Appendix 31: Economic Modelling

1. Introduction

In this paper, the assessment of the economy-wide effects resulting from the introduction of measures to clean up the Waikato River is undertaken through a modelling framework that is based primarily on economic input-output (IO) analysis. Today, IO analysis is one of the most widely applied methods in economics, with the approach being especially popular in the study of regional-level economics (Miller and Blair, 2009). One of the core strengths of IO analysis is that it captures the complex interactions and interdependencies occurring between different actors within an economy. This means that it is possible to consider a vast number of the indirect or flow-on effects that occur throughout an economy as a result of any type of economic change. IO analysis also enables economic impacts to be evaluated at the level of individual sectors or industries, thus providing a disaggregate picture of the nature of economic impacts.

2. Selection of an appropriate modelling framework

As stated above, this paper utilises IO analysis to assess the economic impacts on the Waikato and New Zealand economies associated with the proposed restoration actions under Scenarios 2 and 3 (refer Section 6 of the main Report). The full details of this approach are contained in the remainder of this paper.

It is important to note that alternative methodologies do exist for assessing economic impact, with the key alternative being the use of Computable General Equilibrium (CGE) modelling. The authors of this paper are widely published in the application of both input-output (see, for example, McDonald and Patterson (2004); Patterson and McDonald (2004); McDonald et al., (2006); Patterson et al., (forthcoming); and Smith and McDonald (forthcoming)) and computable general equilibrium (see, for example, Zhang et al., (2008); and Yeoman et al., (2009)) techniques. Key studies undertaken by the authors include the official 1999 and 2003 America's Cup EIAs (Economic Impact Analysis) for the Office of Tourism and Sport/Ministry of Tourism, the EIA of the 2011 Rugby World Cup for the New Zealand Rugby Football Union, EIAs for Auckland International Airport, Exercise Ruaumoko and numerous others.

Based on this experience the authors would like to note several key reasons for the adoption of IO rather than CGE in this Study:

- **Paucity of regional/national data.** The development of a CGE model would require the creation of a multi-regional Social Accounting Matrices (SAMs), if both regional and national impacts were to be reported. No multi-regional SAMs have been generated in New Zealand to date[1]. The production functions used by CGE models require elasticities of demand for each factor component (i.e., K, L). While this data exists in unit statistical records held by Statistics New Zealand, it is however not readily available. Similarly, no regional, and only limited *ad hoc* national, data exists for elasticities employed for household/government/etc. utility functions – a further requirement of CGE models.

- **Comparative statics and transitional dynamics.** The key advantage of CGE over IO is that dynamic behaviour can be simulated, including impacts associated with investment and employment and price change. A key limitation however is that most current CGE models utilise only a comparative static framework based on recursive dynamics i.e., the long-run impact. Unfortunately, this tells us little about the transitional dynamics associated with the driving shocks.

- **Scenario analysis versus optimisation.** The key advantage of the IO over the CGE approach is that it is well suited to studying transitional dynamics through year-by-year comparisons.

- **Timeframe and budget.** Final key reasons for the selection of IO rather than CGE were the constraints of time and budget for this Study.

3. Methodology

Prior to describing the specifics of the methodology, it is helpful to provide readers, particularly those not familiar with input-output analysis, with a brief introduction to the IO framework[2]. This introduction is provided in Section 3.1. The remaining sections of the methodology describe the way in which the three scenarios[3] are incorporated into an IO framework, including the major assumptions that are applied.

3.1 Input-output analysis

At the core of any IO analysis is a set of data that measure, for a given year, the flows of money or goods among various sectors or industrial groups within an economy. These flows are recorded in a matrix or 'IO table' by arrays that summarise the purchases made by each industry (its inputs) and the sales of each industry (its outputs) from and to all other industries. By using the information contained within such a matrix, IO practitioners are able to calculate mathematical relationships for the economy in

[1] Several attempts are, however, currently underway in academia.
[2] Those who wish to learn more about input-output analyses can refer to authors such as Miller and Blair (2009).
[3] Refer to Section 6 of the main Report for a detailed description of the three scenarios which were analysed. Note that this appendix refers to Scenario 1 as BAU (business as usual), Scenario 2 as BMP (best management practice) and Scenario 3 as EBMP (extended best management practice). The BAU, BMP and EBMP terms were subsequently dropped in the final Report but the nature of the scenarios and the actions they cover have not changed.

question. These relationships describe the interactions between industries, specifically, the way in which each industry's production requirements depend on the supply of goods and services from other industries. With this information it is then possible to calculate, given a proposed change to a selected industry, all of the necessary changes in production that are likely to occur throughout supporting industries within the wider economy. For example, if one of the changes anticipated for the Waikato region were to be an increase in the amount of dairy farming, the IO model would calculate all of the increase in outputs required from industries supporting dairy farming (e.g., fertiliser production, fencing contractors, farm machinery suppliers), as well as the industries that support these industries.

Typically the variables that drive an IO model – in other words, the variables that are used as inputs and which determine outcomes of all other variables – are the variables that are referred to as 'final demands'. Final demands constitute the value of each industry's output sold to final markets for production. These final markets are comprised primarily of consumption purchases by households, sales to government, private domestic investment and exports. The value of milksolids sold by dairy farmers to the dairy processing industry, for example, does not constitute a sale to final demands, whereas the value of cheese that is produced from these milksolids by the dairy processing industry and sold as exports is recorded under final demands.

As with all modelling approaches, IO analysis relies on certain assumptions in its operation. Among the most important is the assumption that the input structures of industries (i.e., technical relationships) are fixed. In the real world, however, technical relationships will of course change over time as a result of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason IO analysis is generally regarded as most suitable for short-run analysis, where economic systems are unlikely to change greatly from that which generated the initial data. It can however be noted that in this Study, some effort has been made to incorporate structural differences in the economy between the three scenarios assessed, through the generation of differing IOs for each scenario (this is discussed further below).

3.2 Incorporating the scenarios into the modelling framework

The following sections outline the way in which the scenarios are captured in the modelling framework, and the process used to calculate final economic impact results for each scenario. Essentially, the scenarios are incorporated into the model by using financial information produced in the accompanying appendices of this Study as inputs to the model, along with a series of assumptions regarding the funding arrangements for restoration actions. This is explained in more detail in the following sections of this appendix. As a summary, Figure 1 below (which uses Scenario 2, best management practice (BMP), as an example) shows the way in which information produced in the appendices (depicted in the blue boxes in the diagram) flows into the IO model. The primary components of the IO model are depicted in the grey boxes. The final results that are produced by the model (depicted in orange at the centre of the diagram) are the value added and employment effects associated with the scenario. Note that all results are reported in terms of the net change from the business as usual (BAU) scenario – Scenario 1. For example, the value added impact reported for Scenario 2 (BMP) is not the total value added in the economy under the scenario, but rather the difference in value added between Scenario 1 (BAU) and Scenario 2 (BMP). Table 1 shows how the various types of capital and operating expenditures for bundle of restorative actions (e.g., to do with tuna or shallow lakes) were implemented into the IO framework.

