Economic Evaluation of Wairarapa Regional Irrigation Project

A Report for Greater Wellington Regional Council

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Nimmo-Bell & Company Ltd

In collaboration with

berl economics

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Executive Summary

Background

Nimmo-Bell, in collaboration with BERL Economics Ltd, was engaged by Greater Wellington Regional Council (GWRC) to quantify the economic costs and benefits of a regional irrigation scheme proposed for the Wairarapa Valley (the Project). The task is to provide a cost benefit analysis (CBA) and regional economic impact analysis of a storage-based irrigation scheme. In it's Request for Proposal, GWRC has asked for the analysis to be conducted in two parts:

1. *"…a comprehensive analysis of the economic benefits that will accrue at 3 levels (farm gate, the Wairarapa community and Wellington Region). These benefits should be quantified in terms of output, GDP (value-added) and employment."*

2. *"…a cost/benefit analysis of total community return on each dollar invested into irrigation storage and distribution infrastructure is required. This must meet the needs of Central Government when assessing the relative merits of investment options."*

Securing government support requires robust economic analysis

Irrigation, using water storage, is seen as a key part of any economic development programme. Securing central government support for a regionally led and developed irrigation scheme requires the economic costs and benefits of any publicly funded investment to be assessed using a robust methodology comparable to that used in other public infrastructure projects (e.g., transport).

In undertaking this analysis, Nimmo-Bell and BERL have relied on data supplied in previous studies. The assumptions used in the modelling of costs and benefits are based on technical analyses completed by Beca Carter Hollings Ferner and Baker & Associates on the costs and timing of the irrigation scheme infrastructure and expected financial benefits of irrigated land use (referred to as Beca (2008) and Baker & Associates (2009)).

The Baker & Associates report included a conclusion that there is likely to be a modest rate of adoption of irrigation within the command area (Project irrigable area) because of the relative novelty of irrigation to the region, the likely limited ability of existing land owners to invest in on-farm infrastructure and the likelihood that farms will have to change ownership for land use to change (i.e., not all sheep and beef farmers wish to become dairy or intensive cropping farmers).

Method

CBA was undertaken at farm-gate, Wairarapa community, and Wellington region levels.

Cost-benefit analysis was undertaken at three levels: farm-gate level (farmer perspective); Wairarapa community level; and Wellington region level. The forecast changes in area under four main land uses: sheep and beef, dairy, arable and viticulture were modelled for both a "with" and "without" Project scenarios so that net benefits could be compared to Project costs in a cost-benefit analysis.

For the economic impact analysis the appropriate input-output multipliers

The value of increased output from four main land uses is weighed against the costs of the Project in the CBA and impact assessment.

were applied to the value of farm gate output for the four main land uses (for both the Wairarapa community and Wellington region). These were used to determine the direct employment and GDP generated by the scheme, and the total impact in terms of gross output, employment and GDP including indirect and induced effects.

A modest rate of adoption is modelled (50%) and is based on earlier studies.

The modelling includes an irrigation adoption rate assumption of 50% of the command area (by Year 25) and is based on conclusions reached in Baker & Associates (2009). This rate of adoption takes into account that currently, irrigated farming systems are not widely used in the Wairarapa and will have an initial modest uptake (as was the early experience in the South Island). The impacts of a higher rate of adoption are also considered based on an 80% uptake by Year 25.

A 25 year cashflow is used to produce an NPV.

Over the 25 year cashflow, a net present value (NPV) was calculated in 2009 dollars using a discount rate of 8% using both the expected 50% and higher adoption rate of 80%.

Costs of the Project

The total capital construction costs of the Project are $310 million dollars spent over the first nine years of the Projects, this is shown below.

Table 1. Project Capital Costs ($000s)

	Zone 1	Zone 2	Zone 3	Zone 4	Total
NPV $	30,311	78,764	70,587	78,764	258,425
Year					
1	11,433	26,888	26,625	26,888	91,835
2	11,776	27,695	27,424	27,695	94,589
3	12,129	28,526	28,246	28,526	97,428
4	0	0	0	0	0
5	0	0	0	0	0
6	0	7,221	0	7,221	14,441
7	0	0	0	0	0
8	0	0	0	0	0
9	0	5,854	0	5,854	11,707
10	0	0	0	0	0

Results show a significant regional economic benefit at all three levels.

Results of the cost-benefit analysis

The CBA at the farm gate level factors in on-farm investment to adopt irrigated land uses (e.g., capitalised costs of converting a sheep and beef farm to irrigated dairy) plus annual water charges of $500 per hectare rising to $1,000 per hectare by Year 20. The cost-benefit analysis at the farm gate level shows that the Project generates net economic benefits in NPV terms of $29.8 million (in 2009 dollars) over 25 years. This equates to a Benefit-Cost ratio of 1.76.

Sensitivity analysis shows that at a higher rate of adoption of 80%, the NPV increases to $52.4 million, while a rate of 20% adoption results in an NPV of $7.33 million.

A high benefit-cost ratio is generated by the Project.

Table 2. Results of the CBA at the farm gate (farmers' perspective)

25 year cash flow	20% Uptake	50% Uptake	80% Uptake
Net Present Value (2009 dollars)	7.33 mill	29.85 mill	52.38 mill
Total Benefit / Cost ratio	1.47	1.76	1.83

Table 3 below shows the increase in the value of farm gate output over the 25 year cashflow within the command area (i.e., the value of output *with* the Project *less* the value *without* the Project). The value of output (i.e., gross farm revenue) decreases for sheep and beef because there is less area used for sheep and beef within the command area (i.e., land use has changed to irrigated dairy or arable) and it is assumed that irrigation for sheep and beef production is not profitable and therefore is not used for this land use (conclusion reached by Baker and Associates, 2009). The total additional farm gate value is therefore a new mix of dry-land and irrigated land uses.

The economic benefits of the Project are significant.

Table 3. Increase in the value of farm gate output

NPV ($000s)	Sheep and Beef	Dairy	Arable	Grapes	Total Output
Without Project	203,815	499,699	10,062	55,363	768,939
With Project	162,773	890,365	46,623	68,263	1,168,024
Additional Output	- 41,042	390,665	36,560	12,901	399,084

The rate and level of uptake from farmers significantly impacts economic benefits

Table 4 summarises the economic impacts of implementing the Project, in terms of costs and benefits. The value of benefits for the Wellington Region and Wairarapa community is essentially the additional regional GDP generated by the Project, and was calculated using multiplier analysis[1]. Additional GDP in the region/community includes the spending directly created by the project, plus indirect and induced spending.

The Project will provide a strong net benefit to both the Wellington Region ($330 million) and the Wairarapa community ($407 million) over the projected 25 years.

Table 4. Inputs to Benefit-Cost ratio estimate (25 year cashflow)

Perspective	Costs ($000)	Benefits ($000 GDP)	Net Benefits ($000 GDP)
Farm gate	6,293	11,519	5,226
Wairarapa Community	43,918	450,845	406,927
Wellington Region	120,735	451,695	330,960

Source: Nimmo Bell, BERL.

[1] An explanation of Multiplier Analysis is available in Appendix D of this report.

Conclusions

The decision whether or not to proceed with the Wairarapa Regional Irrigation Project will depend on a range of economic, environmental, social and cultural considerations. The results of the CBA undertaken here indicate that, from an economic perspective, the Wairarapa Regional Irrigation Project will produce significant economic benefits for the region and is a worthwhile investment. Environmental, social and cultural impacts of the proposed Project have not been analysed in this study.

Key conclusions reached from the analysis are outlined below.

- The economic benefits of the Project are significant in terms of increased employment, value added and value of additional economic output.
- The CBA results at a farm gate level show that the project has an NPV of $29.8 million and a 1.76 benefit-cost ratio and would therefore be attractive to irrigation water users.
- From a regional economy-wide perspective, the Project has a net benefit of $407 million to the Wairarapa Community, and $330 million to the Wellington Region as a whole. This translates into a benefit-cost ratio of 10.2 for the Wairarapa and 3.7 for the Wellington Region.
- To place this net benefit of $407 million increase in GDP (over 25 years) in context we estimate the Wairarapa primary sector accounted for $210 million of Wairarapa regional GDP in 2009. Consequently, the average $18 million addition to annual GDP arising from the Project equates to an average 8% percent per year boost in primary sector Wairarapa GDP.
- These economic benefits are comparable, but lower than, results for a similar project, the Opuha Dam Irrigation Project.[2] The key difference between the schemes is that Opuha has processing systems in place within the area, while the Wairarapa will have to export its product to have it processed. Building meat and dairy processing plants in the Wairarapa will increase the economic benefits derived from the Project.

An improved understanding of technical options (that impact Capex) and of potential uptake is recommended.

- These benefits are contingent on a funding strategy that has 50% of the funds for the project come from sources external to the Wellington Region. The analysis also assumes that there is a 50% rate of adoption of irrigation within the Wairarapa Community.
- The modelling shows that a higher level of adoption leads to significant increases in the economic benefits at the Wairarapa community and Wellington region levels. While the 50 percent scenario results in the net benefits of $407 m for the Wairarapa Community, this increases to $584 m in an 80% scenario, an increase of 44 percent. Therefore, efforts made by Project stakeholders to encourage a higher rate of

[2] To illustrate, the total multiplier for the Opuha ex-post study for irrigated land is approximately 3.0, with direct output from farming equal to $2.07 million per 1,000 ha per year, and total output $6.05million per 1,000 ha per year. Comparatively, the multiplier used for the Wairarapa is 1.6. Therefore the processing element (e.g., from Clandeboye dairy factory) within the region is giving a significant boost compared to the Wairarapa.

adoption are likely to be worthwhile.

- The pre-feasibility design for piped water conveyance system fed from large storage dams, means that the capital infrastructure costs are comparatively high, and therefore other more cost effective conveyance options are likely to further improve the CBA results.

- The increases in farm gate returns possible with irrigation will have a large bearing on adoption of irrigation and subsequent farm gate benefits for the region. In general a wider range of potential land uses for water users will increase the likelihood of adoption (i.e., in addition to the four main irrigated land uses modelled here).

