use changes, estimated by Resource Economics for nutrient bottom lines, were combined with cost impacts estimated for farm plans and stock exclusion and provided to NZIER who applied them as 'policy shocks' within their regional computable general equilibrium ('CGE') model. The NZIER's CGE model results showed very small nationwide impacts as a result of these three policies. The marginal impact of the freshwater package on real GDP was reported as a reduction of $193 million or an impact of negative 0.04 per cent by 2050.[6] The results are summarised in table 1.

Table 1 draws on NZIER's table 3 but (unlike NZIER's table) also shows the marginal impact of the package.

Table 1: Major economic indicators

Economic Indicator	2017 NPS-FM by 2050 (per cent)	EFW Package Two (per cent)	Marginal impact of the package (impact of EFW Package Two minus impact of 2017 NPS-FM) (per cent)
Real GDP	–0.17	–0.21	–0.04
Consumption	–0.23	–0.28	–0.05
Investment	–0.08	–0.10	–0.02
Exports	–0.31	–0.37	–0.06
Real wage	–0.17	–0.21	–0.04

Note: Percentage change relative to BAU (except where indicated)

[6] This result is drawn from table 1 in NZIER's report. NZIER reported cumulative impacts so to arrive at the marginal impact of the package (Essential Freshwater Package Two in NZIER's report) it is necessary to deduct the result for 'National Policy Statement' (negative $508 million) from 'Essential Freshwater Package Two' (negative $701 million), arriving at negative $193 million. From table 2 in NZIER's report the marginal impact of the package is -0.04 per cent, this being the difference between -0.21 per cent and -0.17 per cent.

NZIER's modelling also considered the regional impacts of the package. In terms of the per centage change in GDP, the three regions most affected were Southland, Canterbury, and Otago. The results for each region are provided in table 2.

Table 2: Regional economic indicators, marginal contribution of the package, per centage change by 2050

Economic indicator	Consumption	Investment	Exports	Imports	Real GDP	GDP price Index	Nominal GDP	Employment	Real wage
Northland	–0.07	–0.03	–0.08	–0.04	–0.05	0.00	–0.05	–0.01	–0.05
Auckland	0	0.04	0.1	–0.01	0.03	–0.02	0.01	0.03	–0.01
Waikato	–0.04	–0.01	0.01	–0.06	–0.05	0.00	–0.05	0.01	–0.04
Bay of Plenty	–0.01	0.04	0.09	–0.03	0.02	–0.01	0.01	0.02	–0.01
Gisborne	0.01	0.09	0.16	0.02	0.03	0.05	0.08	0.04	–0.01
Hawke's Bay	0.06	0.01	–0.12	0.03	0.01	0.03	0.00	0.02	–0.02
Taranaki	–0.01	0.02	0.01	–0.03	–0.01	0.00	–0.01	0.02	–0.02
Manawatu–Wanganui	–0.08	–0.05	–0.15	–0.07	–0.08	0.02	–0.06	–0.02	–0.05
Wellington	–0.03	0.01	0.09	–0.04	0.01	–0.02	–0.03	0.01	–0.03
Tasman/Nelson	0.02	0.06	–0.09	0.01	0.03	0.01	0.03	0.04	–0.01
Marlborough	0.00	0.05	–0.05	0.00	0.01	0.01	0.03	0.02	–0.02
West Coast	–0.1	–0.07	–0.1	–0.08	–0.11	0.01	–0.09	–0.03	–0.06
Canterbury	–0.21	–0.18	–0.3	–0.14	–0.20	0.01	–0.2	–0.08	–0.11
Otago	–0.16	–0.16	–0.42	–0.13	–0.19	0.04	–0.15	–0.05	–0.09
Southland	–0.25	–0.26	–0.41	–0.15	–0.34	0.09	–0.27	–0.11	–0.14

Source: Marginal calculation based on NZIER's results.

To align with other results from the impact analysis, which themselves were having to comply with requirements of regulatory impact statements, the static analysis undertaken for the nutrient bottom lines was used to generate a present value ('PV') cost. This was done by assuming a gradual transition to full compliance over 30 years, and assuming a three per cent discount rate. The decision to adopt a three per cent discount rate for the PV analysis was taken by the Governance Group (and the rationale is outlined in Resource Economics' report about the cost of the package).[7] Sapere and Resource Economics made their own assumptions about time profiles for transition.

Analysis of the costs likely to be incurred by regional councils

A report on likely council cost impacts of the proposals was commissioned from consulting firm Castalia. Castalia interpreted the brief as comparing future costs with those incurred today, with no allowance being made for how council costs may be impacted by the 2017 NPS-FM. While Castalia provided revisions to its initial report, to try and capture the marginal effect, we

[7] Resource Economics (2020) Essential Freshwater Package: costs analysis. April 2020.

believe there is insufficient consideration of the marginal impacts in the final report. In addition, Castalia's analysis reflected the initial proposals, not the final package.

