Waimea Dam Economic Assessment

Review and update of economic impact assessment of Waimea Community Dam

NZIER report to Nelson Economic Development Agency

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The assistance of all those who gave their time and information to assist this analysis is gratefully acknowledged.

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Key points

Objective of study

This report reviews and updates economic assessments of the Waimea Community Dam, proposed for the Lee Valley south of Richmond. The dam would provide storage of about 13 million cubic metres, sufficient to meet unrestricted demand and enhanced environmental minimum flows in drought conditions in the Waimea river.

This update has been prompted in part by Tasman District Council's (TDC) Plan Changes 45-48, which change future water availability and hence the outlook for the regional economy.

Previous studies provide a solid framework on which our report builds

Previous economic assessment reports reviewed in this report are:

- Financial and economic assessment of water augmentation in the Waimea catchment, by Northington Partners January 2010
- Waimea Community Dam Economic Impact Analysis, by John Cook & Associates and Northington Partners, June 2011.

After detailed examination of these reports and consulting some of those affected by the proposed dam, we find:

- The framework of the previous reports in examining avoided costs of non-augmentation, the benefits to existing irrigated area and to newly irrigated area is broadly appropriate, although some details appear debatable
- The previous reports are not transparent on how they calculated their numbers, and it is not possible to replicate what was done then to confirm the calculations as a basis for updating.

We refine and update the analysis in those reports, providing a cost benefit analysis to estimate the broad worth of the dam in enabling benefits in excess of its costs, and linking this to a computable general equilibrium model of the Nelson-Tasman economy to show the economic stimulus and flow on effects in the economy provided by the dam.

Cost-benefit analysis shows the dam would deliver large net benefits

The cost benefit analysis suggests the dam is likely to provide substantial net benefits, despite recent increases in the estimated costs of the dam. This is based on the assumption of no continuation of the status quo after 2015: in the absence of the dam, reliability of access to water will be severely reduced after all water permits are reviewed as they come up for renewal from 2015, resulting in reduction in total allocation, and there will continue to be sporadic short term rationing cuts, likely to be (on recent experience) 20% of allocation for some days in every year and 50% allocation rationing on some days in most years. Such effects on availability would be almost entirely eliminated by the storage provided by the Waimea Dam.

The duration and frequency of rationing cuts is uncertain so we do not quantify it in our analysis, which is based on assumption that the non-augmentation scenario without the dam would see overall reductions in water availability, which we represent with reductions of 20% and 35% from the current levels. Our central estimate of net benefits of the dam in the event of water allocation restrictions equivalent to a 20% cut in availability is a present value of about $257 million over 25 years (discounted at 8%) or $168 million after deduction of tax. Virtually all of this stems from the dam's ability to avoid the cut-backs in primary production and in providing greater security of water availability to give growers confidence to invest in improving irrigated production both on existing and on new irrigated area.

If there is a 35% reduction in water availability the corresponding figures for net benefits of the dam are larger, with present value over 25 years of $318 million without deducting tax, or $212 million after removing tax.

This is a social cost benefit analysis of effects across the community at large rather than a model of financial viability, and growers will need to do their own private financial analysis to see what works for their particular circumstances. But the analysis suggests the benefits and margins are sufficiently large to more than cover the cost of the dam and resulting land use changes.

The benefits are large enough to be robust to substantial changes in assumptions used: net benefits would still occur if all the base assumptions that drive the benefits were halved, or if the uptake of new irrigation and production gains was much less than the 80% assumed. Actual uptake would depend on private costs and benefits for each grower, which are not analysed here.

We use a more robust model of the regional economy to estimate flow-on effects

Our general equilibrium modelling also shows there are substantial flow-on effects beyond the primary production sectors for the Nelson-Tasman regional economy. Our central estimate based on water allocation cuts equivalent to 20% reduction in availability suggest that the dam construction, avoidance of non-augmentation costs and realisation of augmentation production gains would have an impact on the Nelson-Tasman economy with a present value[1] of $405 million over 25 years (discounted at 8%) and an indirect flow-on effect for processing industries and other sectors either supplying or using the outputs enabled by the dam of a further $186 million in present value terms. The total impact on regional GDP would be $591 million in present value terms.

If availability is reduced by 35%, avoiding those cuts would have benefits in the form of contribution to regional GDP of $482 million on direct primary production, and $260 million on indirect flow-on effects on primary processing sectors and other industries that either supply services to or receive income from the enhanced primary production. The total impact on regional GDP would be $742 million in present value terms.

Our results are higher than in the previous reports, due to some changes in assumptions and the difference in modelling technique which has more comprehensive coverage of all sectors in the regional economy. In particular the costs of non-augmentation in the previous reports appear to have been lower than under the water cut assumptions used here to represent the scale of impact of recent rules changes for general allocation and short term rationing. Our modelling

[1] Present values calculated over 25 years with 8% discount rate.

allows for resource constraints, price changes and resource reallocation in the economy which tend to dampen its results for overall impact of any stimulus to economic activity, compared to the results obtained from unconstrained multipliers such as those used in the 2011 reports.

While our regional impact results are higher than those in previous reports, the modelling used to obtain them is more robust for decision-making purposes.

Our modelling is undertaken at a high level and should be viewed as a broad indication of potential net worth rather than a precise forecast of what will eventuate. It builds on the previous reports' approach to identifying demands in terms of irrigated area equivalents, and estimating potential gains from new irrigated area for different crops, although with some modification that sees less potential for expanding grape production than in the 2011 report. It also uses updated information from available statistics and advice received and information provided from those consulted about production characteristics within the region.

Changes in market conditions and individual growers' circumstances could result in a different pattern of development after the dam than that portrayed here. But on our central estimates the avoidance of non-augmentation costs alone could cover the cost of the dam, so the net beneficial result could accommodate variation in timing and mix of new irrigation-induced production.

Further analysis is required on the charging regime

The main obstacle to the project going ahead is not in its economic worth but in the economic viability for those who stand to gain from the dam. The present proposal to charge a flat rate per hectare irrigated is administratively simple but produces high costs relative to the margins of some current land uses, which may deter some from realising the value of improved water reliability.

Contents

Appendices

Figures

Tables

1. Introduction

This report provides a review and update of economic assessments of the Waimea Community Dam, proposed for the Lee Valley south of Richmond. The dam would provide storage of about 13 million cubic metres, sufficient to meet unrestricted demand and enhanced environmental minimum flows in drought conditions in the Waimea river.

In approaching this review of the Waimea Dam economic analysis we aim to provide an update of the analysis

- That is robust and reliably represents the economic effects of the dam compared to the situation without it
- That will stand up to scrutiny and will engender support among those who will ultimately pay for the dam
- That gives you confidence for making investment decisions.

Previous economic assessment reports reviewed in this report are:

- Financial and economic assessment of water augmentation in the Waimea catchment, by Northington Partners, January 2010
- Waimea Community Dam Economic Impact Analysis, by John Cook & Associates and Northington Partners, June 2011.

Since these reports were prepared the Tasman District (TDC) Council's proposed regional plan changes have been examined in a Commissioners' hearing, with new recommendations of the minimum flows to be provided for sustainable management of water in the regional plan for the Waimea River. Enacting these recommendations would change the availability of water for current users and restrict the ability to provide for future growth in urban and industrial uses and in irrigated agricultural production.

To implement these recommendations TDC has adopted Plan Changes 45-48 regarding Waimea Water Management and Water Augmentation, to replace the interim provisions that had been in place since droughts in the early 2000s. These changes provide for future rural, urban, industrial and environmental purposes, in the event of no dam being built, by:

- Reducing all allocations to irrigation from 2015 in line with each user's previous use, or standard allocations for specific soil types or specific crops
- Implementing new rationing trigger levels and allocation cuts required in the event of drought episodes of different severity
- Placing restrictions on the types of activity that can be allocated new water.

These changes to the notified and interim plan provisions are a principal difference from the situation that prevailed in 2010-2011 when previous economic assessments were undertaken, and form a key part of the context in which the updated analysis will be conducted.

1.1. Changes in the water allocation environment

New rules for water allocation and cuts under Plan Changes 45-48 in February 2014 have superseded the interim measures and raised the river flow thresholds that trigger the cuts in allocation compared to the previous notified levels. These provide for different measures with and without the security provided by the Lee Valley Dam.

Existing water permits will be reviewed when they come up for expiry in 2016 and 2017, and new allocations that can be granted would be *the lower of* **actual water use** as monitored between 2003-2013 or a **standard rate per soil type** or a **standard rate by crop type**. Without the Lee Valley dam, from 1 July 2015 successively deeper rationing cuts (relative to the no cut level) will be triggered as river flows pass lower thresholds, with 70% cuts when flows at the Appleby Bridge in the Lower Waimea are at or below 800 litres per second.

The Waimea Community Dam in the Lee Valley has been designed with a capacity to meet foreseeable demands without rationing cuts up to a one in 60 year drought, and could with management provide security against even more severe droughts. It has sufficient storage capacity to eliminate rationing cuts in all but the most severe and infrequent droughts; to provide for demands for water from growth in irrigated agricultural and horticultural activity and in the urban and industrial activity in both Tasman District and Nelson City; and also to enable the minimum environmental flow in the Waimea River system (including the Lee and Wimea rivers) to be raised from 800 l/s to 1100 l/s at Appleby Bridge in the lower Waimea River.

A critical question is how, given their likely frequency and duration, cuts of these magnitudes in the absence of the dam would affect the productivity of existing irrigated areas, prospects for new irrigated area, and the mix of enterprises across the Waimea catchment. This is primarily an issue for agronomists and farm managers to assess the impact of water shortages on different crops at different times, on a property by property basis that is beyond the scope of this current report. But we use comments from growers about their use of water to adjust the assessments in the previous reports that were informed by farm consultants.

The effect of these changes is that after 2015 all allocations will be reduced from their current level, and that in the absence of the dam, rural water users can expect to face 20% rationing cuts for some days in all years, and 50% rationing cuts for some days in most years. This means non-augmentation will result in costs, risks and lost production compared to the current situation, and that the status quo will not continue unchanged in the absence of the dam.

1.2. Scope of analysis

1.2.1. Terms of reference

We were asked to: provide a review and update of the Cook and Northington 2011 economic impact analysis, with particular focus on vegetable growing (omitted in the previous study), the non-augmentation scenario and costs of doing nothing in light of recent planning decisions on water use, hydro generation, additional land use and impacts on TDC water supply to industrial and residential users.

We approach this with an analysis in two stages:

- A cost-benefit analysis to estimate the value of benefits over costs over a prolonged period, similar to an investment appraisal for the project
- An analysis of economic impact on the regional economy, identifying the project's direct production and indirect flow-on effects across the region.

1.2.2. Different treatment of taxation

The scope of 2011 report differs from what is commonly encountered in economic impact analyses and cost benefit analysis, as it includes estimation of potential tax benefits from enhanced irrigated production, including income tax on increased primary production, processing and hydro generation, and wine excise tax.

The three income taxes are direct taxes on the earnings of private entities, basically claims on the increased profits or earnings from the enhanced irrigated production. Given the complexity of taxation and allowable deductibles it is simpler to measure the gross value added from enhanced irrigation, as in a national economic analysis it makes little difference whether value ultimately accrues to the nation's citizens or its government as tax collector.

From a regional perspective it can be argued that tax should be accounted for, as it detracts from local incomes and the spending generated elsewhere in the local economy. In that case, however, tax is not a local/regional benefit but a deduction or leakage from the local economy.

We model economic impacts without accounting for direct taxes, but do a side estimate of potential tax on the net surplus of primary production in the cost benefit analysis, which approximates to an after-tax return on the investment. Indirect taxes embedded in market prices are included in the economic impact analysis results.

2. Review of previous reports

The 2010 report by Northington Partners was a combined financial and economic analysis primarily aimed at establishing the feasibility of the proposed dam as a private investment. It examined the capital cost of the water augmentation scheme (dam and associated works) and the annual charge per "hectare equivalent" of irrigation required to be recovered from different users likely to join the scheme.