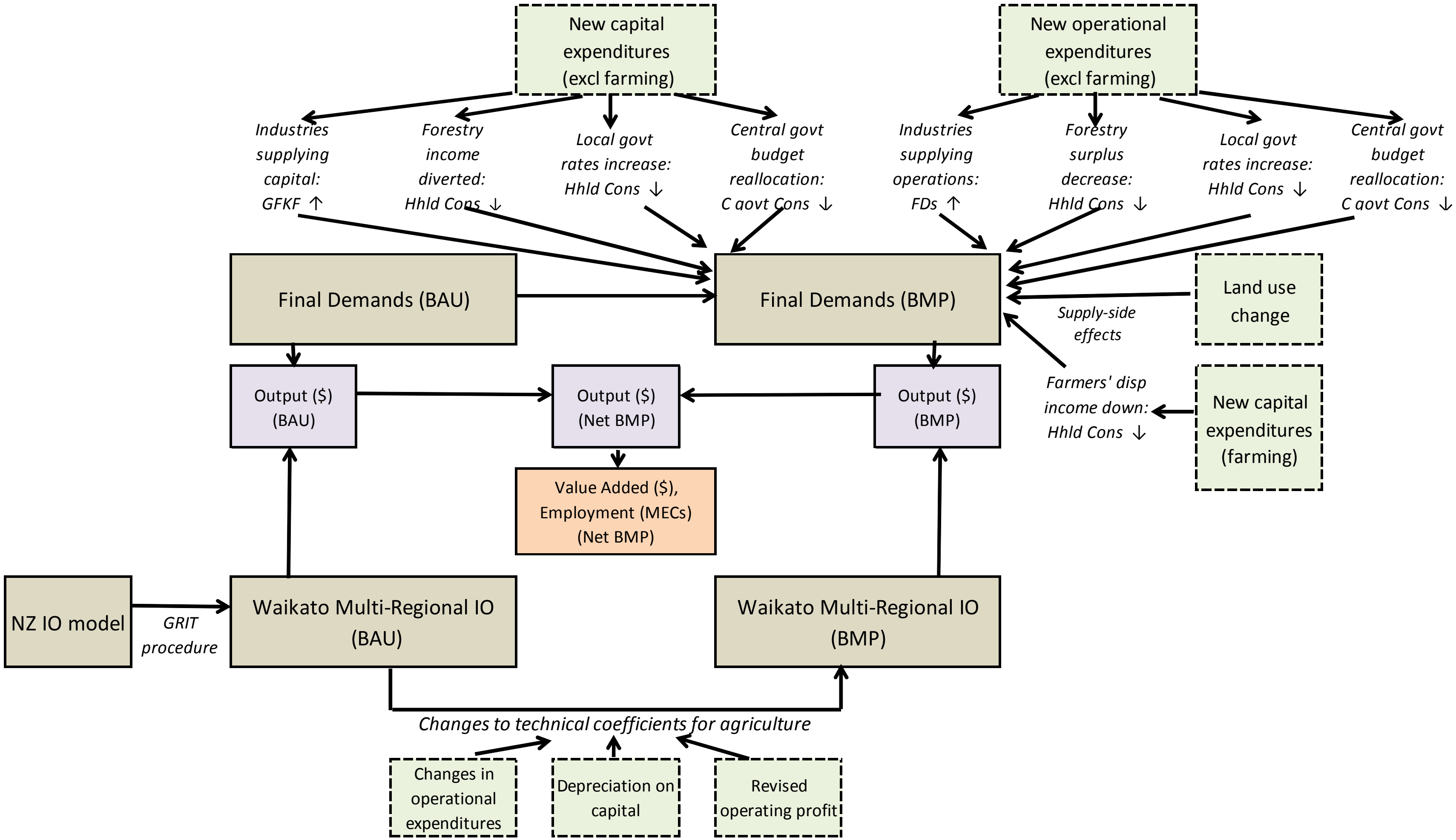

Figure 1: Summary of the modelling framework and input data used to estimate the economic impact of Scenario 2 (BMP).

Table 1: Implementation of capital and operating expenditures into the MRIO framework.

		Capital Expenditure					*Operating Expenditure*				
	Land use change[1]	Is there a change in Gross Fixed Capital Formation?[2]	Is there an associated change in industry investment?[3]	Is there an associated Central Government budget reallocation?[4]	Is there an associated change in local Government rates?[5]	Are adjustments for depreciation on the capital expenditure necessary?[6]	Are there significant structural changes in the input mix of Waikato region industries?[8]	Are there significant changes in the operating surplus of industries per unit of output?[9]	Are there changes in industry output associated with operating activities?[10]	Is there an associated Central Government budget reallocation?[11]	Is there an associated change in local Government rates?[5]
Farming	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No
Forestry	Yes	Yes	Yes	No	No	No[12]	No	Yes	Yes	No	No
Shallow Lakes	Yes[13]	Yes	No	Yes	No	Yes[14]	No	No	Yes	Yes	No
Aesthetics	Yes[13]	Yes	No	Yes	No	No	No	No	Yes	Yes	No
Tuna	No	Yes	No	Yes	Yes	Yes[15]	No	No	Yes	Yes	Yes
Whitebait	No	Yes	No	Yes	Yes	Yes[16]	No	No	Yes	Yes	Yes
Engineering	No	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Social and Cultural	No	Yes	No	Yes	No	Yes[17]	No	No	Yes	Yes	No

Notes

1 This refers mainly to agricultural/forestry land use conversion between the sheep and beef farming and forestry, but to a lesser degree land lost in meeting the mitigation actions. It is captured in direct terms by estimating the net change in gross output associated with the land use change. Downstream economic impacts are captured through the use of a Ghosh inverse matrix.

2 This refers to an increase in capital expenditure. This is implemented by an addition to the appropriate industry forming the capital in the GFKF final demand column.

3 This refers to a change in the funds available to households for investment due to loan servicing by farmers/foresters. This is implemented by a pro-rata change in capital purchases by households in the GFKF final demand column. This change affects not only household capital purchases in the Waikato region, but also purchases by Waikato residents from the rest of NZ.

4 This refers to a central government budget reallocation due to increased loan servicing as required to pay for the capital expenditure. The additional expenditure on loan payments is financed by equivalent reductions in central government investment elsewhere. This is implemented by subtractions from the GFKF column of final demands. The impact is felt throughout all of NZ.

5 This refers to an increase in local government rates due to increased loan servicing as required to pay for the capital expenditure or increased payments for operational expenditure. This is implemented by a pro-rata subtraction from household consumption final demand of the increased rates value. This impact is greatest in the Waikato region.

6 In some cases it may be necessary to depreciate the capital expenditure through time. This is implemented by adding the depreciation value to the Consumption of Fixed Capital row. A real depreciation rate of 5.51% p.a. is assumed i.e., 8.50% p.a. nominal with an adjustment for inflation of 2.84% p.a. The inflation rate was determined using a six-year average (2004 to 2010) of inflation as recorded by the Reserve Bank of NZ (RBNZ).

7 Loans include both principle and interest. A real interest rate of 5.51% p.a. is assumed i.e., 8.50% p.a. nominal with an adjustment for inflation of 2.84% p.a. The inflation rate was determined using a six-year average (2004 to 2010) of inflation as recorded by the RBNZ. All loans are assumed to have a 20-year term.

8 Structural changes are accounted for by updating the technical coefficients in the MRIO based on information contained in the Farms appendix.

9 This refers to change in the operating surplus of an industry due to changes in operating expenditure. The impacts associated with the gain/loss in income are implemented by adjusting up/down the household consumption component of final demands on a pro-rata basis.

10 This refers to changes in operational expenditures leading to associated increases/decreases in the demand for output of industries providing operational activities. This is implemented by additions/subtractions to the total final demands of each industry providing operational activities.

