Southland Region

Regional Economic Profile

&

Significant Water Issues

Part of the Ministry for the Environment's research into the Economic Impacts of Water Policy Decisions

m.e environment

Southland Region: Economic Impacts of Water Policy Decisions Workstream

Regional Economic Profile & Significant Water Issues

Ministry for the Environment

Document reference: MfE 001.13

Date: 13 May 2013

Contact: ***Market Economics Limited***

Lawrence McIlrath (09) 915 5523

Garry McDonald (09) 915 5520

Nimmo-Bell

Brian Bell (04) 472 4629

www.me.co.nz

Market Economics Limited

Level 5, 507 Lake Road

PO Box 331 297, Takapuna

Auckland 0740, NZ

P 09 915 5510

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Executive Summary

This report consists of two parts. The first part presents a regional profile of Southland and highlights current water use trends and implications. Market Economics Limited completed the first part. The second part, prepared by Nimmo-Bell, presents an overview of the significant water issues in Southland.

PART 1: REGIONAL PROFILE (MARKET ECONOMICS LIMITED)

This report has been commissioned by the Ministry for the Environment (MfE) to establish the current situation of water use in the Southland economy. It is part of a series of studies for the Ministry that will be used to inform policy scenarios on quality and quantity limits in freshwater. The objectives of this report are to:

- Develop an economic profile of the Southland economy identifying Southland's key sectors,
- Calculate current water abstractions, discharge levels and nutrient loads by economic industry, and from this information produce a series of ecological water multipliers, and
- Use the ecological water multipliers to produce tentative estimates of future water use, nutrient loads, discharge levels by economic sector under a 'Business As Usual' scenario.

The relationship between environment and economy is inherently complex, capturing the indirect and embodied use of water by many industries and businesses. To unpick this relationship, it is necessary to first assess what economic activities are undertaken in a region/economy, to establish the interdependencies between the industries by exploring production chains (e.g. food processing requires inputs from agricultural, the electricity sector and the transport sector as well as the construction sector). It is then necessary to calculate what natural resources each industry uses in their production processes, while recognising that water is critical for ecosystem services (natural processes that are both biological and chemical). In this report, the use of water is traced through the Southland economy, using:

- Recently published statistics for Southland's economy and demographic profile;
- Market Economics' Economic Futures Model for Southland (a multi-regional input-output model) to calculate the linkages between economic sectors,
- Data contained in Environment Southland's resource consent and monitoring databases to link water use to industry, and
- Published studies that link fertiliser use to economic activity (given that phosphorous and nitrogen contribute to the contamination of water discharged back into the environment).

Southland Profile

Southland has a resident population of 94,900 people of which nearly 56 per cent reside in Invercargill City. The population of Southland is expected to decline over the next 20 years to 88,000. The proportion of

people living within urban areas of Southland is 70 per cent. This is low by national standards, but reveals the vibrant rural economy of Southland for people to both live and work, and indeed reflects the central importance of agriculture and primary industries for the Southland economy.

The primary sector employs 23 per cent (13,780 employees) of Southland's labour force. Livestock and cropping farming employs almost 6,000, although this is decreasing because of the number of dairy farm conversions, with many of livestock and cropping jobs switching to the dairy sector. Thus the face of agriculture is changing in Southland.

Some manufacturing sectors have had to consolidate (e.g. Meat and meat product manufacturing, Basic metal manufacturing, Wood product manufacturing) due recent economic conditions, while others (e.g. Dairy product manufacturing and Construction) have grown in size. Most of the industries related to providing goods and services to households and local business have shown an increase in employment.

Value Added

In 2012 the Southland economy generated around NZ$4bn[1] in value added[2], and provided over 55,000 employment positions in some in 13,600 businesses. The agricultural sectors combined contributed 17 per cent to total value added, with livestock and crop farming contributing 7 per cent ($280m) and dairy cattle farming contributing 9 per cent ($373m). The relative contributions of these two agricultural sectors will probably change in the future, given the trend of converting from livestock farming to dairy farming. Other primary sector activities (including fishing, forestry and mining) contributed a further $120m to Southland's value added.

The importance of agriculture is further evident in the flow on effects to the manufacturing sector. Meat and meat product manufacturing is the largest single economic sector in Southland, with a value added contribution of $625m (15 per cent of the region's value added). This sector is coming under pressure from the large amount of dairy farm conversions.

There are significant other manufacturing industries in Southland. Southland's manufacturing contributed around $1.4bn$_{2012}$ of value added to the region's economy.[3] Manufacturing has been under pressure due to the economic recession. Basic Metal Manufacturing is a key manufacturing activity. This industry has a number of downstream linkages with the rest of the Southland economy.

Key Economic Sectors

Fourteen key sectors were identified for Southland, based on a shift-share framework that considered each sector's:

- Economic contribution (using value added and employment)
- Recent employment performance (using change in employment MECs between 2000 and 2012)
- Comparative advantage (using Simple Location Quotient as indicator), and
- Each sector's contribution to regional exports.

[1] All values are presented in constant 2012 NZ dollar terms
[2] Value added is similar to GDP with the main difference being how tax is treated. Value added excludes tax on products (e.g. GST) whereas GDP includes tax on products.
[3] Note this is all manufacturing including meat processing and dairy processing.

The key sectors are[4]:

1. Dairy product manufacturing
2. Meat and meat product manufacturing
3. Other food manufacturing
4. Sheet and fabricated metal product manufacturing
5. Basic metal manufacturing
6. Livestock and cropping farming
7. Dairy cattle farming
8. Accommodation, restaurants and bars
9. Wood product manufacturing
10. Forestry and logging
11. Machinery and equipment manufacturing
12. Services to agriculture, hunting & trapping
13. Water and rail transport
14. Other farming.

Environment-Economy Interface in Southland

Water is critical to human health and the health of the natural environment. Freshwater is abstracted from either surface water or from ground water. It is also discharged back into the environment, which is problematic if it is modified or contaminated through its use. This study reports on these three elements: surface water take, ground water take and water discharge.

Over the last decade, demand for water in Southland has increased, with dairy farming's growing demand for water driving this growth.

Estimated Abstractions

According to Environment Southland[5] (2010) the total *average* volume of water allocated for use in Southland is 124 million cubic metres. Our review of Environment Southland consent database shows that the average water allocation between 2005/6 and 2009/10 was 126 million cubic metres and increasing to around 150 million cubic metres in 2011/12. Dairying and the other agricultural users tend to extract water from the groundwater resource whereas water for town supplies is mostly sourced from surface water.

Environment Southland completed a survey of groundwater users in 2009/10 and found that the users typically used 28 per cent of the consented water allocation (Environment Southland, 2011). Our analysis is consistent with the findings in that report. Our analysis suggests that the proportion of the allocation used has been increasing since 2000/1 from 13 per cent to around 27 per cent. As expected there are substantial sectoral differences with some sectors using close to their consented maximum (with occasional overdrawing). Livestock and crop farming's use of authorised water take has increased from around 10 per cent to almost 50 per cent in 2010/11 reflecting more intensive use of the available water resource. During the last three years (2009/10 to 2011/12), dairy cattle farming has used between 43 per cent and 46 per cent of its water allocation.

Over time the difference between allowable abstraction (maximum consent) and water actually taken (abstracted) has decreased. In other words the 'unused' portion of the consent has been getting smaller. In 2009/10 around 57 per cent of the total consented groundwater allocation was actually used.

In terms of volume, dairy farming is one of the largest users of Southland's groundwater, accounting for 55 per cent of groundwater extracted. Going forward the sector's share is expected to increase. Together

[4] Tourism is also an important industry in Southland. It does not exist as a stand-alone sector *per se* in the model. It is represented in the key sectors by Water and rail transport and Accommodation, restaurants and bars.

[5] For the purpose of our analysis we relied on the datasets without making unnecessary/ad hoc adjustments. This however means that the numbers we report and those published in some of Environment Southland reports differ.

dairy farming and livestock and cropping are responsible for more than two thirds of ground water abstractions.

Estimated Discharges and Nutrient Loadings

In Southland, most discharge consents are for dairy farming activities. In 2000/01 two out of three discharge consents were for dairy farming but by 2011/12 this has increased to approximately three out of four. The dairy farming discharge consents predominantly covers dairy shed effluent and the subsequent discharge to land via various sorts of irrigation systems.

Meat and meat product manufacturing, and dairy product manufacturing – two key manufacturing sectors closely linked to Southland's agriculture sector – had 21 and 9 discharge consents respectively (2011/12).

In terms of volume discharged, dairy product manufacturing accounted for approximately 9 per cent of discharge (2000/01), increasing to around 30 per cent in 2010/11. Meat and meat product manufacturing accounted for around 36 per cent of discharge in 2000/01 increasing to over almost 50 per cent by 2009/10 before declining to 43 per cent – making it one of the largest dischargers.

Dairy farming is another large discharger with estimates putting this sector's discharge at around 6 million cubic metres per year (this is associated with the dairy shed operations)[6]. If stock water is included, and assumed to be discharged, then dairy farming's discharge would be more than 15 million cubic metres in 2011/12. Two other sectors have discharges which are notable: basic metal manufacturing (including the aluminium smelter) with discharges slightly under 3 million cubic metres per year and Personal and other community services with discharges of around 6 million cubic metres per year.

A by-product of Southland's economic activity, especially the agriculture and processing of agricultural goods, is nutrients which are discharged to the environment. These nutrients include different forms of nitrogen (N) and different forms of phosphorus (P). In addition sediment and e-coli levels are affected but data difficulties limited our ability to include these in the study. The available data from Environment Southland on nutrient concentrations as well as NZIER estimates of total N and P discharged from Southland's agriculture activities enables us to estimate the nutrient loadings[7] for some of Southland's economic sectors. We estimated the nutrient loads for five sectors as shown in the next table (the values in brackets show the low and high estimates).

The four agriculture sectors included above produce approximately 90 per cent of Southland's agricultural value added, and so are important in economic terms, considering that agriculture activity plays a substantial role in Southland's economy. With reference to nitrogen loads, livestock and crop farming is responsible for the largest nutrient discharges. This sector is estimated to have discharged 11,100 tonnes of N to Southland's environment. Over time the N discharged by livestock and cropping has decreased by 22 per cent down from 14,200 tonnes in 2000/01. Similarly phosphorus discharged by livestock and cropping has decreased, dropping from 270 tonnes in 2000/01 to 190 tonnes in 2011/12.

[6] If stock water is included, and assumed to be discharged, then dairy farming's discharge would be more than 15 million cubic metre in the 2011/12 year.
[7] Our analysis focuses on N and P and does not include sediment or e-coli.

Table 1: Estimated discharges for Selected Sectors

	2000/01	2003/04	2005/06	2007/08	2009/10	2011/12
Total N (tonnes)						
Livestock and cropping farming	14,246.83	14,833.02	14,742.66	12,100.66	12,052.94	11,108.30
Dairy cattle farming	2,777.67	4,096.22	4,120.54	4,811.13	6,240.67	6,886.61
Forestry and logging	56.27	58.19	58.76	56.27	56.07	55.00
Dairy product manufacturing	14.43	70.48	70.48	70.32	174.70	104.74
Personal and other community services	2.05 (1.44-2.66)	0.35 (0.25-0.46)	2.89 (2.03-3.74)	8.37 (5.89-10.85)	8.38 (5.90-10.86)	8.42 (5.93-10.92)
Total	17,097.24	19,058.27	18,995.32	17,046.75	18,532.75	18,163.07
Total P (tonnes)						
Livestock and cropping farming	270.10	276.48	274.60	219.78	213.22	192.05
Dairy cattle farming	96.77	142.70	143.55	167.61	217.41	239.91
Forestry and logging	2.81	2.91	2.94	2.81	2.80	2.75
Dairy product manufacturing	2.64 (0.01-5.26)	12.89 (0.07-25.71)	12.89 (0.07-25.71)	12.86 (0.07-25.65)	31.95 (0.17-63.73)	19.15 (0.10-38.21)
Personal and other community services	0.46 (0.01-0.80)	0.08 (0.07-0.14)	0.65 (0.07-1.12)	1.88 (0.07-3.25)	1.88 (0.17-3.26)	1.89 (0.10-3.28)
TOTAL	372.77	435.06	434.62	404.94	467.26	455.76

The values in brackets show the range – a low and high estimate

Dairy cattle farming's nutrient loads increased from approximately 2,800 tonnes of N to close to 6,900 tonnes in 2011/12. Dairy farming discharged an estimated 240 tonnes of P – more than double the 96 tons discharged in 2000/01. Dairy product manufacturing nutrient loads have been increasing matching the growth in dairy farming (and therefore milk processing), increasing to over 100 tonnes in 2011/12. Similarly the P loads from dairy processing has increased corresponding with higher milk processing.

Total N discharged has increased by 0.5 per cent per year (compounded). Likewise, P discharge has also increased rising from 370 tonnes in 2000/01 to over 455 tonnes in 2011/12 – this is a compound growth of 1.7 per cent per year.

Economic and Ecological Multipliers

The idea behind the derivation of ecological multipliers is to demonstrate the extent to which production and consumption of economic goods and services depends on the provision of different types of ecological goods and services, both directly and indirectly. Essentially the multipliers measure all of the downstream or upstream ecological impacts that are 'embodied' in the production of a particular economic good or service. Our results represent an analysis of impacts associated with each industry's output (i.e. the backward linkages). We calculated water abstraction (m^3), water discharge (m^3), total nitrogen (kg) and total phosphorous (kg) ecological multipliers. The main observations are:

- Using the production chains of manufacturing industries responsible for immediate processing of raw primary products (meat and meat product manufacturing and dairy product manufacturing) shows that these industries use and discharge significant quantities of water. This is because these industries are both significant direct users of water, and major purchasers of primary goods *that are also produced* with significant water inputs.
- Once processed, much of Southland's meat and dairy products leave the region as interregional and international exports, rather than being consumed by other local industries and sources of final demand. In this way Southland is an 'exporter of embodied environmental goods'.

Business as usual water impact scenarios

With reference to future water use (abstraction and discharge) under a Business as Usual scenario, the analysis suggests that over 70 per cent of the total additional water demand in Southland is associated with increased demand by the dairy cattle farming sector. A further 7 per cent and 10 per cent is associated with growth in demand respectively by the other agriculture activity and dairy product manufacturing sectors. In other words 87 per cent of future water demand is likely to come from these sectors.

One of the clear findings from this analysis is that, under the business as usual (BAU) scenario, Southland is not showing a large decoupling of economic growth from water demand. The annual average growth rate in water abstraction and water discharge is only slightly less than the annual average growth in value added. This occurs despite assuming an economy-wide rate of efficiency change of 0.5 per cent per annum. Thus under this BAU scenario, the Southland economy is becoming relatively more dependent on industries with comparatively high water demand. This implies that going forward, freshwater management approaches will need to be undertaken in a way that maximises the economic use of water while maintaining (or even improving) the environment, of which water is a sub-component.

Concluding remarks

This work, completed within a short timeframe, provides a good foundation for additional research. By refining the BAU scenario, or defining a new future scenario(s), it would be possible to assess and quantify the economic, water and water related economic implications of changes while considering the interdependencies which exist in the Southland economy.

This research provides some insight into the scale of the issues that Southland region may face in water terms by looking at the economy-environment interface using abstraction, discharge and nutrient loadings. To expand and complete this picture it would be necessary to consider the dynamic feedbacks which exist between the economy and environment. These feedbacks are characterised by non-linearities, lags and complex cause-effect relationships which may produce emergent behaviour not captured in business as usual trends.

Limitations

Our study relied heavily on Environment Southland's resource consent and monitoring datasets. We assumed that this dataset is accurate and up to date. We did not seek to audit or verify its information. We did identify a few anomalies that we have addressed after consultation with Environment Southland. We compared our results against published information and in most cases the results matched. It is important to note that:

- Our analysis does not include the abstractions, discharges and nutrient loads of permitted activities or activities taking/discharging via reticulated systems.
- We did not distinguish between individual catchments, and instead focused on Southland in its entirety.

- We looked at abstractions and discharges individually and did not attempt to reconcile/relate water takes and discharges. Such reconciliation could provide additional insights into sectoral water balances (water in vs. water out).

This study used an Input-Output model to show the economic linkages within and between sectors in Southland, the rest of the South Island and the rest of New Zealand. IO models have a number of limitations and in the context of this study the main limitations are that these models do not account for price changes that may result from increased competition for a scarce resource. In addition, it is assumed that all resources needed to accommodate future growth will be are available i.e. the model is demand driven and not constrained.

PART 2: SOUTHLAND REGIONAL WATER ISSUES (NIMMO-BELL)

Key messages

1. The study has highlighted that the changes required to improve environmental outcomes for water quantity and quality must go beyond dairy to include other rural sectors (i.e. dry-stock, cropping and horticulture) plus industry and urban discharges.
2. Despite the 12 fold increase in dairying in Southland over the last 20 years, the multiple and complex factors that determine the environmental state of water bodies means that it is not certain the extent to which dairying is the cause of water pollution problems. Impacts vary widely depending on soil type, topography, climate and management. Also there is the legacy effect of past land use with a 30-40 year average time lag between water entering the groundwater aquifers and its reappearance as surface water.
3. The ecological health at the majority of the river and stream monitoring sites is good or very good, and sediment and faecal bacteria levels have held steady over the last 10 years. However, the region has high levels of nutrients present in these waterways (some of the highest in the country) and for nitrogen increasing trends, in both surface and groundwater.
4. The most sensitive parts of the catchments (the estuaries, lagoons and coastal lakes) are showing signs of stress. Investigations last year found that the estuaries for two of the region's main rivers (the Jacobs River and New River estuaries at the bottom of the Aparima and Oreti Rivers) had areas that were rapidly deteriorating due to excess sediment and nutrients.
5. Reducing nitrate leaching from agricultural activities is a real challenge as it is directly related to land use intensification, the main driver of wealth creation in the region.
6. Groundwater quality is generally potable and many rural properties in Southland rely on untreated groundwater for drinking water. However, 23% of bores in the region were subject to faecal contamination in 2012 (down from 55% in 2003), mainly from contamination near the bore head rather than from contaminated aquifers. Nitrate concentrations were higher than the drinking water standard in 19% of bores sampled in 2012.
7. While the quantum of effluent from failing septic tanks in the region is estimated to be low in comparison with that derived from livestock sources, such failures do constitute significant human health issues. Environment Southland's 'Water and Land 2020 & Beyond' project includes identifying the sources of contamination to determine the proportional inputs of agricultural and human effluent, but this work is yet to be started.

8. The survey of a small group of key stakeholder representatives highlighted that people have a set of shared values that provide a common ground and underlie sector specific values driven by special interest. There is a common interest in having improved environmental outcomes, but the costs to achieve this vary depending on sector interest e.g. farmers having to bear the direct costs and the community the indirect cost of improvements.
9. The Stakeholder survey showed that Environment Southland's engagement with the community rate positively around how well the Council took their concerns into account on policy discussions, decision making and communications with the public. Respondents rated engagement over policy discussions highest with 88% positive. Taking concerns into account in decision making rated next with 77% positive. How well Council communications with the public over community concerns rated were 63% positive. While it could be expected that the rating for concerns in policy decisions would be rated lower than in policy discussions, the Council should note that more than one third of stakeholder representatives viewed their concerns were not well communicated publicly. This has implications for the Council on channels of communication through the media, direct consultation and publications including the website.