It also examined the costs and benefits of scheme participation from the perspective of irrigation users, as this will be influential on uptake rate which would be critical for the financing of the scheme on a user pays basis. The report also considered the wider regional impacts of not proceeding with the scheme, in terms of lost production of currently irrigated area from cuts in allocation of water, and the opportunity cost of forgoing the development of new irrigated areas.

The report by John Cook and Northington Partners (2011) built on the 2010 report to present an economic impact analysis that estimated both impacts on regional economic activity as measured by contribution to GDP, and a calculation of the net present value of the regional impacts over a 25 year period. The discount rate for general economic impacts is not explicitly stated, although there are two used elsewhere in the report: 7.2% as TDC's cost of capital in building the dam, and a real rate of 5.5% applied to the electricity generation add-on.

While both reports contain useful information on the costs of water augmentation and the farm level impacts, the 2011 report is the more comprehensive economic report in identifying impacts on the region and the scheme's net worth, and details of assumptions used in sector estimates and sensitivity tests. Our review comments are directed mostly at this report and fall into two categories: comments about the **framework** for considering the costs and benefits of the dam, and comments about the **specific assumptions** and calculations in the analysis.

2.1. Framework of previous reports

Both reports define the total economic benefits of the Waimea Dam in terms of:

- Increased production and processing of primary produce, from improved reliability of water which enables
  - Productivity improvements on existing irrigated area
  - Conversion to more intensive water-using land uses in new irrigated areas
- Avoidance of non-augmentation costs, estimated as the opportunity cost of current production that would be lost without the dam due to new water allocation and rationing restrictions
- The bonus of hydro-generation when water is released from the dam.

This is an appropriate coverage of the main categories of benefit. However the ordering of this benefits list, focusing first on increased production from existing or new irrigation, then considering the opportunity cost of non-augmentation and then the bonus of add-on hydro generation, implies the counterfactual "without dam" situation is the status quo. But amendments in Plan Changes 45-48 make the status quo unsustainable, so the counterfactual faced if the Waimea catchment is to meet the new environmental flow requirements is the non-augmentation outcome, with reduction in output from existing irrigated land use and no provision for growth in either irrigation or urban/industrial use. While it might appear a minor change, the context for the dam assessment could be alternatively approached as:

- The current state of economic activity and production in the catchment
- The future state of economic activity and production in meeting the plan change allocation cuts and rationing triggers without water augmentation, which is the "do nothing" counterfactual against which to assess the dam
- The future state of economic activity and production with water augmentation, avoiding costs of non-augmentation and realising enhanced value from increased production and processing from existing areas.

Defining the with/without comparisons raises questions about whether the assessments of adequacy of water for irrigation in the earlier reports are still appropriate with the new Plan Changes 45-48. The 2011 report cites a GNS estimate that meeting a potentially 70% cut in current water allocations would reduce the current irrigated area from 3,800 ha to a manageable 705 ha, implying a need to shift to less intensive land uses and likely some loss of value recovery from stranded irrigation assets. This is an approximately 80% reduction in irrigated area, based on the assumption that all cuts would be borne by irrigation demand so as to maintain water at current levels for urban and industrial uses through TDC's Waimea Water Supply Scheme.

Table 1 summarises the water availabilities in equivalent irrigated hectares. At present the Waimea Catchment has 3,800 hectares of existing irrigation and 620 hectares equivalent going to existing urban and industrial use, totalling 4,420 hectares. A 70% across the board cut would reduce the irrigated hectares to 1,325, with 705 ha for irrigation and 620 for urban and industrial use. But the Waimea dam has been designed to enable 7,765 hectare equivalents, including 2,050 hectares of new irrigated area, 780 hectare equivalents for future urban and industrial growth in TDC and 515 hectare equivalents provided for future regional growth in Nelson City.

Table 1 Availability of water for irrigated area equivalents

	Gross area	Area Equiv.	With 70% cut
	Hectares	*Hectares*	*Hectares*
Existing irrigation - Waimea	3,800	3,800	705
Potential new irrigation - Waimea	1,500	1,500	
Potential new irrigation - Wai-iti	300	300	
Potential new irrigation - other	250	250	
Existing TDC Urban & Industrial		620	620
Allowance for future TDC use		780	
Allowance for future regional use		515	
	5,850	7,765	1,325

Source: Northington Report 2010, p3

The outcome under the 70% cut would be substantially reduced compared to both the current situation and what might be with the supply augmented by the Waimea Dam. Land removed from irrigation is assumed to revert to dryland pasture production. The current water allocation and rationing rules do not require 70% cuts across the board in all years, and the previous reports use such drastic cuts as a worst case scenario, with the average annual cut based at some point along a linear interpolation between the worst case and the current level.

The previous reports represent the reductions in water reliability without the dam by reduced irrigated area, and potential benefit of the dam by increased area, yield per area and value. Reduced water security could also change the mix of crops in the region, with further impacts on processing and other industries. Table 2 shows the potential increase in irrigated area from the two previous reports, and compares this with the without-dam situation under 70% cuts, assuming pro rata reductions in equivalent hectares across each crop type. This table indicates substantial increases in some land uses with augmentation, in particular a tripling of the area of irrigated berryfruit and doubling of the area of kiwifruit over current irrigated areas.

Table 2 Potential increase in irrigated area

Irrigated Hectares	***2008 base ha***	***New with dam ha***	**Area increase**	***Without dam ha***
Pasture	1450	300	21%	269
Apples	1650	860	52%	306
Kiwifruit	80	90	113%	15
Grapes	550	400	73%	102
Berries	70	150	214%	13
	3800	**1800**	**47%**	**705**

Source: Cook & Northngton 2011 Table 1h; from Northington (2010)and Agfirst Land Use data

The results of the 2011 report cost benefit analysis are summarised in Table 3. This shows the contribution of water augmentation to average annual value added or regional GDP, its 25 year GDP and the present value of these benefit streams discounted over 25 years, at a rate not specified.

Table 3 Results of Cook & Northington 2011 Report

Subject of calculation	**Annual GDP** *$m*	**25 year GDP** *$m*	**NPV** *PV$m*
Increased production & processing	66.5	1,187.0	276.8
Cost of non-augmentation	17.5	440.0	63.0
Hydro-generation bonus	5.6	140.0	2.7
Total findings	89.6	1,767.0	342.5

Source: Cook & Northington 2011

2.2. Specific assumptions and results

In presenting results in present value terms, the Cook and Northington (2011) report estimates results of direct output gained from the dam (relative to no-dam alternative), converts these into economic value added terms, and applies economic multipliers from Butcher Associates to estimate the indirect effects of business stimulation flowing on to other sectors. It contains some details about assumptions on current use and response to irrigation of the various sectors, and also results of some sensitivity testing to changes in assumptions.

However, aspects of the calculations in these reports are opaque, and we have not been able to replicate the results in the earlier reports from the information contained in them.

This does not mean the previous reports were wrong but it does leave some aspects in the results which colour the confidence to be placed in them. In particular:

- The present value of the electricity generation add-on, at $2.7m, appears to be over-stated: on the information given in the 2011 report on generator capacity, annual output and wholesale electricity price received, the annual revenue net of costs would be about $0.5 million and discounted over 25 years at 5.5% its present value would be just PV$0.3m. The nine-fold difference in results is not explicable by economic multipliers, which commonly lie in the range of 1.5 to 3 for a sector in a regional economy.
- The non-augmentation costs at PV$63million appear much smaller than the loss of production from a 70% reduction in irrigation water. The loss of farm gate production would have a present value in excess of $300 million discounted over 25 years at a rate of 7.2% and neither converting the figure to value added nor accounting for effects on downstream processing sectors is likely to make this figure as small as $63m.
- While existing reports cover the main irrigated sectors, other water-critical sectors do not figure in the quantified estimates, in particular market gardening, vegetable growing and floriculture. There is also little quantification of industrial uses (except for winemaking) which makes the estimate of value added across the marketing chain obscure.
- Discount rates used in the analysis are not explicit and there appear to be at least two rates used in different parts of the reports – a rate of 7.2% for costs of the dam based on TDC's weighted average cost of capital, and a rate of 5.5% applied to the hydro-generation option.
- The connection between the primary production estimates (which are explained in some detail in the 2011 report), processing value added and conversion to Gross Domestic Product is not explicit, although it is clear that the GDP cited in the results contains the effects of a Type 1 multiplier (i.e. one that looks at the production stimulating effects flowing on from the increased primary production).
- The calculation of wine excise tax on page 13 of the 2011 report appears incorrect in citing excise tax at $260/litre, as current rates are $2.83 per litre of beverage or $20.20 per litre of alcohol. The annual value of excise

stated in the 2011 report does not appear to be due to simple typographical error.[2]

Some other distinctive characteristics of the previous reports are outlined below.

Use of multipliers

The 2011 report uses economic multipliers which are based on input-output modelling of the regional economy. Multiplier coefficients record the relationships between sectors as inferred from inter-industry transactions in an input-output model of the economy. Given an increase in one sector's output (say horticulture) the multiplier will indicate how all other sectors increase their production and consumption in either supplying or using the proceeds of that output increase.

Such input-output models do not allow for any constraints in the economy's inputs, such as land, labour or capital infrastructure. Consequently they are likely to over-state the region-wide effects of a given project. Computable general equilibrium models, such as the one we use for this report, do allow for such constraints: when a project increases demand for inputs that hit one of these constraints, prices rise and inputs are reallocated to those sectors where they are most valuable, leaving other sectors facing higher costs or reduced use of these inputs. The net effect is some business contracts and partially offsets the stimulus gained from the project.

Apart from the general issues with multiplier analysis, their application in the report appears unusual in that (on page 46) they are described as showing direct and indirect downstream effects of increased primary production. Industries have backwards and forwards linkages with other sectors in their production chains, so multiplier impacts act both downstream (on processors) and upstream (on suppliers) of new primary production. If the multipliers are applied as described in the report and only reflect downstream linkages, there is a risk that it understated the contraction that would occur with non-augmentation (notwithstanding the fact that this type of multiplier coefficient will overstate the extent of flow-on impact).

Valuing effects from property values

The 2011 report refers in various places (e.g. section 3.3) to the price of productive land as an indicator of value created by water security. However it is not clear how this affects the calculations or even whether this should be included as an item.

Property prices reflect the capitalised value of future earnings from the property, so dam-related changes in production implicitly drive changes in property values. Including property prices as well as production changes in an analysis could therefore result in double counting. If availability of water increases the potential for a range of different land uses in future, the dam may create an "option value" additional to the actual productive value gain. However, this is usually less than the more immediate increasing value from currently implementable land uses. Simple comparison of current prices with and without access to water is not a robust means of determining the size of this option value.

[2] For example, using the 2011 report's assumptions of 400 ha of new grape growing, 8.5 tonnes of grapes/hectare, and conversion of 640 litres of wine per tonne of grapes, would result in tax at $2.60/litre amounting to $5.8 million a year rather than the 2011 report's $4.6 million – a large difference to be explained by "shrinkage" factors.

Treatment of taxes

The 2011 report includes calculation of taxes, which from a national perspective are transfer payments of no consequence for total value in the economy. In a study of regional impacts there is a rationale for removing taxes paid to central government as these are not available for further spending in the region, but in that case it is erroneous to describe them as "Taxation benefits" from the perspective of the region (as the 2011 report does in section 2.4.1).

The 2011 report ignores GST on grounds that most of the additional horticultural production is destined for export markets and exempt. It calculates national income taxes on the profits generated from potential increased production. It also calculates the excise tax on wine volumes from additional grape production. Excise is an indirect tax that would normally be counted within GDP and it is unclear how it affects the 2011 regional GDP results.

The dam will increase property value and rating capacity but the report rightly ignores rates, as they are collected to meet councils' revenue needs.

2.3. Summary review

In summary the 2010 and 2011 reports provide a workable basis for examining the impacts of the Waimea dam on raising production possibilities and the processing and other economic activity that flow from it. Describing the potential water demand in terms of irrigable area equivalents provides a common metric for the diverse water using activities that would be affected by non-augmentation and the relief and growth opportunities provided by the dam. But some of the calculations appear opaque and the previous reports provide little guidance on the likely effects of the new water regulations introduced this year in the Tasman Resource Management Plan.