11 This refers to a central government budget reallocation due to increased funding of operational expenditure. This is implemented by pro-rata subtractions to the entries in the consumption of central government services final demand column. This impact is felt throughout NZ.

12 Capital costs associated with planted forest are not normally depreciated. IRD allows for land development costs to be spread over time as per depreciation. This is implemented through a decrease in operating surplus, but without the corresponding increase in consumption of fixed capital.

13 Land lost to riparian margins accounts for 1,761 ha in the Shallow Lakes appendix, and a further 1,450 ha in the Riparian Aesthetics appendix.

14 Depreciation is calculated for the items including infiltration filters, weirs, netting, wave barriers, toilets, jetties.

15 Depreciation is calculated for retrofitted culverts, retrofitted flood pumps, and netting used for protection from hydro intakes.

16 Depreciation is calculated for fish-friendly tide gates and culverts.

17 Depreciation is calculated for the following items: foot/cycle paths, capital items associated with historic sites, education of waananga, and monitoring databases.

3.2.1 Development of a Waikato input-output table

As already stated, at the core of an IO modelling framework is a matrix recording transactions between different actors within an economy. Each column of the matrix reports the monetary value of an industry's inputs, while each row represents the value of an industry's outputs. Sales by each industry to final demand categories (i.e., households, local and central government, gross fixed capital formation, etc.) are also recorded, along with each industry's expenditure on primary inputs (wages and salaries, consumption of fixed capital, gross operating surplus etc.). Clearly the data requirements for constructing these IO matrices are enormous, and it is partly for this reason that IO tables are only produced in New Zealand on an infrequent basis. The latest available IO table for the New Zealand economy is based on data for the 1995–96 financial year (Statistics New Zealand, 2001). A subsequent supply-use table, which contains much of the information required to generate an IO table, is however also available for the 2002/03 financial year (Statistics New Zealand, 2007).

The first major step required for the assessment of economy-wide effects is to generate an appropriate IO table for use in the Study. Essentially two major tasks were involved: (1) production of an updated IO table for New Zealand; and (2) regionalisation of the national table so as to produce an IO table for the Waikato region. In terms of the first task, Market Economics Ltd (MEL) has produced an IO table for New Zealand for the year ending March 2007. This is the latest year for which all economic data required to produce an updated table are available. The New Zealand IO is essentially derived by converting the 2002/03 national supply-use table to an IO table, and then updating this table to 2006/07 using data contained within the National Accounts (i.e., gross output, value added and taxes by industry), as well as international merchandise (imports and exports of products classified according to the harmonized system) and Balance of Payments (imports and exports of services) data. Relationships between industries, or technical coefficients[4], are assumed to remain consistent with those in the 2002/03 table.

In terms of the second task, the Generating Regional Input-Output Tables (GRIT) procedure (Jansen et al., 1979; West et al., 1980) was relied on to produce a regional table from the 2006/07 national table. This method consists of a series of mechanical steps that reduce national input-output coefficients to sub-national (regional) equivalents with reference to available regional data. In this case reference was made particularly to employment by industry, population and household income data for the Waikato region.

[4] Refer to Section 3.2.2 for a description of technical coefficients.

A final important point to note about the IO framework utilised in this Study is that it is multi-regional. This means that the model considers not only the relationships between economic actors within the Waikato region, but also the relationships between economic actors within the Waikato and those in the rest of New Zealand. This multi-regional approach provides a means to evaluate the nation-wide implications of the possible clean-up options. The IO model utilised for each scenario contains 48 different economic industries by three different regions (Waikato region, rest of the North Island and rest of New Zealand).

3.2.2 Incorporating economic structural changes into the input-output table

The IO table developed for the Waikato region contains information on the production requirements of each industry in the Waikato economy. By selecting a column pertaining to a specific industry from the table, it is possible to view the total value of inputs purchased by that industry, from all other industries. For illustration, a simplified version of the dairy cattle farming column in the Waikato IO table is provided in Table 2 below. This table shows, for example, that Waikato dairy farmers purchased around $320 million of services from tertiary industries in the 2006/07 financial year.

Table 2: Inputs to dairy cattle farming in the Waikato region, 2006/07 ($mil)

		Dairy Cattle Farming
Industries	*Primary Industries*	236
	Chemical manufacturing	26
	Other manufacturing	217
	Tertiary industries	319
Primary inputs		1,042
Total		1,840

Table 3: Technical coefficients for dairy cattle farming in the Waikato region, 2006/07

		Dairy Cattle Farming
Industries	*Primary Industries*	0.13
	Chemical manufacturing	0.01
	Other manufacturing	0.12
	Tertiary industries	0.17
Primary inputs		0.57
Total		1.00

As part of the process of constructing an IO model, it is necessary to take the information contained within an IO matrix and derive so-called 'technical coefficients'. These technical coefficients indicate how much input is required to produce one dollar's worth of output for any quantity of production, and are derived assuming continuous, linear relationships between the inputs and outputs of each industry. In order to calculate the technical coefficient for inputs of tertiary industries into dairy cattle farming in the example above, it is necessary to simply divide the total input of tertiary industries to the dairy cattle farming industry, by the total output (also equal to the total input) of dairy cattle farming (refer to Table 3). The technical coefficient of inputs from tertiary industries into dairy cattle farming is thus 0.17.

In this Study, the technical coefficients derived from the Waikato IO table are assumed to apply to Scenario 1 (BAU). A core task undertaken for the assessment of the economy-wide effects associated with Scenario 2 (BMP) and Scenario 3 (EBMP) has then been to develop a modified table of technical coefficients for each of the two scenarios. Due to the nature of the scenarios, it has only been considered necessary to alter the technical coefficients for the farming industries, as it is these industries that primarily undergo structural change in the two scenarios. In summary, the process for modifying the technical coefficients for farming industries involves three steps:

Step 1 Separate out data for the Waikato River reaches from the base IO table.

In the base input-output table, the data pertaining to each industry is an aggregation of the data for all business activities across the region classified within that particular industry category. The first major step required for the modification of the IO table for agricultural industries is thus to disaggregate the data for each industry into two components: (1) data which relate to activities located within the Waikato River reaches (WRR); and (2) data which relate to activities located in the rest of the Waikato region (RWR). The result for dairy cattle farming, for example, is that instead of the IO table containing one column of data that specifies the value of each input to the industry, two columns of data are provided in the IO table – the first specifies the value of inputs into dairy cattle farming that is located within the WRR, while the second contains the value of inputs into dairy cattle that is located in the RWR.

Data on value added by industry type and by location are used for disaggregating the input column of each agricultural industry into two columns for the WRR and RWR respectively[5]. Very simply, for each agricultural industry the proportion of a total input value ($2007) in the base industry input column that is allocated to the WRR is equivalent to the proportion of that industry's total regional value added that is estimated to have been produced from within the WRR.

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[5] Statistics New Zealand's Annual Enterprise Survey (AES; www.stats.govt.nz) contains data on employment counts (ECs) by meshblock at the very detailed 6-digit ANZSIC industry level. Market Economics Ltd has created modified employment counts (MECs) based on these data, which unlike standard ECs, include estimates of the numbers of working proprietors for each industry types. Total value added for horticulture and fruit growing, and forestry and logging for each of the two areas' WWR, and RWR are estimated by first collating the total number of MECs for each 6-digit ANZSIC type across the two areas, and then multiplying by the average NZ value added per MEC for each 6-digit ANZSIC industry. An adjustment is also made to account for differences in productivity between regions by using agglomeration elasticity scalars (Maré and Graham, 2009). Finally the value added is aggregated across all 6-digit ANZSIC industries that make up horticulture and fruit growing, and forestry and logging respectively.