This report consists of two parts. In 'Part 1: Regional Profile', Southland is reviewed focusing on the economic production structure and water use by sector. This is used to estimate tentative future water requirements under a Business-as-Usual scenario. The second part, Part 2: Southland Regional Water Issues provides an overview of the significant water quality and quantity issues that currently exist and may possibly exist in the future. This section summarises existing water quality and quantity evidence.

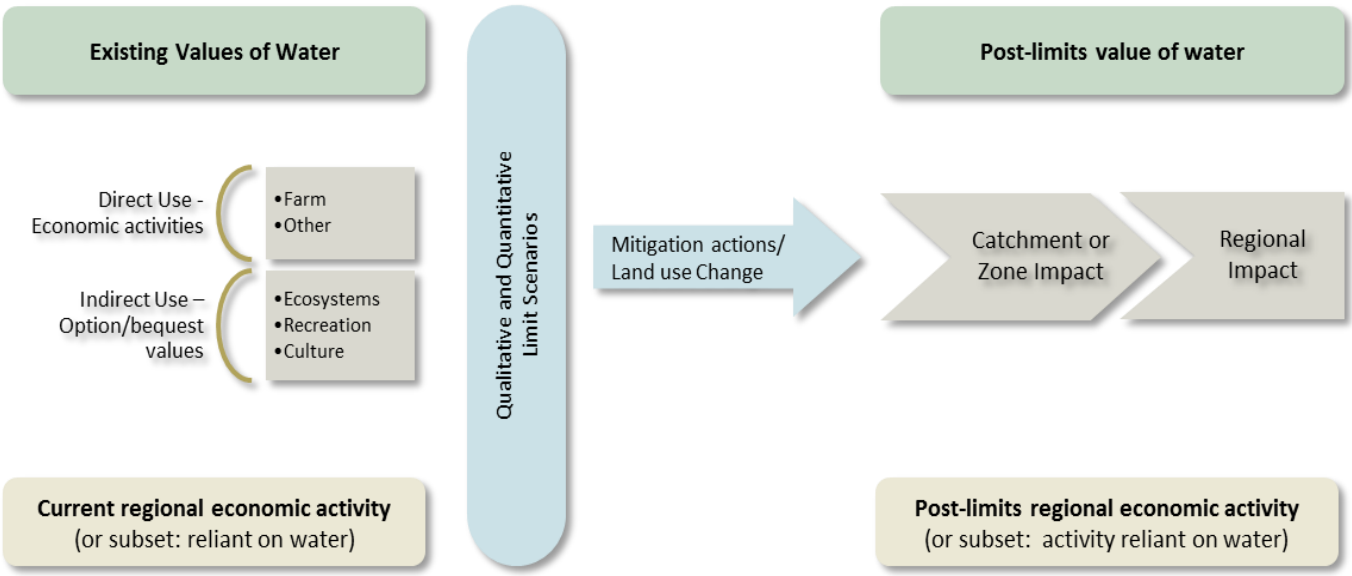
PART 1: REGIONAL PROFILE

1 Introduction

Water resources are critical to human health and the natural environment, and so are vital to the New Zealand economy. Water constitutes an important input into industrial processes (e.g. agriculture, forestry, food manufacturing), is used to produce energy, provides the basis for much of our outdoor recreation, serves as a vehicle for disposal and treatment of wastes, is a critical component of ecological systems from which other important 'ecological goods and services' are derived, and provides important cultural and amenity values. However, like many other forms of environmental resources, water possess a number of features making it unique when it comes to managing its use[8]. As a result, there is an important role for management intervention to ensure the efficient allocation and quality.

The Ministry for the Environment (MfE) has initiated a project, consisting of a series of studies, to enable more accurate assessment of the economic impacts of freshwater quality and quantity issues. The wider purpose of these studies is to assist the MfE to develop policy scenarios on quality and quantity limits in freshwater. This work will also help inform regional councils about the potential economic impact(s) of policy options in regional plans. The Ministry is using a Total Economic Value (TEV) framework as basis for calculating the value attributed to water resources. The TEV framework includes direct use of water in economic activities, the indirect use or ancillary function that can be critical for ecosystem services and cultural systems. Direct (consumptive) and non-direct (or non-consumptive) use of water has values associated with it for individuals and the community. In addition, the TEV framework includes option or bequest values associated with the existence of the freshwater system (Figure 1.1).

Figure 1.1: Total Economic Value Framework



Source: MfE Scope of Work

[8] When describing the unique economic features of water economists use terms such as 'non-rivalry', 'non-exclusive property rights' and 'production of externalities'. Essentially this means that water is a public good and that is both non-excludable and non-rivalrous in that individuals cannot be effectively excluded from use (within geographical bounds). Use by one individual does not reduce availability to others. Importantly, however it is possible for individuals acting in their self/immediate interests to diminish or degrade the original resource.

MfE recognises that there are existing values of water, a subset of which are critical for the regional economy. In exploring the effects of management of water resources through the introduction of qualitative and quantitative limits, the values attached to water may change. These may result from the physical changes within the catchments and freshwater systems, but also due to the changes in economic activity brought about through the setting of those limits or as a consequence of the new freshwater system post-limits.

Developing a full picture of the post-limits values of water requires consideration of wide ranging research themes/areas. MfE has identified the following themes/areas:

- Sector and subject specific research (including on-farm information, cost abatement curves)
- Regional analyses (including an overview of the impact of setting specific quality and quantity limits)
- Key implications – sector and subject specific findings and regional implications of different policy positions and scenarios
- Effect of the potential economic impacts of quality and quantity limits on land use change and regional economic activities using a suitable analysis framework that classifies catchments and zones, acknowledging the economic activities that are reliant on water.

As mentioned earlier, MfE is managing the wider project based on a Total Economic Value (TEV) framework to address the above research themes, by way of individual work streams. These themes cover the subset components of the TEV. This report describes the contributions of Market Economics Ltd and its work stream.

1.1 Project Objectives

This study is part of MfE's wider research agenda which focuses on the value of water within the Southland region. As part of this process, Market Economics Ltd were tasked to:

- Develop a regional economic profile of the Southland economy, describing its structure with reference to key economic indicators such as value added, income, and employment.
- Identify Southland's key economic sectors and prepare sector outlooks describing a potential 'business as usual' future.
- Calculate current water takes, discharges and nutrient loads levels by economic industry, and from this information produce a series of ecological – water multipliers[9].
- Produce tentative estimates of future water use, discharge and nutrient levels by economic sector to show potential future water requirements under a business as usual scenario.

[9] An ecological multiplier may be derived for any environmental resource or residual. A water multiplier specifically looks at water use, discharge and water-related discharges. A water multiplier captures not only the direct use/discharge/nutrient loading in an industry, but also indirect use/discharge/nutrient loadings which are appropriated through supply chains. Often these multipliers are used to show that a seemingly ecologically benign industry may, in fact, be a significant appropriator of an environmental resource. In this report we have used the term 'ecological' and 'water' multiplier interchangeably.

1.2 Methodology

To achieve the project objectives, a two stage process was followed. During the *first* stage, an economic profile of Southland was developed. This profile provided a high level overview of Southland's economy and was used to identify the region's key sectors. A potential development trajectory for each key sector was also formulated by considering available literature.

In the *second* stage, current and future water demand requirements were estimated. Current water requirements i.e. abstractions, discharges and nutrient loads were determined from Environment Southland's consent database and monitoring database. All relevant consents were linked to one of 48 economic sectors allowing us to estimate the future water requirements under a 'business as usual' (BAU) scenario. As part of this step tentative estimates of future water use/discharge and nutrient loadings were derived by applying annual water requirements (estimated in the preceding steps) to a BAU growth outlook. The future use levels account for eco-efficiency gains (under various stated assumptions) in water use, discharge and nutrient loadings. In the context of this report, eco-efficiency relates to how much water is used to produce a unit of economic output and therefore any gains means that the economy uses water more efficiently. Further, 'more efficiently' covers reductions in nutrient discharges (concentrations per cubic meter).

Importantly, the study focuses on developing an understanding of Southland's key sectors, particularly agriculture and the sectors processing agricultural produce. Appendix 1 provides a detailed account of the steps followed in producing the estimates for the two stages noted above, including assumptions made, key limitations, and any caveats of the research.

The study concluded with an overview of future water requirements in light of Environment Southland's current policy regime and water use right policies.

1.3 Data Sources and Information

A range of different information sources were consulted during this project, including:

- Environment Southland's resource consent database
- Environment Southland's compliance monitoring records
- Market Economics' (ME) Economic Futures Model (EFM)
- Statistics New Zealand datasets, including the Business Demographic Statistics (BDS) dataset and population projections.

In seeking to expand our understanding of Southland's key economic sectors we also consulted available literature, including publications written by or reports prepared for:

- Dairy NZ
- Livestock Improvement Corporation
- Venture Southland
- The Tertiary Education Commission

- GIRA Consulting and Research
- Beef and Lamb New Zealand
- Ministry for Primary Industries
- Organisation for Economic Cooperation and Development (OECD)

A full description of the sources is presented in the list of references.

1.4 Report Structure

Section 2 presents a demographic profile of the region using Statistics NZ data (Section 2.1) and income levels within the region (Section 2.2). ME's Economic Futures Model[10] for Southland is used to show the value added (approximately equivalent to Gross Regional Product) for each economic sector and the employment within those sectors (Section 2.3). This enables an identification of important sectors, using shift-share analysis, in Section 2.4. The criteria for identifying the important sectors were consideration of their relative size in the Southland context, and exploring recent growth trends of those sectors (scale and growth).

An outlook for these sectors is then presented in Section 2.5. It is not a forecast, but a scenario created to explore what the Southland economy would look like, if the recent economic conditions were to continue, along with SNZ's projections of population change.

Section 2.6 acknowledges the complexity of the economic system. There are interconnections and dependencies between industries. The backward and forward linkages between industries are presented. The interconnections between industries are not the only web of connections in an economy. Industries are intricately connected to the natural environment, in terms of where they are located, the resources they use, and the environment they discharge into.

Section 3 explores the environment-economy interface, specifically the connection between the economic sector and water use and discharge. The results from the interrogation of Environment Southland's consents and monitoring databases are presented in Section 3.1. This section presents findings on maximum volumes consented, estimated abstractions, discharges, and where possible the discharge of nitrogen (N) and phosphorous (P) into the environment. These figures were then used to calculate ecological multipliers (Section 3.2) – which link economic activity directly to resource use. Finally, future water requirements and discharges were calculated for the business as usual scenario in Section 3.3.

Section 4 concludes with the key research findings of this work stream (Section 4.1). Recommendations for further work, based on lessons learnt through this process are given in Section 4.2, with some practical ideas for improving the reliability and usefulness of data in Section 4.3.

[10] A dynamic multi-regional input output model which uses 48 economic sectors.

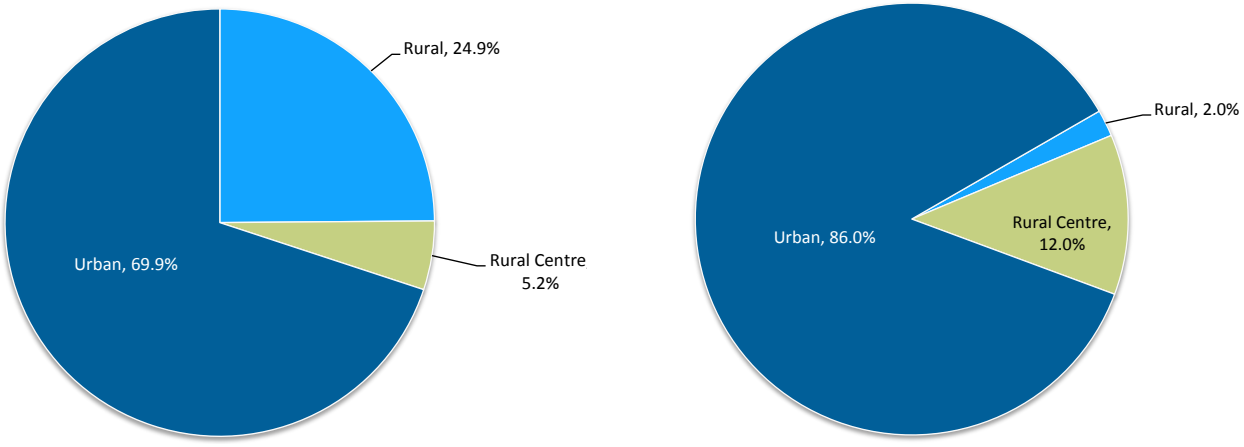
2 Southland – Strategic Perspective

Southland region is predominantly a rural area with strong historical association to agriculture. There are three territorial authorities in the region: Invercargill City Council, Southland District Council and Gore District Council. While Invercargill and Gore are the largest urban centres, various smaller rural centres are distributed through the region including: Winton, Mataura, Otautau, Te Anau, Wyndam, Edendale, Tuatapere, Nightcaps, Mossburn, Manapouri, Wallacetown and Riverton. As a starting point the region's demography is reviewed. The key focus of this section is however on the economy, Southland's key sectors and the outlook for these sectors. The section concludes with a short description of Southland's important economic linkages.

2.1 Demographic Profile

Southland has a resident population of 94,900 people.[11] Nearly 56 per cent (53,000) of Southland's residents are based in Invercargill city, with a further 12,300 residents living in Gore district. Compared to the national average of 86 per cent, the proportion of the Southland population living within urban areas is low, at 70 per cent. Twenty five per cent of Southland residents are classified as living within rural areas and 5 per cent within rural centres (Figure 2.1). The national average for rural living is significantly lower at 14 per cent – 2 per cent in rural areas and 12 per cent in rural centres. The comparatively high rural population within Southland emphasises the high reliance on primary/agricultural industries within the region.

Figure 2.1: Urban-Rural Distribution (2012)



Southland New Zealand

[11] Source: Statistics New Zealand: Subnational Population Estimates as at 30 June 2012.

Southland's total population is expected to decline over the next 20 years from the current level to around 88,000 by 2031. The population of all three districts are set to decline, with Gore District and Invercargill declining slightly faster than Southland District (Table 2.1).

Table 2.1: Southland's Population Projection

Year	2016	2021	2026	2031
Invercargill City	52,390	51,560	50,220	48,540
Gore District	11,870	11,480	10,970	10,390
Southland District	29,640	29,580	29,400	28,970
Total Southland	93,900	92,620	90,590	87,900

Source: Statistics NZ- Medium population estimates[12]

More than a half (60 per cent) of Southland's 39,400 households can be classified as 'a couple without children' or 'one-person' households. Families of various sizes and other multi-person households make up the balance. As population decreases over the next two decades, the number of households is expected to remain constant, but the average household size is expected to decrease. Table 2.2 shows these projected household sizes for each district of Southland.

Table 2.2: Average Household Size (projected)

	Southland District	Gore District	Invercargill City
2011	2.5	2.3	2.3
2016	2.4	2.2	2.3
2021	2.4	2.2	2.2
2026	2.3	2.1	2.2
2031	2.3	2.1	2.1

Source: Statistics New Zealand

With reference to labour force engagement (see Figure 2.2), it appears that Southland makes marginally better[13] use of its available labour force when compared with the nation.

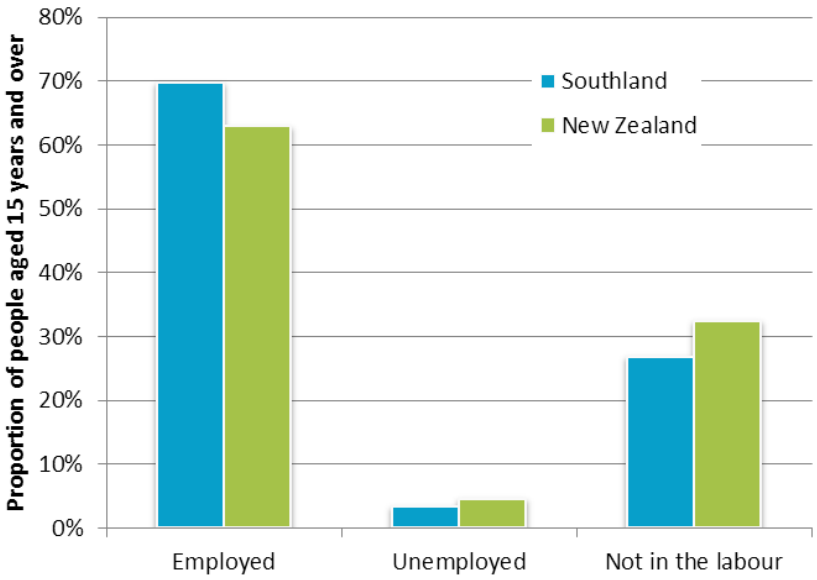
In particular:

- A larger share of Southland's labour force is engaged in employment
- Southland has a slightly lower unemployment rate than the country as a whole
- The proportion of people aged greater than 15 years not within the labour force is smaller.

[12] A description of these population estimates can be found on Statistics New Zealand's website at: http://www.stats.govt.nz/tools_and_services/tools/TableBuilder/population-projections-tables.aspx#subnational

[13] In this context 'better' relates to the percentage of the labour force utilised and is not indicative of labour force productivity

Figure 2.2: Labour force engagement, 2012



Source: Statistics NZ

2.2 Income

Despite Southland's good performance in terms of labour force engagement and employment, personal income levels in Southland are marginally lower than the national average in 2012 for most age cohorts (see Figure 2.3 and Figure 2.4), with the noticeable exception being the 50-54 age cohort. Generally following the national pattern, average incomes also peak at around the 50-54 age cohort, before dropping off towards retirement. From the age of 30 onwards, the average weekly income for Southlander's is greater than the median wage. This indicates that incomes are not evenly distributed and within each of the cohorts, there are a number of 'outliers' in the higher income brackets. This trend appears to be more pronounced in Southland than for the nation as a whole.

The average weekly household income in Southland was $1,471 in 2012, which is $79 per week lower than the national average household income of $1,550 (See Figure 2.5). Over one year, this equates to a difference of $4,120 per household.