Recommendations
The analysis has also led to the following recommendations for GWRC and the Leadership Group to progress their analysis and preparation of proposals for potential stakeholders and investors. We recommend the following:

i. That an economic analysis be undertaken of optimal staged Project roll-out including bringing forward expansion of command area (e.g., area around Lake Wairarapa).

ii. Continue technical investigations into options that reduce the infrastructural costs of the Project.

iii. Sensitivity analysis be conducted on proposed options for Private-Public Partnership (PPP) approaches to the Project to test financial feasibility of these.

iv. Conduct a detailed survey of water users' intentions within the command area, to gain a more reliable indication of likely maximum level and rate of land use change. This research should also test potential water users' ability to invest in on-farm and Project infrastructure and is critical for future discussions.

v. Meet with key primary sector processors (e.g., Fonterra) to gauge what level of forecast increased production is expected to be processed within the region as this has a bearing on regional level economic impacts.

vi. Test environmental "bottom lines" within the GWRC and central government to ensure that the forecast expansion in dairy farming area is environmentally feasible and fits within current and future regulatory framework.

vii. Gain more clarity from the central government on its interest and ability to invest in capital infrastructure for the Project.

viii. A greater range of possible agricultural production scenarios could be assessed, especially higher value enterprises such as specialist seed and intensive horticulture.

1 Introduction

Nimmo-Bell, in collaboration with BERL Economics Ltd, was engaged by Greater Wellington Regional Council to quantify the economic costs and benefits of a regional irrigation scheme proposed for the Wairarapa Valley (the Project). Despite the growth of tourism, wine-making and of the manufacturing and service industries in the Wairarapa in recent years, agriculture is still the region's major source of income and employment[3].

The Wairarapa Valley is predominantly used for a mix of cropping, horticulture, dairy and sheep and beef farming, while sheep and beef farming is the predominant land use in the Eastern Hill country. Land use options and productivity in the Wairarapa Valley are limited by summer dry seasonal patterns and the risk of drought. It is recognised that a regional irrigation scheme, similar to those proposed and operating in various parts of the South island, would increase the range of land use options and productivity in the region and result in significant economic and social benefits.

Central government has infrastructure development as a key plank of its economic development programme for the country. Irrigation, using water storage, is seen as a key part of any economic development programme. Securing central government support for a regionally led and developed irrigation scheme requires the economic costs and benefits to be assessed using a robust methodology comparable to that used for other public infrastructure projects (e.g., transport).

This analysis seeks to provide a cost benefit analysis (CBA) and regional economic impact analysis of a storage-based irrigation scheme. In its Request for Proposal, GWRC has asked for the analysis to be conducted in two parts:

1. *"…a comprehensive analysis of the economic benefits that will accrue at 3 levels (farm gate, the Wairarapa community and the Wellington region). These benefits should be quantified in terms of output, GDP (value-added) and employment."*

2. *"…a cost/benefit analysis of total community return on each dollar invested into irrigation storage and distribution infrastructure is required. This must meet the needs of Central Government when assessing the relative merits of investment options."*

In order to provide broad representation on the project, a Leadership Group was established comprising the three district Mayors, local Iwi, Grow Wellington, Greater Wellington Regional Council (GWRC) and the Wairarapa Regional Irrigation Trust, and recreation and environmental interests. The GWRC has overseen the analysis under the overall direction of the project the Leadership Group.

The assumptions used in the modelling of costs and benefits are based on technical analyses of the Project (Beca (2008) and Baker & Associates (2009) which considered the costs and timing of the irrigation scheme infrastructure and expected financial impacts of irrigated land use. Nimmo-Bell and BERL have relied on supplied data (primarily in the form of these reports) to undertake the analysis. The scope of the analysis does not allow for further verification, research or surveying of potential irrigation users. For the estimates of economic impacts at the farm-gate level, key assumptions have been based on analysis of expected adoption of irrigation, individual farm enterprise analysis (e.g., dry land sheep and beef compared to irrigated sheep and beef) and increases in output. These assumptions are explained more fully in Sections Two and Three.

[3] BERL (2009). Economic Profile and Projections for the Wairarapa Region. (reference #4702).

2 Method

The analysis provides an estimate of economic benefits that will accrue at three levels, namely:

i. Farm gate (i.e., the increased net farm revenue from adopting irrigation).
ii. Wairarapa community.
iii. Wellington region.

Benefits are quantified in terms of the increase in disposable surplus from farming, the value of industry output, GDP (value-added) and employment.

An estimate of the likely increase in output and disposable surplus at the farm gate level is required to assess the increases in the value of output, GDP (value added) and employment for the Project. These values are needed for the cost–benefit analysis (CBA) at a Wairarapa community and Wellington regional levels.

CBA is a well-established method of assessing return on investment. To ensure that this analysis complies with central-government criteria for comparing infrastructure investment, the methodology and key indicators of viability from New Zealand Treasury's Cost-Benefit Primer (New Zealand Treasury, 2005) have been used. These are Net Present Value and benefit-cost ratio. Ford *et al.* (2002) is also referred to as a guide on measures for irrigation scheme viability.

Net present values (NPV) are calculated by discounting future net cashflows over time. All net present values are expressed in 2009 dollars, calculated from net output and spending cashflows over a 25-year horizon using a discount rate of 8% per annum. Using a cashflow period of longer than 25 years doesn't greatly improve the accuracy of the analysis because values are discounted heavily and uncertainty increases in the future.

The benefit/cost (BC) ratio is the sum of present values of benefits divided by the sum of present values of costs. A BC ratio above 1.0 implies a NPV greater than zero and can be used to rank competing projects when there are a number of proposals for an investor to consider - in this case the funders of infrastructure costs. Clearly defining from whose perspective the BC ratio is to be calculated is important in deriving a BC ratio. In this analysis NPVs and BC ratios are provided at three levels (as requested in the TOR) namely, a farm gate level using increase in farm-gate disposable surpluses, Wairarapa community and Wellington regional levels using economic impact assessment values.

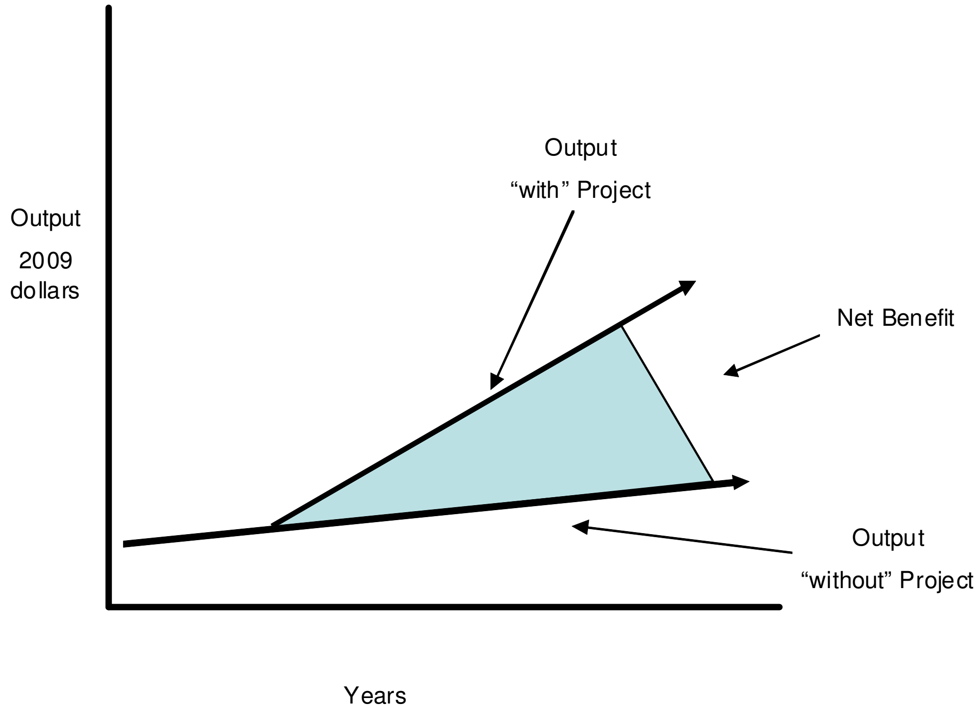
i. Farm gate level

Given that the Project increases the value of agricultural and horticultural production, Project benefits are assessed by estimating farm gate level benefits and up and down-stream benefits are extrapolated from these values. Cashflows of disposable surplus (as an indicator of on-farm profitability) "without" the scheme have been compared to those "with" the scheme and weighed against the costs of the project.

The net benefit approach has been used to assess changes in output likely from the Project. The analysis assumes that dry-land farming systems continue to progress in their productivity and profitability and that some private irrigation development such as on-farm storage would occur even without the project as existing systems do not remain static. Regional increases in farm gate output and on-farm capital costs are developed using studies of farm enterprise analysis and aggregated to a regional level.

Essentially, two scenarios have been modelled into the future by identifying the net benefits that can be attributed to the Project, less the benefits that would occur without the scheme. The graph below illustrates the approach to assessing net-benefits, the shaded area (the difference between the two curves) is the area weighed against the costs of the Project.

Figure 2.1 Net-Benefit Approach



In quantifying the benefits at the farm gate level, the following steps were taken:

a) A review of information that defines the nature, design and costs of the proposed irrigation project as set out in studies provided by GWRC.

b) Identification of capital and operating expenditure by year for each irrigation zone and the expected timing of benefits.

c) A review of current land uses to determine the aggregated farm gate benefits and increased output within the proposed area (derived from GIS Agribase data, 2003) and rounded up to 30,000ha. The output from four main land uses were modelled for both dry-land and irrigated systems being pastoral (sheep and beef), cropping, dairy and viticulture.

d) Assessment of future land use change "with and without" the Project within the command area over 25 years (largely affected by adoption rate of irrigation and choice of land use). Land use change assumptions are based on conclusions on the adoption of irrigation in Baker & Associates (2009).

e) Use of enterprise analysis data to model aggregate change in volumes and values of farm gate output and disposable surplus for both "with and without" scenarios over 25 years.

f) A test of the sensitivity of model outputs to changes in rate and magnitude of adoption of irrigation.