Step 2 Adjust input transactions to reflect new costs structures for agricultural industries

Scenario 2 (BMP) and Scenario 3 (EBMP) entail some quite significant structural changes for farming in terms of the quantities of various inputs that are required per unit of farming output produced. The application of nitrification inhibitors to dairy farming pastures will, for example, require an increase in the input costs for agricultural chemicals. Similarly, increased costs are also proposed under Scenario 3 as a result of the additional labour required for the management of herd shelters during winter. By contrast, some reduction in operational costs are also presumed for dairy farming under both scenarios as a result of improved nutrient management, enabling a greater proportion of the nutrients contained within animal effluent to be captured and recycled, thus reducing fertiliser requirements. In Step 2, each of these new operational costs identified for Scenario 2 and 3 are either added to (where operational costs increase) or subtracted from (where operational costs decrease) the inputs column of the appropriate WRR agricultural industry in the scenario's IO table.

Scenarios 2 and 3 also imply changes in capital expenditures for farming. Additional capital costs are, for example, associated with fencing, construction of herd houses and so on. Importantly, an industry's purchases of capital are not included within the industry's inputs column in an IO table, although the depreciation on capital (called 'consumption of fixed capital') is included (i.e., under the primary inputs category). This approach is consistent with standard accounting practice in that depreciation on capital is viewed as an expense for industries (i.e., an input in the IO table). In order to capture the additional capital expenditures for farming in the IO tables of Scenarios 2 and 3, it is thus necessary to make appropriate adjustments to the depreciation inputs for each industry. A depreciation schedule listing all additional capital items purchased by each agricultural industry is used to calculate the additional depreciation on capital incurred by each agricultural industry for each year of the Study under the two scenarios. A real depreciation rate of 5.51 percent is applied across all capital items for the purposes of these calculations. Having calculated the depreciation for each year, these values are then averaged across the whole of the Study period so as to derive an average increase in depreciation for each agricultural industry for the two scenarios. These values are used to adjust the IO tables for Scenarios 2 and 3[6].

Operating profit is another important primary input category included in the inputs column for each industry. It should be noted that for every change in operational costs for farming, there will be an associated impact on operating profit. Say for example, if

[6] Note that the Study team have not included expenditures on planting in the depreciation calculations. These costs are classified as land development expenditures and thus do not attract depreciation.

the fertiliser costs for Waikato dairy farmers were to decrease but the Study team were to assume that the price received for milksolids were to remain constant, the net result for dairy farmers would be an increase in operating surplus. It is thus necessary to also make appropriate changes to the operating surplus entries in the IO tables to reflect the operational changes proposed for farming. Appendix 9: Farms provides estimates of the revised cash operating profit generated by each farming type, per hectare, according to the new agricultural practices proposed under each scenario. This information is used as a starting point for adjusting the operating surplus entries in the IO tables to reflect the new scenarios.[7] Appropriate additions and subtractions are also made to the new estimates of operating surplus to account for the changes in operational expenditures proposed under the two scenarios as well as the additional depreciation on new capital items.

Step 3 Recalculate technical coefficients

The above steps result in the production of a new column of input transactions for each agricultural industry in the WRR and for each scenario. In the final step, these input transaction columns are added back together with the appropriate parent industry input transaction column, thereby producing two new IO tables for Scenarios 2 and 3 respectively. Having completed these tasks, it is then possible to calculate coefficient matrices for the two scenarios.

3.2.3 Estimating future final demands

As stated above, primary demand variables constitute a core input into the IO model. For each of the three scenarios investigated in this Study it has therefore been necessary to generate a set of annual final demand projections by economic industry, covering the period 2011 to 2040. For Scenarios 2 and 3, the final demand projections for a particular year are developed by taking the final demand data from the base IO table, and then making appropriate additions and subtractions to capture the implications of each scenario occurring in that year. For Scenario 1 (BAU), the final demand projections are simply assumed to remain constant with those of the base year[8].

The additions and subtractions that are made to the final demand variables for Scenarios 2 and 3 are undertaken essentially to capture the capital and operational expenditures

[7] A series of steps are first required to convert cash operating profit to operating surplus. These include the removal of tax from the data, application of price deflators, and the apportionment of profit among the two primary input categories 'compensation of employees' and 'operating surplus'.

[8] Over the course of the Study period it is likely that there will be a number of external factors causing final demands variables to grow and change over time, such as demands for commodity exports, oil prices, government policies and so on. Given that these factors will impact on each scenario equally, and that the Study team are only interested here in calculating the net changes between scenarios, it has not been necessary to attempt to incorporate these influences in the future projections of final demands.

derived for the various restoration actions. Some changes in final demand variables are further necessary to capture changes modelled in the analysis of farming systems (see Appendix 9: Farms). The methods used to capture these changes in final demands are discussed in more detail below.

3.2.3.1 Capital expenditures

For most of the various restoration actions considered (see accompanying appendices) there are capital items that are proposed to be introduced under Scenarios 2 and 3. Examples include the flood pumps and hydro screening necessary for tuna (freshwater eels) restoration (Appendix 5: Tuna), boat ramps (Appendix 25: Boat ramps), marae (sacred meeting place) water treatment facilities (Appendix 17: Marae water supply), and the new education waananga (fora) (Appendix 27: Engagement). For the sake of consistency and convenience, all capital items from these appendices are treated in a similar manner. Two steps are required in order to incorporate the capital items into the IO model:

Step 1 Increase gross fixed capital formation

When an industry sells output for the purposes of forming new fixed capital items, this sale is included in the final demands category called gross fixed capital formation (GFKF). The first step required for the inclusion of a capital item in the IO model is therefore to determine which industries are responsible for supplying the capital item. In terms of footpaths and cycle paths it is, for example, assumed that 100 percent of the costs of the capital are supplied by the construction industry. For those industries deemed to be responsible for supplying, sales to GFKF are then increased by a value equivalent to the costs of the capital items supplied. Note that for plant and machinery capital items it is assumed that 20 percent of the value of the capital is obtained from offshore.

Step 2 Allocate funding for the provision of capital items

The next step is to derive and apply assumptions around the funding of capital items. For the majority of the capital expenditures specified in Scenarios 2 and 3, it is assumed that central government is responsible for providing an appropriate funding source. There are, however, a few capital items specified in the scenarios, such as the capital required for improved municipal wastewater treatment, where it is considered that funding is more likely to come from local government.[9] Overall, summing all capital expenditures identified, it is assumed that 24 percent is provided by local government and 76 percent

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[9] If it is assumed instead that capital assumed are funded by the private sector, considerable additional work would be required to calculate the impacts due to the necessity to capture structural changes in the IO table. Not only would it be necessary to incorporate these changes in the IO table for each scenario, it would also be necessary to construct new IO tables for each year of the Study.

by central government under Scenario 2, while under Scenario 3 the funding split is seven percent local government and 93 percent central government.

Having determined who pays for capital, it is then necessary to determine the way in which capital is funded. In this Study it is assumed that all new capital items are paid for over time through a loan system. The total loan payments incurred by central and local government for each year of the Study are calculated by assuming that a loan payback period of 20 years and a real interest rate of 5.5 percent are applicable to all capital items.