As outlined in the next two sections, our analysis adapts the approach of the previous reports, updates input assumptions with reference to published sources and canvassing of growers and industrial water users, and uses the revised information in a cost benefit analysis and an economic impact analysis. We examine the robustness of the results by varying some of the main assumptions, and identify some caveats and limitations on the results.

3. Revised and updated cost benefit analysis

Our updated analysis follows the structure and approach of the previous reports where feasible to do so, without duplicating or replacing background work already done for those reports. But it deviates from previous work where new information has come to light about the implications of the dam.

This section provides a revised cost benefit analysis to appraise the dam as an investment for the regional community of water users. Section 4 provides an impact analysis of the flow on effects to other sectors from the stimulus provided by the dam's installation and subsequent operation. The cost benefit analysis in particular has been informed by consultation with interested parties in the Tasman District.

The basic parameters of the cost benefit analysis are:

- The analysis estimates the extent of benefits net of costs obtained from the dam, compared with a situation in which the dam does not proceed, from the perspective of the Nelson-Tasman community at large
- Analysis covers a 25 year period to cover the initial building and operation of the dam, with costs and benefits projected in constant dollar 2013 terms[3]
- The analysis is discounted at rates of 6% and 8% real per year, to reflect a likely range of opportunity costs of capital for those involved in the project
- The principal analysis is undertaken exclusive of tax, but the effects of income tax removals from the region's production are examined in a subsidiary analysis.

Our choice of discount rate follows the guidance of the Treasury, which uses a default rate of 8% for public sector projects, and of the New Zealand Transport Agency, which uses rates of 4%, 6% and 8% for its infrastructure investment appraisals. This differs from the previous reports which used rates based (as far as can be inferred) on the Weighted Average Cost of Capital (WACC) for the Tasman District Council. The analysis covers effects on private parties as well as the TDC and all parties will have their own individual WACC depending on their own individual circumstances. Hence it is more straightforward to employ a single social discount rate for the whole analysis and leave the affected parties themselves to assess their involvement with their own customised rates.

3.1. Consultation

We have contacted a number of water users and other potential interested parties in the Waimea Dam by email and telephone to assist in this update. In particular these contacts have aimed to:

- Understand water users' responses to the sorts of restrictions and rationing now in place under Plan changes 45-58

[3] We conduct this analysis in terms of 2013 dollar terms in preference to forecasting prices at some future date when the dam is actually built. This simplifies the analysis and removes the risk of forecast distortion.

- Confirm or correct the assumptions on cost structure and growth potentials for irrigated activities in the previous reports, and understand the extent to which the production economics in Tasman District may differ from national or other regional data
- Obtain other views on the dam's potential impact.

Initial contact was made by telephone from a list provided by TDC, and those willing to participate were sent a short questionnaire survey about responses to future water restrictions and the costs used in the previous reports for different land use enterprises.

Those unwilling to participate in the survey were questioned over the phone about some key particularities in the survey. Questionnaires returned were not always filled in completely and were followed up to fill in key gaps.

The consultation involved a small sample and was not intended to provide statistically valid results, rather a sounding board with those familiar with land use in the district.

3.1.1. Horticultural activities

We consulted with a range of horticultural uses in the district. In general they confirmed that the cost structures used in the 2011 report were not much different from what they would expect (allowing for some price change over time) and that the rationing cuts could have significant impact on their productive activities, worse for deeper and more prolonged cuts but bearable for shorter and shallower ones.

All respondents were using substantially less water than their allocated amount on average, but we were unable to ascertain their use of water in the peak summer period when water shortages and rationing are most likely.

One exception was wine growers, who indicated operating costs in Nelson rather higher than those reported by Ministry for Primary Industries (MPI) in Marlborough, and a water use that does not coincide with the summer peak period. They expressed concern at the possible cost recovery for the dam on a cost per irrigated hectare basis, as wine has a low water use per hectare on average as well as in the peak. They also doubted the 2011 report's expectation for 400 hectares of new irrigated grape growing enabled by the dam. As this 400 hectares is greater than MPI estimates of non-irrigated grape growing across the whole of Tasman District (including areas beyond the Waimea catchment) we agree this area looks optimistic and could only be obtained by land being converted to grape growing from other uses at much greater capital cost than in the earlier reports. We have lowered our assumption on new grape area and grape prices compared to the 2011 report.

Another exception was vegetable growers, who were wholly omitted from the quantitative calculations in the earlier reports. This sector is a difficult one to model because of the wide variety of crops and a relatively low proportion of output going to export, but it is a significant source of employment in the District, both permanent and seasonal. Many of these crops are quite sensitive to water shortages at critical times in the growing and harvest cycle, but margins per hectare in these activities are among the lowest of any irrigated land uses in the district, creating concern about the sustainability of these crops if subject to dam charges of $500/hectare or more.

We have adjusted the base assumption of irrigated areas by crop type in the 2011 report (as presented in Table 2 above) to accommodate vegetable production. We do not attempt to model individual vegetable crops in detail, but note from our regional economic model and feedback from consultation that vegetable crops commonly have margins in the range of $800-$1100 per hectare, and select the lower value as a conservative assumption of the value at risk from non-augmentation.

3.1.2. Industrial activities

There are four major industrial activities in Tasman District which are major users of water from TDC's Waimea Water Supply Scheme: the Alliance Meat Works, the Nelson Pine sawmill and MDF plant, ENZA packing facility and Cold Storage Nelson. All have major demands for water in the December-March peak summer period when water flows are at their lowest.

Commercial sensitivities preclude the quantitative modelling of potential impacts on industrial users of water rationing, but all indicate increasing loss of production and operational costs as rationing becomes deeper and of longer duration. Past records of flows below the new rationing trigger points in the Waimea indicate the following frequencies of rationing of use in the WWSS (Table 4).

Table 4 Depths and duration of rationing in the Waimea Water Supply Scheme

Average frequency over the past 14 years

	Total days per year of cuts of this or greater amount[1]	Days/year of cuts of this amount
10% cuts in allocated amount[2]	37.5	4.8
25% cuts in allocated amount[2]	32.7	10.7
50% cuts in allocated amount	22.0	11.4
70% cuts in allocated amount	10.6	10.6

Note [1]: This table shows cumulative and individual figures e.g. there were 22 days when cuts of 50% or deeper occurred (11.4 days of 50% cuts and 10.6 days of 70%).

Note [2]: Rationing cuts to the water supply system at mild levels of shortage are lower than to irrigation, reflecting priority to human consumption purposes

Source: NZIER, drawing on information from TDC

While most of the industries indicate they could limp through the short duration 10% cuts, in moving to 25% costs would more than double and their output would be reduced. Deeper cuts would lead to even larger cost increases and losses.

These industries have some alternatives that would require substantial capital investment – e.g. some might gain relief from seeking water from Nelson City and the MDF plant could install reverse osmosis technology to extract water from wood fibre for use in their processing – but these are costly and not perfect substitutes for reliable reticulated supply. In the extreme, meat for processing or fruit for packing or storage may have to be diverted to facilities in other regions if capacity to handle local produce is restricted, which would involve further costs in transport and product wastage in transit.

Precise rules for how rationing will affect industrial users of water from the WWSS have yet to be issued. All industrial users stress they have a contractual expectation for water supply and that there would be financial penalties on the WWSS for supply interruption. However, those penalties would not fully compensate the industries for their potential losses. Those supplying export customers in particular stress that failure to meet delivery dates would adversely affect their reputation as a reliable supplier, with longer term effects on volumes and prices achieved, in addition to any direct losses caused by immediate delay.

We have no basis for quantifying the impact on industrial users and the WWSS in general (with its priority given to residential supply) at this stage. However, our economic impact modelling does reflect the effect on the industries of changes in agricultural production and the processing throughput. The costs of non-augmentation will be understated because of this lack of quantification.

3.2. Costs

Costs in this analysis fall into two main parts: the cost of building and operating the Dam (and the hydro-electric add-on), which creates a financial liability for whichever entity is going to own and operate the dam; and the opportunity costs on water using activities that are affected by water restrictions under the new arrangements, the avoidance of which form the principal benefits of the dam.

3.2.1. Dam costs

The 2011 report had an estimated cost of $42 million for the installation of the dam, which TDC has since updated by reference to a forecast cost index to $56 million in 2017 when the dam is expected to be built.

Recent announcements from TDC however have placed the cost at closer to $69 million in 2017 to account for costs additional to the original construction estimates, and that total costs would be higher because of work already undertaken on the project. It also indicated that figures of $60 million, $70 million and $80 million in 2017 are likely to be used in public consultation, because of uncertainty around the final price which will not be resolved until firm tenders have been received for its commissioning.

For this analysis we use historic figures in 2013 dollar terms rather than incur additional risk around forecasts around prices at some point in the future.[4] TDC's estimate of $56 million implies an annual average percent change of 4.3% over the 2011 figure, so we back-cast the $60m, $70m and $80m figures at 4.5% per year to arrive at equivalent values in 2013 dollar terms. The results are summarised below.

[4] The inter-industry model at the heart of our Nelson-Tasman regional model is denominated in 2013 dollar terms. Rather than recalibrate all transactions in a more recent or future dollar terms with appropriate deflators, we conduct the analysis in 2013 dollar terms, as if it is being assessed from the end of 2013.

Table 5 Expected costs of Waimea Dam installation

Source	Dam cost	Alternative Medium	Alternative High
Northington	42 million		
TDC (2017)	56 million		
Consultation (2017)	60 million	70 million	80 million
Consultation (2014$)	52.8 million	61.6 million	70.4 million
Consultation (2013$)	**50.6 million**	**59.1 million**	**67.5 million**

Source: NZIER, drawing on information from Northington (2010) and TDC

Work already undertaken on the project is a sunk cost of no significance to a forward looking economic analysis so it is excluded. The 2011 report also assumed $0.4 million a year in operating costs for the dam, which we have updated to $0.45 million using Statistics New Zealand's Producer Price Index for Electricity and Gas supply (which includes hydro plant operation).

With respect to the hydro-electric generation add-on the 2011 report assumed a cost of $4.5 million for installation, which was confirmed in a later assessment commissioned from consultants Parsons Brinkerhoff. Given the low wholesale prices available in recent years due to the weakening of electricity demand (which has caused an overhang of new plant consented but not being built), and the fact that as a water supply reservoir the plant could not be run to optimise its revenue from electricity, generation would be marginal at this cost of installation (see Appendix D.2). However, in consultation we have been informed installation could be achieved at lower cost using different supply sources. Accordingly we assume the hydro add-on could be installed for an up-front cost of $2.5 million, with annual operating costs of $0.145 million (the $0.129 million from the 2011 report updated by the PPI).

3.2.2. Water restrictions

We base our assessment of the impact of new water restrictions on the same approach as used in the 2011 report (see Table 1 and Table 2 above). However, we also need to account for 400 hectares of vegetables and floriculture use (mostly outdoor, but including some glasshouses). We assume the capacity of the dam to service hectare equivalents is the same as in previous reports, so we accommodate the 400 hectares into the 3,800 hectares of current irrigated land by removing a pro rata share from other land uses. The result is summarised below.

Table 6 Revision of water allocation scenarios

Incorporation of vegetables and floriculture into existing irrigated areas

Irrigated Hectares	*Without dam*	*Base areas*	*New with dam*
Pasture	241	1300	400
Apples	275	1480	960
Kiwifruit	13	70	90
Grapes	91	490	200
Berries	11	60	150
Vegetables & floriculture	74	400	
	705	3800	1800

Source: NZIER

As in the previous reports, we assume at the extreme a 70% cut in water availability results in an 80% reduction in irrigated land area to 705 hectares, which we distribute across the land uses on a pro rata basis. For new potential irrigation with the dam, we assume none for vegetables (because margins are so low), and reduced area of potential growth in grapes from 400 in the 2011 report to 200, with the difference spread across irrigated pasture and apples to maintain the 1800 hectares of new irrigated production.