Estimates of on-farm financial benefits of irrigation for the main land uses are sourced from Baker and Associates (2009). Farm gate level increases in disposable surplus include a capital charge for farmer investment in on-farm irrigation infrastructure (e.g., irrigators, pipes and pumps), the cost of changing land uses and the cost of water supplied to the farm. The aggregated farm level benefits are weighed against assumptions of an annual water charge (to farmers) to cover Project operating costs to derive the farm-gate benefit-cost ratio. Water charges are assumed to start at $500 per hectare and rising to $1,000 per hectare by Year 20 (GWRC provided assumption).

ii. Wairarapa Community Level; and
iii. Wellington Region Level.
The results of an economic impact assessment are also presented. This partially counts Project construction costs as a benefit to the region depending on the source of Project investment funds. Standard regional input-output multiplier techniques have been used to model the economic impacts of the infrastructure investment and change in aggregated output. The modelling quantifies the regional economic impacts for up and downstream processing sectors and employment. To summarise, the following steps were undertaken:

a. Utilised aggregated value and volume of output data from the “with and without” scenarios as a basis for modelling impacts over 25 years.

b. Allowed for funding of scheme infrastructure that may come from outside the region (e.g., central government funding) and counted this as an economic benefit.

c. Determined the relevant multipliers for estimating up and downstream impacts.

d. Used regional input-output analysis to assess the macroeconomic impacts of the scheme at a regional level. This analysis shows the change in regional value added/GDP output by sector and employment.

Essentially two methods of economic analysis are used, a CBA and economic impact assessment using partial equilibrium analysis (see Appendix D for explanation). Both forms can be used by Project stakeholders to evaluate the economic benefits of the Project.

Any technical assumptions on the design or investment costs of the Project are sourced from Beca (2008). Input-output multipliers are provided by Butcher and Associates, 2009. More information on how these multipliers are derived is available in Appendix D.

3 Data and assumptions used

This section outlines the data and assumptions used in modelling the Project's economic benefits. Table 3.1 shows the estimated land use before the Project and is classified under dryland and irrigated land use for each of the main farm enterprises. The table shows that there are small areas of irrigated arable, dairy and viticulture within the command zones using private irrigation water sources[4].

Table 3.1 Current land use data by Irrigation Zones

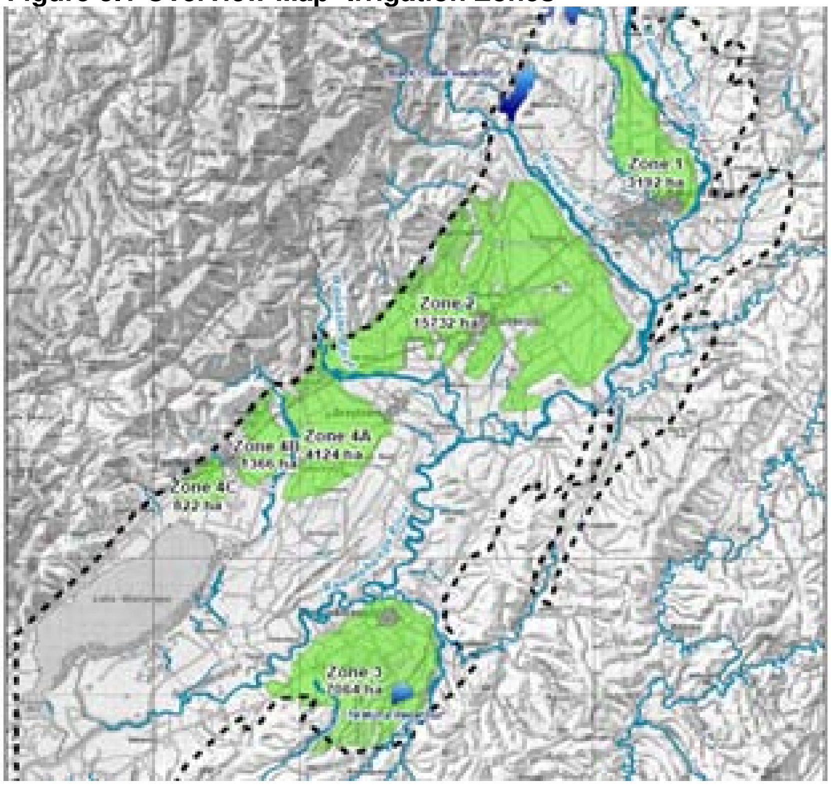
Before Scheme		Zone 1	Zone 2	Zone 3	Zone 4	Total
Dryland	Arable	65	1,172	34	-	1,270
	Sheep and Beef	2,111	7,523	6,281	3,833	19,748
	Dairy	322	6,520	291	1,112	8,245
	Viticulture	-	-	-	-	-
	Total Dryland					**29,263**
Irrigated	Intensive Arable	3	62	2	-	67
	Intensive Dairy	17	343	15	59	434
	Intensive Viticulture	11	141	84	-	235
	Total irrigated					**736**
Total		**2,529**	**15,760**	**6,707**	**5,004**	**30,000**

Figure 3.1 contains an overview of the irrigation zones within the proposed Project and the irrigation zones used as the basis for the economic modelling. The target irrigation zones are based on soil type and proximity to main rivers and are labelled 1, 2, 3, 4a, 4b and 4c.

Note: Current irrigated land use within the command zone needs to be placed in context with land use in other parts of the Wairarapa Valley. It is estimated that there is approximately 118,000 ha of farm land under 7 degree slope in the Wairarapa Valley and that 6,000 – 8,000ha of this area is irrigated (GWRC irrigation consent data).

[4] References to the irrigation structures (e.g., Te Mara, Black Creek and Te Muna) are only referred to when inputting capital costs into the model. All land areas are based on the aggregated GIS data shown in Table 3.1.

Figure 3.1 Overview Map- Irrigation Zones



Source: Beca 2008

As outlined in Section Two, estimates of the increases in total farm output are based on financial analysis in Baker & Associates (2009). This analysis accounts for the variation in soil type within Zones 1 – 4 of the command area. The excerpt below describes the technical assumptions of the soils within the zones.

> *The information provided in the report "Irrigation benefits for pasture production in the Wairarapa" completed by HortResearch Report No 17964 dated November 2005, has also been used [in addition to Baker and Associate in-house modelling]. This was a desktop review completed for Meridian but following discussions with the author (Steve Green) we understand this was based on 30 years of data and we consider it provides a fair comparative base.*
>
> *This HortResearch report provided figures for seasonal grass production for three Wairarapa soil types.*
>
> *A Ahikouka silt loam soils. For our dairy modelling we have extended the figures under irrigation to be applicable to good alluvial soils that are well drained such as around Greytown and also similarly productive alluvial over clay. (Similar to Pirinoa)*
>
> *B Kokotau clay loam soils. These soils are silt or loess based with a pan and some drainage limitations in their natural state.*
>
> *C Tauherenikau shallow silt loam soils. These have very good natural drainage being over gravel. In their natural state these are naturally lower fertility highly drought prone stony soils that in places can have cultivation limitations due to boulders.*

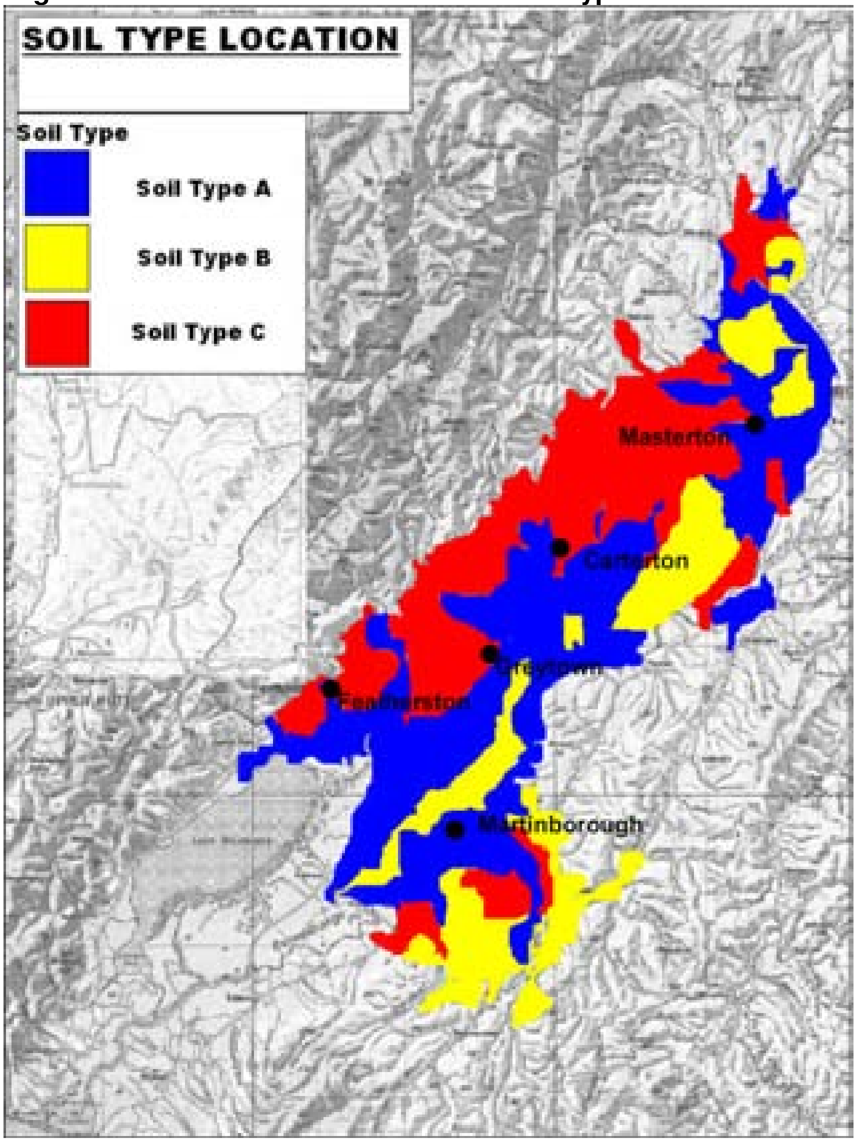
Both soil type and irrigation zone information have been overlaid to estimate the area of each soil type contained within each zone. This allows us to accurately model the returns for each land use given the variation in production between soil types. The table below shows the breakdown of each soil type by zone.