KEY POINTS:

1. **Southland has a population of 94,900 people, which is expected to decline over the next two decades.**
2. **Southland has a high percentage of rural (including rural centre) based population at 30.1 per cent, compared to the national average of 14.0 per cent**
3. **'One-person' and 'couple without children' households are the most common (60 per cent), and the average household size across Southland is decreasing.**
4. **Southland has a higher proportion of the labour force in work than the national average.**
5. **Average household and personal income levels in Southland are slightly below the national average.**

Figure 2.3: Income by Age Cohort – Southland (2012)

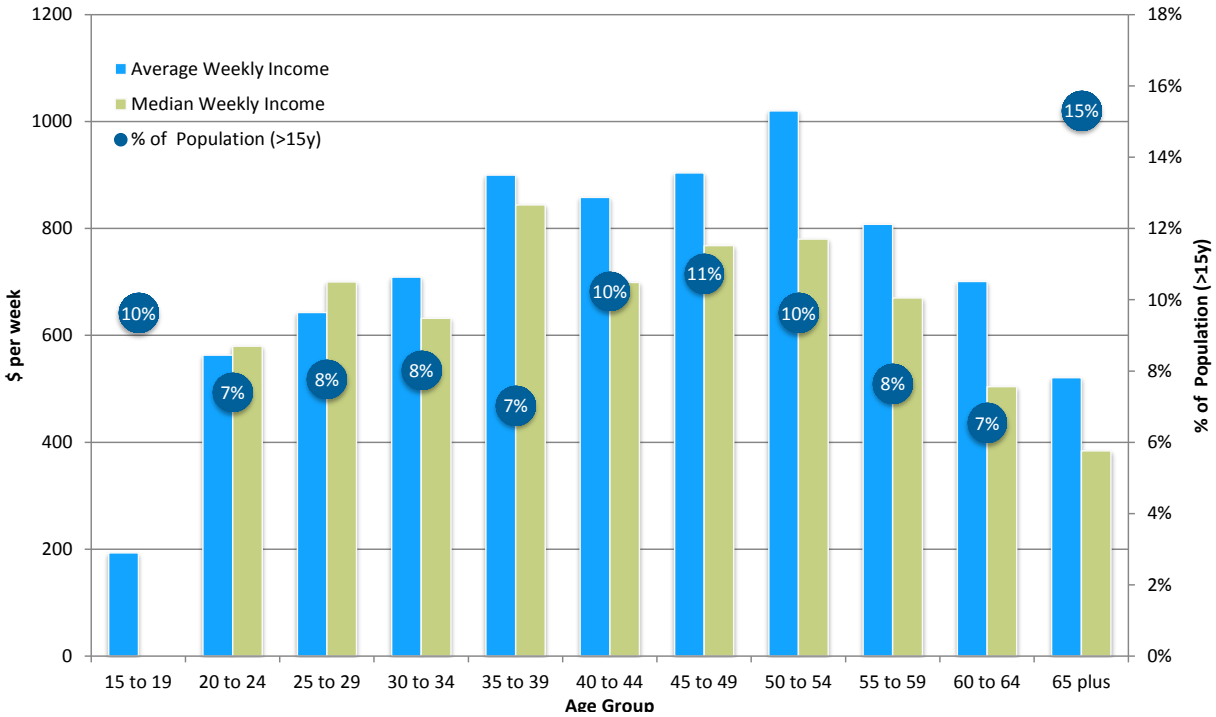
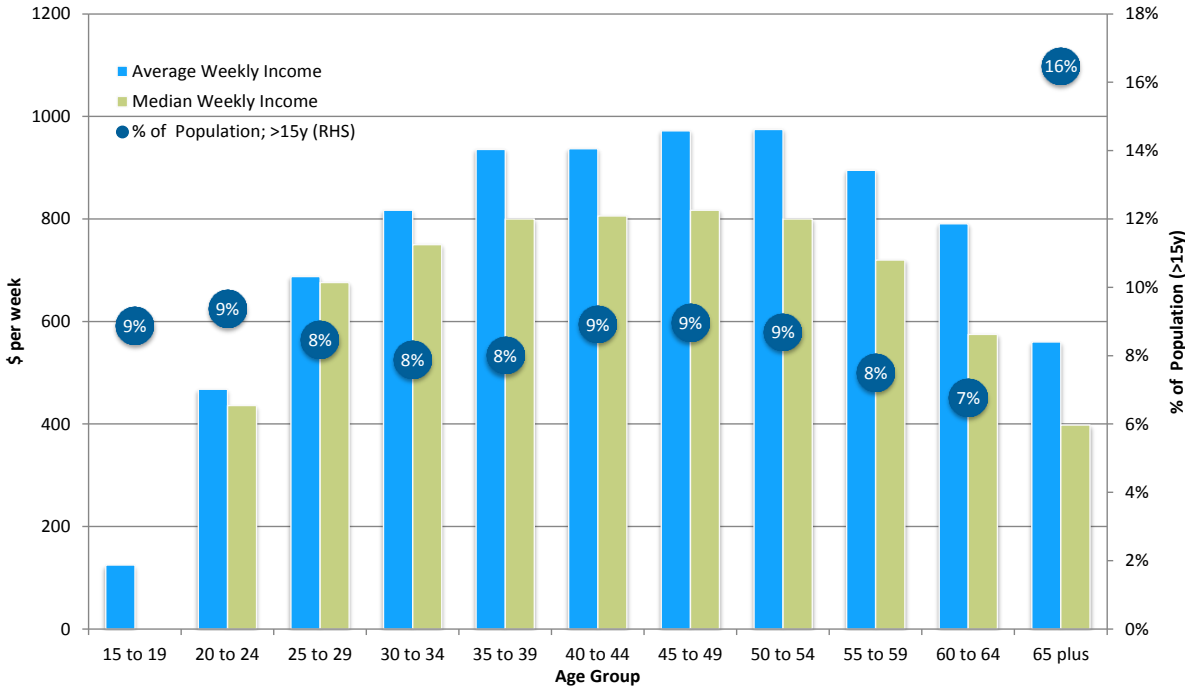
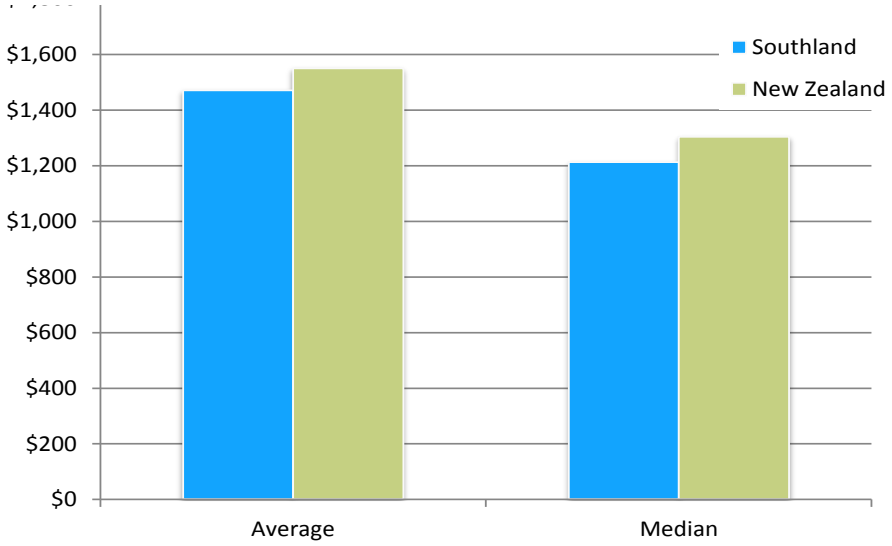


Figure 2.4: Income by Age Cohort – New Zealand (2012)



Source: Statistics NZ

Figure 2.5: Average household income ($2012/week)



Source: Statistics NZ

1.3 Economic Profile

In this section, the economy of Southland is reviewed using value added and employment as indicators. This provides a high-level overview and performance of the Southland economy, and subsequent more in-depth discussion of particular sectors are given in the ensuing sections. Agriculture has traditionally been the mainstay in Southland and this is not anticipated to change, at least over the medium-term. New Zealand's only aluminium smelter is located close to Invercargill City and is among the most high-profile industries within the local economy. In 2012 the Southland economy generated around NZ$4bn in value added,[14] and provided over 55,000 employment positions[15] in some in 13,600 businesses.[16]

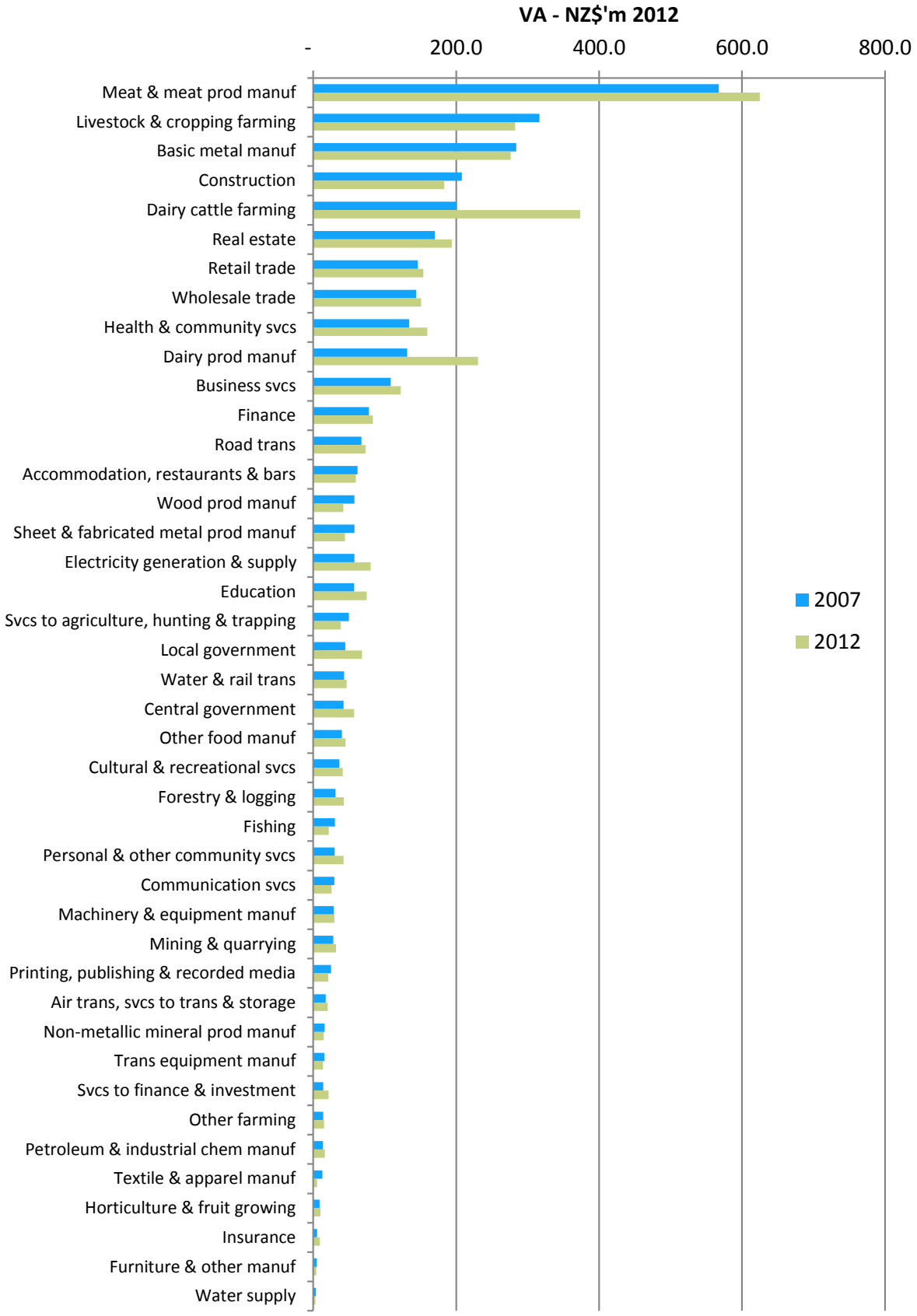
The following describes Southland's economy by examining the performance of individual sectors operating within the economic system. The focus is on the total contribution of each sector to the Southland economy, as well as each sector's relative performance. The analysis was undertaken at the level of 48 different sectors using ME's EFM. The dominant industries for Southland are discussed only, and a comparison of the relative size of each industry is evident in Figure 2.6.

[14] Value added measures all payments to factors of production (land, labour and capital), and excludes all purchases of intermediate inputs. Value added includes compensation of employees (salary and wages), operating surplus (company profits), consumption of fixed capital (depreciation), and taxes less subsidies. In broad terms it is similar to gross domestic product (GDP). The main difference is taxes of products which is included in GDP and not in value added. Little information exists about regional contributions to tax (from a sectoral perspective) so therefore the M.E models are set-up to report value added (as oppose to GDP). We have prepared regional GDP estimates but tend to use crude estimates of regional tax on products when estimating these.

[15] The term Employees, as used in this context, captures both employees and working proprietors. M.E uses the term Modified Employee Counts or MECs to describe this metric.

[16] A geographic unit (GEO) is defined as a separate operating unit engaged in (predominantly) one kind of economic activity, from a single physical base.

Figure 2.6: Southland's value added per sector



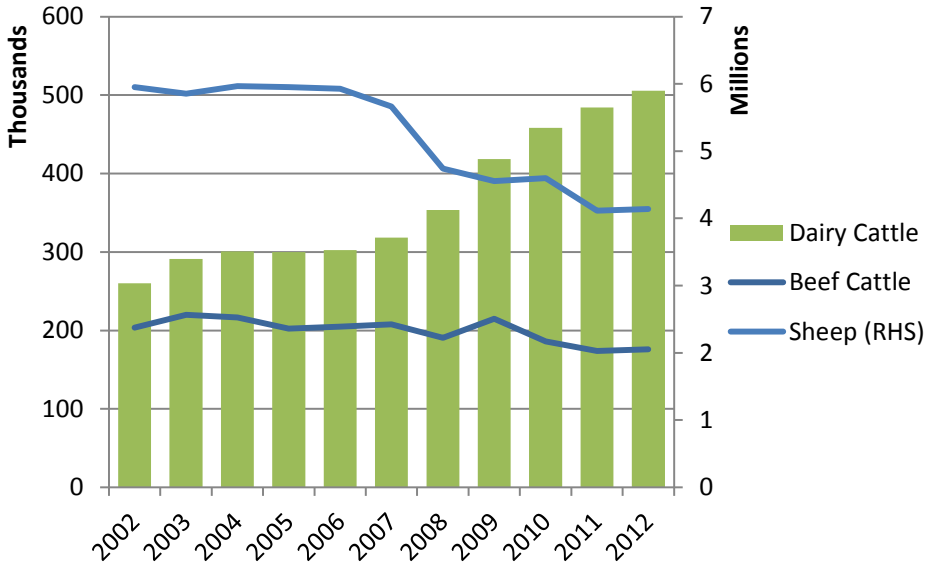
Source: M.E Calculations based on SNZ and the Economic Futures Model

We begin by presenting the estimated value added contribution of each of the 48 economic sectors. The key messages are:

1. Agriculture remains the backbone of the Southland economy

- The agricultural sectors contribute a large portion of Southland's total value (16.7 per cent of the region's value added). Since 2007 the agricultural industries have all seen a slight increase in their regional value added contribution (up from 14.8 per cent of total value added), but the importance of the primary sector to Southland has remained relatively constant.
- In 2012, livestock and crop farming contributed $\$283m_{2012}$, or 6.9 per cent, to the Southland economy. This is down by almost $\$34m_{2012}$ from 2007, even though meat prices are up on 2007, albeit currently on a downward trend (Beef and Lamb NZ, 2013). This is likely to be due to a large number of sheep and beef farms which converted to dairy.
- Dairy cattle farming contributed $\$373m_{2007}$ or over 9 per cent to local value added. Land is rapidly being converted to dairy, this figure is up by over $170m since 2007. This is most likely due to the dairy conversions and large increase in dairy numbers (DairyNZ, 2012). The trends in stock numbers for sheep, beef and dairy are reflected in Figure 2.7. The decline in Sheep and the increase in dairy cattle is evident. Dairy cattle increased from around 200,000 in 2002 to over 505,000 in 2012 – this is an annual increase of 7 per cent. Sheep numbers have declined from 5.9 million in 2002 to 4.1 million in 2012 (an annual decline of 3.6 per cent). The number of beef cattle in Southland also declined (at 1.4% per year 2002-2012, with a slight increase in 2009). However, this decline has not been as pronounced as sheep stock. These trends point to the changing nature of Southland's farming i.e. the increasing importance of dairy farming.

Figure 2.7: Trend in Stock Numbers



Source: Dairy NZ & LIC, Beef and Lamb, SNZ

2. Other primary industries are small but important

- Other primary sector activities (including fishing, forestry and mining) contributed a further $89.7m$_{2012}$ (2.2 per cent) of Southland's value added.
- The Forestry and Logging industry, have a high profile due to the quality/nature of its outputs. However, this sector is comparatively small in terms of value added to the region. However, this sector has grown when compared to 2007 but is relatively flat over the last ten years.
- Mining and quarrying, although relatively small with a value added of around $30m$_{2012}$ over the last 5 years (0.8 per cent of Southland's total value added). This sector is an important supplier of raw materials to local construction industries.

3. There are significant industries within Southland's manufacturing base

- In addition to the aluminium smelter, Southland has a well-established manufacturing base. Most of the manufacturing activities have been under severe pressure due to the economic recession. The main features of the manufacturing are:
    - Meat and meat product manufacturing with a value added contribution of $567m$_{2012}$ in 2007 (12.7 per cent of total value added) is one of the largest manufacturing sectors in Southland. This is an increase of $60m since 2007. This sector has (and is still continuing) come under pressure from a large amount of dairy farm conversions.
    - Basic Metal Manufacturing is another key manufacturing activity. This sector includes NZAS Tiwai Aluminium Smelter and had a value added contribution of over $285m$_{2007}$ (8 per cent of total value added).[17] This industry has a number of downstream linkages with the rest of the Southland economy.
    - Dairy product manufacturing contributed $230m$_{2012}$ (5.6 per cent of total value added) to the Southland economy. When combining this figure with that of dairy farming (as an input into the wider dairying industry) then the size of this overall industry becomes apparent – these two sectors contribute over $600m$_{2012}$ to Southland's value added. The on-going conversions to dairy farms mean that future growth of this sector is expected.
    - Other noteworthy manufacturing industries include Sheet and fabricated metal product manufacturing ($45m$_{2012}$ value added), Wood product manufacturing (down $15m$_{2012}$ from 2007 to $42m$_{2012\ in}$ value added) and Machinery and equipment manufacturing at $29m$_{2012}$.

4. Southland's household sector generates economic activity

- As with any economy, a portion of the local economy is geared towards supporting Southland's households as well as the local firms. These sectors include:

[17] We note that a previous report (Infometrics, 2012) have estimated this sectors value added at over $380m for Southland. Without having details of the techniques used in that study, we presume that the difference is due to the regionalisation methods applied. This figure of $380m appears to be high and would suggest a value added per employee in excess of $450,000. This is greater than any other industry, including other capital intensive industries such as electricity generation.

- Retail trade, with a value added $154m_{2012}$ (4.0 per cent of Southland's total).
- Health and community services with a value added of $160m_{2012}$ (4 per cent of Southland's total).
- Real estate and finance industries which contributed around $193m_{2012}$ (4.7 per cent) and $114m_{2012}$ (3 per cent) of Southland's value added respectively.
- The education sector, which contributed $75m_{2012}$ (2 per cent) of the region's value added.
- Accommodation, restaurants and bars, which fell slightly to $60m_{2012}$ (3.8 per cent) in value added between 2007 and 2011. This was in line with the decline in other tourism and entertainment related industries. Cultural and recreational services grew to sit at $41m_{2012}$ value added (1 per cent of Southland's value added).