3.3. Benefits

Benefits of the dam consist chiefly of sustaining current irrigated output and enabling new irrigated output under new restrictions on river flows. There will also be an environmental benefit to the extent that the dam enables the minimum environmental flow at Appleby Bridge to be raised to 1100 litres/second from 800 litres/second without the dam. Such benefits are difficult to value and are not part of this analysis.

3.3.1. Avoidable costs of non-augmentation

Without the dam, current production from irrigated areas in the Waimea catchment could not be sustained, so the avoidance of such lost production is a benefit of the dam. We have followed the approach of the previous reports, which identified a maximum loss from a 70% cut in water allocation which reduced irrigated productive areas from 3,800 to 705 hectares, pro-rated across the different land use types.

We assume that Waimea is very unlikely to face a sustained 70% reduction in water availability in any one year. Rather, as in the previous reports, we take the 70% reduction (705 hectares) as a worst case outcome and use this to calculate with linear interpolation pro rata reductions in production at lesser restrictions in water availability. The new water allocation environment allows for a reduction in total allocation for each user, plus periodic short duration rationing of that entitlement at times of low flows. As the new individual allocations depend on the lower of three different criteria (as outlined in section 1.1 above) it is not possible to accurately estimate the change in water availability across all crop and soil types from the information we have available. We model two levels of water restriction: a 20%

reduction and a 35% reduction from current levels. Land no longer irrigable was assumed in the 2011 report to convert to dryland dairy production, although that report also stated that increased dairy production in the area was unlikely because of relatively few suitable blocks of land suited to dairy conversion. Dairy is even more unlikely to be the default dryland use if horticulture's irrigated area contracts, leaving pockets of land scattered across the catchment in need of alternative unirrigated use. Accordingly we assume land no longer irrigable reverts to dryland sheep and beef pasture, not dryland dairy as previously.

Thus the costs of non-augmentation are calculated from the gross margins per hectare from each land use times the reduction in irrigated hectares. The sum of the losses from reduced horticultural land uses minus the gain in dryland sheep and beef production is the net cost of non-augmentation, which will be eliminated by the dam.

3.3.2. Growth in existing irrigated productivity

Existing irrigated areas may increase their productivity with greater security of water flows and reduced occurrence of rationing that the dam would provide. As in the previous reports we estimate a value gain per hectare from the effect of changes in yield and prices achieved for different enterprises. The assumptions in these estimates are summarised below (see also Appendix D1).

Table 7 Assumptions on yields with and without dam

		Without dam		With dam		Gross margins $/ha	
	Units	Yield / ha	Price $ / unit	Yield / ha	Price $ / unit	Without dam	With dam
Pasture	Stock units	6.5	102	12	102	663	1,225
Apples	Tce[1]	3,500	23	3,750	23	27,898	33,523
Kiwifruit	Trays	11,500	9	12,000	9	24,575	28,975
Grapes	Tonnes	8.5	1,700	9	1,800	487	1,337
Berries	tonnes	18	2,000	20	2,000	12,800	16,800

Note [1] Tray carton equivalents (average 18 kg). We use a standard margin of $800/hectare for all vegetable crops, which are too numerous to be itemised here.

Source: NZIER, drawing on Cook & Northington 2011, MPI Farm monitoring, interviews

3.3.3. Production growth from new irrigated area

The third source of benefit is the production growth from new irrigated area, which follows the approach as the previous reports. The estimates combine the information on new irrigated areas from Table 6 above with the yield, price and margin data from Table 7, with information on development costs from the 2011 report.

The net gain from the dam also needs to consider the opportunity cost of the land being transformed by irrigation, i.e. the value in whatever use it would have in the absence of the dam. We have no information on whether the new irrigated areas are being formed from previously unirrigated areas of the same crop or from a different land use altogether. As a default we use the value of dryland sheep and beef, although recognising that this may understate the opportunity cost and overstate the gain from new irrigated area.

3.3.4. Value of electricity generation

Although in the 2011 report the electricity generation option was an optional add-on which appeared marginal under the assumptions used then, at the new lower costs of installation assumed for the update it would be less marginal. We combine the new revised costs with the same price of wholesale electricity ($80/MWh[5]) to provide a conservative estimate of what the power generation could add to the value of the dam.

As in previous reports generation is subsidiary to supply of water, and constrained by limiting power to the capacity of a 22 kV line and avoiding the cost of higher capacity. While in principal adding extra generation to the Nelson-Tasman network should improve security for the network against failures in the long spur line supplying it from further south, the generation capacity is so small as to have negligible influence on its own.

3.3.5. Impact of taxation

The 2011 report presented adjustments for taxation to reflect the removal of tax payments from the regional income and spending. We ignore tax in the base estimates (i.e. the estimates are gross values without the deduction of tax) but allow for the deduction of tax on gross margins at 28% in a subsidiary analysis. This is a rather simplified assessment of tax impact, as we are not in a position to estimate the actual tax liability of entities likely to face tax in an analysis of this kind.

The 2011 report ignored GST on grounds that most new production would be destined for export markets where it is not payable. We do the same, although noting that by including vegetables in the quantified analysis, which are less export oriented, more GST would be payable; but we do not have a model disaggregated enough to distinguish export and domestic output at this level.

The 2011 report also provided an estimate of wine excise tax on increased wine production in the region. Excises are taxes intended to be passed on in prices and paid by consumers, most of whom are not resident in Nelson-Tasman. We do not estimate this tax, as it is a small component of the whole, and to do so would be inconsistent with treatment of other excise taxes on motor fuels, which were also not estimated in the 2011 report.

3.4. Balance of costs and benefits

We have compared the different costs and benefits over a 25 year period in which:

5 Approximate long term price of energy contracts, as recorded at http://www.energylink.co.nz/wp-content/uploads/2014/09/energy-trendz-66-sep-14.pdf

- Dam building costs are spread equally over years 1 and 2, allowing for dam filling in year 3 and full operation in year 4
- Hydro generation installation costs are spread over years 3 and 4 and operation in year 4
- Non-augmentation and current user benefits begin in year 4
- New irrigated use benefits occur from year 4 for pasture, year 5 for berries, year 6 for apples and year 8 for kiwifruit and grapes, to allow for structural adjustments and delay in reaching full operational maturity
- Results are estimated for two levels of water restriction – a modest 20% across the board cut and a more severe 35% cut.

The results of the basic analysis for 20% cuts with 8% discount rate are presented in Table 8. With only 20% cuts in water availability, new irrigation at 80% uptake is the largest component of benefit, but avoidance of non-augmentation costs alone would be sufficient to outweigh the costs of the dam. The benefits from hydro operation are very small by comparison. Overall the gross benefits exceed costs, with benefit cost ratios of 5.4:1 before accounting for tax, or 3.9:1 after deducting tax.

Table 8 Basic results for 20% cuts at 8% discount rate

Assuming 20% reduction in allocations		*Before tax*		*After tax*	
Discounted over 25 years at	8.0%	***PV$m***	***PV$m***	***PV$m***	***PV$m***
Avoided non-augmentation cost			81.8		58.9
Benefits for existing irrigation		58.6		42.2	
Benefits of new irrigation uptake	80%	173.9		125.2	
Combined irrigation benefits			232.5		167.4
Full hydro option at 8c/kWh			1.3		0.9
Combined benefits			315.6		227.2
Cost of water supply dam			-58.8		-58.8
Direct net benefits of dam over period			**256.8**		**168.4**

Source: NZIER

The results of the basic analysis for 35% cuts in water allocation are presented in Table 9. With deeper cuts in water availability, the non-augmentation costs become more significant although still not larger than the new irrigation at 80% uptake. The benefits from hydro operation are unchanged. Overall the gross benefits: cost ratios are larger, at 6.4:1 before accounting for tax, and 4.6 after deducting tax.

Table 9 Basic results for 35% cuts at 8% discount rate

Assuming 35% reduction in allocations		*Before tax*		*After tax*	
Discounted over 25 years at	8.0%	***PV$m***	***PV$m***	***PV$m***	***PV$m***
Avoided non-augmentation cost			143.2		103.1
Benefits for existing irrigation		58.6		42.2	
Benefits of new irrigation uptake	80%	173.9		125.2	
Combined irrigation benefits			232.5		167.4
Full hydro option at 8c/kWh			1.3		0.9
Combined benefits			377.0		271.4
Cost of water supply dam			-58.8		-58.8
Direct net benefits of dam over period			**318.1**		**212.6**

Source: NZIER

These results indicate that at face value the dam ought to provide substantial net benefit. Despite recent increases in cost estimates for dam building, avoiding loss to current production, providing gain for current irrigated land use and providing scope for new irrigated land uses, together outweigh the costs by sufficient margin that estimates would need to be badly awry to obtain a different result.

Avoiding non-augmentation costs alone or benefits of new irrigation uptake alone would be sufficient to outweigh the costs of providing the dam. But how sensitive are the results to the assumptions used in the analysis?

3.5. Sensitivity to assumptions

Table 10 shows the results of analysis at the lower discount rate of 6% real. All the present values are larger as the discounting is less severe, and the net benefits and benefit:cost ratios are also larger, at 6.9 and 5.0 respectively before and after tax.

Table 10 Basic results for 20% cuts at 6% discount rate

Assuming 20% reduction in allocations		*Before tax*		*After tax*	
Discounted over 25 years at	6.0%	***PV$m***	***PV$m***	***PV$m***	***PV$m***
Avoided non-augmentation cost			102.2		73.6
Benefits for existing irrigation		83.6		60.2	
Benefits of new irrigation uptake	80%	236.1		170.0	
Combined irrigation benefits			319.7		230.2
Full hydro option at 8c/kWh			1.9		1.4
Combined benefits			423.9		305.2
Cost of water supply dam			-61.6		-61.6
Direct net benefits of dam over period			**362.3**		**243.6**

Source: NZIER

A similar pattern emerges in Table 11 which shows the effects of 35% cuts in water at 6% discount rate. The net benefits and benefit cost ratios are very large, at 8.1 and 5.9 before and after tax respectively.

Table 11 Basic results for 35% cuts at 6% discount rate

Assuming 35% reduction in allocations		*Before tax*		*After tax*	
Discounted over 25 years at	6.0%	***PV$m***	***PV$m***	***PV$m***	***PV$m***
Avoided non-augmentation cost			178.8		128.8
Benefits for existing irrigation		83.6		60.2	
Benefits of new irrigation uptake	80%	236.1		170.0	
Combined irrigation benefits			319.7		230.2
Full hydro option at 8c/kWh			1.9		1.4
Combined benefits			500.5		360.4
Cost of water supply dam			-61.6		-61.6
Direct net benefits of dam over period			**438.9**		**298.8**

Source: NZIER

As noted above, the new irrigation estimates are affected by uncertainty about the opportunity cost of land converted to new irrigation. Table 12 shows the results at 8% discount rate of only 50% uptake of the new area available for irrigation. The new irrigation benefits would be much reduced, below the present value of costs of the dam project, but combined with benefits from non-augmentation and existing irrigation they are still sufficient to outweigh the project costs.

Table 12 Changes in the uptake of new irrigation

Assuming 20% reduction in allocations		*Before tax*		*After tax*	
Discounted over 25 years at	8.0%		*PV$m*		*PV$m*
Avoided non-augmentation cost			81.8		58.9
Benefits for existing irrigation		67.0		48.2	
Benefits of new irrigation uptake	50%	54.9		39.5	
Combined irrigation benefits			121.9		87.8
Full hydro option at 8c/kWh			1.3		0.9
Combined benefits			205.0		147.6
Cost of water supply dam			-58.8		-58.8
Direct net benefits of dam over period			**146.2**		**88.8**

Source: NZIER

Such is the scale of estimated benefits derived from assumptions, benefits would have to be over-estimated by a factor of five to change the result. In such circumstances it is unlikely that the dam would not be a worthwhile economic proposition in the sense of delivering greater benefits than the costs it incurs. The obstacles to the dam are more around making it a financially viable proposition which is affordable for those who stand to benefit from it.