Table 3.2 Existing land use by zone and soil type (hectares)

Soil Type	Arable	Sheep & Beef	Dairy	Viticulture	Total
Zone 1					
Soil A	20	633	102		755
Soil B	41	1,267	203		1,511
Soil C	7	211	34	11	263
Total	**68**	**2,111**	**339**	**11**	**2,529**
Zone 2					
Soil A	-	-	-	-	-
Soil B	925	5,642	5,148		11,715
Soil C	308	1,881	1,716	141	4,046
Total	**1,233**	**7,523**	**6,864**	**141**	**15,760**
Zone 3					
Soil A	11	1,884	92		1,987
Soil B	14	2,512	123		2,649
Soil C	11	1,884	92	84	2,071
Total	**36**	**6,281**	**306**	**84**	**6,707**
Zone 4a					
Soil A	-	-	-	-	-
Soil B	-	-	-	-	-
Soil C	-	2,685	660	-	3,345
Total	**-**	**2,685**	**660**	**-**	**3,345**
Zone 4b					
Soil A	-	-	-	-	-
Soil B	-	-	-	-	-
Soil C	-	717	208	-	925
Total	**-**	**717**	**208**	**-**	**925**
Zone 4c					
Soil A	-	-	-	-	-
Soil B	-	-	-	-	-
Soil C	-	431	303	-	734
Total	**-**	**431**	**303**	**-**	**734**
Grand Total (ha)	**1,337**	**19,748**	**8,679**	**235**	**30,000**

The map in Figure 3.2 also shows the indicative location of the main soil types within the Wairarapa valley.

Figure 3.2 Indicative locations of main soil types



Source: Baker and Associates (2009)

3.1 Land use change

It is assumed that over 50%[5] of the total command area will be irrigated as a result of the Project by Year 25. This assumption is based on conclusions reached in Baker & Associates (2009). The rationale behind this rate of adoption is that:

- with two-thirds of the command area currently in sheep and beef, and that using irrigation for sheep and beef production is not economically viable ,it will most likely require a change in land ownership for land to be converted to a new irrigated land use;

[5] Including the small area (736ha) currently irrigated within the command zone.

- even with a desire to change to an irrigated land use, existing landowners are likely to have a limited ability to finance on-farm infrastructure; and

- irrigated farming systems are not currently widely used in region and that it can require a new generation of landowners to fully exploit the opportunities that exist with irrigation.

While the information provided for this analysis indicates 50 percent adoption, a sensitivity analysis using a higher rate of adoption has also been modelled in the next section.

Table 3.3 below shows forecast land use based on 50% adoption by Year 25. Using these assumptions, the area in dry-land sheep and beef is expected to roughly halve (from 19,748 ha to 9,574ha) with a major increase in irrigated dairy farming and intensive arable production such as specialist seed crops.

A similar shift in land use is also expected for dry-land arable and dairy. There is expected to be a modest increase in viticulture due to the limited availability of suitable soils within the irrigation zone (Type C[6]), lower profitability and high development costs.

Table 3.3 Forecast Land use under the "With" (Year 25)

With Scheme		Zone 1	Zone 2	Zone 3	Zone 4	Total
Dryland	Arable	32	586	17	-	635
	Sheep and Beef	1,056	3,761	3,140	1,917	9,874
	Dairy	161	3,260	146	556	4,122
	Viticulture	-	-	-	-	-
	Total Dryland					**14,632**
Irrigated	Intensive Arable	292	1,347	752	479	2,871
	Intensive Dairy	978	6,571	2,520	2,052	12,121
	Intensive Viticulture	11	235	131	-	376
	Total irrigated					**15,368**
Total		**2,529**	**15,760**	**6,707**	**5,004**	**30,000**

Future land use has been estimated within the zones "without" the Project (refer Table 3.4 below). This scenario (counterfactual) allows for limited private irrigation development (5%[7]) that would still occur possibly using on-farm development of storage ponds given that existing groundwater resources are fully allocated with limited further consent provision.

Table 3.4. Forecast Land use under the "Without" Scenario (Year 25)

Without Scheme		Zone 1	Zone 2	Zone 3	Zone 4	Total
Dryland	Arable	62	1,113	32	-	1,207
	Sheep and Beef	2,005	7,147	5,967	3,642	18,761
	Dairy	306	6,194	277	1,056	7,833
	Viticulture	-	-	-	-	-
	Total Dryland					**27,800**
Irrigated	Intensive Arable	32	190	77	48	347
	Intensive Dairy	113	966	266	258	1,603
	Intensive Viticulture	11	150	89	-	249
	Total irrigated					**2,199**
Total		**2,529**	**15,760**	**6,707**	**5,004**	**30,000**

[6] Baker & Associates 2009 enterprise modeling analysed financial returns by soil type (from HortResearch modeling) and location. Soil type A incorporated Ahikouka silt loam soils are free draining alluvial silt soils. Soil type B incorporated Kokotau clay loam classified as silt or loess based with a pan and drainage limitations. Soil type C incorporated Tauherenikau shallow silt loam soils being free draining lower fertility soil over gravel.
[7] Based on discussions with GWRC.

3.2 Value and volume of production from irrigated land use

The increase in financial returns estimated includes a capital charge for investment in on-farm irrigation plant and infrastructure. The data in Tables 3.3 and 3.4 is used to model increases in farm gate disposable surplus and shows the benefits from a farm gate level (i.e., project costs vs. the increase in farm gate returns).

The modelled cashflows also account for productivity growth[8] for both the dry-land and irrigated land uses. The estimate of annual productivity growth is based on the most recent assessment by MAF (Cao and Forbes, 2007). It also assumed that the rate of productivity growth on irrigated enterprises is higher (4%) than for dry-land enterprises (2.5%). This difference is based on the rationale that the reliability enabled by irrigation allows for a higher level of experimentation and innovation to develop in a business whereas in a dry-land system it can be more difficult to isolate responses to changes in management from weather-induced swings in the production (Garland, C. *pers comm.*[9]).

The total increase in the value of farm gate output per hectare ("with and without" the Project) is used to model regional level economic impacts. The table contained in Appendix C shows significant increases are possible in the value of output for users by adopting irrigation. In reality there will be a wider mix of enterprises that make use of irrigation, such as other forms of intensive horticulture, that have not been included in previous technical reports.

3.3 Discount rate

A discount rate of 8% has been used for the discounted cashflow analysis. This rate is based on information provided in New Zealand Treasury guidelines (New Zealand Treasury, 2008). In applying the formula for the Crown Weighted Average Cost of Capital, a value 8% is estimated. This is also the default and recommended value for infrastructure projects.

[8] Productivity growth refers to the growth in outputs that cannot be otherwise explained by an increase in inputs. In other words, it measures how efficiently inputs are being used in the process of production and reflects innovation and management expertise improvements from year to year.

[9] Director (registered sheep and beef consultant)- Baker and Associates Ltd.

4 Results of the Farm Gate Analysis

4.1 Cost Benefit Analysis

The CBA quantifies the costs and benefits over a 25 year period. The NPV (as described earlier) is the sum of future Project related costs and benefits expressed in today's dollars. In the modelled scenarios, the cashflows start at Year 0 (shown as 2009) with construction beginning in Year 1 and benefits beginning in Year 4, although in reality a number of years are required for consulting and consenting before construction begins.

A positive NPV indicates a positive benefit, where benefits outweigh costs (or a return in excess of the discount rate) and also indicates the magnitude of the benefit.

4.1.1 Irrigation Scheme Costs

Project capital and operating costs have been sourced from Beca (2008) and are included in Table 4.1 below. Total capital costs of the scheme have been rounded down from $323 million to $310 million to maintain consistency with other work commissioned by GWRC. Capital costs occur over nine years and the steady state operating costs are approximately $5.4 million per annum. The costs included in the modelling are based on conveying irrigation water by pipe from storage sites to catchment irrigation zones.

The Beca (2008) report notes that the geography of the Wairarapa potentially lends itself to a conveyance system that uses the major rivers to convey water. The report also notes that GWRC is investigating alternatives to piped water conveyance that may significantly reduce the upfront infrastructure costs of the Project.

4.1.2 Irrigation Water Charges

In the modelling of farm gate level benefits it has been assumed that an irrigation operating group would charge farmers $500 per hectare per year for irrigation water rising to $1,000 by Year 20. Increases in disposable surplus also include a capital charge for on-farm infrastructure (such as centre pivots) and the capital costs of changing land uses such as dairy milking sheds and farm development[10].

The table on the next page sets out the capital costs of constructing the Irrigation Project. The NPV values show the capital costs of the Project in 2009 dollars discounted at 8%. The total construction cost in nominal terms is $310 million. All costs are based on data used in the pre-feasibility report and rounding to $310 million on GWRC guidance.

[10] Baker & Associates (2009) enterprise analysis includes on-farm infrastructure costs of $300,000 for a centre pivot irrigator charged at 8% interest ($24,000) and depreciation of $15,000 per year for each 100ha unit. Enterprise analysis also capitalizes land use change costs.

Table 4.1 Project Capital Costs ($000s)

	Zone 1	Zone 2	Zone 3	Zone 4	Total
NPV $	30,311	78,764	70,587	78,764	258,425
Year					
1	11,433	26,888	26,625	26,888	91,835
2	11,776	27,695	27,424	27,695	94,589
3	12,129	28,526	28,246	28,526	97,428
4	0	0	0	0	0
5	0	0	0	0	0
6	0	7,221	0	7,221	14,441
7	0	0	0	0	0
8	0	0	0	0	0
9	0	5,854	0	5,854	11,707
10	0	0	0	0	0

Source: Beca (2008).

The table below shows the ongoing operating cost of delivering water to water users and is based on the water charges charged to farmers for the annual cost of providing water to the farm gate. At 50% adoption the PV of the annual water charges ($39.3 million) is within 5% of the annual operating costs estimated in Beca (2008) of $37.9 million. Table 4.2 show these costs in 2009 dollars discounted at 8%.