KEY POINTS:

1. **The agricultural sector contributed almost 17 per cent of Southland's economy in value added terms.**
2. **Livestock and cropping farming contributed 7 per cent ($287m$_{2012}$) and Dairy cattle farming contributed 9 per cent ($373m$_{2012}$). These are the two largest primary sectors.**
3. **Southland has a well-established manufacturing base, all though the economic recession has placed pressure on these industries.**
4. **Meat and meat product manufacturing contributed $624m$_{2012}$ (15 per cent). which was the biggest sector in Southland, although it is facing pressure from pricing trends and the conversion from livestock to dairy farming.**
5. **The strong dairy sector is expected to continue to show growth as more farms undergo conversion to dairy.**
6. **The industries involved in the production of (including the NZAS Tiwai Aluminium Smelter) and/or use of fabricated or sheet metal products make up 8.2 per cent, but have strong linkages to other economic sectors and play an important support role in the Southland economy.**
6. **Industries focussed on supporting local households and firms make up an important part of the economy. For example, Retail trade and Health and community services had contributions of $154m$_{2012}$ (4 per cent) and $160m$_{2012}$ (4 per cent) respectively.**

2.2.1 Employment

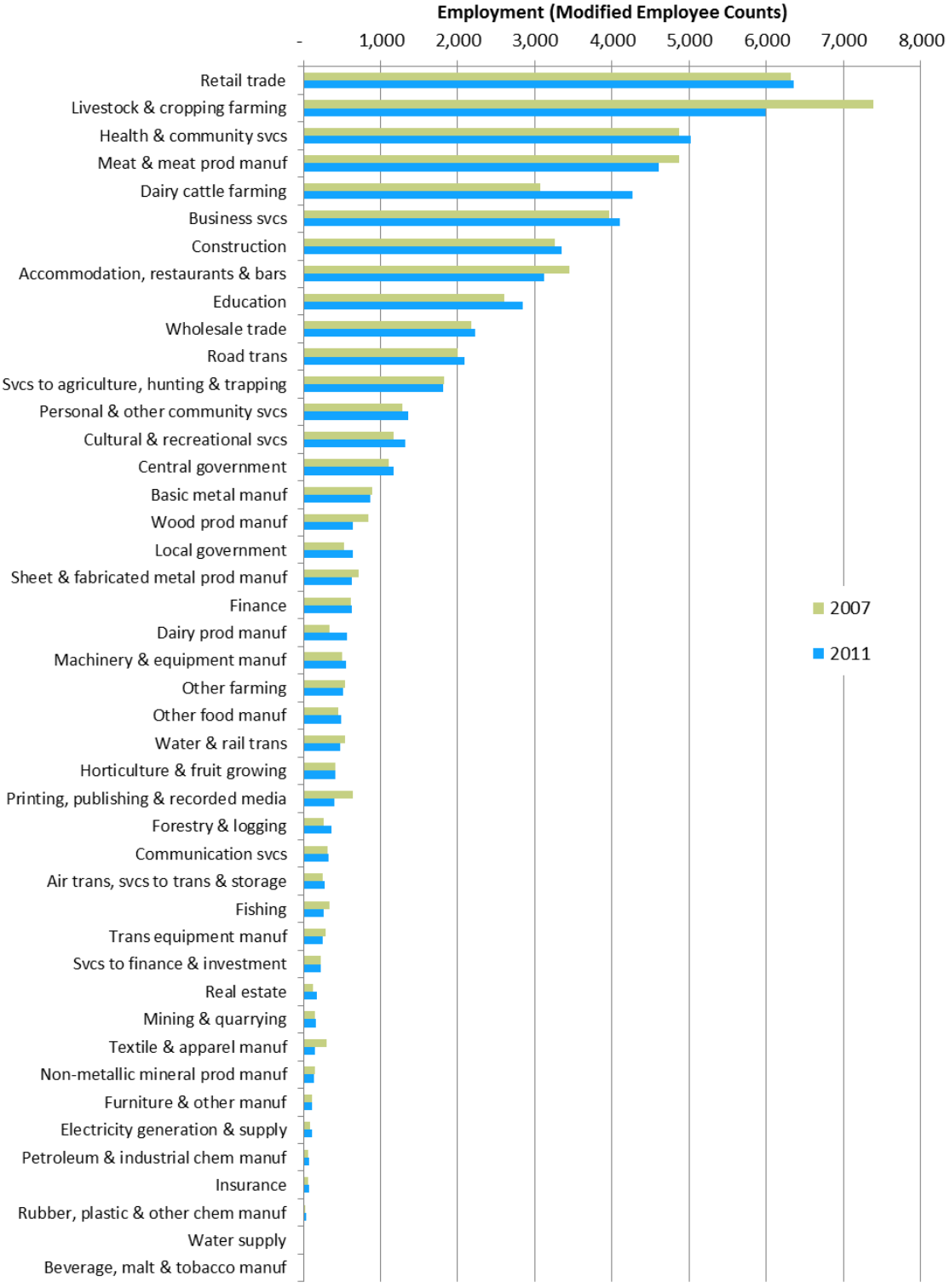
Employee counts are used to measure the number of employees (full and part time) within the Southland economy. It is however also necessary to consider working proprietors in this assessment. Employee counts (SNZ's measure) are adjusted to account for working proprietors, resulting in Modified Employee Counts or MECs. We use this latter indicator as it is a better reflection of the 'true' employment situation. Figure 2.8 shows the employment of each sector for 2007 and 2011.

Again, the importance of the **primary sector** – particularly agriculture – is clear.

- The land based agricultural sector accounts for a significant proportion (21.9 per cent) of Southland's total employment.

- Livestock and cropping farming employs 5,990 people (10.1 per cent of total Southland MECs) and is the largest employer in the primary sector. This sector is losing share to dairy farming. Since 2007 this sector has lost over 1,400 MECs to other agricultural activities.

Figure 2.8: Southland Employment per Sector



Source: M.E Calculations based on the Economic Futures Model

- Dairy cattle farming is a major employer in the primary sector with 4,270 MECs (7.2 per cent of total Southland MECs). Since 2007 this sector has grown by 1,200 MECs, picking up employees from Livestock and cropping farming.
- Services to agriculture, hunting and trapping employs around 1,810 MECs (2011). This sector's employment has remained relatively stable and has experienced a marginal drop in employment since 2007 of only 20 MECs.
- Other farming has decreased from 546 MECs to 516 MECs, and there was no change in the number of MECs employed in Horticulture and fruit growing (410 MECs in 2011).
- Mining and quarrying has also stayed relatively constant and has increased marginally from 154 MECs (2007) to 164 MECs (2011). Southland has 3 billion tonnes of recoverable lignite (72 per cent of national availability), however the extraction of this lignite is a topic of hot debate and currently this resource is not being developed.[18]
- Forestry and logging has increased its labour force by around 100 MECs, almost 40 per cent, to 360 pointing to some growth in this sector (2007 to 2011).

With reference to Southland's **manufacturing base**, this sector has traditionally been strong in the region. As indicated earlier, the smelter at Tiwai Point is a high profile enterprise, but Southland has various other manufacturing and industrial activities as part of its manufacturing base. These industries provide inputs into agricultural production in the form of intermediate products, with engineering capability embedded in the products. Further, the manufacturing activities transform the agricultural produce before exporting it out of Southland. The main industries are:

- Meat and meat product manufacturing, which is one of the largest manufacturing employers, with over 4,600 MECs (7.8 per cent of total Southland MECs). Since 2007 this industry has been consolidating, shedding 250 jobs. This is due to a number of reasons, including an increase in processing efficiency with the use of improved technologies. Also, as more sheep and beef farms get converted to dairy, there may be less meat available for processing, reducing the demand for labour in the industry. It is likely that some of these jobs will be absorbed by dairy processing.
- Dairy product manufacturing has shown a strong increase in employment over the last 5 years increasing its employment from 340 to 570 – growth of 67 per cent. This uplift is associated with the growth in dairy farming.
- Basic metal manufacturing provides 872 MECs, most of which come from a single employer – the NZAS Tiwai Aluminium Smelter. By 2011 employment numbers in this industry had dropped by 20 MECs since 2007. The future outlook for this sector is unclear due to a combination of uncertainty in the global aluminium sector[19] and domestic (New Zealand) factors influencing the cost of inputs[20,21].

[18] http://www.radionz.co.nz/news/national/128807/solid-energy-drops-lignite-plan-for-southland
[19] http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10854158
[20] http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10852675
[21] NZ Aluminum Smelters Ltd Media Statement, 13 March 2013. Please see: http://www.nzaluminium.co.nz/index.php?pageLoad=134

- Wood product manufacturing, with strong links to Forestry and logging, employs 639 MECs (1.1 per cent of Southland's total MECs) and has seen a decline in employment by 203 MECs since 2007.
- Other industries that recorded an increase in MECs between 2007 and 2011 include Machinery and equipment manufacturing and other food manufacturing. Both these sectors are however comparatively small with some niche activities and specific markets.
- Construction, while not a manufacturing sector, is another large employer with over 3,350 MECs (5.7 per cent of Southland's total MECs). This sector plays an important role in the conversion of farms from sheep and beef to dairy, as the dairy requires different infrastructure (e.g. milking shed) than what is generally required for a sheep and beef farm. The construction industry is also involved in civil projects.

The third group of industries provides goods and **services to the region's households and businesses**.

- Retail trade is the largest employer in this group employing over 6,350 MECs. This is up by 30 since 2007 despite of the recession.
- Health and community services are another large employer and have increased its labour force since 2007. This sector has added 150 MECs in the past 5 years and currently sits at around 5,030 MECs. This increase could in part be explained by the ageing population and an increase in social spending.
- Business services have increased from 3,960 jobs in 2007 to over 4,125 MECs. This increase has been driven by changes in labour supply services, non-residential property operators and legal services. The increase in labour supply services could reflect the move of sheep and beef farm workers to agricultural contractors, as they move into the dairy industry. Real estate services have experienced the largest decrease with 105 fewer jobs in this sector. This decline could be explained by the tight property market experienced in the past four to five years, as well as the emergence of new practices in the property sector (e.g. private internet advertising, etc.).
- Accommodation, restaurants and bars, typically associated with tourism as well as local discretionary expenditure, has lost just over 300 MECs in the last five years to 3,120 MECs (5.3 per cent of Southland's total MECs). This is a decline of over 10 per cent, underlining the impact of the global financial crises on household confidence and tourism activity in general.

KEY POINTS:

1. **The primary sector accounts for 23 per cent of Southland's total employment.**
2. **Livestock and cropping farming employs almost 6,000 MEC, although this is decreasing because of the number of dairy farm conversions, with many of these jobs switching industries.**
3. **Some manufacturing sectors have consolidated (e.g. Meat and meat product manufacturing, Basic metal manufacturing, Wood product manufacturing) due recent economic conditions, while others (e.g. Dairy product manufacturing and Construction) have grown in size.**
4. **Most of the industries related to providing goods and services to households and local business have shown an increase in employment.**

2.3 Important Sectors

In this section, Southland's key sectors are identified. The purpose in undertaking this task is to assist in understanding the role of water in Southland. The following criteria were used to identify key sectors:

- The relative size of the sector in the Southland context (assessed in terms of value added, exports and employment (MECs)).
- Recent growth trends and each sector's relative contribution to that growth.

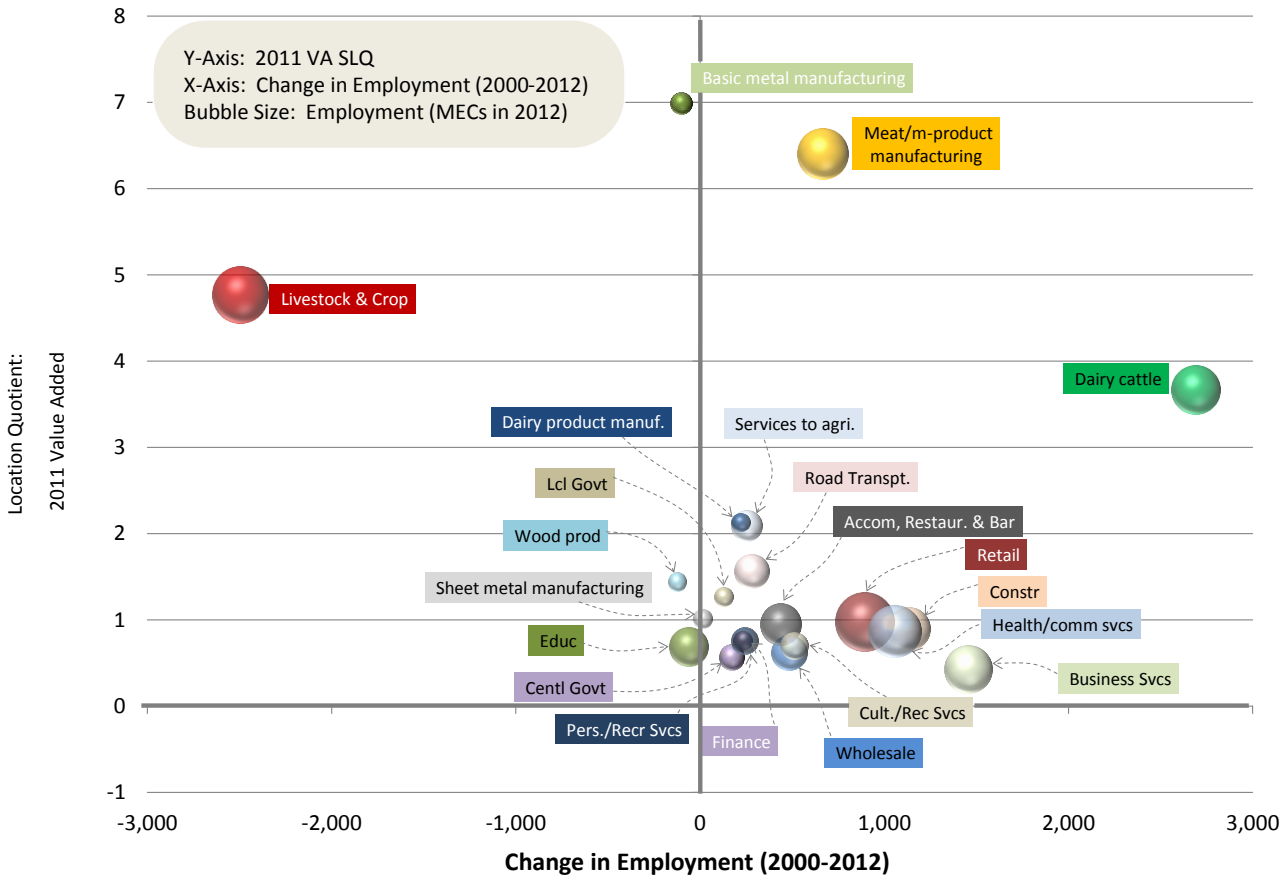
Combining these two criteria into a shift-share framework ensures that all sectors are included in the assessment, and that both scale and recent performance is considered. The 2007 and 2011 value added and export estimates were derived from ME's Economic Futures Model (EFM).[22] This data was also supplemented with GDP estimates obtained from a report into Southland's labour market and economic profile (Infometrics, 2012). Once again the economy was disaggregated into 48 different economic sectors for the purposes of the assessment. Employment was assessed using Statistics New Zealand's Business Demographics Statistics (BDS), which provides information at the level of over 500 sectors. As a direct relationship exists between the EFM sectors and the BDS sectors, the BDS data was aggregated into the same 48 sector definitions.

Figure 2.9 shows Southland's 20 largest sectors using the three key parameters of relative size: Simple location quotient (SLQ)[23] for value added (on the y-axis), the total change in employment between 2000 and 2012 (on the x-axis), and the total number of employees in 2012 (bubble size). Note that the sectors included in this figure account for around 90 per cent of Southland's total employment.

[22] The Economic Futures Model (EFM) is a by-product of a (then) Foundation for Research, Science and Technology (FoRST) project. The EFM integrates numerous datasets using a dynamic multi-regional input-output framework that not only reflects the economic linkages between all sectors (for example agriculture, manufacturing and services) within an economy, but it also captures inter-regional and international relationships.

[23] A SLQ is a measure of an industry's concentration in an area relative to a reference area (New Zealand in this instance). It compares an industry's share of local employment (or another indicator, we used Value Added) with its share of national employment. A SLQ greater than one means the industry is comparatively more important in the local region than the reference region, while a SLQ less than 1 implies that the industry's importance in the local region is relatively low.

Figure 2.9: Shift Share Analysis



For the purpose of this analysis, the key sectors are interpreted as:

- sectors making the largest economic contribution (using value added[24] and employment)
- sectors with the largest growth (using change in MECs between 2000 and 2012)
- sectors with a comparative advantage (using Simple Location Quotient as indicator), and
- sectors with large exports.

Table 2.3 lists the top sectors for each of these four dimensions.

[24] Note that this analysis is based on 2007 constant values.

Table 2.3: Results per Indicator

Exports	SLQ Value Added	Change in MECs 00-12	Value Added (scale)
Dairy prod manufacturing	Basic metal manufacturing	Dairy cattle farming	Meat & meat product manufacturing
Meat & meat product manufacturing	Meat & meat product manufacturing	Business services	Retail trade
Wholesale trade	Livestock & cropping farming	Construction	Health & community services
Other food manufacturing	Dairy cattle farming	Health & community services	Livestock & cropping farming
Sheet & fabricated metal product manufacturing	Fishing	Retail trade	Business services
Accommodation, restaurants & bars	Dairy product manufacturing	Meat & meat product manufacturing	Dairy cattle farming
Wood product manufacturing	Services to agriculture, hunting & trapping	Cultural & recreational services	Construction
Forestry & logging	Other farming	Wholesale trade	Wholesale trade
Retail trade	Road trans	Accommodation, restaurants & bars	Real estate

Drawing on the above results a short-list of important sectors was prepared. Each sector within this short list was then assessed individually from a 'water perspective' and based on recent economic trends, enabling a final list of key sectors to be obtained. Table 2.4 presents this short-list, along with comments explaining why each sector is/was not selected for the final list of key sectors.[25]

Table 2.4: Key Sector Short-list

Sector	Comment	Key Sector?
Dairy product manufacturing	• Strong employment growth. • Growing importance in the Southland economy. • Enjoys a comparative advantage. • Backward linkages to dairy farming.	Yes
Meat and meat product manufacturing	• Exhibits a comparative advantage. • Strong backward linkages to livestock farming. • Employment increased over the last decade (although employment levels have been under pressure in the last two to three years).	Yes
Wholesale trade	• Supports economic activity by linking different parts of production systems. • Weak comparative advantage position (SLQ<1), suggesting that this sector focuses primarily on the local market and that the region looks elsewhere to meet all its 'wholesaling needs'. • Goods flow through the wholesaling sector (via bulk breaking type activities). In itself this sector does not generate a lot of (direct value) and it expected to have relatively small impacts on water values/volumes used in Southland.	No
Other food manufacturing	• In employment terms, this is one of the smaller sectors. • The sector shows some relatively strong export levels with some future growth potential. • Relationships with some of the smaller/niche agriculture activities.	Yes
Sheet & fabricated metal product manufacturing	• Employment under pressure. • Strong links to basic metal manufacturing with some specialist (niche) manufacturing taking place. • Supports local construction activities including dairy conversion activities.	Yes
Basic metal manufacturing	• Dominated by one large entity (NZAS Tiwai Smelter) with linkages to the rest of the economy. • Exposed to external/global economic forces and risk.[26] • Some uncertainty about future operations.[27]	Yes
Livestock & cropping farming	• Historically a strong sector in Southland. • Niche product farming taking place. • Strong linkages with meat product manufacturing.	Yes

[25] For the purpose of this study we reviewed the short list and based on each sector's features (as defined in terms of the comments and the preceding analysis) decided if it would be appropriate to include that sector as a key sector. We note that the selected key sectors cover a large part of the Southland economy (discussed elsewhere).