Another way of looking at the economic benefit of the dam is to calculate an internal rate of return (IRR) of benefit stream compared to the costs. Taking the conservative assumption of 20% water cuts (hence lower non-augmentation cost), the IRR of our central assumption set is 26.2% when there is 80% uptake of production gain and new irrigation, 19.1% with 50% uptake, and 9.9% with 20% uptake. All these are high relative to alternative returns on capital suggesting the dam would be worthwhile, given appropriate structure for implementing and financing it.

3.6. Paying for the dam

Although paying for the dam is not within scope of this update of the 2011 report, it is clear from consultation that potential costs and charges are a potential obstacle to uptake of the advantages offered by the dam. The previous reports did not specify a particular structure for paying for the dam, other than envisaging some corporate body to pay for installation and recover costs from the beneficiaries, including users of water for irrigation, the ratepayers of TDC and for customers of its Waimea Water Scheme and Nelson City Council. They would also include TDC ratepayers to contribute towards the costs of the dam in maintaining environmental flows.

The Northington report in 2010 proposed a charge per user at a flat rate per hectare of irrigation equivalent, in line with the provisions outlined above in Table 1. In the previous reports that figure was around $500 per hectare per year But with the rise in the estimated costs of the dam, such figures will also have increased. As noted by some of those consulted for this update, this is a large sum relative to the gross margins of some irrigated land uses, such as irrigated pasture and field vegetables and may deter some from fully realising the potential benefits created by the dam.

3.7. Caveats and limitations

The estimates in this section have been made from a high level analysis with many assumptions and simplifications of detail. This is sufficient to demonstrate the broad economic characteristics of the dam, but not to represent the financial implications for any particular party considering investment in the scheme.

While we have followed the approach of the previous reports and consider it fit for purpose of a high level analysis, there are a number of deficiencies that would aid action on the project in practice. That would include more refinement on the seasonal supply and demands for water for different activities, including the demands placed by residential and industrial uses which have been taken as a given in this and the previous reports.

4. Revised and updated economic impact analysis

As pointed out in Section 2.2, the 2011 report relied on economic multipliers which are based on input-output modelling of the Nelson-Tasman economy. Such models typically over-state economic impacts because they assume that prices are fixed (have no role in decision making) and that economic resources such as land, labour and capital inputs are infinitely available.

In contrast the revised economic impacts we present in this section are based on NZIER's TERM-NZ model, which is a bottom-up regional CGE model of the Nelson-Tasman and New Zealand economies.

CGE modelling is widely regarded as providing a more robust analysis than multiplier methodologies.[6] This is because CGE models are not only driven by prices but also account for resource constraints and flow-on effects.

This means that CGE models produce more conservative, but more credible, economic impacts compared to multiplier methodologies.

4.1. Nelson-Tasman CGE model

TERM-NZ treats the Nelson-Tasman region as a separate economy but linked to the rest of New Zealand through inter-regional trade in goods and factors. A technical description of TERM-NZ is provided in Appendix C.

We use TERM-NZ to estimate the potential economic costs of non-augmentation and the likely long term economic benefits of dam installation and expansion of irrigated areas in the Waimea plains. In particular, we analyse the impacts of:

- 20% water cuts
- 35% water cuts
- augmentation (dam installation and expansion in irrigated areas)

Our CGE modelling is driven by cost and benefit estimates from Section 3.

Under the non-augmentation scenario, we reduce the gross margins of six directly-affected industries: pasture (dairying), apples, kiwifruit, grapes, berries, vegetables & floriculture, but increase the gross margin of dryland sheep and beef to account for land use shifts arising from water restrictions. We then let the model determine the consequent employment and flow-on effects to other parts of the Nelson-Tasman economy.

Because of resource reallocation, it is possible that the negative impacts on directly-affected agriculture industries may be offset by slight expansions in other industries. However not all land and capital resources can move elsewhere following water cuts.

6 On Input-Output tables: Uses and abuses of http://www.pc.gov.au/__data/assets/pdf_file/0008/128294/input-output-tables.pdf

Our modelling of water augmentation scenario also relies on the cost and benefit estimates from Section 3, plus the $59.1 million investment required for dam construction (Table 5: alternative medium scenario).

If the dam construction increases demand for inputs that hit any resource constraints, prices rise and resources are reallocated within the Nelson-Tasman economy. Once the dam is operational, the likely expansion in irrigated areas may also result in resource reallocation that would reverberate within the Nelson-Tasman economy. This leaves other sectors facing higher costs or reduced use of these inputs. The net effect is that some business contracts and partially offsets the stimulus gained during dam construction and operation phases.

4.2. Interpreting the results

We analyse the overall impacts on the Nelson-Tasman economy by focusing on value changes in key economic metrics, particularly regional gross domestic product (RGDP) and household consumption. The direct impacts look different from those on the CBA because they are measuring different things: the RGDP includes value attributed to labour which is not included in the economic surpluses estimated in CBA.

RGDP measures the total value of goods and services produced in the regional economy in a given year. Household consumption measures the amount that Nelson-Tasman consumers spend on goods and services. Thus household consumption is a measure of economic well-being (i.e., how 'well-off' or 'worse-off') of all Nelson-Tasman residents.

We then trace in detail the direct economic impacts – i.e., on directly-affected industries – and the consequent flow-on effects to other parts of the economy.

In the next two sections, we present the economic impacts as value changes from the current Nelson-Tasman economy.

4.3. Economic impacts of non-augmentation

Table 14 presents the economic impacts (in million $NZ per year) on the region. The Nelson-Tasman economy would be smaller by $17.5 million and $33.3 million as water allocations cuts increase from 20% to 35%.

All components of Nelson-Tasman RGDP would also contract. Under a 20% water allocation cut, investment and exports would be smaller by $0.9 and $0.3 million, respectively. Exports fall as insecurity of water supply and land use changes reduce the productive capacity of key agriculture sectors in the Waimea plains. In turn, reduced profitability (gross margins), production and exports pull down investments – i.e., lower returns reduces incentives to invest

Our measure of economic well-being (household consumption – labelled 'Consumption' in the tables that follow), indicates that Nelson-Tasman residents would be 'worse off' by between $4.6 and 10.6 million annually. This arises as incomes from wages, and operating surplus (returns to land and capital) in the region would fall by $3.4 and $13 million under a 20% water cut; and by $7.8 and $24.2 million under a 35% water cut.

Table 13 shows significant long term RGDP impacts. Over 25 years, Nelson-Tasman's GDP (in $PV terms, discounted at 8%) would be smaller by $186.7 million and $368.7 million as water allocation cuts increase from 20% to 35%. As benefits do not occur until the dam is completed, the present value from the start of dam construction would be $155.6 million and 306.8 million for the 20% and 35% cuts respectively. Viewed from 2014 and assuming the dam is built until 2017 and 2018 and the benefits of augmentation would not begin until 4 years from now, the present value of non-augmentation costs in RGDP that would be avoided with the dam range from $123.5 million to $243.5 million with allocation cuts of 20% and 35% respectively.

Table 13 Regional gross domestic product (RGDP) impacts from non-augmentation

Water cuts of 20% and 30%, in 2013 $NZ million per year (nominal terms)

	20% cut	35% cut
Consumption	-4.6	-10.6
Investment	-0.9	-2.4
Government	-0.3	-0.6
Exports	-15.5	-30.9
Imports	3.8	9.9
RGDP (expenditure-side)	-17.5	-34.5
Employee compensation	-3.4	-7.8
Operating Surplus (returns to land and capital)	-13.0	-24.2
Production taxes[7]	-0.4	-1.0
Commodity taxes	-0.7	-1.6
RGDP (income-side)	-17.5	-34.5
RGDP 25-Year PV (at 8% discount rate)	-186.7	-368.7
RGDP 25-Year PV (at 8% discount rate), benefits 2 years after dam build starts	-155.6	-306.8
RGDP 25-Year PV (at 8% discount rate) lagged 4 years	-123.5	-243.5

Source: NZIER

We now trace the impacts on directly-affected industries. Table 14 shows that direct non-augmentation losses would be in the order of $11 and $19.7 million per year.

Under a 20% water allocation cut, the apple industry would incur $10.4 million in value added losses.[8] This effect is driven by the industry occupying roughly 43% of

[7] Calculation of GDP includes indirect taxes that are embedded in market prices and difficult to remove (like excise duties). Production taxes are those paid by business sectors, commodity taxes are those paid on consumption.

[8] Value-added is the industry equivalent of regional Gross Domestic Product.

total land area in the Waimea plains. The other directly-affected industries (kiwifruit, grapes, berries, vegetables & floriculture, and dairying) show value added losses ranging between $0.1 and $0.4 million per year. Partly offsetting the negative impacts is the $0.6 million expansion in dryland sheep and beef pasture.

Table 14 also shows the indirect 'flow-on' impacts to other industries in the region. The negative impacts are partially offset by higher value added contributions from other primary industries (fishing and forestry, $0.5 million) and other manufacturing industries ($0.1 million). These industries expand as they benefit from additional and cheaper capital and labour resources no longer in use by directly-affected agriculture industries.

The value added contribution of the food processing industry would fall by $1.2 million due to scale effects — i.e., owing to reduced output of directly-affected industries for further processing. The value added contributions of the wholesale and retail industries would also be smaller by $1.3 and $2 million, respectively. These are industries that households spend money on and are indirectly affected by lower household incomes.

Table 14 Industry impacts of non-augmentation

Impacts on value-added; Water cuts of 20% and 35%, in 2013 $NZ million per year (nominal terms)

	20% cut	35% cut
Apples	-10.4	-18.7
Kiwifruit	-0.4	-0.7
Grapes	-0.2	-0.4
Berries	-0.2	-0.3
Vegetables & Floriculture	-0.1	-0.1
Dairy	-0.3	-0.5
Sheep and beef (shift)	0.6	1.0
Total direct impacts	**-11.0**	**-19.7**
Other primary sectors	0.5	0.8
Food processing	-1.2	-2.8
Other manufacturing	0.1	0.3
Wholesale	-1.3	-2.8
Retail	-2.0	-4.2
Other industries	-1.9	-4.6
Total indirect impacts	**-5.8**	**-13.2**
Total value added (direct + indirect) impacts	-16.8	-32.9
Add: Commodity taxes	-0.7	-1.6
RGDP	**-17.5**	**-34.5**
25-Year PV (8% discount rate)	**-186.7**	**-368.7**
RGDP 25-Year PV (at 8% discount rate) lagged 4 years	**-123.5**	**-243.5**

Source: NZIER

4.4. Economic impacts of augmentation

Table 15 shows the economic impacts (in million $NZ per year) of dam installation and the consequent benefits from water augmentation in the Waimea plains. Our modelling of dam construction should not be seen as a full investment appraisal. This is because we do not consider how the dam would be funded as discussions on financing arrangements are ongoing. We recommend re-running the model when additional information on the financing becomes available.

On the first year, the construction of the dam would generate an additional $59 million in investment.[9] This will result in Nelson-Tasman's RGDP increasing by $55.1 million and would lift household consumption (our measure of 'well-being') by $27.4 million due to higher incomes.

Table 15 Key regional economic indicators

Dam installation, in 2013 $NZ million per year (nominal terms)

	Dam installation
Regional GDP	**55.1**
Investment	59.2
Imports	-57.7
Consumption	27.4

Source: NZIER

RGDP increases by less than the amount of dam investment because the materials used to construct the dam are mostly imported from outside the region. Nonetheless, this additional investment spending would also indirectly boost activity in supplying sectors such as construction, construction services and wholesale trade.

In our modelling, we assume that the full production benefits from expansion in irrigated areas would only occur 8 years after the dam has been constructed. Table 16 shows the economic benefits associated with water augmentation and expansion in irrigated areas in the Waimea plains.

9 The dam would be constructed over two years and this is reflected in the cost benefit analyses in section 3, but in this static model the full capital injection needs to be accounted for in a single year.