Table 4.2 Project Water Charges Paid by Farmers ($000s)

	Zone 1	Zone 2	Zone 3	Zone 4	Total
NPV $	3,315	20,663	8,793	6,560	39,331
Year					
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	31	192	82	61	366
5	65	403	171	128	766
6	101	631	269	200	1,202
7	141	878	374	279	1,672
8	184	1,144	487	363	2,177
9	229	1,428	607	453	2,717
10	278	1,730	736	549	3,292
11	329	2,050	872	651	3,902
12	383	2,388	1,016	758	4,546
13	440	2,745	1,168	872	5,226
14	501	3,120	1,328	991	5,940
15	564	3,514	1,495	1,116	6,689
16	630	3,926	1,671	1,246	7,473
17	699	4,356	1,854	1,383	8,291
18	771	4,804	2,044	1,525	9,145
19	846	5,271	2,243	1,673	10,033
20	924	5,756	2,449	1,827	10,956
21	1,004	6,259	2,664	1,987	11,914
22	1,088	6,781	2,886	2,153	12,907
23	1,175	7,321	3,115	2,324	13,935
24	1,264	7,879	3,353	2,501	14,997
25	1,357	8,456	3,598	2,685	16,095

Source: Beca (2008).

4.2 Farm gate benefits of the Project

The assumptions used to quantify the impact of irrigation at the farm level have been outlined in Section Three. The aggregated economic benefits at the farm gate for Zones 1 – 4 have been set out in a cashflow over 25 years contained in the Table 4.3 below.

The table shows that the two scenarios (“with and without”) starting in Year 3 (the final year of construction) and by Year 25 an additional $32 million per annum of additional disposable surpluses at the farm gate (after on-farm costs, excluding water charges) assuming a 50% rate of adoption within the command area. The modelling shows that “with” the Project, total farm gate disposable surpluses are likely to increase by 75% .

Table 4.3 Total increase in disposable surpluses at the farm gate

	Surplus "With" Project	Surplus "Without" Project	Increase in Surplus (Benefit)
NPV $(000s)	344,639	275,454	69,185
Year			
1	0	0	0
2	0	0	0
3	24,309	24,309	0
4	25,533	25,002	531
5	26,839	25,719	1,120
6	28,231	26,460	1,771
7	29,714	27,226	2,488
8	31,295	28,019	3,276
9	32,979	28,839	4,141
10	34,773	29,687	5,086
11	36,682	30,564	6,117
12	38,713	31,473	7,240
13	40,875	32,413	8,462
14	43,174	33,387	9,787
15	45,619	34,395	11,224
16	48,217	35,439	12,778
17	50,979	36,520	14,459
18	53,913	37,641	16,272
19	57,029	38,802	18,227
20	60,338	40,005	20,333
21	63,851	41,252	22,599
22	67,579	42,546	25,034
23	71,535	43,886	27,649
24	75,731	45,277	30,454
25	80,180	46,719	33,461

4.3 Cost Benefit Analysis at the farm gate level

Table 4.4 below shows the costs and benefits of the scheme over the 25 year period at the farm gate so that an NPV can be calculated.

This shows that from an increase in farmgate disposable surpluses, that the benefits for farmers of investing in irrigation and using assumed cost for water charges provides an NPV of $29.4 million over 25 years. This also produces a Benefit-Cost ratio of 1.79.

Table 4.4 Costs and Net benefits of the Project (50% adoption)

	Water Charges	Increase in Disposable Surplus	Net Benefits
NPV $(000s)	39,331	69,185	29,854
Year			
1	0	0	0
2	0	0	0
3	0	0	0
4	366	531	165
5	766	1,120	353
6	1,202	1,771	569
7	1,672	2,488	816
8	2,177	3,276	1,099
9	2,717	4,141	1,423
10	3,292	5,086	1,794
11	3,902	6,117	2,215
12	4,546	7,240	2,694
13	5,226	8,462	3,236
14	5,940	9,787	3,847
15	6,689	11,224	4,535
16	7,473	12,778	5,306
17	8,291	14,459	6,167
18	9,145	16,272	7,127
19	10,033	18,227	8,194
20	10,956	20,333	9,377
21	11,914	22,599	10,684
22	12,907	25,034	12,127
23	13,935	27,649	13,714
24	14,997	30,454	15,456
25	16,095	33,461	17,366

At a farm gate level, the CBA shows that the project is economically viable. As stated in Section Two, the benefits are those received by farmers in increased net disposable surplus (inclusive of on-farm costs) weighed against the costs of paying for water. Sensitivity analysis in Table 4.5 shows that a higher rate of adoption of the irrigation the NPV increases to $47.8 million.

Table 4.5 Project Benefits at the farm gate

25 year cash flow	20% Uptake	50% Uptake	80% Uptake
Net Present Value (2009 dollars)	7.33 mill	29.85 mill	52.38 mill
Total Benefit / Cost ratio	1.47	1.76	1.83

5 Economic Analysis for Wairarapa Community and Wellington Region

This section sets out the economic impact of the Project at a Wairarapa Community level and a Wellington Region level. When looking at a wider picture, costs and benefits of the Project are different to (and greater than) those experienced at farm gate level. For instance, the increased output generated by farmers has a multiplicative effect on a region's economy, as the additional sales income generates additional spending within the region.

There are two main parts to the Project, which are modelled separately in this analysis: the initial infrastructure construction, and the ongoing farm operation. For each of these parts, we calculate the benefits and costs.

In essence, the **benefits** of the project is the additional GDP (value added in NPV terms) accruing from the Project during both construction and operation stages, while the **costs** are the total of the payments (in NPV terms) incurred during both the construction and operation stages.

5.1 Construction

5.1.1 Costs

The overall infrastructure costs of the project total approximately $258 million in 2009 dollars in net present values. This estimate is derived from the Beca study, the results for which are outlined in Table 4.1. These costs are total costs, however, and do not account for the costs experienced at a Wellington Region or Wairarapa Community perspective.

Table 5.1 below outlines the net present value of capital costs of the Project. The costs have been broken down using a potential scenario for Project funding sources. For the purposes of this analysis we assume that Central Government, the Wellington Regional Council, plus a private sector third party will invest 50%, 25% and 25% of the Project capital costs respectively.

Table 5.1 Infrastructure costs

Cost type	Cost estimates ($000, net present values)			
	Central Government	Regional Government	Private Sector (incl large nationals)	Total
Infrastructure Costs	129,213	64,606	64,606	258,425

When looking at a regional or community-level perspective, it is important to define the sources of investment funding. Funds from outside a region are costs that are not borne by the residents of the region. On the other hand, funds that originate within the region do hold a cost - spending money on the Project means taking money away from other regional projects.

In calculating infrastructure costs from the perspective of the Wellington Region, we have included the following as costs:

- the $65m funding from regional government
- a proportion of the $129m central government funding that is assessed as the 'share' coming directly from Wellington Region taxpayers.
- a proportion of the $65m funding from private sector that is assessed as coming from within the Region.[11] However, in the absence of better information, we assume that all this funding accrues from outside the Region, and so this proportion is effectively zero.

We have assumed that the Wellington 'share' of central government is 13% (based on Wellington share of national GDP).

Similarly, we make the same calculation at a Wairarapa Community perspective. We include the following as costs:

- a proportion of the $65m funding from regional government that is assessed as the 'share' coming directly from Wairarapa ratepayers
- a proportion of the $129m central government funding that is assessed as the 'share' coming directly from Wairarapa taxpayers
- a proportion of the $65m funding from private sector that is assumed as coming from within the Wairarapa. Again, in the absence of better information, we assume that all this funding accrues from outside the Wairarapa, and so this proportion is effectively zero.

We have assumed that the Wairarapa 'share' of central government is 0.9% (based on Wairarapa share of national GDP) and that Wairarapa 'share' of regional government is 5.3% (based on Wairarapa share of Wellington Region GDP).

Table 5.2 summarises the results from our estimates of infrastructure costs at a Wellington Region and Wairarapa Community perspective.

[11] Private sector investors could include specialist infrastructure investors or raising capital from farmers.

Table 5.2 Wellington Region and Wairarapa Community Infrastructure Costs

Perspective	Infrastructure Costs ($000, net present values)			
	Central Government	Regional Government	Private Sector	Total
Wairarapa Community	1,163	3,424	0	4,587
Wellington Region	16,798	64,606	0	81,404

The infrastructure costs at a Wellington Regional level are $81.4m, but are only $4.5m when analysed at a Wairarapa Community level.

5.1.2 Benefits

The infrastructure costs outlined in Table 5.1 above will also have an economic benefit to the Wairarapa community and the Wellington Region, in the sense that construction companies (assuming they are local) do the work. This increases the level of economic activity in the region and has further flow-on effects.

When calculating the economic benefit to the region of the capital investment, it is important to know the source of the funds. If they are from outside the region, then it is effectively a cash injection into the local economy assuming the work is done by local contractors. Funds paid by local players are simply redistributed funds, in the sense that they would have been spent for another purpose within the region anyway.

Infrastructure costs paid by the Wellington Regional Council are effectively being funded by Wellington Region ratepayers. In this case, if we are analysing the Wairarapa community only, the funding is coming from mostly out-of-region sources. Therefore, there is an economic benefit that can be measured. As we assume that Wairarapa takes up a 5.3 percent ‘share’ of regional government, 94.7 percent of funds provide an economic benefit. Looking at the impact on the Wellington Region as a whole, there is no economic impact from the region’s share of infrastructure construction as it is assumed that all funds come from within the region.

In the case of Central Government, it can be assumed that most of the $129 million provided amounts to a cash injection into both the Wellington and Wairarapa regions, excluding the proportion of that figure that will be funded by Wellington/Wairarapa taxpayers. In the case of Wellington, this proportion is 13 percent; for the Wairarapa, the proportion is 0.9 percent. Therefore, 87 percent of Central Government funding is a cash injection at a Wellington perspective, while 99.1 percent of funding is a cash injection at a Wairarapa Community perspective.