[26] http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10854158

[27] http://www.stuff.co.nz/southland-times/business/8030406/Tiwai-set-to-cut-more-costs

Table 2.4: Key Sector Short-list

Sector	Comment	Key Sector?
	• Gradual loss of farmland to dairying.	
Dairy cattle farming	• Conversion to dairying taking place and is likely to continue for some time. • Farm productivity higher than national productivity rates. • Strong linkages with other sectors (as inputs into dairy farming as well as to construction during the conversion process).	Yes
Fishing	• A smaller industry focusing around marine activities. • Some supply of local value added to products prior to export.	No
Retail trade	• Retailing is a large employer in Southland and has experienced strong employment growth. • Predominantly demand driven and moves with the trends in the rest of the economy.	No
Health and community services	• Health and community services delivers services to the local community and includes activities such as hospitals, age care residential services, medical services and social assistance services. • This sector delivers services aimed at the Southland community.	No
Business services	• Business Services have seen reasonable employment growth of 3.7 per cent (compound growth) from 2000-2012 and employs around 4,124 people. Non-residential property operators make up over 800 of these employees. These operators include activities such as agricultural land renting, and commercial property renting or leasing. • Southland's business services sector is focused on supporting agriculture and the processing of agricultural produce. A third of this sector's business comes from these sectors.	No
Construction	• Construction is tied to dairy conversions and residential/household construction activity. • The sector is mostly demand driven and is facing competition for labour/resources from the Christchurch rebuild, with Southland losing some skills to the rebuild.	No
Accommodation, restaurants & bars	• Associated with tourism but also serves Southland residents • Accounted for 7 per cent of employment growth between 2000 and 2012 by adding 540 employees.	Yes
Wood product manufacturing	• Employment under pressure with quite substantial decline since 2007. • Quite substantial part of Southland's industrial base with around 50 firms operating. • Sector is dominated by a few large firms.	Yes
Forestry & logging	• Stable employment force with low growth. • Strong links to the local wood product manufacturing sector. According to Venture Southland, more than three quarters of the regional harvest is processed in Southland.	Yes
Machinery & equipment manufacturing	• Activities are concentrated around supporting the agriculture sector. • A large share of this sector's employment is in subsectors with clear links to agriculture such as: agricultural machinery and equipment, machine tool and parts manufacturing, and other machinery and equipment manufacturing. • This sector also supports Southland's manufacturing activities e.g. meat and meat product manufacturing, dairy product manufacturing and basic metal manufacturing.	Yes
Services to agriculture, hunting & trapping	• This sector consists of the following subsectors: shearing services; other agriculture and fishing support; and hunting and trapping. Employment in this services sector is dominated by shearing services (51 per cent) and other agriculture and fishing support (47 per cent). • There is stronger employment growth in other agriculture and fishing support, over the period between 2000 and 2012, compared to shearing services. A net additional 355 jobs were added to the economy from other agriculture and fishing support. This growth is associated with dairying conversions.	Yes
Other farming	• While dairying and livestock farming dominates Southland's agricultural landscape, a number of niche products are grown in the region. This ranges from deer farming to the bulb industry. Some of the bulb farming activities are on a small scale with a predominantly export focus.	Yes
Road transport	• Transport provides an important service in linking different economic processes together. • Road freight transport employed over 1,200 people in 2012– up from 1,110 in 2000. • Meat and meat product manufacturing accounts for much of the activity in this sector. • Other sectors supported by road transport include dairy farming, basic metal manufacturing and wood and wood product manufacturing • Because this sector outputs are primarily used as intermediate inputs (they are a function of the activities in other sectors), future trends in the industry are captured by trends in the remainder of the economy.	No
Water and rail transport	• This sector includes scenic and sightseeing transport, therefore having strong links to tourism activity. This subsectors employment grew from around 160 employees in 2000 to around 240 in 2007/8 before contracting slightly to 230 employees in 2012. • Other water transport related activities include the port and port terminal operations and stevedoring services, which had minor employment figures. These services were excluded from further analysis.	Yes

Out of the above shortlist of 22 sectors, the following 14 key sectors have been selected:

1. Dairy product manufacturing
2. Meat and meat product manufacturing
3. Other food manufacturing
4. Sheet and fabricated metal product manufacturing
5. Basic metal manufacturing
6. Livestock and cropping farming
7. Dairy cattle farming
8. Accommodation, restaurants and bars
9. Wood product manufacturing
10. Forestry and logging
11. Machinery and equipment manufacturing
12. Services to agriculture, hunting & trapping
13. Water and rail transport
14. Other farming.

This selection reflects what we believe to be Southland's most critical economic sectors. Not surprisingly, this selection shows a strong correlation with the economic activities as outlined in an economic profile[28] prepared for the region (see Appendix 3).

KEY POINTS:

1. **Agricultural sectors, with their combination of high employment, export focus and value added contributions to the region dominate the list of key sectors in Southland.**
2. **Another important cluster of sectors in the Southland economy are those sectors which relate to metal production and metal related machinery and equipment manufacturing.**
3. **Tourism is also an important industry in Southland and this is reflected by Water and rail transport and Accommodation, restaurants and bars.**

[28] Report produced by Venture Southland and Southland NZ, available through: http://www.southlandnz.com/

2.4 Key Sectors – Outlook

In this section, the outlook for each key sector is presented. Essentially, the sector outlook is used to inform the generation of a business as usual scenario of economic growth for the region. It is important to realise that this BAU scenario is not a 'forecast', as much uncertainty about future growth and developments remain. We prefer to use the term 'projection' rather than 'forecast' in this regard.

Important: This BAU scenario reflects a conservative growth future assuming that current economic conditions, in general, continue and remain constant. While every attempt has been made to incorporate up-to-date information into the BAU scenario, any projection of the future has a high degree of uncertainty. For example, while recent developments around Solid Energy appear to rule out economic development of Southland's lignite resources in the near term, it is difficult to rule out the use of these resources in the long term in economic development of the region. The intention of this work is to provide a type of baseline future against which to compare alternatives, different growth conditions and changes in the wider economy and policy environment. In the context of this study, the BAU scenario also allows us to generate a baseline picture of future water requirements. It is however important to note that these projections do not account for any supply-side constraints which may emerge if over-utilisation of the water resource was to occur. If supply-side constraints were to kick in, then it is likely that economic activity would be impacted. For example if water quality degrades, becoming unsuitable for certain uses, then the economic growth in Southland is likely to be lower. Similarly, the BAU scenario as modelled here reflects a demand driven approach meaning that it is assumed the resources required to meet the growth will be available i.e. not constrained by supply.[29]

The key sectors' outlooks are summarised below using value added growth for 4 five-year periods: 2011-16; 2016-2021, 2021-2026 and 2026-2031. The key sectors are also discussed in five broad groups: (1) dairy cattle farming and dairy product manufacturing, (2) other agriculture and agriculture support, (3) sheep and beef farming, meat products and other food manufacturing, (4) other manufacturing and (5) tourism.

2.4.1 Dairy cattle farming and dairy product manufacturing

Southland has seen rapid expansion in its dairy farming industry in recent years with many of the dairy farms in the region less than 6 years old (MPI, 2012). In 2000/01 there were 527 dairy herds in the region and by 2011/12 the region had 904 herds – an increase of over 70 per cent. Dairy farming employs over 4,430 people. This sector's employment has grown at around 8.1 per cent per annum since 2000.

A typical herd in Southland has 559 cows compared to 393 nationally i.e. 42 per cent higher than the national average. Southland accounts for (Dairy New Zealand, 2012):

- 7.7 per cent of New Zealand's dairy herds,
- 10.9 per cent of New Zealand's dairy cows,
- 11.3 per cent of the effective hectares[30].

[29] M.E has developed supply constrained models for the Waikato to limit economic growth based on land use limitations.

[30] An effective hectare constitutes the total farm area minus the area occupied by roads, woodland, wasteland and buildings, and with rough grazing expressed in terms of its pasture equivalent.

Southland's dairy farms produce 384 kg of milk solids per cow compared to the national average of 364 kg per cow. This highlights Southland's relative productivity advantage in dairying.

The rise in dairy farm numbers is mirrored by a decline in sheep and beef farms, and this trend is expected to continue into the near future. The factors driving conversions include:

- Favourable farm economics,
- Affordable land,
- Suitable climate (reducing the need to irrigate compared against other regions),
- Productive soils, and
- Continued innovation and invention within the dairy industry.

It is estimated that for every four dairy farm conversions, another farm is required for dairy support (Southland Regional Economic Profile[31]). This requirement for ancillary inputs means that even putting aside land suitability constraints, it would be highly unlikely for all agricultural land to be used directly for dairy farming. In addition, some catchments are already over-allocated meaning that land-use change (e.g. dairy conversions) won't be possible in all areas of Southland. Southland's dairy farms supply the region's dairy processing plants, which altogether account for an additional 600 jobs since 2000, growing at almost 3.9 per cent per year. The strong growth in the sector corresponds to significant increases in the availability of milk for processing.

Southland is home to Fonterra's Edendale site – one of New Zealand's largest dairy processing plants, accounting for a quarter of Fonterra's annual milk powder production[32]. During peak milk production season, Edendale processes approximately 15 million litres of milk per day (equivalent to 650 tanker loads). Total annual production of milk powder and cream products is over 300,000 tonnes, most of which is exported. In addition to the Edendale site, Open Country Dairy Ltd opened a dairy processing plant in Awarua, expanding the region's processing capacity. There are also several small boutique dairy product manufacturers that sell products (e.g. speciality cheeses) domestically and internationally. In some cases sheep milk is utilised in addition to cow's milk.

According the OECD/FAO (2011), the expansion of New Zealand's milk processing capacity is likely to slow from 2013 onward, but the conversion of sheep and beef farms to dairy farms is expected to continue, mainly in the South Island. Further, the medium term outlook for dairy products remains relatively strong (OECD/FAO, 2011). The popularity of dairy products, the westernisation of diets and the increasing range of dairy products will continue to drive global dairy markets. In the next 10 years, world milk production is projected to increase by 153 million tonnes. Globally, the average growth rate for the projection period (2011-2020) is estimated at 1.9 per cent, slightly below the 2.1 per cent rate witnessed in the last decade. In New Zealand, the dairy farm output growth is projected to average 2.3 per cent over the 2011-2020 period – such growth is, however, dependent on normal weather and pasture growth (OECD/FAO, 2011).

The adopted growth rates for Southland's dairy farming and processing industries are presented in Table 2.5, using estimated growth in value added as the measure.

[31] Report produced by Venture Southland and Southland NZ, available through: http://www.southlandnz.com/
[32] http://www.fonterra.com/cn/en/About/Our+Locations/NewZealand/Edendale

Table 2.5: Dairy Group - Estimated Growth (Compound growth) in value added

	2011-16	2016-21	2021-26	2026-31
Dairy farming	3.0%	2.7%	2.8%	3.3%
Dairy product manufacturing	3.3%	2.8%	2.5%	2.2%

2.4.2 Other Agriculture, and Agriculture Support

With reference to crop farming, Southland's climate and soils support efficient and profitable crop farming. This sector is comparatively small with steady employment growing at around 1% per year since 2000 to the current 385 employees. The most important subsectors include:

- Outdoor Vegetable Growing with 150 employees,
- Outdoor Nursery Production employs 155 (down from a peak of 217 in 2010),
- Berry Fruit Growing with 50 employees (up from 6 in 2000),
- Other Fruit and Nut Growing with 15 employees, and
- Some small niche floriculture operations.

In addition to on-farm activities, agriculture is supported by a range of ancillary industries. Employment in these support services has been growing at an average annual rate of 1.3 per cent since 2000 and currently employs 1,770 people. Shearing services account for almost half of this employment, but this subsector has been declining, as stated, due to dairying conversions.

Southland's farming is not confined to livestock and dairy cattle. It has a rich diversity of agricultural activity. The region is also home to 22 per cent of New Zealand's deer stock, the largest of any region (Beef + Lamb NZ, 2012). Venison and velvet products are the key exports and stock numbers tend to be dictated by the price of these products. Other farming types present in the region (although not very large) include horse farming, pig farming, poultry farming (meat and egg) and beekeeping. However, the majority of these farming types have been reducing in size in recent years. Other Agriculture and Fishing Support Services make up 890 jobs, which apart from one year of growth in 2009, has also been declining over the last decade. As dairy conversions take place, some of the support services will align with the needs of dairying, as well as other emerging primary sector activities, so we assume a levelling off in this support sector.

The projected value added growth for the each sector is shown in Table 2.6. This growth reflects the medium term outlook for each sector and is based on New Zealand level trends, refined to reflect Southland growth outlook.

Table 2.6: Other Agriculture Group - Estimated Growth (Compound growth) in VA

	2011-16	2016-21	2021-26	2026-31
Other farming	1.4%	0.0%	1.3%	1.2%
Services to agriculture, hunting & trapping	1.3%	1.5%	1.4%	1.6%

2.4.3 Sheep and beef farming, meat products and other food manufacturing

Southland boasts ideal sheep farming conditions. The region has the highest lambing percentage[33] in New Zealand (134 per cent). Southland also has around 14 per cent of New Zealand's sheep stock, (and 5 per cent of beef stock). However, over recent times the profitability of sheep and beef farming, especially when compared with dairying, has been very low. Partly this is a reflection of unfavourable exchange rates which have had a relatively high impact on farm gate prices, especially lamb. Additionally, foreign debt issues and high unemployment have constrained demand for red meat products in Europe – traditionally a very important market for New Zealand (Beef + Lamb NZ, 2013).

It is expected that pressure on farmers to convert land into dairy will continue. In the short term the region will remain an important area for livestock farming in New Zealand and the industry will continue as a dominant employer, however in the longer term it is far from certain that this trend will continue.

Currently the industry employs over 5,900 people, but this has been decreasing at a rate of around 3 per cent per year since 2000. The subsectors are:

- Specialised sheep farming: this activity captures 60 per cent of employment within the sub-sector, but is also facing the most pressure to convert to dairying.
- Sheep and beef cattle farming is the next biggest subsector with over 1,200 employees and has shown some employment growth.
- Specialised beef cattle farming, although comparatively small at around 390, is expanding and has doubled since 2000.

In terms of manufacturing, Southland has a number of meat processing plants and other food processing operations. Good infrastructure and transportation services link the processing plants with the primary sector.

Meat processing supports around 4,700 jobs. This is 20 per cent higher than in 2000, but is down from the peak of over 5,000 in 2008/10. Meat processing has been under pressure due to reduced demand associated with the downturn in global economic conditions. In addition the large meat work firms have indicated that they are moving and restructuring their operations[34]. This will have an impact on job numbers, especially in the short term. In addition to the global economic conditions, the dairy conversions will further constrain meat supply to downstream processors. In turn this could lead to industry consolidation and resizing, potentially resulting in fewer jobs in the meat processing industry.

One of the most important factors affecting the outlook for these sectors is the scale and pace of dairy conversions. Presently the outlook for lamb commodities is muted. The debt crisis in Europe is still far from over, and there are additionally concerns about the economic prospects for the US. On the positive side for sheep farmers, China has become an increasingly important destination and some diversification into high value export cuts to this market is promising. On the other hand, China's economic growth slowed to about 8 per cent in 2013, the lowest in a decade.

[33] The number of lambs successfully reared in a flock compared to the number of ewes that have been mated.
[34] http://www.odt.co.nz/your-town/mataura/232207/alliance-restructuring-process-settled

Overall, for the purposes of the BAU future, relative conservative growth rates have been adopted for this group of sectors (Table 2.7).

Table 2.7: Estimated Growth (Compound growth) in VA

	2011-16	2016-21	2021-26	2026-31
Livestock and crop farming	0.4%	0.4%	0.4%	0.3%
Meat and meat product manufacturing	0.7%	0.6%	0.5%	0.5%
Other food manufacturing	1.3%	0.6%	1.2%	0.6%

2.4.4 Other manufacturing

A number of manufacturing activities take place in Southland. Some of these activities primarily support other local industries, while others are export focused. In addition to dairy and food processing, which have already been included above, Southland's major manufacturing activities are:

- Basic metals manufacturing
    - The aluminium smelter
- Wood and wood product manufacturing
    - Medium density fibreboard (MDF) manufacturing,
    - Plywood veneer production, and
    - Wood chip processing
- Transport equipment manufacturing
    - Niche car building, and
    - Boat building
- Machinery and Equipment Manufacturing
- Structural, Sheet and Fabricated Metal Product Manufacturing

Each manufacturing subsector is discussed separately. **Basic metal manufacturing** includes the Tiwai Aluminium Smelter. The smelter accounts for 98 per cent of employment in the basic metals sector. The smelter is one of the region's largest employers. However the business is facing difficult trading conditions and has completed a restructuring process that reduced the number of roles at the operation by 100 (New Zealand Aluminium Smelters Ltd., 2012a). In trying to turn the operation cash positive, New Zealand Aluminium Smelters will stop planned capital expenditure and review its maintenance programme to reduce cost (New Zealand Aluminium Smelters Ltd., 2012b). This industry supports a range of Southland businesses with 13 per cent of its New Zealand expenditure staying in Southland.

Outlook for Aluminium – globally the underlying trend for aluminium demand is upward. Aluminium use in various end-use sectors is increasing due to the benefits offered by this metal as a replacement to conventional metals. Aluminium use in automotive applications is enabling manufacturers to reduce weight thereby enhancing fuel efficiency.

In 2011 there were around 120 aluminium smelters operating worldwide (excluding Chinese smelters). During 2000-2008 global aluminium production and consumption expanded rapidly, but the global financial crisis has since put the industry under pressure. More specifically, the market experienced an oversupply of aluminium creating downward pressure on prices, while at the same time producers faced rising energy costs in production. These effects rendered production of aluminium unprofitable for some manufacturers, leading to production cuts and shut-downs. The industry has been recovering since 2010, however in January 2013, aluminium prices were still 34 per cent down from the peak in 2008.[35] The smelter is likely to remain operating in the area in the short to medium term while the business seeks to return to profitability. However the growth associated with this industry will be somewhat muted.

The second manufacturing sector is **wood product manufacturing**. This sector is associated with **forestry and logging**. Since 2000 the Forestry and logging industry has increased employment numbers by an average of 1 per cent per year. The sector is, however, subject to quite strong fluctuations and currently employs 337. Forestry work is spread fairly evenly across the region, with people based in Invercargill, Gore and other rural areas across Southland. This is a direct result of the wide forest cover in Southland. *Radiata Pine* comprises 54 per cent of the planted forest, *Douglas-fir* makes up almost 30 per cent of the planted forest, and *Eucalypt* species 14.1 per cent. The small remainder is made up of *Cypress*, other softwoods and other hardwoods.

Wood product manufacturing has a significant history in Southland, dating back over 150 years. This sector employs 615 people, down from its 2005 peak of over 900. New mill technology has increased productivity, creating economies of scale, requiring fewer staff. However, some of the smaller and medium size plants have closed or downsized due to difficult trading conditions and slow exports. However, there is still a strong presence of wood processing in the area which is likely to continue for some time. Key plants/wood products created in the region include medium density fibreboard (MDF) manufacturing, plywood veneer production and wood chip processing. The sector export focussed, particularly to the Asia-Pacific region, and this is likely to increase over the next 15 years, as Southland's most recently planted forests mature.

The third manufacturing industry is the **structural, sheet and fabricated metal product** manufacturing. This industry employs almost 650 and has had annual growth of 0.2 per cent since 2000. Products from this industry are likely to be used to support the local dairy industry and also products will be exported domestically and internationally.

Transport equipment manufacturing has shown strong employment growth of 4.4 per cent per year since 2000. The sector employs 285 people. Boat building (and repair) is the biggest subsector, supporting 153 jobs. These activities are related to, and support, the commercial fishing industry. There are also a few well-respected boat builders, particularly aluminium boats, who supply domestic and international markets with pleasure craft, passenger and tourist vessels.

[35] Expressed in US dollar terms; sourced from *Indexmundi* quoting World Bank. Date accessed: - 28/02/2013. Sourced from: http://www.indexmundi.com/commodities/?commodity=aluminum&months=60

Agricultural related machinery dominates the **Machinery and equipment manufacturing** sector in Southland, which has grown by 3.8 per cent annually since 2000 and employs 530 people. This sector has benefitted significantly from the conversion of farms from sheep and beef to dairy, as there are significant differences in the required machinery. This sector can also expect on-going work from repair and maintenance of machinery. This sector plays an important supporting role but its outlook is tied to the growth prospects of other sectors.