Table 16 Regional gross domestic product (RGDP) impacts from augmentation

2013 $NZ million per year (nominal terms)

	Augmentation
Consumption	12.7
Investment	3.5
Government	0.7
Exports	46.6
Imports	-8.9
RGDP (expenditure-side)	54.5
Compensation of employees	9.1
Operating Surplus (returns to land and capital)	42.0
Production taxes	1.4
Commodity taxes	2.0
RGDP (income-side)	**54.5**
RGDP 25-Year PV (8% discount rate), benefits from year 8	**366.9**
RGDP 25-Year PV (at 8% discount rate), benefits phased in 2 years after dam build starts, fully realised year 8	**386.5**
RGDP 25-Year PV (at 8% discount rate) lagged 4 years	**306.8**

Source: NZIER

On the 8th year after the dam has been built, the Nelson-Tasman RGDP would expand by $54.5 million per year. Much of this increase would be driven by higher exports revenue associated with increased agricultural production in the Waimea plains. Higher production and profitability would encourage additional investment.

All Nelson-Tasman residents would be better off. Household consumption would increase by $12.7 million per year due to higher incomes (wages and profits) linked to increased production. Over 25 years, Nelson-Tasman's GDP (in NPV, discounted at 8%) would be higher by $366.9 million, from the viewpoint of the start of the dam construction. Viewed from 2014 on the assumption the dam is built over 2017 and 2018, the present value of impacts on RGDP would be $306.8 million.

Table 17 shows the direct and indirect value added impacts 8 years after the dam has been constructed. The highest value added gains would accrue to the apple industry since we assume that it would gain an additional 960 hectares of land with access to irrigation. The value added gain of the berry industry ($8 million) would come from a combination of increased land area and gross margins.

Table 17 Industry impacts of augmentation

Industry value added; 2013 $NZ million per year (nominal terms)

	Augmentation
Apples	25.3
Kiwifruit	2.1
Grapes	0.1
Berries	8.0
Vegetables & Floriculture	0.0
Dairy	0.5
Sheep and beef (shift)	0.5
Total direct impacts	**36.4**
Other primary sectors	-1.5
Food processing	3.6
Other manufacturing	-0.4
Wholesale	3.8
Retail	5.8
Other industries	4.8
Total indirect impacts	**16.1**
Total value added (direct + indirect) impacts	52.5
Add: Commodity taxes	2.0
RGDP	**54.5**
25-Year PV (8% discount rate), benefits start year 8	**366.9**
RGDP 25-Year PV (at 8% discount rate), benefits phased in 2 years after dam build starts, fully realised year 8	**386.5**
RGDP 25-Year PV (at 8% discount rate) lagged 4 years	**306.8**

Source: NZIER

The indirect 'flow-on' impacts to other industries in the Nelson-Tasman region from augmentation are generally positive except for value added losses in 'other primary industries' and 'other manufacturing' industries which are affected by resource reallocation effects.

The value added contribution of food processing industry would increase by way of expanded operations: now more agricultural inputs for further processing. Finally, household-dependent industries such as wholesale and retail industry would realise value added gains owing to increased household incomes and business activity in the Nelson-Tasman region.

Assembling these impact results, Table 18 shows the GDP impacts of the dam in alleviating a 20% cut in water availability, showing the direct impacts on primary production and flow on impacts on food processing and other industries.

Table 18 Direct and indirect impacts on GDP from 20% water cut

Present value impacts on regional GDP, calculated over 25 years at 8% discount rate

PV$m	Direct impact	Food Processing	Other industry	Total
Construction	49.1[10]			49.1
Avoided cost of non-augmentation	97.8	10.7	47.1	155.6
Augmentation production benefit	258.2	25.5	102.8	386.5
Total	**405.1**	**36.2**	**149.1**	**591.2**

Source: NZIER

Table 19 does the same for the effect in alleviating 35% cuts in water allocation. In both cases the production boost for primary industries and food processing is the same, but the avoided cost of non-augmentation is the main driver of differential impact, and its effects spill over into differential impacts on other industries as well.

Table 19 Direct and indirect impacts on GDP from 35% water cut

Present value impacts on regional GDP, calculated over 25 years at 8% discount rate

PV$m	Direct impact	Food Processing	Other industry	Total
Construction	49.1			49.1
Avoided cost of non-augmentation	175.2	24.9	106.7	306.8
Augmentation production benefit	258.2	25.5	102.8	386.5
Total	**482.5**	**50.4**	**209.5**	**742.4**

Source: NZIER

These results are larger than those in the 2011 report, which had a central estimate with present value over 25 years of $275.5 million in direct impact and $60.2 million for food processing. At first sight this is surprising as we have used many of the same assumptions as the previous reports for our direct estimates and, where we alter the assumptions, we have adjusted them down (e.g. areas of new grapes, prices for grapes and kiwifruit). However, our assumptions for water allocation cuts and non-augmentation costs to be avoided are bigger than in the previous analysis, and our economic modelling reflects all the linkages to upstream and downstream industries more thoroughly than the previous report's application of multipliers to a selection of primary production and processing industries. Given these differences in assumptions and approach our results can be larger even though the modelling allows for resource input constraints and price changes which tend to dampen the estimated impact.

[10] This is the $55.1m RGDP from Table 15, equally divided between the first two years of analysis and then discounted at 8%.

5. Summary and conclusions

In this report we have reviewed and updated the cost benefit analysis and economic impact analysis of the Waimea Community Dam, prepared in 2010 and 2011. We follow a similar approach adapted to new scenarios to reflect the current water use restrictions announced in 2014 to be in force from 2015.

We have used a more robust model of the regional economy…

The basic approach of the previous reports appears sound and we have built on and used the previous material as the basis for this analysis. However, we have not been able to replicate the results of the previous reports and have diverged from them.

In particular we have used a model of the Nelson-Tasman region that explicitly accounts for resource input constraints, price changes and resultant reallocation of resources across sectors in response to the shock imposed on the economy by increased production enabled by the dam. The previous reports' modelling of flow-on effects through the economy used economic multipliers with no resource constraints, and was less comprehensive in its coverage.

…with updated industry coverage and assumptions

We have canvassed a selection of local growers and found that the previous reports provided a reasonable base on which to estimate likely changes in the district. An exception was grape growing, in which we have reduced both the increase in area and in prices assumed by the previous reports.

Another difference is that we have explicitly provided for an area of irrigated land to be occupied by vegetable growing, which was omitted from the quantified estimates in the previous reports.

A further change is in the option of an add-on hydro-generation plant for the dam, which on the figures used in the previous report would have been barely marginal at the wholesale prices likely to prevail into the medium term future. If it is possible to reduce the cost of the hydro option by using different components, its viability improves and it could make a modest additional contribution to recovering the costs of the dam. We use costs for installation of the hydro plant that are about 60% those used in the previous reports.

The dam will deliver large net benefits under all reasonable scenarios

The first part of our updated estimates presents a cost benefit analysis to establish whether the dam would be worthwhile in delivering benefits in excess of costs. Assuming benefits that are close to and in some cases less than those in the earlier reports, we find the dam should deliver healthy net benefits over the costs of installation and operation. Our central estimates suggest the dam would have a net benefit over 25 years with a present value of $256 million (or $168 million after tax).

These results are sufficiently large to be robust to changes in the input assumptions. The benefits could be cut in half and still deliver a sizeable net benefit over a 25 year period, other things held constant.

A large risk is in the uptake rate of irrigation to create new irrigated area. We assume an 80% uptake rate with the full impact realised 8 years after dam construction. But even if uptake was lower or slower this would not overturn the positive outlook for the dam. The security it would give for water supply to avoid the costs of non-augmentation and encourage investment in productivity gains on existing irrigated areas would be more than sufficient to yield benefits in excess of costs.

The wider regional economic impacts will also be significant

The second part of our updated estimates presents an analysis of economic impacts on the combined Nelson-Tasman regional economy. This feeds the benefit estimates from the cost benefit analysis into the regional economic model, where their impact is traced through the processing sectors and all other sectors of the economy which receive the stimulus of increased income and demands in the region.

The key results are:

- With conservative assumption of water restrictions equivalent to 20% allocation cuts, the value of dam construction, avoidance of non-augmentation costs and achievement of production gains from water augmentation would have an impact on regional GDP with a present value (discounted at 8% over 25 years) of $405 million directly for the primary production sectors, and further flow on effects from food processing ($36 million) and other sectors ($150 million) totalling $591 million
- With a stronger assumption of water restrictions equivalent to 35% allocation cuts, the corresponding impacts on regional GDP in present values (discounted at 8% over 25 years) would be $483 million direct impact, $50 million on food processing and $209 million on other sectors, totalling $742 million.

Our results are higher than in the previous reports, due to some changes in assumptions and the difference in modelling technique which has more comprehensive coverage of all sectors in the regional economy. However, these still show the dam as having a positive impact over the 25 years after its building, with the impact on primary industries augmented by the flow on effects in other sectors of the economy.

Limitations and further work

This is a high level analysis which, in the absence of detailed information on how the new water rules (which reduce current allocations according to the lowest of three criteria) will affect water availability for different industries, has relied on information from the previous reports about land use and likely changes with greater water security, feedback from those consulted in the Tasman Nelson region, and assumptions about what this means for production response to the reduction in water availability. Our modelling is not a prediction of what will happen (which will depend on more variables than modelled here), but rather a demonstration of the potential net gains for the region's economy from the construction of the dam, which remain positive unless the assumptions are substantially awry.

We cannot tell precisely how the combination of reduced allocations and more frequent short term rationing cuts will impact on primary production. We have assumed these can be represented by across the board cuts of 20% and 35%. These may be conservative, particularly if some crops are critically dependent on water at times of shortage, which would imply greater non-augmentation costs than estimated in this report. Deep impacts on particular crops would also have more widespread effects in stranding assets and infrastructure developed to provide for them. This is a limitation of all high level analyses.

Similarly we have not undertaken a financial analysis of the dam for different parties involved in it, because the actual form of the dam enterprise and its financial arrangements have yet to be finalised. Decisions on how to respond to the dam depend on how diverse private parties assess the effects of non-augmentation in light of their own circumstances of soil type, cropping opportunities and financial arrangements, all of which are beyond the scope of this report.

This analysis builds on the approach and information in the previous reports so it shares some of its weaknesses. In particular the approach to estimating water demand in terms of irrigable hectares equivalent is adequate for a high level analysis, but leaves some uncertainty as to the detail of impacts that might occur. More refined land use and water modelling that considered current land uses and capability for other irrigated uses, and agronomic modelling that considered the water needs of different crops at different times of the year, and where and when water is most critical, might give different results for the mix of new irrigated enterprises and give reassurance as to the feasibility of the changes in land use, crops and net returns obtained from the dam.

6. References

Cook & Northington (2011) Waimea Community Dam Economic Impact Analysis; report to Nelson Regional Economic Development Agency

Ministry of Primary Industries: 2012 Farm Monitoring Models, for Pipfruit, Dairy, Kiwifruit, Viticulture

Lincoln University (2013) Financial Budget Manual

New Zealand Horticulture (2013) Fresh Facts

Northington Partners (2010) Financial and Economic Assessment of Water Augmentation in the Waimea Catchment; report to Waimea Water Augmentation Committee

Appendix A Water allocation rule changes

The new rules for water allocation and cuts under Plan Changes 45-48 are outlined in Figure 1 below. As presented in a TDC Powerpoint presentation on Waimea Water Management of 24 January 2014, Step 2 is not expected to be used at this stage and its new and previous triggers are not defined in the presentation.