In order to generate a budget that is sufficient to cover the additional loan payments associated with new capital items, it is assumed that local government undertakes an increase in household rates[10]. A corollary of the rates increase is that Waikato households will have reduced funds available for the consumption of other goods and services. This effect is captured in the IO model by decreasing all purchases by Waikato region households (i.e., household final demands) on a pro-rata basis by a total amount equivalent to each year's additional loan payment.

In terms of central government, it is assumed that the additional loan payments required to finance new capital are met by reductions in central government investment elsewhere. This is implemented by reducing GFKF for all regions in New Zealand, with the total reduction in capital for each year equivalent to that year's additional loan payments.

3.2.3.2 Capital expenditures (farming)

The impact of new capital items on farm profitability, as well as the depreciation on new capital items for farming, have already been included in the IO model via the changes made to farming input structures (refer to Section 3.2.2). To complete the treatment of agricultural capital items, it is now necessary to make appropriate adjustments to final demands so as to capture the impacts of funding capital. In this Study it is assumed that all additional capital items required by farms under the Scenarios 2 and 3 will be funded directly by farmers[11]. As with the capital items discussed above, it is also assumed that farmers use a loan system to spread the costs of capital across time.

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[10] It is possible that local government would also increase rates for businesses in order to fund additional expenditures. Significant additional information would, however, be required to incorporate the effects of a rates increase on businesses within the model, including the distribution of rates payments among industry types and the ownership structures of Waikato businesses.

[11] Incentives for farmers to fund restoration include 'good citizenship', industry accords, premiums for 'clean green' products and statutory requirements.

The first step involved in adjusting final demands for agricultural capital expenditures under Scenarios 2 and 3 is thus to calculate the loan payments incurred by farmers for each year of the Study. A loan period of 20 years and a real interest rate of 5.51 percent are assumed. Next, it is reasoned that the additional investment required to finance the loan payments will divert farmers' expenditure away from other capital investments. This is affected in the model by adjusting down the GFKF column of final demands on a pro-rata basis, with the total reduction each year equivalent to farmers' additional loan payments.

3.2.3.3 Capital expenditures (forestry)

Under Scenario 3 there is additional expenditure required for preparation and planting land for conversion from sheep and beef farming to forestry. In order to incorporate the impacts of these capital expenditures into final demands, it is first necessary to identify which industries will provide the new capital[12]. It is determined that all planting and land preparation will be undertaken by the forestry and logging industry itself, and thus sales by this industry to GFKF are increased to account for the additional capital provision.

The funding for forestry capital items is treated in an analogous manner to farming. It is assumed that landowners are responsible for funding the land preparation and planting costs required for establishing new forest stands, and that this occurs through a loan system with a 20 year payback period and a real interest rate of 5.5 percent[13]. It is also assumed that the funding of these items by landowners will cause a reduction in capital investment elsewhere.

3.2.3.4 Operational expenditures

A range of operational expenditures will be associated with the various restoration actions proposed for Scenarios 2 and 3; for example, costs for pruning required with increased forestry, Marae-based training, ongoing work in restoring stream habitats, and septic tank maintenance. Two major steps are required to include these operational expenditures in the IO model for each scenario.

Step 1 Identify industries responsible for providing operational activities

The first step requires selection of industries that are most likely to be responsible for undertaking each type of operational activity. Then, in order to incorporate the additional output required by industries undertaking these operational activities,

[12] Although these expenditures are actually classified as land development expenditures, rather than capital expenditures in accounting terms, for this component of the Study the distinction is irrelevant.
[13] Incentives for farmers to fund afforestation include 'good citizenship', the desire to control erosion, and the long-term earnings. An impediment is the availability of capital and low income until harvest.

appropriate additions are made to final demands[14]. It is, for example, assumed that Marae-based training is most likely to be undertaken by professional consultants included in the business services industry. The final demands by not-for-profit organizations for business services are thus increased by an amount equivalent to the operational expenditure.

Step 2 Allocate funding for operational expenditures

As with capital expenditures, it is assumed that the additional operational expenditures are funded either directly or indirectly by local or central government. Overall, summing the operational expenditures across all restoration actions, it is assumed that 35 percent and 65 percent of expenditures are funded by local and central government respectively under Scenario 2, and 35 percent and 65 percent under Scenario 3. The same assumptions are also applied in regards to the way in which government funds these expenses. In summary, for those operational expenditures funded by local government, it is assumed that there is a corresponding increase in household rates and a decrease in other household consumption. Operational expenditures funded by central government are assumed to cause a corresponding decrease in all other central government expenses (i.e., final demands).

In regards to forestry, it is assumed that all additional operational expenditures are funded by the forestry and logging industry itself. It is also assumed that the loss in forestry income resulting from these additional expenditures will impact directly on household consumption. Thus for each scenario, household consumption is adjusted downwards on a pro-rata basis. The total value of the decrease in household consumption is equivalent to the total increase in forestry operational expenditures.

3.2.3.5 Operational expenditures (farming)

For the most part, changes in farming operational expenditures under Scenarios 2 and 3 have already been dealt with above in terms of changes to the IO matrices. There is, however, one additional effect resulting from changes in operational expenditures that needs to be implemented via changes to final demands. This effect is the change in consumption expenditures likely to occur as a result of changes in the profitability of farms.

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[14] For the majority of cases, it is appropriate to make the additions within the final demands columns of central and local government sectors. Some operational expenditures (e.g., those associated with Marae water treatment) are, however, more appropriate to include in the final demand column for not-for- profit organisations. For the purposes of calculating the results of this Study, it is actually irrelevant which column of final demands the operational expenditures are added to.

As described in Section 2.2.2 above, changes to both farming practices and operational expenditures under the two scenarios, results in revised estimates of operating surplus for each farming activity. In this Study, it is assumed simply that any change in operational expenditures from Scenario 1 has an equal but opposite impact on household consumption or 'business consumption' for corporate farms. Thus for each scenario, household consumption is adjusted upwards on a pro-rata basis, with the total value of the increase in household consumption equivalent to the total reduction in operational expenditures across all farming types.

3.2.4 Depreciation on capital items

In order to complete the treatment of capital items from restoration actions it is necessary to deal with depreciation of capital. In economic terms, depreciation represents the decrease in value of a capital stock over a year. As already stated above, it is included in an IO table via the primary input category 'consumption of fixed capital'.

As with the depreciation on capital for farming, the calculation of depreciation for capital items associated with other restoration actions, commences with the compilation of a depreciation schedule. This schedule identifies all capital items to be depreciated, the year in which each item is purchased and the industry that is responsible for the new capital. Using this information it is possible to calculate the additional depreciation expense incurred by each industry for each year of the Study, under the two scenarios. Again, a depreciation rate of 5.51 percent per annum is applied in the calculations. Important to note is that many of the capital items included in the restoration actions do not constitute 'fixed capital' and thus are excluded from the depreciation calculations.

Once the additional depreciation for each industry for Scenarios 2 and 3 is calculated, the values are simply added to the primary inputs results for each year of the Study[15].

3.2.5 Incorporating land use changes

In most examples of regional economic impact analysis, the focus is on estimating demand-side effects.

In this type of analysis, the aim is to identify where there is a change in demand for the output of a selected industry, and then estimate the change in output of all up-stream industries from which the selected industry depends for the supply of inputs. In this Study the Study team have endeavoured to capture not only these demand-side (refer to

[15] In order to balance the IO table, any increase in primary inputs of an industry must be matched by a corresponding increase in the outputs of the same industry. It is assumed that the necessary increases in output occur in the final demands columns.