A summary of the adopted growth rates is provided in Table 2.8

Table 2.8: Other Manufacturing Estimated Growth (Compound growth) in VA

	2011-16	2016-21	2021-26	2026-31
Basic metal manufacturing	2.0%	2.2%	2.0%	1.8%
Transport equipment manufacturing	1.1%	2.1%	1.0%	0.9%
Structural, sheet and fabricated metal product manufacturing	2.0%	2.1%	1.6%	1.8%
Wood product manufacturing	0.0%	0.4%	0.0%	0.4%
Forestry and logging	4.4%	4.6%	3.7%	3.1%

2.4.5 Tourism

Tourism is a growing part of Southland's economy, with high value placed particularly on its natural landscape. Fiordland National Park is located within the region and is a major destination for single- and multi-day visitors.

The Tourism sector is not a specific sector within the 48 sectors of the EFM, but rather is made up from parts of a number of different sectors. For the purpose of this study, the following three sectors are considered to relate particularly to tourism:

- Accommodation, restaurants and bars,
- Water and rail transport,
- Cultural and Recreational Services.

Since 2000, employment in the accommodation, restaurants and bars sector has grown, on average, by 1.5 per cent per year, and currently sits at around 3,270 MECs. This sector has, however, been affected by the recession and has lost around 370 jobs since 2007. With reference to the subsectors, approximately one third of people are employed in accommodation, while cafes and restaurants employ 970 and pubs, taverns and bars a further 670. These two subsectors support Southland's households as well as visitors. It is estimated that around 65 per cent and 80 per cent of the subsectors outputs are consumed locally (i.e. by Southland households or businesses).

Another subsector supporting tourism is water and rail transport. This subsector includes activities such as stevedoring and 'port and water transport terminal operations'. Scenic and sightseeing transport falls within this subsector and accounts for 43 per cent of employment in this subsector.

Employment in businesses/agencies with a focus on nature reserves and conservation parks has more than doubled since 2000, and currently accounts for 280 MECs. Together with recreation related sub-sectors, which are also showing growth over the longer period, this creates a significant and important part of employment in Southland's cultural and recreational services industry. These sectors have benefited from Southland's important and growing tourism industry[36].

The adopted future growth rates are shown in Table 2.9.

Table 2.9: Tourism - Estimated Growth (Compound growth) in VA

	2011-16	2016-21	2021-26	2026-31
Accommodation, restaurants and bars	0.7%	0.7%	0.5%	0.2%
Water and rail transport	0.9%	1.2%	0.9%	1.1%
Cultural and Recreational Services	1.1%	0.7%	0.7%	0.7%

2.5 Economic Linkages

In an interconnected economic system, the activities occurring within one economic sector ultimately (through direct and indirect production chains) impact on all other sectors within that economy. These impacts are known as linkages, and there are two types; backwards and forwards linkages.

Backward linkages are demand related. If, for example, a sector increases its production output, it will need to purchase more products/materials from sectors that supply its production process, as more outputs necessitates more inputs. Therefore, increases in demand for one sector's output leads to demand increases for goods and services of suppliers back up the supply chain. A backward linkage indicator measures this level of interconnection between sectors from a purchasing perspective. For example, if the backward linkage of sector 1 is higher than that of sector 2, then it could be reasoned that an expansion of the same value in sector 1 would be more beneficial to the economy than an expansion in sector 2. This is because it would generate more productive activity in the economy per dollar of growth.

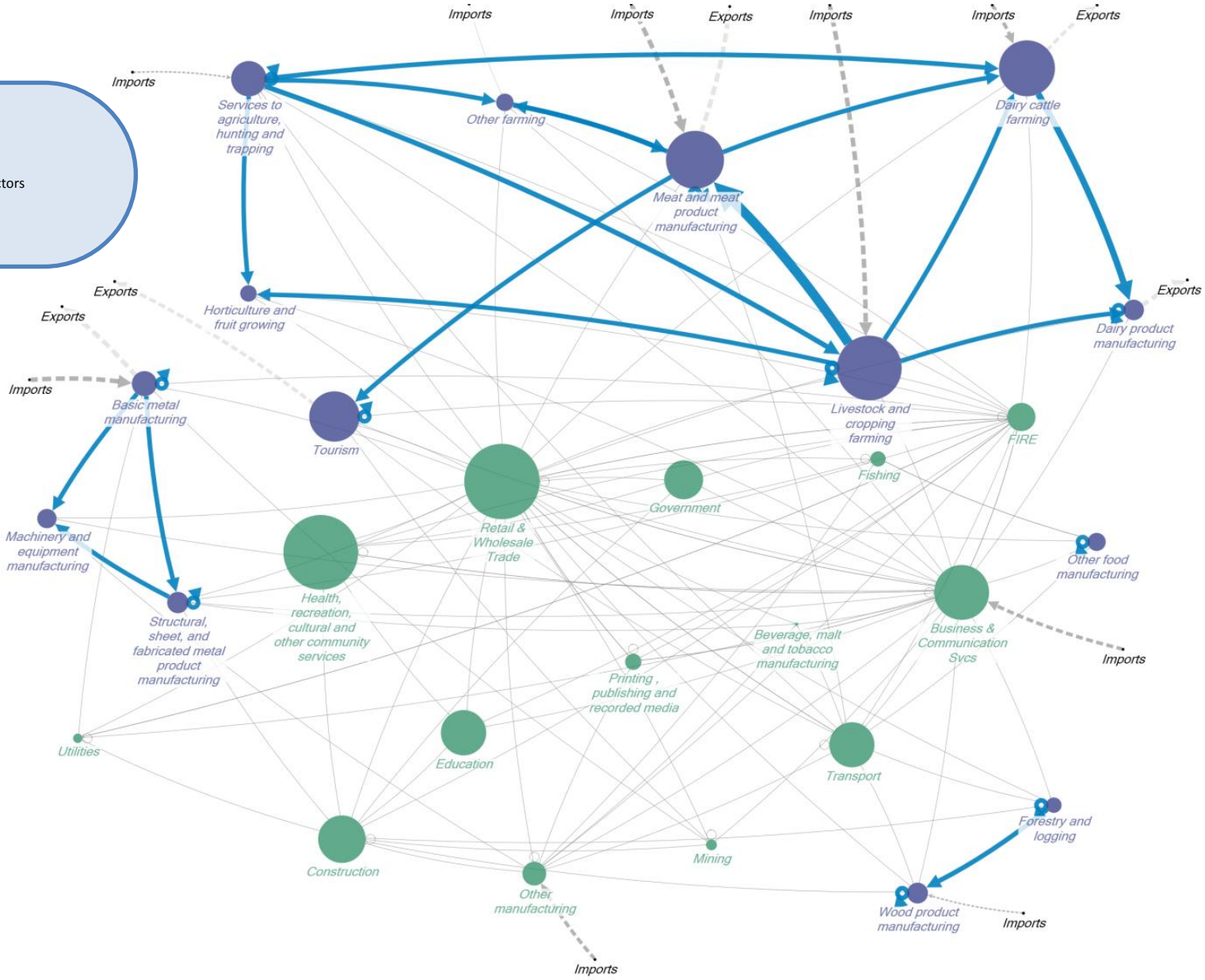
Forward linkages, on the other hand, relate to sector supply. An increased output from any particular sector will mean that there are greater amounts of product available for use (as inputs for production) by other sectors. Forward linkage indicators therefore measure the interconnection between industries from a selling perspective. For example, if the forward linkage of sector 1 is greater than the forward linkage in sector 2, then it would stand that an increase in output from sector 1 would be more valuable to the economy than the same level of increased output from sector 2. This is because a higher level of production activity could be supported within the overall economy.

Figure 2.10 provides a visual representation of the backward linkages existing between Southland's identified key sectors (blue bubbles) and other sector groups in the region (green bubbles).

[36] http://www.southlandnz.com/Work/Industries/Tourism

Figure 2.10: Key Sectors' Linkages

Legend:
Size of Bubble – Value Added (2011)
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – Rest of the economy



From the key linkage directions it can be seen that primary sector industries support the processing/manufacturing plants in Southland. For example:

- Meat and meat product processing purchases 57 per cent of its inputs from livestock and cropping farming;
- Dairy product manufacturing purchases 87 per cent of its inputs from Dairy cattle farming and Livestock and cropping farming,
- Dairy cattle farming and Livestock and cropping farming both purchase from Services to agriculture, hunting and trapping (9 per cent and 18 per cent respectively),
- Structural, sheet and fabricated metal product manufacturing buys 23 per cent of its inputs from basic metal manufacturing, while Machinery and equipment manufacturing primarily buy from both Structural, sheet and fabricated metal manufacturing (32 per cent) and Basic metal manufacturing (18 per cent),
- Wood product manufacturing purchases 30 per cent of its inputs from Forestry and logging,
- The backward linkages diagram shows industries in a similar field (e.g. metals, agriculture, wood) support each other in terms of who they buy from to produce their product, and
- This is intuitively what you would expect, with the raw material producers selling their product to a processing industry.

The description of the forward linkages (of intermediate consumption) between Southland's key sectors is presented below, with the figure showing these linkages contained in Appendix 4. Detailed analyses of the forward linkages of individual key sectors are shown in Appendix 5.

What is evident from the Forward Linkage diagram (Appendix 4) is how most of the key sectors identified support the major agricultural and agricultural processing industries. For example:

- Machinery and equipment manufacturing (which purchases from Structural, sheet and fabricated metal product manufacturing (32 per cent of inputs) and Basic metal manufacturing (18 per cent of inputs)) sells to Meat and meat product manufacturing (8 per cent of outputs), Dairy cattle farming (9 per cent of outputs) and Livestock and cropping farming (9 per cent of outputs).
- Other food manufacturing sells 14 per cent of its outputs to Dairy cattle farming, 7 per cent to Meat and meat product manufacturing and 20 per cent to Tourism.
- Services to agriculture, hunting and trapping (as expected) sells 43 per cent of its outputs to Livestock and cropping farming, 16 per cent to Meat and meat product manufacturing and 16 per cent to Dairy cattle farming.

Meat and meat product manufacturing is clearly one of the most important industries in the Southland economy. As the diagram suggests, a significant number of industries sell a large proportion of their own product into this industry, e.g. Livestock and cropping farming (80 per cent), Other farming services (75 per cent), Horticulture and fruit growing (24 per cent), Dairy cattle farming (16 per cent), Services to agriculture, hunting and trapping (16 per cent), Transport (39 per cent), Tourism (30 per cent). This has

wide ranging implications, the most obvious being the rapid rate of dairy farm conversion. This will remove raw product supply to the industry, meaning that in order for the meat processing plants to continue operating at similar levels, they will have to replace local product with imported product, for example from Otago (which, to some extent is already happening).

Wood and wood product manufacturing sells 35 per cent of its outputs to Construction (which is also an important sector for many Southland industries) and 2 per cent of its outputs go to Basic metal manufacturing.

2.6 Concluding remarks

The conversion from sheep and beef farming to dairy farming is rapidly changing the face of Southland. The traditional focus in Southland on sheep and beef farming meant that a large meat and meat product processing industry developed, with large amounts of infrastructure. It is one of the largest employers in the region. Several other industries developed in the region with a primary focus on supporting this dominant sector. More recently however, the profits available through dairy farming have been greater than those through sheep and beef farming, leading to rapid conversion of land to dairy cattle farming. As a result, Dairy product manufacturing has expanded in the region. With Meat and meat product manufacturing consolidating in response to the reduction in demand, the key sectors in the Southland economy have to shift their focus to meet the demands of the dairy industry.

It needs to be noted that at present Meat and meat product manufacturing, and livestock and cropping farming are two of the largest sectors in the region and are still important to the local economy. However, the strong growth in dairy operations means that dairy is becoming more important and is likely to play an increasingly important role in Southland's economy. As it stands, the profits available through dairy farming means that conversions are not likely to slow down, unless there are significant changes in the price for both meat and dairy products. Limiting factors to conversion include appropriate land and farmer preference.

The change in land use and intermediate consumption structures will have implications for fresh-water demand and runoff quality. Firstly this comes in the form of land use (including irrigation demands, fertiliser requirements, stock effluent), and, secondly, from water volumes used and waste produced in manufacturing processes.

3 Economy – Water Relationships

The economy is critically dependent on water. Institutional arrangements have emerged for the management of water, as a natural resource. The government set out the goals and framework for the sustainable management of natural resources, including water in the Resource Management Act, 1991, the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010, and the National Policy Statement for Freshwater Management, 2011, which are applicable across all regions of the country.

New Zealand property rights are constrained through the effects-based legislation of the Resource Management Act, and those relating to water quality are largely administered by Regional Councils. How each Regional Council institutes their policies is a matter for each region. Planning rules can change pre-existing individual property rights, or indeed determine them. How these policies are instituted depends on the political context within that region – which, in turn, is strongly influenced by the economic activities that take place there.

Under RMA (Section 5) 'sustainable management' means:

> *'..managing the use, development, and protection of natural and physical resources in a way, or at a rate which enables people and communicates to provide for their social, economic, and cultural wellbeing and for their health and safety while-*
>
> *a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
>
> *c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment'*

The RMA includes as one of the Matters of National Importance (Section 6(a)):

> *'The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development.'*

Under the RMA, National Policy Statements may be issued. These are used to strengthen the provisions under the RMA particularly surrounding 'matters of national significance.' In recognition of the importance of water for 'New Zealand's economic, environmental, cultural and social well-being', the National Policy Statement for Freshwater Management (NPS-FM) was released in May 2011. The National Policy Statement includes direction for decision-makers on a range of issues, such as setting limits for water quality and quantity, and improving and maximising the efficient allocation and use of water. The NPS-FM sets objectives around improving the quality, ensuring sufficient quantity and integrated management of water

and the need for policies to be consistent with the interests of Tanagata whenua and the Treaty of Waitangi. One of the key provisions in respect of ensuring water quality is that the policy requires Regional Councils to change plans as required to 'Establish freshwater objectives and set freshwater quality limits for all bodies of fresh water in their regions'. The NPS-FM does not set minimum quality requirements or discharge limits but it provides a narrative about fresh water's life-supporting capacity and the need to maintain, improve and protect outstanding water bodies. It also highlights the important value of wetlands. How the Regional Councils choose to implement these policies will determine the policy's (NPS-FM) effectiveness. Councils have two options to give effect to the National Policy Statement: a 'go-early' timeframe of December 2014; or to wait until 2030 to give effect. In cases where standards (i.e. freshwater objectives) are not met Councils are required to state targets (a limit to be met over a defined timeframe) and methods for achieving them. Councils will need to implement measures to ensure that limits are managed and that freshwater objectives are achieved. In recognition that water catchments and the pressures placed on the resource may vary across regions, it is the responsibility of regional government to implement the NPS-FM in a way that reflects the needs of local communities.

Water use is a critical issue in New Zealand, with numerous and often conflicting stakeholders within communities. The availability of water supply is necessary for the economy, given its high dependence on agricultural products and their role in the total exports of the country. Electricity generation is dependent on the hydro-electro stations, a product (electricity) that is consumed within New Zealand, although the technologies developed within the sector are exported. New Zealand's tourism sector relies on water, both in terms of transport and the ecological values that visitors experience from water. Water is a life-force and has significant values in New Zealand's cultural heritage. Indeed, potable water is a basic human need, a prerequisite for any living activity.

Environment Southland has a set of planning documents that affect water. These include, but are not limited to, the Regional Policy Statement and the Regional Water Plan. Environment Southland's long–term goal to improve water quality across the region is undertaken in a package of initiatives under the Water and Land 2020 programme, to deliver the Council's interim measures and catchment limits and to meet the requirements of the National Policy Statement on Freshwater. The goal in the Regional Water Plan (which became operative in 2010) is to improve water quality standards by 10 per cent. At this time, intensive dairying was recognised as having significant impact on water quality. The Regional Water Plan (Environment Southland, 2010) included a specific plan change for: farm dairy effluent (Plan Change 1), silage (Plan Change 2) new dairy farming (Plan Change 13).

In drafting the Regional Water Plan, there was a clear recognition of the effects of increasing intensification of land use, in a region that has high quality stream and river systems within National Parks and upland areas, but reduced water quality in lowland water courses, particularly with phosphorous and sediment. Specific rule sets have been devised for different sectors of Southland's economy. For dairy farms, a resource consent is required for the disposal of effluent onto land, the discharge of effluent to any water and the abstraction of more than 20,000 litres of water per day. Other activities are permitted (subject to meeting specified conditions, such as minimum setbacks from surface water bodies), such as drilling bores, taking water, sludge disposal, discharges to farm dumps and offal pits and the discharge of silage leachate (Environment Southland, undated). All farms are covered by the same rules.

As with all activity involving the use of natural resources, there are complex sets of rules to be followed. The use of water within the environment and economy is also complex. Water can be used directly, and quite literally sold (e.g. in the form of bottled water), or it can be sold indirectly through other production

processes (e.g. as milk), while it also is used to create other products (e.g. for cooling in power stations, in the production of electricity), or it can be used in ecosystem services (e.g. waste assimilation).

The aim of this section is to present a picture of current and future water abstraction and water related discharge and nutrient loadings based on Environment Southland's resource consent and compliance monitoring databases. Our focus is on water takes, discharges and nutrient loadings, but more importantly how these abstractions/discharges relate to economic production. As water is not always bought and sold in a marketplace, its true value is oftentimes overlooked as a factor input.

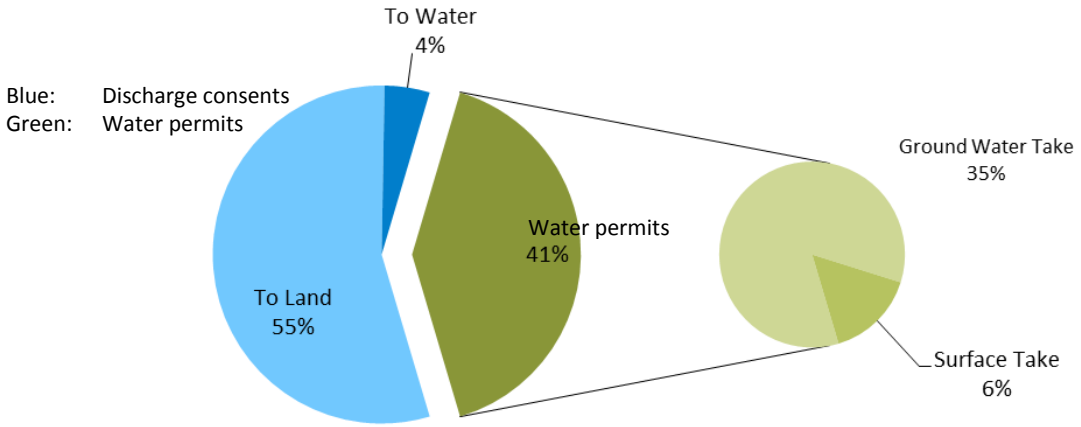
By estimating the volume of water industries use and discharge (including estimated nutrient loadings based on concentrations estimated by the NZIER work stream) by sector and, in turn, matching this to economic growth projections, we are able to derive future estimates of use, discharge and nutrient loadings. This process is useful for scenario building, enabling an understanding of current and future water constraints. To do this, water multipliers are constructed. These multipliers link production of goods and services with water use. In some industries, it is obvious that water is used – for example agriculture and farming. However, for upstream industries, the water use may not be so apparent. Something which may be considered benign, such as entering a query in a search engine on the internet, can rely on water use – in such a case, water may be used to generate electricity and it may also be used to cool down the computer processers. The use of multipliers enables the tracing of water use throughout the economy, and similarly such an exercise can be undertaken for all physical inputs into the economy.