Figure 1 Flow levels that trigger water allocation cuts

Amended Plan Changes 45-48		***Water allocation and use rules***			
	Flow triggers litres/second and allocation cuts				
	Notified	**Interim**	**New**	**Rationing**	**Flow Level Location**
Consultation	3500	2800	3000		Wairoa River at Gorge
Step 1	3000	2500	2750	20%	Wairoa River at Gorge
Step 2				35%	Wairoa River at Gorge
Step 3			2300	50%	Wairoa River at Gorge
Step 4			800	70%	Level at lower Waimea River (by Council nursery)

Source: NZIER, from TDC handout summarising amendments to Plan Changes 45-48

New allocation rules in February 2014 have superseded the interim measures and reduced the river flow thresholds that trigger the cuts in allocation below the previous notified levels. Without the Lee Valley dam from 1 July 2015 the following level of restrictions apply, with successively deeper rationing cuts (relative to the no cut level) as river flows pass lower thresholds:

- 20% cuts with flows of 2750 litres / second (l/s) at the Wairoa River Gorge
- 50% cuts with flows at or below 2300 l/s at the Wairoa Gorge, and
- 70% cuts with flows at or below 800 l/s at the lower Waimea (by TDC nursery).
- Cease take may be imposed by the Dry Weather Task force if river flows drop further to extreme low levels, risking seawater incursion into aquifers.

The dam is designed with a capacity to meet foreseeable demands without rationing cuts up to a one in 60 year drought, and could with management provide security against even more severe droughts.

In the without dam scenario, water permits will be reviewed when they come up for expiry in 2016 and 2017. New allocations that could be granted would be *the lower of* **actual water use** as monitored between 2003-2013 or a **standard rate per soil type** or a **standard rate by crop type**. The standard irrigation rates by soil type and crop type are presented in Figure 2.

Figure 2 Allocation rates by enterprise type under the Commissioners' ruling

	mm/wk	m3/ha/wk
Irrigation rates by soil type		
Braeburn	25	250
Dovedale	30	300
Mapua and Rosedale	19	190
Waimea	30	300
Richmond and Wakatu	27	270
Riwaka and Sherry	30	300
Ranzau, Motupiko, Hau	35	350
Irrigation rates by crop type		
Apples,Pears,Hazelnuts	35	350
Grapes, Olives	14	140
Kiwi, Feijoa,Chestnuts	35	350
Berryfruit,Hops,Peonies	29	290
Stonefruit,almonds,walnuts	29	290
Gardening,veg,floriculture	35	350
Pasture	35	350
Any other irrigation	30	300

Source: Operative Resource Management Plan Chapter 31: Figure 31.1D and 31.1DA

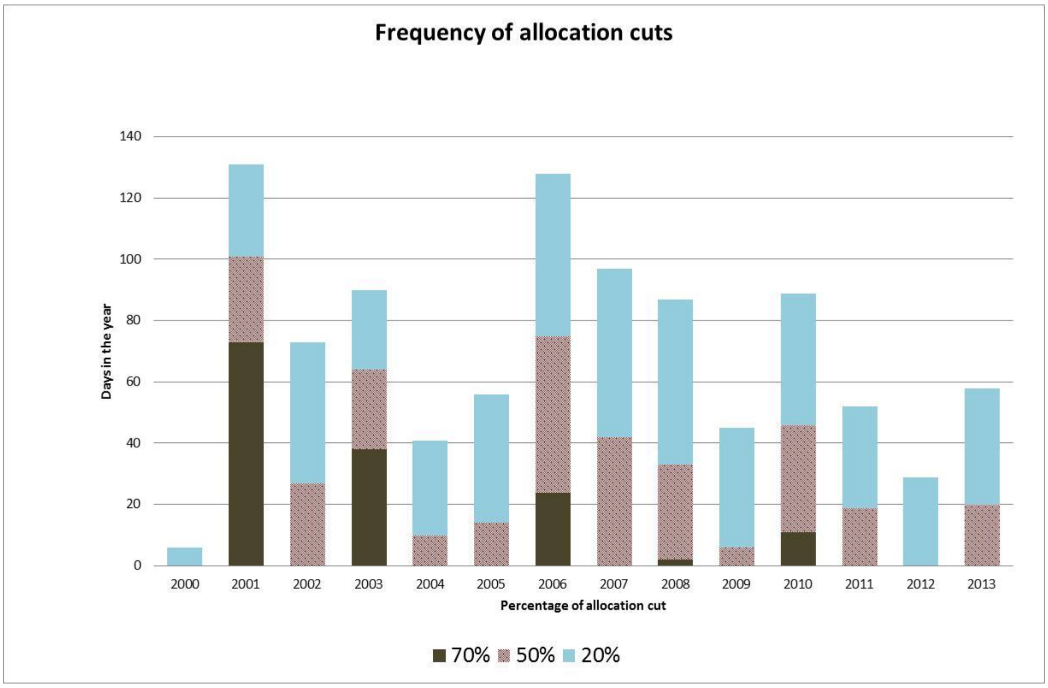
A critical question is how, given their likely frequency and duration, cuts of these magnitudes would affect the productivity of existing irrigated areas, prospects for new irrigated area, and the mix of enterprises across the Waimea catchment.

Frequency of low flows invoking rationing cuts

Waimea river flow records, as summarised in Figure 3 below, show that

- one or other of these rationing cuts would have applied for 70.1 days a year on average over the 2000-2013 period, ranging from 6 days to 131 days
- the threshold for 20% rationing cuts in allocation has been passed in all of the past 14 years, and the number of days they would have applied (i.e. excluding the deeper cuts) ranged from 6 to 55 days per year with an average of 37.5 days
- most years have passed the threshold for 50% rationing cuts, and the number of days they would have applied ranged between 6 and 42 days with an average of 22 days.
- the threshold for 70% rationing cuts was passed in only 5 of the last 14 years, and the number of days they would have applied ranged from 2 to 73 days with a mean of 10.6 days

Figure 3 Frequency of allocation cuts in recent years



Source: TDC presentation on Decisions on Plan Changes 45-48, January 2014

The effect of these changes is that after 2015 all allocations will be reduced from their current level, and that rural water users can expect to face 20% rationing cuts for some days in all years, and 50% rationing cuts for some days in most years.

The Waimea Community Dam in the Lee Valley has been designed with sufficient storage capacity to eliminate rationing cuts in all but the most severe and infrequent droughts, to provide for demands for water from growth in the urban and industrial activity in both Tasman District and Nelson City, and also to enable the minimum environmental flow in the Waimea to be raised from 800 litres per second to 1100 l/s at Appleby Bridge in the lower Waimea catchment.

Appendix B Economic analysis approaches

The Northington (2010) and Cook and Northington (2011) reports contain two types of economic analysis – cost benefit analysis (CBA) and economic impact analysis (EIA). Whereas the EIA approach is oriented at providing a snap-shot of total economic activity in a particular period, the CBA is more aimed at assessing the return of resources over and above what they would earn in other uses, and hence focuses on a narrower band of economic surpluses as indicative of benefits to the economy.

CBA is an extension of the discounted cash flows found in financial analyses, but rather than assessing investments from the private perspective of a single entity, it takes account of the effects on multiple parties to arrive at a community net benefit.

EIA is based on examining current transactions and flows across the economy, and provides snap-shots of activity that are specific to short periods of time. Such analysis may estimate how expansion in one sector, such as irrigated agriculture, stimulates activity in other sectors that supply it with inputs or use its outputs.

CBA in contrast forecasts a flow of costs and benefits over a period into the future and applies a discount rate to convert these values into a net present value. While it may look at flow on effects in other sectors, that depends on supplementary information on this being available, for instance from EIA. So EIA may be described as having breadth of scope in looking at inter-dependencies in the economy, whereas CBA has greater depth in looking at long term consequences of decisions and their net value over opportunity cost of resources used.

Their differences and commonalities are illustrated in Figure 4. The left hand column shows two methods of measuring gross domestic product or value added in the national accounting framework, which provides the metrics for economic impact analysis (EIA).

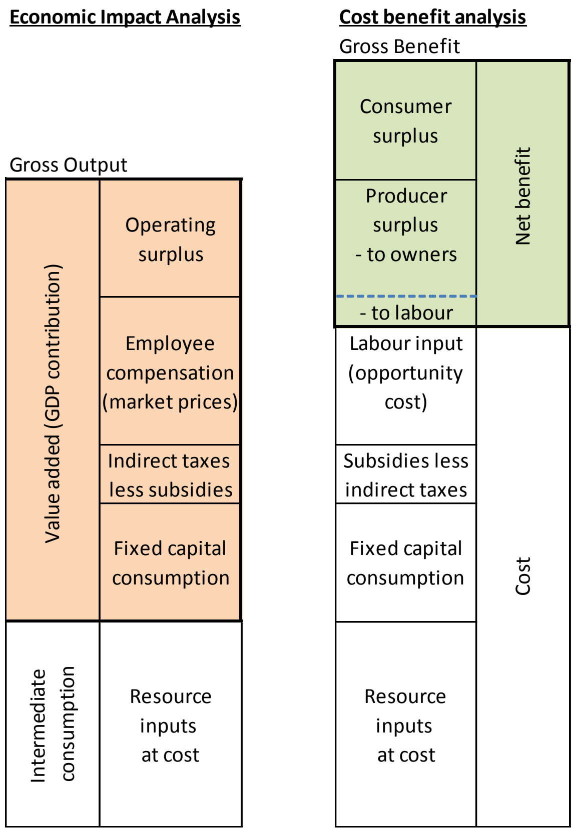
The production approach estimates value added as the difference between a sector's gross output (e.g. sales to domestic market, exports and net change in stocks of produced goods) and its intermediate consumption of resource inputs used in producing that output.

The income approach estimates value added from incomes earned by various factors of production, which are principally operating surplus (or profit) to business owners, employee compensation (wages) to workers, fixed capital consumption (or economic depreciation) which is the amount required for owners to maintain the capital stock in constant condition, and indirect taxes net of subsidies to government.

National accounting differs from private commercial accounting in that transfer payments between parties within the sector or economy are generally ignored (as one party's loss is another's gain, signifying no net improvement in productivity). Also, whereas private companies regard labour and indirect taxes as costs that detract from their profitability, national accounting regards them as a legitimate share of the value added in gross output, and hence as beneficial to national income.

Economic impact analysis concentrates on such measures of economic activity as expenditures, output, incomes and employment as measures of economic benefit.

Figure 4 Alternative views of economic effect



Source: NZIER

The right hand column shows the same accounting breakdown and how it would be used in a cost benefit analysis (CBA) framework, which has been developed from investment appraisal techniques to identify the net balance of costs and benefits arising from a project, wherever they may occur. The metric of such analysis is economic welfare or well-being, the sum of economic surpluses accruing to producers and consumers as a result of the project or policy being evaluated. In such a framework, labour is a cost recorded at its opportunity cost as are fixed capital consumption and other resource input costs.[11]

The producer surplus to project providers/owners closely corresponds to the operating surplus in the national accounting framework, except that if employees earn more in a new project/policy than their opportunity cost, that represents an additional productivity gain and source of producer surplus. The cost benefit

11 Note the CBA has an item for subsidies less indirect taxes, as a way of representing that government input into incurs a cost which only partially recovers from indirect taxes. In most CBA, however, the focus is on resource costs and the funding source is only a secondary consideration so the net subsidy would not feature in the analysis. It features in the economic impact framework as indirect taxes less subsidies because it is a claim on the value of gross output and because government is one of the recipients of income from that output activity.

framework also includes effects on the consumer surplus, which occurs when consumers obtain a good or service at less than their willingness to pay for it.

Economic impact analysis is commonly used to provide estimates of contribution to a region’s economic value added or Gross Domestic Product. Economic value added includes items that fall outside of the private perspective of profit – payments to labour, depreciation of capital and indirect taxes (such as excise duties) that are embedded in market prices, because these represent “returns” to the factors of production in the economy. Government also collects direct taxes from the earnings of businesses and workers (i.e. income taxes), but for simplicity these are excluded from the diagram and the basic national accounting framework, as these are transfer payments to government of a portion of the operating surplus and employee compensation and do not affect the total of national production.