Section 3.3 below) effects, but also the most important supply-side effects associated with each scenario.

Clearly the most important supply-side effects that will occur under Scenarios 2 and 3 are those associated with changes in the amount of land devoted to different types of farming and forestry. In both these scenarios it is envisaged, for example, that there will be quite substantial lengths of riparian margins that will be retired from farming and instead planted with vegetation. In terms of another example, Scenario 3 also envisages that there will be relatively significant conversions of land from agriculture to forestry. These types of land use changes are likely to impact particularly on industries down-stream from farming and forestry, such as dairy product, meat product and wood product manufacturing. The conversion of livestock farms to forestry under Scenario 3, for example, by creating a reduction in the supply of livestock, is also likely to create a reduction in the output of New Zealand's meat product manufacturing industry although this may be compensated by an increase in timber production.

In order to capture the supply-side effects resulting from land use change, reference is made to Ghosh multipliers (Ghosh, 1958, 1964; Miller and Blair, 2009) that are derived from the base IO table. Essentially these multipliers measure, for every unit of output change in a selected industry *i*, the corresponding changes in output of all sectors that depend on sector *i*'s product as an input to their own production processes. Of course, the basic assumption in applying this supply-side approach is that the output distributions within the economic system are stable. This means that if the output of a sector is, say, doubled, sales from that industry to all other industries that purchase from that industry will also be doubled. Although this assumption is unlikely to hold for many economic situations (see, for example, Giarrantani, 1980, 1981), it is considered to be a relatively reasonable assumption to apply in the assessment of changes to Waikato's agricultural and forestry industries. This is because the industries that will be primarily affected by the supply-side effects are those that use commodities produced by agriculture and forestry to produce manufactured products (i.e., dairy product manufacturing, wood product manufacturing, meat product manufacturing etc.). For these industries it is likely that there will be a relatively constant relationship between the availability of commodities for processing and the value of manufactured products produced.

In short, three steps are required for the incorporation of supply-side effects. The first is to estimate the loss or gain in agricultural output for each agricultural industry resulting from land use change. An assumed constant relationship between output and land use is used for this purpose. Second, the change in output for all down-stream industries is estimated through application of the Ghosh multipliers. Finally, reference is made to mathematical identities to determine the change in final demands necessary to affect the calculated change in output resulting from supply-side impacts (i.e., land use change). Note that the final step is to translate the supply-side impacts into changes in final demands, as it is final demands that are used as inputs into the IO model for the purposes of calculating the final results for each scenario.

3.3 Calculating economic impacts

Having derived an IO table and set of final demand projects for each scenario, it is now possible to calculate the economic output ($2007) for each economic industry, both within the Waikato region and the rest of New Zealand. Very simply, the vector of output by industry, *X*, is calculated according to the equation,

$$X = (I - A)^{-1} Y$$

Where *A* is the matrix of technical coefficients, *I* is the identify matrix and *Y* is the vector of final demands by industry. Note that economic output by industry is the core result produced by the IO model. The output series is then translated into the final reporting variables, i.e., value added ($2007) and employment (MECs), by assuming for each respective industry constant ratios between output and the three reporting variables.

It is interesting to note that in many IO applications, the quantities of goods and services that are consumed by households (i.e., the household components of final demands) are treated as exogenous variables. This means that household demands are determined at the outset by the modeller and there is limited ability to capture feedbacks occurring between changes in industrial output and consumer spending. In the real world, however, households (i.e., consumers) earn incomes in payment for their labour inputs to production processes, and thus it is likely that any impacts on industrial outputs which alter labour income will have flow-on implications to consumer spending. Such effects can be viewed as positive (i.e., reinforcing) feedbacks, since changes in consumer spending will further impact on industrial outputs.

Some of the most important induced impacts in this Study arise as a result of additional infrastructure investment. Both Scenarios 2 and 3, when compared to Scenario 1, incorporate considerably larger investment in infrastructure required for the restoration of the Waikato River. Examples include investments in boat ramps, wastewater treatment technologies, and riparian margin planting. For those industries that are responsible for supplying infrastructure, additional household income will be generated associated with the increase in demands for output. On the other hand, negative induced impacts are also associated with the proposed clean-up options. Scenarios 2 and 3 both involve, for example, a reduction in output from the dairy farming industry compared with Scenario 1. This will create associated reductions in consumption by dairy farmers.

In order to capture the feedbacks relating to consumer spending (often referred to as 'induced' impacts in economic impact assessments), this Study utilizes an IO model that is 'closed' with respect to the household sector when calculating the impacts of changes in final demands. According to this approach, households are treated in a similar manner to industries in the IO matrix, with a column and row of the matrix recording inputs and outputs of the household 'sector'. Transactions presented along the household row of the matrix record the income generated for households by each industry within the economy in the form of payments for labour, while transactions recorded in the household column of the matrix record the structure of household purchases (i.e., consumption). Now, if it is assumed that the structure of household expenditure among different product types remains constant irrespective of the level of income, it is possible to calculate a vector of technical coefficients for households which can be included in the *A* matrix described above. When the change in final demands is multiplied by the Leontief inverse, the model will therefore calculate the value of outputs from each industry that will be purchased by households. Household incomes are, in turn, also determined by the level of output of each industry.

4. Results

4.1 Summary results

The summary results generated from this Study are described in Table 4. Based on the modelling approach and assumptions described above, it is calculated that the BMP scenario will generate a relatively neutral economic impact. Over the period 2011-2040, it is estimated that the scenario will result in a net gain in value added for the Waikato region of $\$_{2007}$1,260 million, but a net loss for the rest of New Zealand of $\$_{2007}$1,010 million. For the country as a whole the positive gain in value added is estimated at around $\$_{2007}$251 million, equivalent to just $8.4 million or around 0.005 percent of current GDP on average for each year of the Study. In terms of employment, the estimated increase for the Waikato region under Scenario 2 is 13,900 MEC job years[16], while for the rest of New Zealand the estimated loss is 15,850 MEC job years. Overall, for New Zealand it is estimated that Scenario 2 will result in a net loss of employment of 1,950 MEC job years during the course of the Study period, equivalent to 65 MECs per year or 0.003 percent of employment.

There are a number of reasons why Scenario 2 generates a relatively neutral economic impact when compared with Scenario 1:

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[16] A MEC job year is the employment of one person, measured as one Modified Employment Count (see footnote 4 above) for one year.

- **High multipliers for capital formation.** Scenario 2 entails increased expenditure on capital items above that of Scenario 1. In this Study it has been assumed that all capital items are funded by a loan system, thus entailing relatively significant interest payments. The losses to the local economy associated with these payments are, however, to a large extent balanced by the gains to the economy created through the purchases of capital. This occurs especially because the industries that are responsible for supplying capital (particularly the Construction industry) have relatively high backward linkages in the New Zealand economy.

- **Reductions in purchases of imports.** Related to the above point it is also worth noting that a number of capital expenditures (and operating expenditures) in this Study are assumed to be funded by across-the-board reductions in household consumption. This is important because a proportion of total household consumption is directed towards purchases of commodities produced overseas. The displacement of expenditure on these items towards expenditure on commodities produced in New Zealand acts as net gain for the New Zealand economy.

- **Increases in farming profitability.** The alterations in farming practices (e.g., improved nutrient management) proposed under Scenario 2 result in improved profitability for farming. Although for dairy farmers there is still some reduction in disposable income despite the improved profitability, because of the need to invest greater amounts in capital, for the economy this is more than compensated for by dairy farmer's increased purchases of capital and operational expenditures. These additional expenditures create flow-on impacts through the entire economy and are relatively substantial when aggregated across all farmers within the Waikato River reaches. Overall, the positive economic gains generated from the Farms appendix act to counterbalance the losses to the economy generated from the actions described in the other appendices.