3.1 Water as resource and current usage

Environment Southland manages the region's water resource using the provisions of the Resource Management Act 1991 (RMA). Water can be taken from surface or from groundwater. A consent is required for both, if the amount taken is over a daily limit (Environment Southland, 2013). Environment Southland's consent database, covering almost 12,000 consents, was reviewed and over 6,000 water related consents were selected/extracted for this study. From these, only qualifying consents that were relevant to water consents were included in the subsequent analysis (see Appendix 1 for details, which summarises the classification process and the rules and process to identify how consents relate to economic activities). The final list contained over 3,500 individual consents covering both water takes (abstractions) and water discharges. This list included the period from April 2000 to March 2012.

Figure 3.1 shows the distribution of the consents between discharge permits and water take (or abstraction) permits. Of the 3,566 consents included in the analysis, 59 per cent are discharge permits and 41 per cent are water take permits. Note these are for the number of consents, and not the volume of water per consent, which is described in (Section 3.1.1). With reference to the discharge permits the bulk is for discharge to land (over 90 per cent of discharge permits). Ground water take permits account for more than a third of water related consents and 84 per cent of abstraction consents.

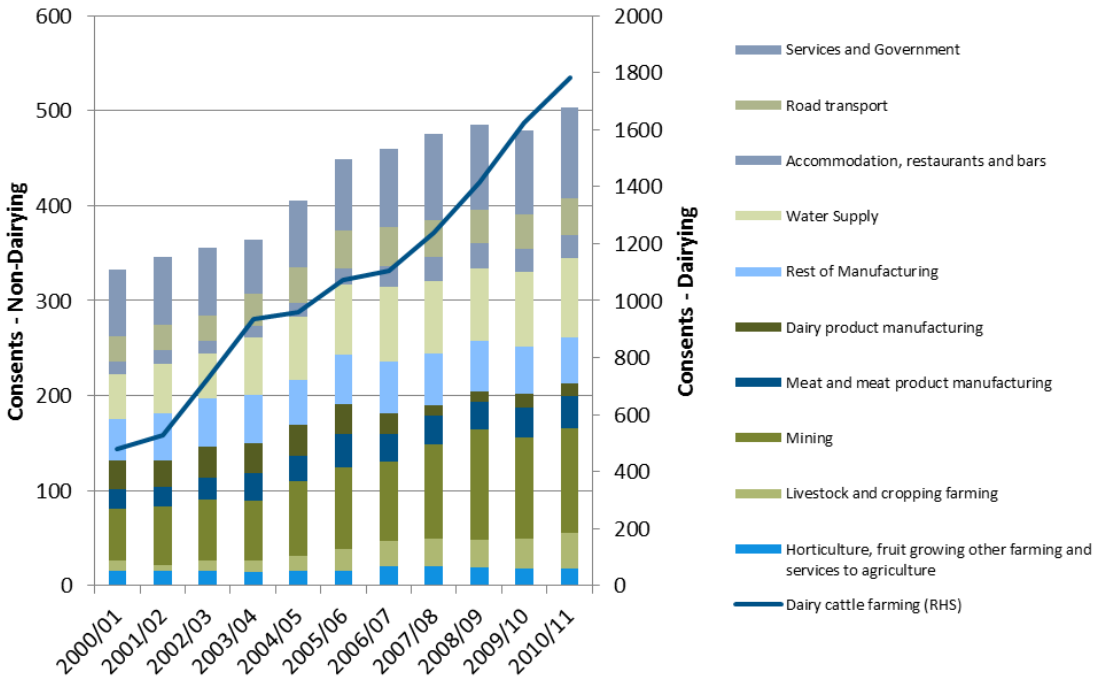
Figure 3.1: Environment Southland's Water Consent Breakdown



Source: Environment Southland Consent Database

Demand for the region's water resource has been increasing over the past decade. Most sectors' demand for water (as expressed using the number of consents issued) increased since 2000/1. While most sectors' water demand increased, dairy farming's growth and its demand for water dominate the consenting pattern. The number of dairy farming consents dwarfs the other sectors (hence the distinctive scale for dairy farming on the right hand side of Figure 3.2).

Figure 3.2: Consents per broad economic sector (All consents; Dairying on RHS)



Source: Environment Southland Consent Database

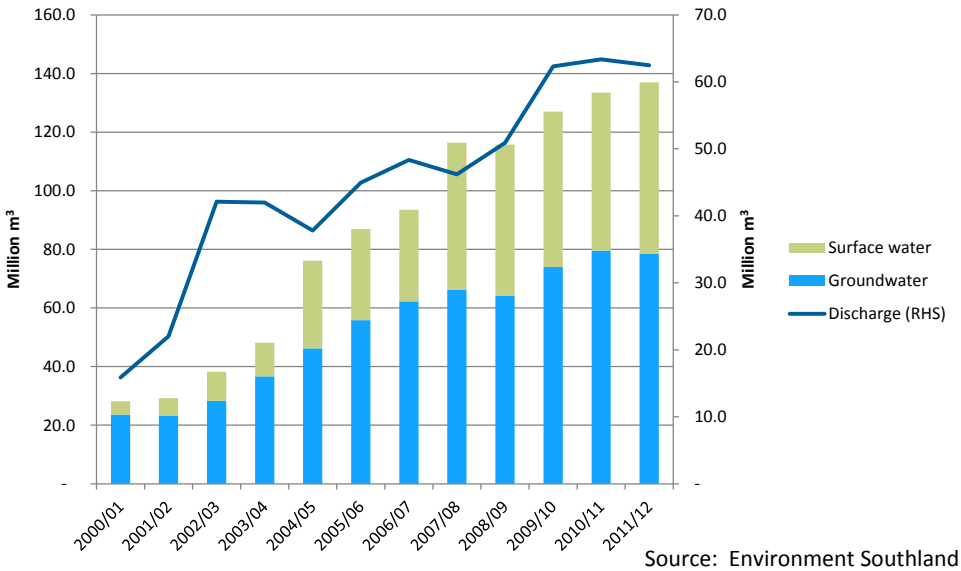
Dairying accounted for over three quarters of consents in 2010/11 up from around 60 per cent of consents in 2001/2. This shows the increase in demand for Southland's water from dairy farming. Manufacturing accounts for between 4-5 per cent of water consents. Manufacturing, including meat and meat product manufacturing, dairy product manufacturing and basic metals has a slightly larger share of discharge consents than abstraction consents. The manufacturing sector accounts for 3.4 per cent (2010/11) of abstraction consents and 4.8 per cent of discharge consents.

The number of water consents has increased almost threefold between 2000/1 and 2010/11 to around 2,300 consents. Water abstraction consents for dairy operations was the largest driver of the increase in abstraction consents accounting for (on average) over 89 per cent of the growth in abstraction consents between 2000/1 and 2010/11. Mining and water supply also saw an increase in the number of consents issued for these activities. Importantly, in the context of this study, aggregate mining includes activities where aggregate is mined and washed. Such aggregate is typically used in road and other construction activities. We note that a number of 'hobby mining' activities are included in the consent database. The water demanded by such mining operations tends to be smaller than fully-commercial operations. We note that some of the mining (and other sectors) discharge consents include both storm water and wastewater discharges making it difficult to accurately estimate mining's direct water usage.

3.1.1 Consented Maximums

According to Environment Southland (2010) the total *average* volume of water allocated for use in Southland is 124 million cubic metres or around 0.14% of annual rainfall. It is however not clear what 'average' means in this context. Our review of Environment Southland consent database (see Appendix 1 for details) shows that the average water allocation between 2005/6 and 2009/10 was 126 million cubic metres, but because the water allocation has been increasing for every year since 2000/1 this 'average' should be interpreted with caution. If all (relevant) consents are included then the maximum consented maximum appears to be higher than the 124 million cubic metres allocated water rights. Figure 3.3 shows the growth in maximum consented abstractions. Importantly, this figure shows the surface water and ground water consents.

Figure 3.3: Maximum Consented Volumes (Million m^3)



Source: Environment Southland Consent Database

This figure shows that the maximum water take is just under 140 million cubic metres in 2010/11. This total includes both groundwater and storm water takes. We note that the 74 million cubic metre ground water allowance (for 2009/10) is less than the value estimated by Environment Southland which puts the total ground water consents at around 78.8 million cubic metres for that year[37].

With reference to the surface water takes, a large variation exists between estimates derived directly from the consent database and the volumes implied in Environment Southland's 'Our Uses, Southland Water 2010: Part 3' document. This document states that 53 per cent of water was allocated for use from the region's ground water resource. This means that the surface water resource is estimated at 44.6 million cubic metres[38]. A number of reasons could explain this discrepancy, including:

- Some water users (consents) could be excluded from the Environment Southland analysis. For example, it is not known if the 44.6 million cubic metres quoted by Environment Southland is inclusive of the 16.4 million cubic metres associated with 'Consent: 99139' which authorises the water take for Invercargill town supply.

- In some cases seasonal limits might apply to the stated/consented maximums. For example, 'Consent: 203358' authorises one of the region's meat and meat product manufacturers to take up to 22,500 cubic metres of surface water per day. However this might be limited to a stated number of days per year. Our review of the consent data suggests that in some cases seasonal limits apply. We suspect that in most cases the seasonal limits are reflects using a 'maximum' in the consent description.

- We note that the volume authorised by 6 consents totals some 54.3 million cubic metres of take, compared to the 44.6 million cubic metres stated in the Environment Southland report. We have discussed these consents with Environment Southland and found that some of these consents while active and legitimate, are not being used. Some of these consents are for emergency situations[39].

For the purpose of this report the maximum consented values estimated out of the consent database were used. This removed the risk of undercounting or omitting any records. Relying on the entire consent database means that all available data is considered without subjectively excluding any records.

With reference to water discharges, consent has been issued for over 62 million cubic metres to be discharged to the environment. The consented maximum for discharges has been increasing since 2000/1 when authorised discharge volumes have sat at around 16 million cubic metres. Since then the consented maximum has increased by 12 per cent per year (compounded).

The consented maximums offer insights into the total allowable take and discharge. However this does not mean that consent holders use the total allowable volumes. In the next two sections the estimated abstractions and estimated discharges are discussed.

[37] The difference of 4.8 million cubic metres could be explained by the way we include consents. Our analysis uses a 'full year' meaning that, for example, if a consent covers only a portion of the year (e.g. 2 months) then it is not included in that year.

[38] This includes stream depletion effects of around 11 per cent or 13.6 million cubic metres.

[39] For example some of the consents allow for water to be transferred to between streams so that there is sufficient water at the locations where water is abstracted for town supply. If water levels fall below certain thresholds (at the primary locations) then the pumps at these points would run dry potentially damaging them.

3.1.2 Estimated Abstractions

Environment Southland completed a survey of groundwater users in 2009/10 and found that the users typically used 28 per cent of the consented water allocation (Environment Southland, 2011). Our analysis is consistent with the findings in that report. Our analysis suggests that the proportion of the allocation used has been increasing since 2000/1 from 13 per cent. As expected there are substantial sectoral differences. The data[40] suggests that (before the closure of the Mataura paper mill, paper and paper product manufacturing used close to its consented maximum. Since 2000/1, some of the other economic sectors have periodically overdrawn their allocation. Examples include 'other farming' (in 2007/8 and 2011/12), beverage, malt and tobacco manufacturing (2009/10), and cultural and recreational services (2002/3). Table 3.1 lists the percentage of allocation abstracted for a selection of sectors (this table shows the 'medium' estimate and Appendix 6 the low and high estimates).

The main points from Table 3.1, with particular reference to primary agricultural production are:

- Livestock and crop farming's use of authorised water take has increased from around 10 per cent to almost 50 per cent in 2010/11,
- During the last three years (2009/10 to 2011/12), dairy cattle farming has used between 43 per cent and 46 per cent of its water allocation[41].
- Other farming's level of water use (in terms of share of authorised water take) has been volatile moving from over extraction to in 2007/8 to using 42 per cent in 2009/10 and then back up to using its entire allocation (98 per cent in 2010/11).

Table 3.1: Share of allocation used – Selected Sectors.

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Livestock and cropping farming	12%	12%	12%	12%	17%	38%	9%	8%	15%	26%	49%
Dairy cattle farming	28%	28%	28%	21%	20%	27%	29%	30%	32%	43%	46%
Other farming	0%	0%	0%	0%	22%	17%	13%	102%	98%	42%	98%
Meat and meat product manufacturing*	24%	24%	65%	46%	35%	23%	44%	1%	31%	19%	13%
Dairy product manufacturing	19%	19%	19%	10%	6%	37%	37%	44%	44%	54%	56%
Beverage, malt and tobacco manufacturing	46%	46%	55%	46%	38%	53%	94%	18%	79%	121%	92%
Wood product manufacturing	9%	9%	8%	11%	7%	5%	10%	0%	24%	54%	46%
Basic metal manufacturing	31%	31%	31%	48%	14%	5%	11%	16%	11%	38%	52%
Accommodation, restaurants and bars	23%	23%	33%	23%	17%	26%	47%	45%	43%	54%	67%
Cultural and recreational services	0%	0%	112%	42%	18%	13%	30%	31%	3%	56%	17%
Average for all sectors[42]	13%	15%	20%	19%	14%	17%	18%	19%	22%	28%	27%

* We note some variance in this sector. The information presented in this table is derived directly from Environment Southland data. We have accounted for this variance is subsequent modelling by using average values.
This table shows the 'medium' estimate and Appendix 6 the low and high estimates.
Source: Calculations based on ES Consent Database

[40] The data covering this sector is relatively weak with only a few data points.
[41] Under the high scenario this sector used 66 per cent of its allocation and 28 per cent under the low scenario.
[42] This table does not show all sectors, only the main water users.

Combining estimates of the share of allocation used with the maximum consented water abstraction data provides a way to estimate total water abstracted (discharge estimates are discussed in the next section). To do this, the maximum consented value is used – as estimated from the total Environment Southland database without any omissions.

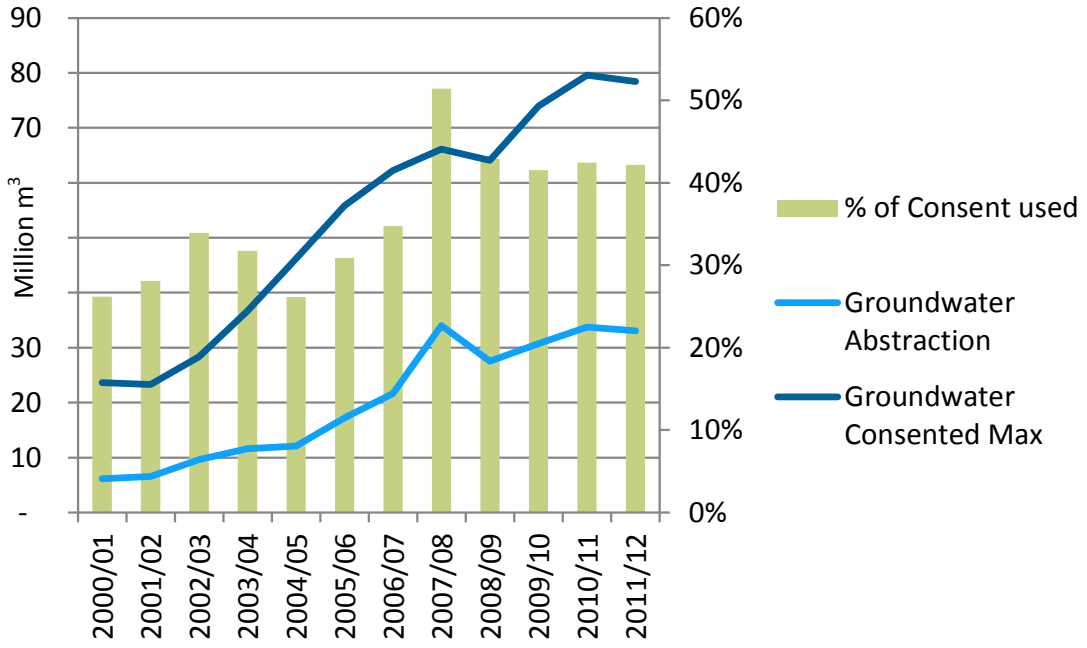
3.1.2.1 Groundwater Abstractions

The total water abstracted as groundwater has been increasing over the last 10 years; rising from an estimated 6 million cubic metres in 2000/01 to over 33 million cubic metres in 2011/12. Figure 3.4 shows the increase in groundwater abstracted along with allocated groundwater rights (consented maximum).

The figure shows the increase in both the consented maximum and the ground water abstractions. Generally, the rise in ground water abstraction follows the trend in consented maximum. The bars in the figure reflect the 'used' water volume. The share of water used has been trending up. In 2007/08 around 51 per cent of the total consented groundwater allocation was actually used.

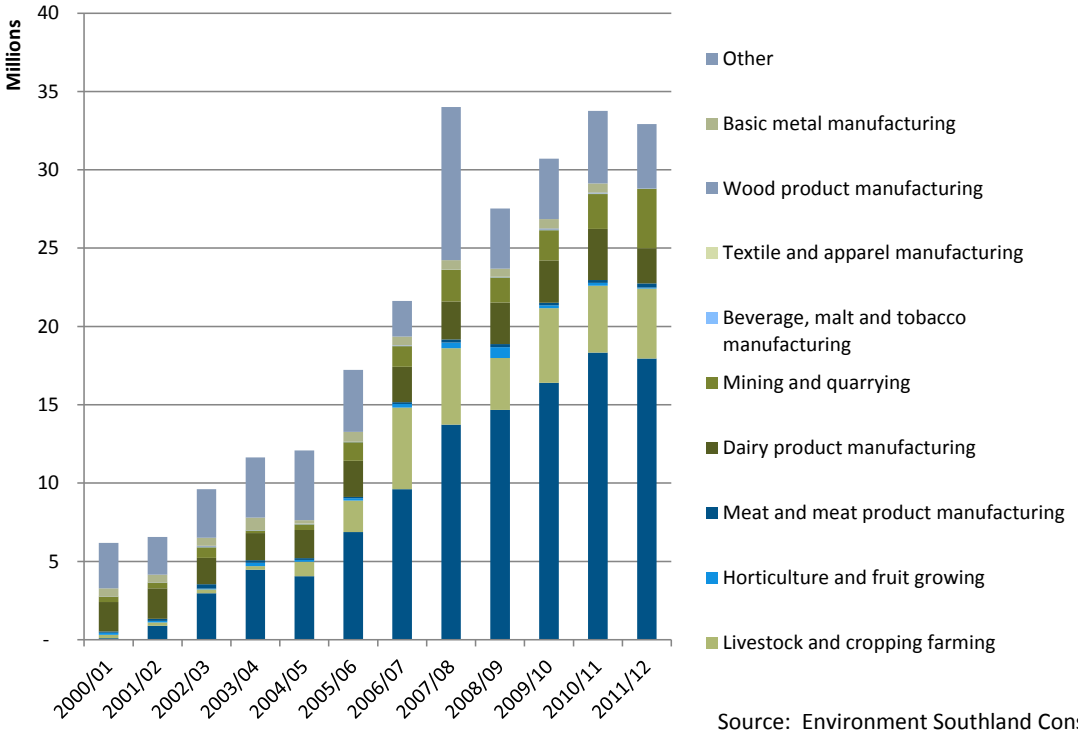
This total use can be broken down by economic sector. Figure 3.5 shows the sectoral distribution of ground water.