With private funding, it is difficult to determine whether these can be classified as a cash injection into the Wairarapa community or the Wellington Region. We assume in this model that private funding will come from out of the region, and therefore is a cash injection.

Table 5.3 summarises the benefits generated by the infrastructure part of the project.

Table 5.3 Infrastructure benefits – direct output

Perspective	Infrastructure Benefits ($000, net present values)			
	Central Government	Regional Government	Private Sector	Total
Wairarapa Community	128,050	61,182	64,606	253,838
Wellington Region	112,415	0	64,606	177,021

Source: Nimmo Bell, BERL.

The results summarised above describe benefits in terms of the direct output generated by the infrastructure project.

The economic impact of the infrastructure, in terms of Wellington Region and Wairarapa community GDP and employment, is calculated using a conventional multiplier method. Multiplier analysis is used to determine direct and total (indirect and induced) economic impacts and a full explanation of how these multipliers are derived is provided in Appendix D. In measuring the impact of building the infrastructure of the Project, we use Wellington and Wairarapa construction sector multipliers.

How much additional output, employment and GDP is generated including indirect and induced effects depends on the size of the region analysed. As the size of the region increases, there is less potential for leakages[12], therefore multipliers are higher. As such, the multipliers for the Wairarapa community are generally lower than those for the Wellington Region (as the Wairarapa is a subset of the Wellington Region).

Table 5.4 shows the additional employment and GDP generated in the Wairarapa by the construction phase of the Project.

Table 5.4 Additional employment and GDP generated by Project construction

Year	Direct employment (FTEs)	Direct value added (GDP, $000)
1	423	21,807
2	435	22,461
3	448	23,135
4	0	0
5	0	0
6	66	3,429
7	0	0
8	0	0
9	54	2,780
Total of all years	**1,426**	**73,613**

[12] Leakages occur when inputs and output come from outside of the region analysed. For more information on leakages, refer to the Appendix D.

Over the construction period of the project, an additional 1,426 FTEs[13] and $73.6 million in GDP is generated. These FTEs are generated in the years of construction activity, as shown above.

Table 5.5 below shows the direct and total effects generated by the construction of the Project. Employment data are expressed in FTEs.

Table 5.5 Direct and total effects of Project construction

Region	Direct effect			Total effect		
	Gross output ($000)	Employment	GDP ($000)	Gross output ($000)	Employment	GDP ($000)
Wairarapa	252,944	1,426	73,354	445,181	2,580	149,237
Wellington Region	193,819	1,089	56,208	383,762	2,226	135,673

The increase in direct spending over the nine-year construction phase is $253 million for Wairarapa. This additional spending creates the equivalent of 1,426 FTEs, and around $73 million in GDP for Wairarapa during this period.

When looking at the Wellington region as a whole, the increase in direct spending is about $194 million, creating the equivalent of 1,089 FTEs and $56 million in GDP over the nine years. The impact is higher for the Wairarapa Community than for Wellington region as a higher proportion of funds is expected to come from outside the Wairarapa than Wellington (i.e., more a case of re-allocating resources).

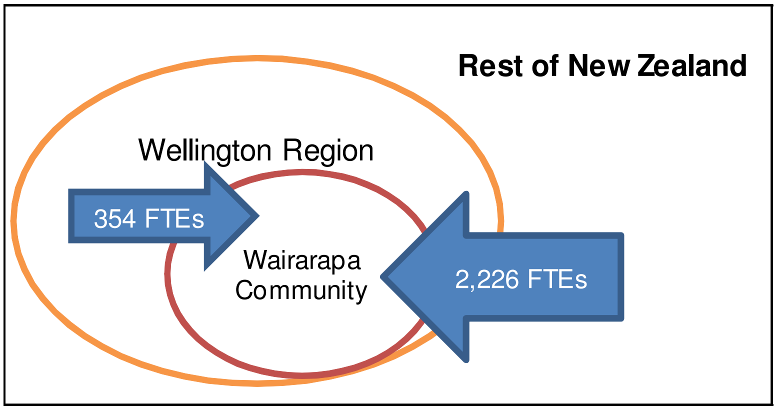
Including indirect and induced effects over the nine years of the construction phase, the Project construction creates an equivalent of $445 million in output for the Wairarapa, an additional 2,580 FTEs, and $149 million in GDP during this period. When looking at the Wellington Region as a whole, output is $384 million; FTEs are 2,226; and an increase in total GDP of $135 million over the nine years.

It is not initially apparent why the employment generated at a Wellington Region perspective would be lower than the employment at a Wairarapa Community perspective. Logically, as Wairarapa is a subset of Wellington Region, you would expect that the FTEs for the Wairarapa would be a fraction of that seen at a regional level. The reason why Wairarapa shows greater employment growth than the Wellington Region is due to the source of the labour.

Figure 5.1 shows the sources of the FTEs created during the construction of the Project.

[13] Employment is measured in terms of the number of full-time annual equivalent (FTE) positions.

Figure 5.1 Sources of FTEs for Project construction



2,226 FTEs are employed from outside of the Wellington Region. These FTEs are counted as additional for both Wellington and Wairarapa perspectives. There are 354 FTEs that are transferred from other projects within the Wellington Region (outside of Wairarapa) to the Wairarapa Irrigation Project. These FTEs are not counted as additional for the Wellington Region, as they are already employed within the Region. They are, however, viewed as additional from a Wairarapa Community perspective.

5.1.3 Net benefits

Subtracting the total infrastructure costs from the benefits of the infrastructure development (in GDP) results in the net benefit of this part of the project.

Table 5.6 Net infrastructure benefits

Perspective	Costs ($000)	Benefits ($000 GDP)	Net Benefits ($000 GDP)
Wairarapa Community	4,587	149,765	145,178
Wellington Region	81,404	123,915	42,511

As many of the costs for the infrastructure of the Project are from outside of the Wairarapa Community, benefits significantly outweigh the costs, leading to a net benefit of $145 m. Looking at a Wellington Region perspective, costs are higher, leading to a more moderate net benefit, of $42 m over the 25 years of the cashflow modelled. The reason that the net benefit in GDP terms for the Wellington Region are less than that for the Wairarapa is identical to the explanation provided above for employment (see Figure 5.1).

5.2 Farm operation

5.2.1 Costs

It is assumed that operating costs will be funded through water charges to users. As shown in Table 4.4, the net present value of water charges paid by farmers over 25 years equates to $39.3m, assuming the 50 percent land use scenario.

As all users (the farmers) fall within both Wellington Region and Wairarapa Community, costs for the operation of the Project remain the same, whatever the perspective used.

5.2.2 Benefits

If the Project is implemented, there will be a shift away from sheep and beef farming to more profitable irrigated enterprises. Therefore, there will be a fall in output for sheep and beef over the 25 years modelled, when compared to the "without project" scenario. However, there will be strong growth in the output of dairy farming, and more moderate growth in arable and viticulture production.

To determine the benefits of the scheme in current dollar terms, the net present value (NPV) of the farm gate value must be determined. Table 5.7 below summarises the net present value of the Project for each land use.

Table 5.7 Output of irrigation project

NPV ($000s)	Sheep and Beef	Dairy	Arable	Grapes	Total Output
Without Project	203,425	523,081	13,759	53,660	793,925
With Project	162,462	942,138	52,104	66,847	1,223,550
Additional Output	- 40,963	419,057	38,345	13,187	429,625

Over the 25 year cashflow modelled, it is estimated that the irrigation project will create $430 million of additional farm gate value to Wairarapa's farmers (in 2009 dollars). The majority of this increase is caused by the change in land use from sheep and beef to dairy farms.

To calculate the direct and total economic impact of Project operation, we again use multiplier analysis to derive GDP and employment numbers from the output estimates. We used regional industry multipliers appropriate for each land use, as outlined in Table 5.8.

Table 5.8 Concordance of multiplier industry with Project land use[14]

Irrigation Project Land Use	Multiplier Industry
Arable	Horticulture and fruit growing
Sheep and Beef	Livestock and cropping farming
Dairy	Dairy and dairy cattle farming
Grapes	Horticulture and fruit growing

Table 5.9 below shows the additional direct employment and GDP created by the Project (excluding infrastructure related employment) over the 25 year cashflow modelled in this report.

[14] The Multiplier Industry is matched as close as possible according to the definitions used in the BERL input-output tables.

Table 5.9 Additional direct employment and GDP generated by the Project operation

Year	Additional direct employment (FTEs) Total	Additional direct value added (GDP, $000) Total
0	0	0
1	0	0
2	0	0
3	0	0
4	19	390
5	39	815
6	61	1,277
7	85	1,779
8	111	2,322
9	140	2,910
10	170	3,545
11	203	4,230
12	238	4,969
13	277	5,764
14	318	6,620
15	362	7,538
16	409	8,525
17	460	9,582
18	514	10,715
19	572	11,929
20	635	13,227
21	701	14,614
22	772	16,097
23	848	17,679
24	929	19,368
25	1,016	21,185
Total of all years	**8,879**	**185,080**

The additional 8,879 FTEs and $185 million GDP generated by the operation of the Project are spread across 25 years and exclude additional employment and GDP generated by the construction phase. The majority of the additional employment/GDP is in the dairy farming industry, with smaller rises in the arable and viticulture industries, and a fall in sheep and beef.

By year 25 of the Project, over 1,000 new jobs will be created, and over $21 million additional GDP will be generated, per annum. This level continues to rise as the area under irrigation increases and would continue to increase beyond the cashflow forecasts as new land area is converted to irrigation.

Table 5.10 10 shows the direct and total impacts of the Project. The direct effects include the present value of additional farm gate output received by farmers who adopt irrigated land uses such as intensive arable, dairy and viticulture. The total effect includes the direct effect plus the induced and indirect effects created when farmers require increased supplies, further wages and profits are generated by downstream processing activities and additional salaries, wages and profits (after tax) are spent on consumption within the Wairarapa community and Wellington region.