Hence, when reporting the results from Castalia's analysis, we have reported the sum of the lower bounds of Castalia's itemised estimates. This leads to an annual marginal cost of $76 million per annum, in contrast to the $151 million reported by Castalia.[8]

Analysis of the costs arising from the stock exclusion policy, farm plans and telemetry

The stock exclusion cost estimate is $61 million per annum. This reflects an estimate of the capital expenditure needed to deliver the new fencing implied by the policy, amortised over 25 years using a three per cent interest rate, and the opportunity cost of removing land from production three metres either side of a newly fenced stream.[9] The package does not propose moving existing non-compliant fences. It was estimated that approximately 34,000 km of new fencing would be required. This estimate reflects analysis that combined terrestrial and land-use data with detailed findings from the latest Survey of Rural Decision-makers. Fencing costs and profit data were based on assumptions provided to officials by consultants at AgFirst.[10]

Costs related to developoing a freshwater module in farm plans were based on estimates of the number of farms requiring a freshwater module, existing council requirements related to farm plans and industry bodies' pre-existing intentions regarding voluntary farm plans. Overall, 25,000 new freshwater farm modules were assumed. The combined cost of purchasing and ongoing maintenance of the freshwater module of the farm plan was assumed to be $8,000 per farm spread throughout a decade ($4,000 for the purchase and $4,000 for ongoing maintenance/audit of the plan). Amortising this expense over 10 years assuming a three per cent interest rate led to a cost estimate of $23 million per annum.[11]

Telemetry cost estimates were based on current costs of relevant equipment.

Detailed outlines of the methodology and findings from this analysis can be found on the Ministry for the Environment's website www.mfe.govt.nz/action-for-healthy-waterways.

---

8 Castalia (2020) Administrative Costs of Proposed Essential Freshwater Package on Regional Councils. March 2020.

9 Capital expenditure was estimated at $773.4 million and interest costs, assuming a 3 per cent interest rate, were estimated at $326.9 million. Amortising these expenses over 25 years produces an annual repayment of $44 million. Opportunity costs of land lost to production were estimated at $17.7 million per annum. The present value of an annual flow of $61.7 million ($44 million plus $17.7 million), from 2023 to 2050, was estimated to be $1,092 million.

10 AgFirst (2019) Modelling of mitigation strategies on farm profitability testing Ag package regulations on farm. Sep 2019. link The authors relied on a 2016 study from the Ministry of Primary Industries (National Stock Exclusion Study – analysis of the costs and benefits of excluding stock from New Zealand waterways link).

11 For the purposes of estimating a present value (PV) for the farm plan policy, the marginal impact of the policy was assumed to be bringing forward by ten years effective water modules (industry farm plans initiatives were assumed to be fully operational and effective by 2035). This led to a PV cost estimate of $253 million.

References

AgFirst. 2019. *Modelling of mitigation strategies on farm profitability: Testing Ag package regulations on farm*. Prepared for the Ministry for Environment by AgFirst Waikato Ltd. Wellington: Ministry for the Environment. Retrieved from www.mfe.govt.nz/sites/default/files/media/Fresh per cent20water/modelling-mitigation-strategies-on-farm-profitability.pdf (28 May 2020).

Castalia. 2020. Administrative Costs of Proposed Essential Freshwater Package on Regional Councils. March. Prepared for the Ministry for Environment by Castalia Ltd. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/administrative-costs-of-proposed-essential-freshwater-package-regional (28 May 2020).

Ministry for the Environment. 2020. *Action for healthy waterways: Summary of modelling to inform environmental impact assessment of nutrient proposals*. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/summary-of-modelling-inform-environmental-impact-assessment-of-nutrient (28 May 2020).

Ministry for Primary Industries. 2016. *National Stock Exclusion Study: Analysis of the costs and benefits of excluding stock from New Zealand waterways July 2016*. Wellington: Ministry for Primary Industries. Retrieved from www.mpi.govt.nz/dmsdocument/16513/direct (28 May 2020).

Ministry for Primary Industries. 2017. *Modelling the potential impact of New Zealand's freshwater reforms on land-based Greenhouse Gas emissions*. Ministry for Primary Industries Technical Paper No. 2017/22. Wellington: Ministry for Primary Industries.

NZIER. 2020. *The economic effects of water quality proposals, modelling scenarios.* Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/economic-effects-of-water-quality-proposals-modelling-scenarios (28 May 2020).

Perrin Ag Consultants. 2020. *Estimated on-farm economic impacts of selected mitigation options.* March 2020. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/estimated-farm-economic-impacts-of-selected-mitigation-options (March 2020).

Resource Economics. 2020a. *Essential Freshwater Package: Benefits analysis.* Prepared for the Ministry for Environment by Resource Economics. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/essential-freshwater-package-benefits-analysis (April 2020).

Resource Economics. 2020b. *Essential Freshwater Package: Costs analysis.* Prepared for the Ministry for Environment by Resource Economics. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/essential-freshwater-package-costs-analysis (April 2020).

Sapere. 2020. *Essential Freshwater Regulations – Industry Impact Analysis.* Authors David Graham, William Li and David Moore. Prepared for the Ministry for Environment by Sapere. Wellington: Ministry for the Environment. Retrieved from https://www.mfe.govt.nz/publications/fresh-water/essential-freshwater-regulations-industry-impact-analysis (May 2020).