The results calculated for Scenario 3 are less favourable than Scenario 2 in terms of value added and employment impacts. Compared with Scenario 1, it is estimated that Scenario 3 will generate a gain in value added of around $\$_{2007}$602 million (an average of $\$_{2007}$20.1 million for each year of the Study) in the Waikato region, and a gain of 11,590 MEC job years (386.3 per year). For New Zealand as a whole, the value added loss is calculated as $\$_{2007}$4,131 million (137.7 million per year or 0.082 percent of GDP), while the employment effect is calculated as a loss of 56,720 MEC job years (1,891 MEC jobs per year or 0.085 percent of employment).

A core reason for the reduction in value added and jobs under Scenario 3 relates to the effects of land use change. According to Scenario 3, there are significant tracks of land converted from sheep and beef farming to forestry. Under the Study team's model these conversions result in output loss for industries closely connected to sheep and beef farming (e.g., meat processing). Although these effects should, in theory, be compensated by an increase in output for industries closely connected to forestry (e.g., wood processing), these effects are generally outside of the Study team's study due to the large timeframes required for trees to mature to a state that can be harvested. It should also be noted that the loss of dairy farming land due to restoration actions is slightly higher under Scenario 3 compared with Scenario 2. This acts to further increase the impacts of land use change for Scenario 3.

Another observation that can be made from the summary results is that the economic impacts generated within the Waikato region are generally more favourable than those occurring in the rest of the New Zealand economy. The reasons for this are obvious. On the one hand, it is assumed under both scenarios that operational and capital items will generally be provided by industries located within the Waikato, thus creating positive benefits for the regional economy. On the other hand, it is assumed that a significant proportion of the capital and operational expenditures required for implementing the proposed restoration actions will be funded by central government, thus creating some loss in other central government expenditure throughout the New Zealand economy.

Table 4: Cumulative and average net economic impacts, 2011 – 2040; 'best management practice' equates with Scenario 2 and 'extended best management practice' with Scenario 3.

	Cumulative Net Economic Impacts		**Average Net Economic Impacts Per Year**	
	Value Added	**Jobs**	**Value Added**	**Jobs**
	$\$_{2007}$m	**MEC[1] Years**	**$\$_{2007}$m**	**MEC[1] Years**
Best Management Practice				
Waikato Region	1,260	13,900	42.0	463.3
Rest of New Zealand	-1,009	-15,850	-33.6	-528.3
Total	**251**	**-1,950**	**8.4**	**-65.0**
Extended Best Management Practice				
Waikato Region	602	11,590	20.1	386.3
Rest of New Zealand	-4,733	-68,310	-157.8	-2,277.0
Total	**-4,131**	**-56,720**	**-137.7**	**-1,890.7**

Notes

1. Modified Employment Count. This includes both employment counts and working proprietors.

4.2 Distribution of economic impacts across time

Table 5 provides a summary of the way in which the value added and employment impacts under Scenarios 2 and 3 are distributed across time. Not surprisingly, the first year of the Study entails substantial positive economic benefits in terms of value added and employment for both scenarios. It is, for example, estimated that there will be around $\$_{2007}$213 million of additional value added generated under Scenario 2 for the Waikato region during 2011, and $\$_{2007}$521 million under Scenario 3 for the same region and year. These results are a reflection of the significant amounts of capital expenditure that are assumed to occur predominantly during the first year of the Study. This expenditure on capital not only creates value added and employment growth in industries responsible for supplying capital, it also produces flow-on impacts throughout the rest of the New Zealand economy.

As it is assumed that capital items are funded over a period through a loan system, the negative economic consequences of capital expenditure are spread out across time. These negative effects (resulting in reductions in expenditure elsewhere) are more noticeable under Scenario 3 as the scenario contains some very large capital items not included in Scenario 2 (particularly dairy herd shelters and hydro dam intake nets). Note that after 2030 the loss in value added and employment under both scenarios starts to fall away. This occurs because it is assumed that all loans are taken out for a period of 20 years and thus by 2030 a number of the loans have been paid off.

Table 5: Net economic impacts 2011 – 2040; 'best management practice' equates with Scenario 2 and 'extended best management practice' with Scenario 3

	Value Added	Change in Value Added						
	2007	2011	2015	2020	2025	2030	2035	2040
Value Added	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Waikato Region								
Best Management Practice	14,892	213	57	53	24	23	27	65
Extended Best Management Practice	14,892	521	153	89	-50	-51	-37	96
New Zealand								
Best Management Practice	168,365	310	22	3	-31	-31	4	57
Extended Best Management Practice	168,365	762	75	-109	-318	-318	-173	48

	Employment	Change in Employment						
	2007	2011	2015	2020	2025	2030	2035	2040
Employment	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]
Waikato Region								
Best Management Practice	167,731	203	650	634	193	195	262	283
Extended Best Management Practice	167,731	502	2,218	1,420	-862	-861	-654	-564
New Zealand								
Best Management Practice	2,221,400	4,362	78	-163	-618	-594	-84	145
Extended Best Management Practice	2,221,400	11,173	913	-1,507	-4,607	-4,591	-2,532	-1,211

Notes
1. Modified Employment Count. This includes both employment counts and working proprietors.

4.3 Distribution of economic impacts across industries

Table 6 below provides a summary of the value added impacts for each scenario distributed by time and by economic industry. Again the results are relatively predictable. As a general rule, the industries that benefit most across the Study period are those that are primarily responsible for providing the additional capital items and operational activities required under the scenarios. The construction and the business services (included under Industry Group 15) industries, for example, which are both significant providers of capital, show significant increases in value added under both scenarios, especially during the first year. Another interesting observation is that the quite significant gains for Industry Group 9 (other manufacturing) under both scenarios occurs partly because of the changes in operational costs for dairy farming, resulting in increased purchases of nitrification inhibitor chemicals.

The effects of land use change are also evident in the results for Scenario 3. In these regards it can be noted that the livestock and cropping industry, and to a lesser extent the dairy cattle farming industry, exhibits declines in value added across the Study period. These impacts clearly flow onto the meat and meat product manufacturing industries, as well as the dairy product manufacturing industries.

Table 6: Net value added impacts for selected Waikato industries, 2011 – 2040.