Table 5.10 Direct and total effects of additional farm gate output generated by the project

Level	Direct effect			Total effect		
	Gross output ($000)	Employment	GDP ($000)	Gross output ($000)	Employment	GDP ($000)
Wairarapa Community	429,625	8,879	185,080	682,228	14,691	301,081
Wellington Region	429,625	8,879	185,080	736,301	14,805	327,780

The estimated $430 million increase in farm gate output over the 25 years creates the equivalent of 8,879 additional FTEs by creating additional jobs on farms, and around $185 million in GDP[15].

Including indirect and induced effects, the Project generates the equivalent of an additional $682 million in output for the Wairarapa community, 14,691 FTEs, and $301 million in GDP, over the 25 years cash flow period. When looking at the Wellington Region as a whole, output is $736 million; FTEs are 14,805; and total GDP is $327 million over the 25 years.

5.2.3 Net benefits

Subtracting the total operating costs from the benefits in GDP generated by the additional production results in the net benefits of operation.

Table 5.11 Net operational benefits

Perspective	Costs ($000)	Benefits ($000 GDP)	Net Benefits ($000 GDP)
Wairarapa Community	39,331	301,081	261,750
Wellington Region	39,331	327,780	288,449

Source: Nimmo Bell, BERL.

For the Wairarapa Community, benefits are lower than the Wellington Region. This is due to leakages, and partly caused by the fact that there is currently no processing plants situated in the Community, which means that product must be shipped elsewhere to be processed. Building this processing capability in the Wairarapa will reduce the leakage and increase net benefits. As it stands, Wairarapa net benefits of operation is $262 million, while Wellington Region net benefits equalled $$288 million, over the 25 years modelled.

[15] Note: the direct effects are the same for the Wairarapa Community and Wellington Region at the farm gate because all additional farm gate value is created within the Wairarapa area (i.e., there is no additional farm gate revenue generated in the Wellington region outside Wairarapa).

5.3 Summary

Summing together the net benefits of the infrastructure and operational parts of the Project provides us with the total net benefits of the project. Table 5.12 summarises the results of the analysis.

Table 5.12 Net benefits of the Wairarapa Irrigation Project

Perspective	Costs ($000)	Benefits ($000 GDP)	Net Benefits ($000 GDP)
Wairarapa Community	43,918	450,845	406,927
Wellington Region	120,735	451,695	330,960

Over the 25 years modelled, the Project has the potential of providing a net benefit of $407 m to the Wairarapa Community, and $330 m to the Wellington Region as a whole. This translates into a benefit-cost ratio of 10.2 for the Wairarapa, and 3.7 for the Wellington Region.

This strong net benefit shows that the Project has the potential to have a significant positive impact on the agricultural sector of the Wairarapa.

The result of this analysis can be compared with the economic impacts estimated from the Opuha Dam project[16]. The Opuha Dam study analyses the results of an irrigation scheme located in the Timaru District and Fairlie Basin area based on a full uptake of an area of approximately 32,830 irrigated hectares. This compares with a forecast uptake of 50% of 30,000 ha in the Wairarapa Project. The scheme added $41m in total GDP *per year* to the Timaru/Fairlie Basin economy although the study does not specify a time period.

This is comparable with the estimated net benefit in GDP terms calculated in this study of $407 million over 25 years (including value added from farm operation and infrastructure). This is an average of $16 million per year in 2009 dollars and appears broadly consistent with the relative sizes of the projects, adoption rates and multipliers used in the analyses.

To place this net benefit of $407 million (over 25 years) in context, we estimate the total Wairarapa GDP in 2009 to be $1.3 billion. Further, the Wairarapa primary sector accounted for $210 million of Wairarapa GDP. Consequently, the average $18 million addition to annual GDP equates to an average of 8% percent per year boost in primary sector regional GDP from the Project.

[16] The Opuha Dam: An *ex post* study of its impacts on the provincial economy and community. Harris Consulting (2006)

6 Conclusion

The decision whether or not to proceed with the Wairarapa Regional Irrigation Project will depend on a range of economic, environmental, social and cultural considerations. Experience from establishing irrigation projects in other regions of New Zealand indicates that irrigation brings significant ownership and land use change, significant social and community change, improvement in social quality measures and a transformation in business community and economy (Ford, 2006). This study also notes that community demographics change (younger age structure), community facilities prosper (e.g., schools), new families enter the region and adoption of irrigation requires new skills, knowledge and technology.

The results of the CBA undertaken here indicate that, from an economic perspective, the Wairarapa Regional Irrigation Project will produce significant economic and employment benefits for the region and is consistent with the assessment of economic benefits in other regions. Environmental, social and cultural impacts of the proposed Project have not been analysed in this study.

Key conclusions reached from the analysis are:

- The economic benefits of the Project are significant in terms of increased employment, value added and value of additional economic output.

- The CBA results at a farm gate level show that the project has an NPV of $29.8 million and a 1.76 benefit-cost ratio and would therefore be attractive to irrigation water users.

- From a regional economy-wide perspective, the Project has a net benefit of $407 million to the Wairarapa Community, and $330 million to the Wellington Region as a whole over the 25 years. This translates into a benefit-cost ratio of 10.2 for the Wairarapa and 3.7 for the Wellington Region.

- These economic benefits are comparable, but lower than, results for a similar project, the Opuha Dam Irrigation Project, which is approximately double the modelled Wairarapa Projects' size in hectares. The key difference between the schemes is that Opuha has processing systems in place within the area, while the Wairarapa will have to export its product to have it processed. Building meat and dairy processing plants in the Wairarapa will increase the economic benefits derived from the Project.

- These benefits are contingent on a funding strategy that has 50% of the funds for the project come from sources external to the Wellington Region. The analysis also assumes that there is a 50% rate of adoption of irrigation within the Wairarapa Community.

- The modelling shows that a higher level of adoption leads to significant increases in the economic benefits at the Wairarapa community and Wellington region levels. While the 50 percent scenario results in the net benefits of $407 m for the Wairarapa

Community, this increases to $584 m in an 80% scenario, an increase of 44 percent. Therefore, efforts made by Project stakeholders to encourage a higher rate of adoption are likely to be worthwhile.

- The pre-feasibility design for piped water conveyance system fed from large storage dams, means that the capital infrastructure costs are comparatively high, and therefore other more cost effective conveyance options are likely to further improve the CBA results.

- The increases in farm gate returns possible with irrigation will have a large bearing on adoption of irrigation and subsequent farm gate benefits for the region. In general a wider range of potential land uses for water users will increase the likelihood of adoption (i.e., in addition to four main irrigated land uses modelled here).

Recommendations

The analysis has also led to the following recommendations for GWRC and the Leadership Group to progress their analysis and preparation of proposals for potential stakeholders and investors. We recommend that the following:

i. That an economic analysis be undertaken of optimal staged Project roll-out including bringing forward expansion of command area (e.g., area around Lake Wairarapa).

ii. Continue technical investigations into options that reduce the infrastructural costs of the Project.

iii. Sensitivity analysis be conducted on proposed options for Private-Public Partnership (PPP) approaches to the Project to test financial feasibility of these.

iv. Conduct a detailed survey of water users' intentions within the command area, to gain a more reliable indication of likely maximum level and rate of land use change. This research should also test potential water users' ability to invest in on-farm and Project infrastructure and is critical for future discussions.

v. Meet with key primary sector processors (e.g., Fonterra) to gauge what level of forecast increased production is expected to be processed within the region as this has a bearing on regional level economic impacts[17].

vi. Test environmental "bottom lines" within the GWRC and central government to ensure that the forecast expansion in dairy farming area is environmentally feasible and fits within current and future regulatory framework.

[17] To illustrate, the total multiplier for the Opuha ex-post study for irrigated land is approximately 3.0, with direct output from farming equal to $2.07 million per 1,000 ha per year, and total output $6.05million per 1,000 ha per year. Comparatively, the multiplier used for the Wairarapa is 1.6. Therefore the processing element (e.g., from Clandeboye dairy factory) within the region is giving a significant boost compared to the Wairarapa.

vii. Gain more clarity from the central government on its interest and ability to invest in capital infrastructure for the Project.

viii. A greater range of possible agricultural production scenarios could be assessed, especially higher value enterprises such as specialist seed and intensive horticulture.

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8 Appendix A- Basic Assumptions for enterprise analysis

- 100 hectares has been adopted for each land use policy modelled and the policy assumptions for each of the soil type are defined in Baker and Associates (2009). These assume a status quo year once irrigation becomes fully effective. In the case of viticulture an annual cash flow is developed that includes accrued interest costs from the capital development and is based on a status quo scenario in Year 6.

- Models assume best practice such as would be achieved by the top quartile of farm managers.

- Annual operating profit both before and after servicing of the capital relating to the establishment of irrigation is estimated. Operating profit is calculated to cover water costs, management, input, profit and risk and existing debt servicing.

- The annual cash-profit benefits are compared as the operating farm surplus per hectare.

- For Dairy Class A soils production has been assessed under irrigation as being very similar regardless of location. Masterton located farms require less irrigation water given the higher annual rainfall.

- When assessing the cost of irrigation for all policies (with the exception of viticulture) centre pivot irrigation systems are assumed to cost a total of $300,000 including the cost of upgrading farm infrastructure and installation.

- Capitalized on-farm infrastructure and development costs are based on an interest rate of 8% equating to $24,000 pa. If alternative irrigation systems are used, such as would be required for cropping, the capital cost would be less but annual labour costs more. Baker and Associates were advised that the planned water pressure delivered to the boundary of each property will be 50psi which is sufficient for central pivot with no further pumping costs required.

- The operational cost of electricity has been based on 20c unit (Based on negotiated bulk rates).