Appendix C Computable General Equilibrium (CGE) Modelling

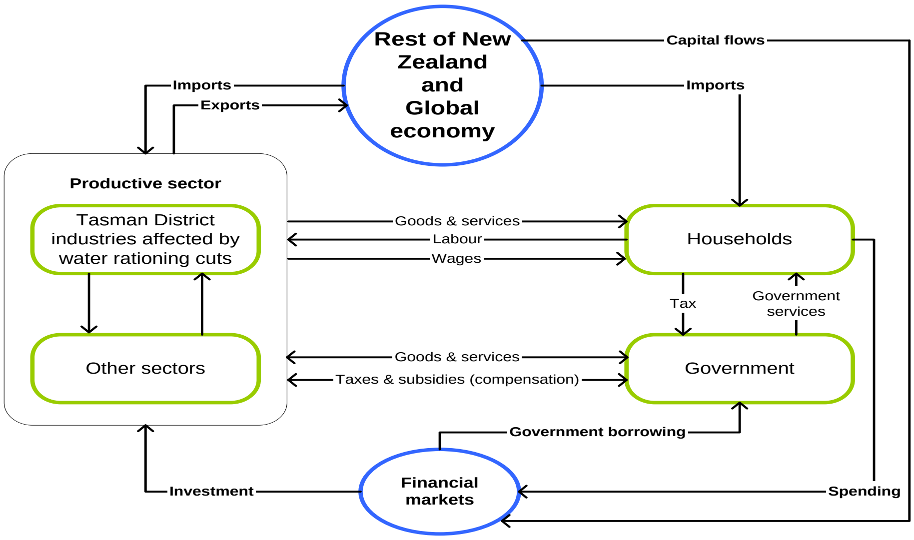
The economic impact estimates presented in Section 4 were derived from NZIER's TERM-NZ model, which is a static bottom-up regional CGE model of the New Zealand economy and its key regions.[12]

TERM-NZ contains information on up to 106 industries, 205 commodities and 15 regions. For this study, we have aggregated the model's database to 50 industries, 100 commodities and 2 regions, namely Nelson-Tasman and the rest of New Zealand.

TERM-NZ treats each region as a separate economy and is an ideal tool for examining detailed region-specific impacts. By modelling each region individually, TERM-NZ accounts for region-specific inter-linkages between industries, as well as their links to households (via the labour market), the local and central government, capital markets, the rest of New Zealand (via inter-regional trade) and the global economy (via imports and exports).

TERM-NZ also captures the economic relationships between regions of the New Zealand economy. A visual representation of the model is shown in Figure 5. It highlights the complex and multidirectional relationships between the various parts of each regional economy and how each regional economy interacts with the rest of New Zealand and rest of the world.

Figure 5 Nelson-Tasman perspective of our regional CGE model



Source: NZIER

[12] TERM-NZ stands for "The Enormous Regional Model" of the New Zealand economy. It was developed at NZIER by Dr. Erwin Corong based on the original Australian TERM model created by Professor Mark Horridge of the Centre of Policy Studies, Victoria University-Melbourne, Australia. http://www.copsmodels.com/term.htm

A key benefit of using a regional CGE model is that it is based on an empirical, government-produced database (Statistics New Zealand's Input-Output table) that identifies the structure of the industries involved.

A second key benefit of a regional CGE model is that it considers both the first round effects of changes within the Nelson-Tasman region (non-augmentation and with dam scenarios) and the flow-on impacts that these changes have on the region and the rest of New Zealand. For example, it explicitly calculates the flow-on impacts on suppliers to agricultural industries; and to households by way of wages that come from the demand for labour and rates of return to productive capital.

Appendix D Assumptions behind estimates

D.1 Land use assumptions

Table 20 Principal assumptions in land use estimates

	Irrigated hectares 2011 report	Hectares inferred from MPI figures & contacts	Irrigated hectares adjusted pro rata	New irrigated hectares 2011 report	New irrigated hectares adjusted	Hectares with 70% water cut without dam	Hectares with 20% cut without dam	Hectares with 35% cut without dam
Pasture	1450		1300	300	400	241	1871	2300
Apples	1650		1480	860	960	275	1142	888
Kiwifruit	80		70	90	90	13	54	42
Grapes	550		490	400	200	91	378	294
Berries	70		60	150	150	11	46	36
Vegetables & floriculture		400	400		0	74	309	240
	3800		3800	1800	1800	705	3800	3800

	Yields	2011 report Units/ha	2014 report Units/ha	2011 report Price $/unit	2014 report Price $/unit	2011 report Cost/ha	2014 report Cost/ha	2014 report GM $/ha
Pasture	SU/ha		6.5		102.00	384	331	332
Apples	TCE/ha	3500	3500	23.00	22.50	50850	50,852	27,898
Kiwifruit	Trays/ha	12000	11500	13.00	8.80	76670	76,625	24,575
Grapes	Tonnes/ha	8.5	8.5	2,150.00	1,700.00	12736	13,963	487
Berries	Tonnes/ha	18	18	2,000.00	2,000.00	23200	23,200	12,800
Vegetables & floriculture	Tonnes/ha	na	0		-		0	800

Irrigation enhanced production				2011 report Price $/unit	2014 report Price $/unit	*Var Cost/ha $/ha/yr*	*Devt Cost $/ha/yr*	*Net Margin Net $/ha*
Pasture	SU/ha		12		102.00	331.35	0.00	893
Apples	TCE/ha		3,750	23	22.50	46,934.00	6,113.00	31,328
Kiwifruit	Trays/ha		12,000	13	8.80	71,750.00	7,070.00	26,780
Grapes	Tonnes/ha		9	2,150	1,800.00	10,873.00	4,058.00	369
Berries	Tonnes/ha		20	2,000	2,000.00	23,200.00	2,195.00	14,605
Vegetables & floriculture	Tonnes/ha		0		0.00	0.00	0.00	800

Source: NZIER

Assumptions for estimation of the impacts of non-augmentation and the effects of augmentation on increasing production from current irrigated area and from new irrigated area are based on the 2011 Cook and Northington report with some changes.

Areas of currently irrigated land with different crop types have been reduced on a pro rata basis to accommodate 400 hectares in use by outdoor and indoor vegetables.

Crop yields and prices have been adjusted in some cases with reference to feedback from consulted growers and the Ministry of Primary Industries farm monitoring models.

Cost and margin assumptions have been adjusted in response to feedback from growers consulted and information contained in the MPI's farm monitoring models.

D.2 Electricity generation add-on

The 2011 Economic Impact report (Cook & Northington Partners 2011) provides details of a hydro-electric add-on option. This would have 1200 kW output capacity, generating 6.4 GWh per year. The report assumed a total additional capital cost of $4.5 million (in 2010 dollars), comprising $2.65 million on generation equipment and $1.85 million on connections and upgrade to the distribution network. Staffing costs were assumed to be zero with labour input absorbed by existing dam staff and systems, but there would be operational overheads of $129,000 per year (including contribution to dam operations and maintenance). The report estimated the revenue to be $493,000 per year, assuming a wholesale price of 8 c/kWh ($80/MWh). It concluded that the hydro generation option was marginal unless a higher wholesale price was received by the generator.

The 2011 report coincided with the end of a period of long term rise in wholesale electricity prices, which has resulted in an overhang of consented new generation capacity that is not being built, pending recovery in price trajectory. The planned decommissioning of three gas and coal generating units at Huntly Power Station in stages between 2014 and 2020 will reduce the excess of generation capacity, but countering this is uncertainty over the future of the Tiwai Point aluminium smelter, which if closed would free up substantial spare capacity. Significant rises in wholesale electricity prices look unlikely over the next 5 years or so.

To update the analysis we have adjusted the capital costs from 2011 with Statistics New Zealand's Producer Price Index (PPI) for heavy civil engineering and construction and the operational costs with the PPI for electricity and gas supply, to bring the costs up to March 2014 dollar terms.

We have also received an opinion that the earlier assessment overstated the amount of work that would be required to add the generation capability to the dam.[13] In that opinion, there is no structural alteration required of the dam; turbines will be installed in outlet pipes that will be required anyway, and ancillary structures such as generator shed and connection to the local distribution network would not involve major construction. On that basis, the generation installation at the dam could cost around $1.5 million and the ancillary connection works no more than $1.0 million, almost halving the capital cost of the hydro generation option. The operational costs would also be much lower at around $40,000 per year.

The original, updated and alternative hydro options are compared in Table 21 below. This shows the effect of two different discount rates – the 5.5% rate used in the 2011 assessment and the 8% rate used by the New Zealand Treasury as its default public sector rate for infrastructure investment.

The result shows the 2011 assessment discounted at 5.5% as marginal with $50,000 surplus per year. The updated version is even more marginal, because although the costs have been updated the price is unchanged at $80/MWh. In each case the long run marginal cost of generation from the plant is less than the expected price of $80/MWh so the plant would be worthwhile, but it would not be the most cost effective new generation option given the existence of geothermal plant proposals with LRMC of around $70 or less.

[13] Pers. Comms with David Inch of NZ Energy Ltd

The alternative option with lower capital and operating costs appears less marginal, returning $290,000 or 11.6% on its investment. The difference from the updated estimate from the previous reports is because both the annualised capital cost and the operational costs have substantially reduced, while the output and revenue earned from it remains the same. Its long run marginal cost is $35.37/MWh which is far lower than that of stand-alone new generation, a result obtained by adding to a dam that is already built. Some of its surplus can be considered to be an implicit rental for occupying the dam, and depending on ownership arrangements it would be available to defray some of the cost of building and operating the dam.

Table 21 Economics of the hydro-generation option

2010 $ terms; excluding GST and before allowance for direct taxes

	2011 version	Update	Alternative	2011 version	Update	Alternative
	$m	*$m*	*$m*	*$m*	*$m*	*$m*
Capital cost	4.5	**4.9**	**2.5**	4.5	4.9	**2.5**
Annualised/yr	0.34	0.36	0.19	0.42	0.46	0.23
Operations/yr	0.13	**0.14**	**0.04**	0.13	**0.14**	**0.04**
Total $m/yr	**0.46**	**0.50**	**0.23**	**0.55**	**0.59**	**0.27**
Revenue $m/yr	0.51	0.51	0.51	0.51	0.51	0.51
Surplus $m/yr	**0.05**	**0.01**	**0.29**	**-0.04**	**-0.08**	**0.24**
LRMC: $/MWh	$72.57	$78.36	$35.37	$86.02	$92.89	$42.84
Price $/MWh	$80.00	$80.00	$80.00	$80.00	$80.00	$80.00
Margin $/MWh	$7.43	$1.64	$44.63	-$6.02	-$12.89	$37.16
Discount rate	5.5%	5.5%	5.5%	8.0%	8.0%	8.0%
Term years	25	25	25	25	25	25
GWh/year	6.4	6.4	6.4	6.4	6.4	6.4

Source: NZIER

The comparison of the three versions with an 8% discount rate (to the right of the table) shows that both the 2011 version and its 2012 update would have a net annual loss on the assumptions used here, whereas the alternative configuration would still return $240,000 a year before tax. Company tax at 28% would be $80,000 a year at 5.5% discount rate or $67,000 a year at 8% discount rate, leaving $206,000 or $67,000 as potential contribution towards the overall cost recovery from the dam.

The hydro-electric add-on could therefore be a worthwhile addition to the dam's revenue sources if the costs were substantially less than those in the 2011 study. Our information from a company with practical experience of building and running similar sized generation plant would suggest that is possible.

Aside from financial return, the hydro-electric add-on would provide about 0.8% of the electricity currently carried by network Tasman. On its own it provides little additional security to the Nelson-Tasman area, which is a net importer of electricity at the end of a long transmission spur, but combined with other small distributed generation it would contribute to resilience against breaks in transmission.

Appendix E People consulted for this analysis

Trevor Bolitho	Waimea Estates
Rob Conning	Conning Market Garden
Nick Dalgety	Ministry of Primary Industries
Brian Gargiulio	Market Gardeners (MG)
Evan Heywood	Heywood Farms
Andrew Kinnimont	Hoddy Fruit-growers
Neil McCliskie	Alandale Orchards
Mark O'Connor	Appleby Fresh
Nick Patterson	Wai-West Horticulture
Philip Woollaston	Woollaston Estates
Alister Morison	Cold Storage Nelson
Clayton McIntyre	ENZA International
Terry Kreft	Plant Manager, Alliance Group
Chris Turner	Nelson Pine
Philip Wilson	Nelson Pine
Wayne Mackey	Network Tasman
David Inch	NZ Energy Ltd