	2011	2015	2020	2025	2030	2035	2040
	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Best Management Practice							
1 Other farming and services to agriculture	9	3	4	0	0	0	0
2 Livestock and cropping farming	1	0	0	0	0	0	0
3 Dairy cattle farming	1	0	-1	-1	-1	-1	-1
4 Forestry and logging	5	0	0	0	0	0	0
5 Other primary industries	2	1	1	1	1	1	1
6 Meat and meat product manufacturing	0	0	0	0	0	0	0
7 Dairy product manufacturing	0	0	0	0	0	0	0
8 Other food and beverage manufacturing	0	0	0	0	0	0	0
9 Other manufacturing	30	16	16	8	8	8	9
10 Wood and paper manufacturing	6	2	2	2	2	2	2
11 Utilities	4	2	1	1	1	1	1
12 Construction	58	2	2	0	0	1	1
13 Wholesale and retail trade	16	2	2	0	0	1	1
14 Transport	4	1	1	1	1	1	1
15 Communication, finance, insurance, real estate and business services	60	5	5	1	1	3	3
16 Government	1	21	20	12	10	9	9
17 Other services	6	1	1	1	1	2	2
Total	**203**	**58**	**55**	**25**	**24**	**27**	**28**
Extended Best Management Practice							
1 Other farming and services to agriculture	31	21	18	0	0	0	0
2 Livestock and cropping farming	0	-11	-22	-25	-25	-25	-25
3 Dairy cattle farming	1	-3	-6	-8	-8	-7	-7
4 Forestry and logging	7	48	-6	-13	-11	-10	0
5 Other primary industries	6	2	2	1	1	1	1
6 Meat and meat product manufacturing	0	-7	-13	-15	-15	-15	-15
7 Dairy product manufacturing	0	-1	-2	-3	-3	-3	-3
8 Other food and beverage manufacturing	1	-1	0	0	0	0	0
9 Other manufacturing	65	33	32	7	7	8	9
10 Wood and paper manufacturing	16	8	7	3	3	3	3
11 Utilities	10	2	3	0	0	1	1
12 Construction	162	32	31	2	2	5	7
13 Wholesale and retail trade	39	-1	3	-8	-8	-6	-3
14 Transport	10	9	4	1	1	1	1
15 Communication, finance, insurance, real estate and business services	140	1	15	-5	-5	0	4
16 Government	1	27	24	15	12	11	9
17 Other services	13	-4	1	-1	-1	0	1
Total	**502**	**154**	**89**	**-49**	**-50**	**-37**	**-17**

5. Discussion

This section outlines some of the important caveats and matters for further consideration relating to this Study.

(1) Funding sources for new operational and capital expenditures

When reviewing the results of this Study, a matter that requires particular consideration is the issue of project funding. In these regards it should be noted that, in order to undertake a full assessment of the economic impacts associated with Scenarios 2 and 3, it is essential that each proposed restoration action is allocated to an appropriate funding source. It is further necessary to consider the flow-on implications of the additional funding requirements for each funding source, in terms of reduced expenditure elsewhere in the economy. For the purposes of this Study it has been necessary to make a set of assumptions regarding which organisations/persons will be responsible for funding each restoration measure (both operational and capital expenditures) and the budget reallocations that will occur to provide this funding. It has, for example, been assumed that farmers will be responsible for funding all farming-related capital and operational expenditures, and that these additional expenditures will be financed through reductions in farmers' capital investments and consumption elsewhere. It has also been assumed that the majority of the new engineering infrastructure envisaged under the two scenarios, such as new wastewater treatment facilities, hydro dam intake nets, culverts and so on, will be funded by either local or central government. Where central government is responsible for funding, it is assumed that the funds are made available by reductions in other central government consumption and investment. Where local government is responsible for funding, it is assumed that the funds are made available by increases in rates for regional households. It is further assumed that all capital expenditures are financed by a 20-year loan with a real interest rate of 5.5 percent.

Importantly, the way in which the new expenditures are funded will impact on the distribution of effects across the New Zealand economy. In these regards, whereas the introduction of additional expenditure for capital and operational activities generally adds positively to the regional economy (by requiring additional output from local industries), the funding of such expenses is generally a negative effect on regional and/or the national economies (as it reduces available funds for consumption and investment elsewhere). Thus, if restoration actions are to be financed predominantly by local government and local residents, then the majority of the negative impacts associated with funding will occur within the Waikato region. Conversely, if central government is primarily responsible for the funding, then the impacts are more likely to be distributed across the entire country, although this will depend on the particular way in which government reallocates its budget to generate the required funds.

Related to the last point, it is worth noting that the results of this Study are dependant not only on who it is assumed will be funding the restoration actions but also, and perhaps more importantly, the particular expenditures that it is assumed will be forgone in order to provide sufficient funding. Obviously different types of commodities have different production requirements. Some commodities are produced from production chains that are extensive within the New Zealand economy, and thus loss of expenditure on these items will generate quite substantial impacts to the New Zealand economy. Other commodities, however, are produced with relatively little input from New Zealand industries and therefore reallocation of expenditure away from these items will have relatively little impact. Overall, the particular assumptions employed in the Study regarding the way in which funds are provided for restoration actions is an important determinant of the magnitude of the economic impacts.

In conclusion, it is important to recognize that these assumptions that have been made in this Study regarding funding of expenditures are only one set of many plausible funding arrangement options. It is therefore recommended that the Study is undertaken again once there is more information available as to the likely funding structures, and for testing out the implications of alternative funding arrangements.

(2) Loans

Related to the above Section on funding, it is important to note that all capital expenditures are assumed to be paid for using loans. There are several limitations to this approach:

- **Farming and forestry industries.** No attempt has been made to assess whether or not the farming sectors are able to absorb the loans necessary to pay for the capital-based restoration actions. It is indeed possible that many farmers will not have sufficient income or collateral to secure the loans necessary to undertake the proposed restoration actions, particularly under Scenario 3.

- **Land use conversion under Scenario 3.** It is highly unlikely that the sheep and beef farmers tasked with land use conversion under Scenario 3 will be able to raise sufficient capital to undertake the conversions. Under Scenario 3 it is noted, for example, that Class 3 sheep and beef farmers already have a negative cash operating profit. A further deterrent to securing loans is the fact that any conversion to forestry is unlikely, without a fully implemented ETS, to realise any revenues until 18 to 26-plus years after planting.

- **Local government loans.** It has been assumed that loan-based borrowing by local government will be funded through rates increases. Other possibilities, however, include reallocation of the local government budget, central government subsidies, targeted rates, user charges and financial contributions. It is important to note that with the exception of central government subsidies, the burden associated with any local government mitigation initiative is likely to rest with Waikato residents.

- **Central government loans.** It is assumed that loans borrowing by central government will be paid for via a budget reallocation. Other alternatives however exist. It is important to note that under a central government funding scheme, the burden of the funding is likely to be shared by all New Zealanders.

(3) Scheduling of capital expenditures

The timing of capital expenditures can have a significant influence on the quantum of the economic impacts realised under each scenario over different years. It has, for example, been assumed in the discounted cash flows (DCF) analysis (which is the primary source of information for this Study) that all capital expenditures associated with tuna and riparian aesthetics restoration, and engineering works occur in 2011; respectively these account for $203 million and $434 million under Scenarios 2 and 3. These capital expenditures will have greatest impact in the 2011 year, after which, without further capital expenditure or growth, the Waikato economy would return to near its pre-2011 state. It is further worth noting that placement of the capital expenditures in the near, rather than distant, future produces the largest impacts in net present value (NPV) terms.

(4) Forestry harvest costs and revenues

This assessment of economic impacts has not incorporated any costs or revenues associated with harvesting the new forest stands proposed for the EBMP scenario. One reason for the exclusion is that, because the Study covers only the next 30 years, it is quite possible that the harvests will occur outside of the Study period. A second reason is that the harvests are likely to involve substantial changes to the structure of the Waikato economy, but for just a relatively short period over which the harvests occur. Incorporating these structural changes into the IO modelling framework is simply beyond the project time and budget constraints.

In terms of interpreting the results of this Study the important point to note is that, had the forests' harvests been included, the impact on the results for Scenario 3 would be positive. Obviously the revenues generated from harvesting forests are significantly higher than harvest costs. The net increase in forestry revenues will generate not only higher value added for the forestry and logging industry, it will also result in flow-on impacts to consumer spending thus generating increases in value added and employment for other industries.

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