Source: (Baker and Associates, 2009)

9 Appendix B – Increase in disposable surplus per hectare

	Increase in Disposable Surplus		Disp Surplus ($/ha) Dryland	Irrigated	$/ha Increase	Prodtvty gain per year
	Arable- Existing Area					2.5%
	Soil A	to Irrigated Arable	532	998	466	4.0%
	Soil B	to Irrigated Arable	514	863	349	4.0%
	Soil C	to Irrigated Arable	369	972	603	4.0%
	Soil A	to Irrigated Dairy	532	906	374	4.0%
	Soil B	to Irrigated Dairy	514	314	- 200	4.0%
	Soil C	to Irrigated Dairy	369	1,020	651	4.0%
	Sheep and Beef- Existing Area					2.5%
	Soil A	to Irrigated Arable	424	998	574	4.0%
	Soil B	to Irrigated Arable	387	863	476	4.0%
	Soil C	to Irrigated Arable	369	1,132	763	4.0%
	Soil A	to Irrigated Dairy	424	906	482	4.0%
	Soil B	to Irrigated Dairy	387	314	- 73	4.0%
	Soil C	to Irrigated Dairy	369	1,020	651	4.0%
	Soil C	to Irrigated Viticulture	369	1,880	1,511	4.0%
	Dryland Dairy- Existing Area					2.5%
Zones 1&2	Soil A	to Irrigated Dairy	3,052	3,534	482	4.0%
Zones 1&2	Soil B	to Irrigated Dairy	1,539	2,121	582	4.0%
Zones 1&2	Soil C	to Irrigated Dairy	2,064	3,545	1,481	4.0%
Zones 3&4	Soil A	to Irrigated Dairy	2,480	3,052	572	4.0%
Zones 3&4	Soil B	to Irrigated Dairy	1,196	2,096	900	4.0%
Zones 3&4	Soil C	to Irrigated Dairy	1,492	3,398	1,906	4.0%
	Viticulture- Existing Area					2.5%
	Soil C	to Irrigated Viticulture	1,692	1,880	188	4.0%
	Source: Baker and Associates- 2008					

10 Appendix C– Increase in the value of output per hectare

	Increase in Disp Surplus		Value of Output/ha Dryland	Irrigated	$/ha Increase
	Arable- Existing Area				
	Soil A	to Irrigated Arable	1,177	2,072	$ 895
	Soil B	to Irrigated Arable	1,106	1,993	$ 887
	Soil C	to Irrigated Arable	1,012	2,261	$ 1,249
	Soil A	to Irrigated Dairy	1,177	9,227	$ 8,050
	Soil B	to Irrigated Dairy	1,106	7,576	$ 6,470
	Soil C	to Irrigated Dairy	1,012	9,194	$ 8,182
	Sheep and Beef- Existing Area				
	Soil A	to Irrigated Arable	1,073	2,072	$ 999
	Soil B	to Irrigated Arable	1,026	1,993	$ 967
	Soil C	to Irrigated Arable	1,012	2,261	$ 1,249
	Soil A	to Irrigated Dairy	1,073	9,227	$ 8,154
	Soil B	to Irrigated Dairy	1,026	7,576	$ 6,550
	Soil C	to Irrigated Dairy	1,012	9,194	$ 8,182
	Soil C	to Irrigated Viticulture	1,012	18,431	$ 17,419
	Dryland Dairy- Existing Area				
Zones 1&2	Soil A	to Irrigated Dairy	7,128	9,227	$ 2,099
Zones 1&2	Soil B	to Irrigated Dairy	4,999	7,576	$ 2,577
Zones 1&2	Soil C	to Irrigated Dairy	6,225	9,194	$ 2,969
Zones 3&4	Soil A	to Irrigated Dairy	6,455	9,227	$ 2,772
Zones 3&4	Soil B	to Irrigated Dairy	4,598	7,756	$ 3,158
Zones 3&4	Soil C	to Irrigated Dairy	5,027	9,194	$ 4,167
	Viticulture- Existing Area				
		No Change			
	Soil C	to Irrigated Viticulture	16,588	18,431	$ 1,843
	Source: Baker and Associates- 2009				

11 Appendix D– Multiplier analysis

This multiplier analysis uses multipliers derived from inter-industry input-output tables for the Wellington Region. Wellington Region input-output tables have been derived from the national input-output tables and other data by Butcher Partners, Wellington - a recognised source for regional input-output tables and multipliers.[18]

Multipliers allow for the identification of the direct, indirect and induced effects in terms of output (GDP) and Full Time Equivalent (FTE) employment.

11.1 Measures

11.1.1 Gross Output Multipliers

Gross output is the value of production, built up through the national accounts as a measure, in most industries, of gross sales or turnover. This is expressed in $ million at constant prices. Gross output is made up of the sum of:

- compensation of employees (i.e. salaries and wages)
- income from self employment
- depreciation
- profits
- indirect taxes less subsidies
- intermediate purchases of goods (other than stock in trade)
- intermediate purchases of services

11.1.2 Value added (GDP) multipliers

Value added multipliers measure the increase in output generated along the production chain, which, in aggregate, totals Gross Domestic Product (GDP). Value added is made up of the sum of:

- compensation of employees (i.e. salaries and wages)
- income from self employment
- depreciation
- profits
- indirect taxes less subsidies

11.1.3 Employment Impact multipliers

[18] For a discussion on regional input output tables and the validity and reliability of the Butcher input output tables see *Statistics New Zealand (2003) Regional Input Output Study.*

Employment impact multipliers determine the number of FTE roles that are created for every $1 million spent in an industry for one year. It provides a measure of total labour demand associated with Gross Output.

An FTE is the percentage of time an employee works represented as a decimal. A full-time position is 1.00; a part-time position is 0.50.

11.2 Direct, indirect and induced effects

The underlying logic of multiplier analysis is relatively straightforward. An initial expenditure (**direct** effect) in an industry creates flows of expenditures that are magnified, or "multiplied", as they flow on to the wider economy. This occurs in two ways:

- The industry purchases materials and services from supplier firms, who in turn make further purchases from their suppliers. This generates an indirect effect.
- Persons employed in the direct development and in firms supplying services earn income (mostly from wages and salaries, but also from profits) which, after tax is deducted, is then spent on consumption. There is also an allowance for some savings. These are the induced effects.

Hence, for any amount spent in an area (**direct** effect), the actual output generated from that spend is greater once the flow on activity generated (**indirect** and **induced** effects) is taken into account.

11.3 Leakages

Generally the more developed, or self sufficient, an industry in a region is, the higher the multiplier effects. Conversely, the more reliant an industry is on supply inputs from outside the region, the lower the multipliers. These outside factors can be referred to as "leakages".

To put this another way, if a house was purchased in Wellington Region, and all the materials and labour were sourced in Wellington Region, and all the materials and labour that went into making the housing materials were made in Wellington Region and so forth, and then the labour spent their wages or salaries in Wellington Region, again on goods or services produced solely in Wellington Region, then all the multiplier effects would be captured by Wellington Region. Where inputs or outputs come from outside Wellington Region, leakages are said to exist, and the multiplier effect is reduced.

11.4 Limitations of multiplier analysis

11.4.1 Partial equilibrium analysis

Multiplier analysis is only a "partial equilibrium" analysis, assessing the direct and indirect effects of the development being considered, without analysing the effects of the resources used on the wider national and regional economy.

In particular, it assumes that the supply of capital, productive inputs and labour can expand to meet the additional demand called forth by the initial injection and the flow on multiplier effects, without leading to resource constraints in other industries. These constraints would lead to price rises and resulting changes in overall patterns of production between industries.
To assess inter-industry impacts in full would require economic modelling within a "general equilibrium" framework. Applying such models becomes more relevant where the particular development is considered significant within the overall economy.

11.4.2 Additionality

Related to partial equilibrium, using multipliers for economic impact assessments assumes that the event is something that would not have been undertaken anyway and that it will not displace existing activity. That is, the event is additional to existing activity. If it does either of the above, then the economic impact is less than that determined by the multiplier and it would be necessary to subtract both the activity that would have occurred anyway and the displacement effect.

11.4.3 Impact

Again related to "partial equilibrium", multiplier analysis assumes that an event will not have an impact on relative prices. However, in a dynamic environment, it can be assumed that a large event would have an impact on demand and supply and hence prices. Hence, the larger the event and the more concentrated it is in a single industry or region, the more likely it is that the multipliers would give an inaccurate analysis of impacts. For example, if multiplier analysis was used to determine the effect of residential building construction nationally it would likely be inaccurate as residential building construction accounts for over 6% of GDP.

11.4.4 Aggregation

Industries outlined in input output tables are aggregates of smaller sub-industries. Each sub industry has unique inputs and outputs. The higher the level of aggregation the less accurate these inputs and outputs become. Thus, if determining the multiplier effect of a very specific event using highly aggregated data, there will be a lower level of accuracy. Similarly, if an event encompasses a range of industries and multipliers from a single industry are applied the accuracy levels will diminish.

11.4.5 Regions and boundaries

The smaller or less defined a region and its boundaries, the less accurate the multiplier analysis will be. Similarly, the easier it is to move across boundaries, the less accurate the analysis will be. For example, at the national level, the multipliers will be very accurate as it is easy to determine the inputs and outputs crossing through the New Zealand borders.

Similarly, it would also be more accurate to determine a North Island/South Island split. As smaller regions without obvious geographic boundaries are selected, a higher level of assumptions needs to be made and the multipliers become less accurate. For example, an individual could work in the Auckland Region but live in the Waikato Region and spend a large proportion of his/her recreation money in the Bay of Plenty Region.

For any regional analysis the level of accuracy will have to be accepted. As a rule of thumb, the larger and more defined the Region, the more accurate the analysis will be.

12 Appendix E– Higher adoption scenario

The economic impact of a higher adoption rate scenario were also modelled. While the analysis must rely on existing studies, it is possible with appropriate policies to encourage land use change and the adoption of irrigation, so that a higher rate of adoption could be achieved within the cashflow period.

Table 122.1 summarises the results of the cost benefit analysis using the assumption that 80% of land owners adopt irrigation by Year 25.

Table 122.1 Net benefits, 80 percent adoption rate

Perspective	Costs ($000)	Benefits ($000 GDP)	Net Benefits ($000 GDP)
Farm gate	6,293	11,519	5,226
Wairarapa Community	67,516	651,566	584,049
Wellington Region	144,333	670,216	525,882

Source: Nimmo Bell, BERL.

The net benefits at the higher rate of adoption greatly increase the economic benefit of the Project. While the 50 percent scenario results in the net benefits of $407 m for the Wairarapa Community, this increases to $584 m in an 80% scenario, an increase of 44 percent. Therefore, the adoption rate of farmers has the potential to greatly affect the economic impact of the Project.