Figure 3.4: Groundwater Abstractions and Consented Maximums



Source: Environment Southland Consent Database

Figure 3.5: Groundwater Abstraction by Sector (m^3)



Source: Environment Southland Consent Database

Dairy farming is the largest user of Southland's groundwater, accounting for 55 per cent of groundwater extracted. Dairy farming's share of the groundwater take has been increasing for the last ten years. Livestock and crop farming is another large user of this resource, using around 15 per cent of regional ground water per year. Together Dairy farming and Livestock and cropping are responsible for more than two thirds of ground water abstractions.

3.1.2.2 Surface water takes

With reference to surface water takes, we have some reservations about these results, particularly the volume of surface water abstracted, as calculated from the consent database. Surface water takes are higher than figures quoted in some of Environment Southland's publications. As indicated earlier, we suspect that this might be due to 'removing' some consents (and/or sectors) from their analysis. The following discussion is based on the Environment Southland's consent database.

The sectors with the largest consents (by volume) to surface water are:

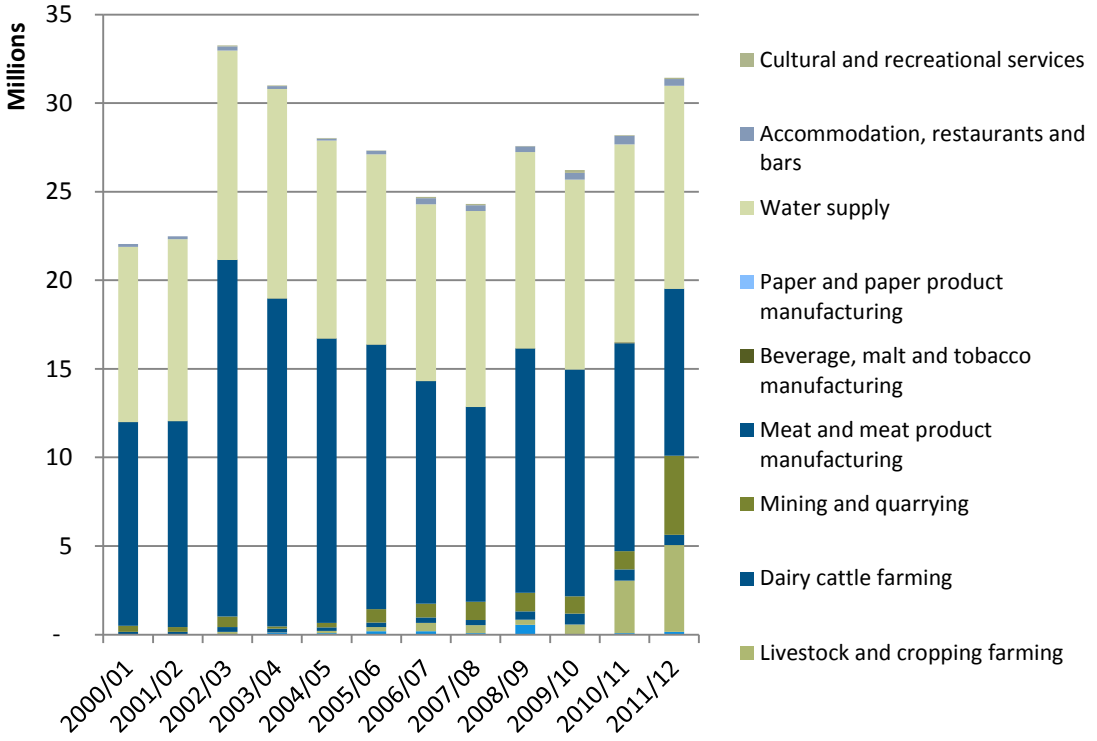
- Water supply with a consented maximum of around 21 million cubic metres per year (this includes an allowance to take up to 45,000 cubic metres of water per day from the Oreti River at Branxholme for Invercargill town supply).
- The Meat and meat processing industry with large surface water allowances – the surface water allowances sum to over 9 million[43] cubic metres per year. These consents relate mainly to Alliance Group meat works.

[43] The scale of these consents will need to be confirmed as they appear large.

- Livestock and crop farming is another large consent holder accounting with consent to abstract over 5 million cubic metres of surface water.
- Mining and quarrying have consents for around 4.5 million cubic metres of surface water. However mining's consented surface water take has ranged between 1 million and 1.5 million cubic metres before increasing to 4.5 million cubic metres 2011/12. Mining and quarrying surface water take includes situations where water is diverted to streams around mining activities so the volume association with mining does not strictly reflect mining's actual 'water use'.
- Paper and paper product manufacturing's authorised surface water take declined from around 12 million cubic metres before 2006/07 to 4.5 million cubic metres since then. Importantly, the paper and paper product manufacturing consents relate to the Mataura paper mill. This mill ceased operating ten years ago but the plant has retained water permits. This means that the water consent is still active but not currently exercised.

In terms of the relationship between surface water use and allowable abstraction (consented maximum) we used the same profile as determined using the ground water. Over the last five years, on average 44 per cent of the maximum surface water consented has been abstracted. The main users of surface water were meat and product manufacturing using approximately 12 million cubic metres of surface water per year over the past five years (see Figure 3.6).

Figure 3.6: Estimated surface water takes



Source: Environment Southland Consent Database

In terms of total consented surface water actually taken, Invercargill's town supply uses more than a quarter of this. Water supply used around 50 per cent of its surface water consent and amounts to annual

surface water extractions of around 11 million cubic metres per year. These extractions have remained relatively stable since 2000/1. The water supplied to Invercargill City (as abstracted from the Oreti River at Branxholme)[44] accounts for 80 per cent of water supplied to towns with the balance going to the small towns.

Surface water used by the two largest sectors (Water supply and Meat and meat processing) has remained relatively stable over the past five years. During this time, these two sectors had a combined abstraction of 20 and 25 million cubic metres of surface water.

Depending on the use of water in industry, a proportion of the water will enter into further production, and if exported, will be consumed elsewhere, while a proportion of the water will be discharged back into the environment. The quality of that water depends on how that water has been used. The next section discusses water discharge per sector and the associated nutrient loadings.

3.1.3 Estimated Discharges and Nutrient Loadings

Environment Southland is responsible for managing the discharge of contaminants to land and water. In the context of this study this includes water related discharges from agricultural and industrial processes as well as discharge from households via the waste water treatment plants.

3.1.3.1 Water Discharges

In Southland, most discharge consents are for dairy farming activities (see Figure 3.7). In 2000/01 two out of three discharge consents were for dairy farming but by 2011/12 this has increased to approximately three out of four. The dairy farming discharge consents predominantly covers dairy shed effluent and the subsequent discharge to land via some sort of irrigation system. The scale of the discharge consent is expressed on a 'number of cow' basis.[45]

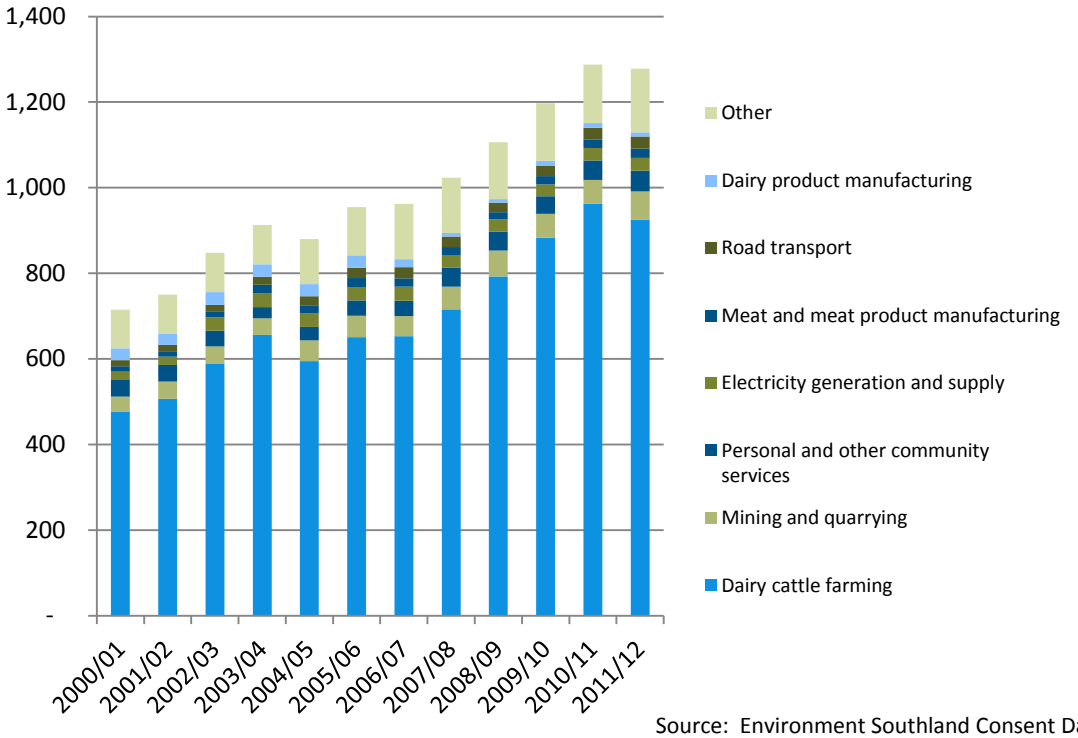
After Dairy farming, Mining and quarrying is one of the largest dischargers (in terms of consent numbers) and had over 60 discharge consents in 2011/12 – up from around 40 in 2000/01. This was followed by Personal and other community services with 49 discharge consents (in 2011/12); an increase of 10 since 2000/01. According to Environment Southland, the increased number of discharges in the Community services category is related to commercial developments with communal sewage systems and the development of new reticulated sewage systems for some existing townships, such as Tuatapere). Examples of the type of discharges associated with this sector include discharge of treated sewerage and discharge from waste water treatment plants. Thirty discharge consents have been issued for electricity generation and supply activities.

Meat and meat product manufacturing, and Dairy product manufacturing – two key manufacturing sectors closely linked to Southland's agriculture sector – had 21 and 9 discharge consents respectively. The number of discharge consents that have been approved for Meat and meat product manufacturing has increased from 13 in 2000/01 to 21 by 2011/12. However, the number of discharge consents for Dairy product manufacturing has declined from around 30 in 2000/01 to less than 10 in 2011/12.

[44] Note the 2011/12 value for water abstracted for Invercargill City was equated to the 2010/11 value in the actual abstraction database to remove an obvious gap in this dataset.

[45] This is the case in 99.2% of consents.

Figure 3.7: Discharge Consents per Sector



Source: Environment Southland Consent Database

According to Environment Southland (2010) Fonterra held a large number of discharge consents, for discharging whey/sludge on various properties in Southland. However, in 2009/10 Fonterra held less than 5 consents covering the same level of activity (discharge). This was because the Regional Effluent Plan permits the discharge of whey to land, if certain criteria are met, as well as a consolidation of multiple consents into larger consents covering multiple properties.

As part of this study, we attempted to estimate the total water discharged. For non-dairy farming activities we used the consented maximum and estimates of actual discharge levels using Environment Southland's consent database.

Overall, it is estimated that the total discharge across Southland is on average around 61 million cubic metres per year (2009/10 to 2011/12). This analysis excludes any discharge from hydro-electric power generation activities because the scale[46] of water discharged. Figure 3.8 shows the estimated total discharges.

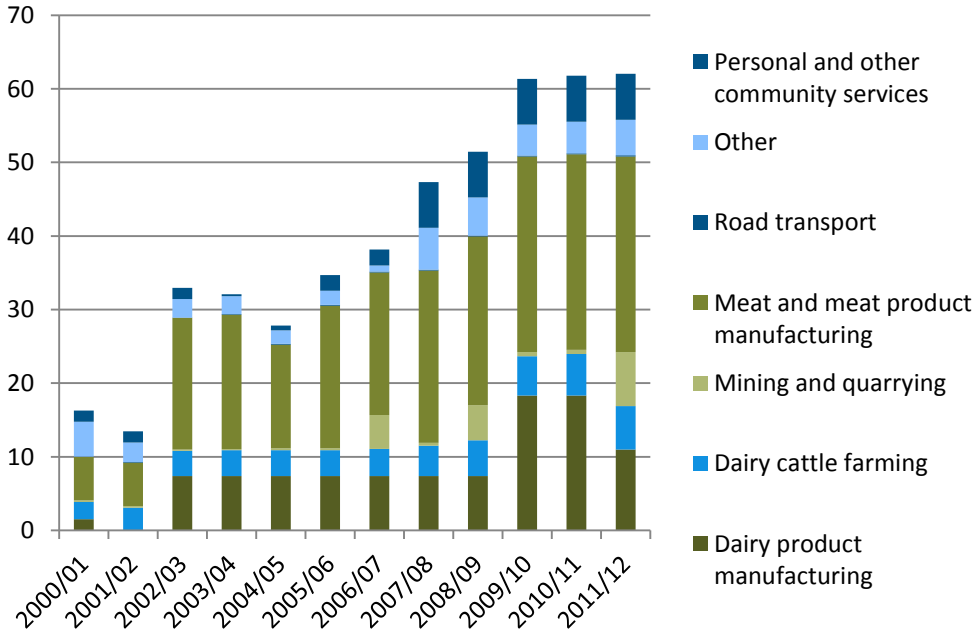
Dairy product manufacturing, and Meat and meat product manufacturing, are capturing an increasing share of total discharges. Dairy product manufacturing accounted for approximately 9 per cent of discharge, increasing to around 30 per cent in 2010/11. Meat and meat product manufacturing accounted for around 36 per cent of discharge in 2000/01, increasing to over almost 50 per cent by 2009/10 and then declining to 43 per cent – making it one of the largest dischargers. The step change (2002/03) in volume discharged by Meat and meat product manufacturing coincides with the granting of two new discharge consents in that

[46] For example, Consent number 99025 gives the discharge from the hydro-electric power house to Freshwater Basin as discharge 270,000 litres of tail water per hour.

year. These consents relate to the Alliance Group (one consent is associated with the Lorneville[47] operations and the other with the Makarwa operations).

Dairy farming is another large discharger with estimates putting this sector's discharge at around 6 million cubic metres per year (this is associated with the dairy shed operations). Dairy farming uses around 50 litres per cow per day.[48] This is water used in the dairy shed operation. In addition, stock water is consumed by the cows. According to Environment Southland, the total water use per cow per day is around 101 litres per cow per day. This includes 50 litres/day/cow used the in shed operations. If stock water is included, and assumed to be discharged, then dairy farming's discharge would be more than 15 million cubic metres in the 2011/12 year.

Figure 3.8: Estimate Southland Total Water Discharges (million cubic metres per year)



Source: Environment Southland Consent Database

The Mining and quarrying sector also discharges water but the reason for the discharges differ. In some instances water is discharged to enable mining activity to take place i.e. dewatering. In other cases, water is discharged after being used as part of the mining operations e.g. dredging. In another situation, water is used to wash the gravel and the contaminated water is discharged. In terms of volume discharged, mining uses comparatively little water but a few large and infrequent discharges are noted. For example in 2011/12, a consent allowing the discharge of up to 12,000 cubic metres of untreated water per day from an open cast mine was granted. This is one of the larger discharge consents and is valid until 2020. Based on the consent description, it is assumed that this consent supersedes two other consents for the same activity. These two prior consents were both for one year (2006/7 and 2008/9).

[47] This discharge consent is for wastewater from the meat processing plant but also provides for sewage from Wallacetown to be discharged to the Makarewa River.

[48] Other studies have allowed for an intake per cow of 70 litres per day (stock drinking figure) and hence used this for discharge also. Based on work done by Environment Southland, we considered this figure of 70 litres for discharge too high. Some of this is discharged either in the shed or directly onto land while grazing, while some of this gets turned into milk and enters the dairy processing industry.

Two other sectors have discharges which are notable: Basic metal manufacturing (including the aluminium smelter) with discharges just under 3 million cubic metres per year and Personal and other community services with discharges of around 6 million cubic metres per year. Personal and other community services include discharges such as treated sewerage effluent discharges, discharges from water treatment plants, oxidation pond effluent discharges and septic tank effluent.

A range of smaller discharge consents have been approved for different activities though the region, but those outlined above cover more than 95 per cent of discharges.

3.1.3.2 Nutrient loadings

A by-product of Southland's economic activity, especially the agriculture and processing of agricultural goods, is nutrients which are discharged to the environment. These nutrients include different forms of nitrogen (N) and different forms of phosphorus (P). The available data from Environment Southland on nutrient concentrations as well as NZIER estimates of total N and P discharged from Southland's agriculture activities provides an ability to estimate the nutrient loadings for some of Southland's economic sectors. Table 3.2 summarises the nutrient loads for the following five sectors:

- Livestock and cropping farming,
- Dairy cattle farming[49],
- Forestry and logging,
- Dairy product manufacturing, and
- Personal and other community services.

Table 3.2 presents the N and P loadings for these five sectors and shows the trend over time. These nutrient loadings have been estimated using data from NZIER's (baseline scenario) and animal stocking levels. As a first step the reference nutrients per animal was estimated and then applied to other years to reflect the total nutrients. With reference to Dairy product manufacturing and, Personal and community services, Environment Southland monitoring data, was used to estimate the nutrient discharges from these sectors. Due to the large variance in data for Personal community services (discussed above), it was decided to prepare low, medium and high estimates of this sector's nutrient discharges. The low and high estimates are presented in brackets.

Due to the lack of information on the other sectors we are not able to provide robust estimates[50] of the nutrient loads for the rest of the economy. The agriculture loads were estimated using trends in stock numbers and forestry activity. The agriculture sectors included above produce approximately 90 per cent of Southland's agricultural value added, and so are important in economic terms, considering that agriculture activity plays a substantial role in Southland's economy.

[49] Environment Southland highlighted a 1999 study that found dairy shed effluent discharge concentrations of 310 mg/l for nitrogen and 48 mg/l for phosphorus. This study by SoilWork Limited is: Irrigation of farm dairy effluent in southland, (1999), P B Greenwood, SoilWork Ltd, Dunedin However given that this study is now over 12 years old we relied on the NZIER and ES data in our analysis.

[50] We attempted to derive standard values for the other sector's nutrient loads using sources such as the New Zealand Physical Input-Output Tables, Waikato Independent Scoping Study and a wide literature study. However we were uncomfortable with the implied values because they were generic and reflected country wide nutrient loadings which are not applicable to Southland. Further analysis would be required to derive specific values for Southland industries.

Table 3.2: Nutrient Loads – Selected Sectors

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Total N (tonnes)												
Livestock and cropping farming	14,246.83	14,677.98	14,548.55	14,833.02	14,785.44	14,742.66	14,166.63	12,100.66	11,863.96	12,052.94	10,987.63	11,108.30
Dairy cattle farming	2,777.67	3,542.17	3,964.39	4,096.22	4,085.68	4,120.54	4,336.71	4,811.13	5,696.42	6,240.67	6,591.57	6,886.61
Forestry and logging	56.27	57.50	57.65	58.19	59.82	58.76	58.79	56.27	56.01	56.07	55.49	55.00
Dairy product manufacturing	14.43	0.48	70.56	70.48	70.50	70.48	70.38	70.32	70.33	174.70	174.68	104.74
Personal and other community services	2.05 (1.44-2.66)	2.05 (1.44-2.66)	2.05 (1.44-2.66)	0.35 (0.25-0.46)	0.88 (0.62-1.13)	2.89 (2.03-3.74)	2.90 (2.04-3.76)	8.37 (5.89-10.85)	8.37 (5.89-10.85)	8.38 (5.90-10.86)	8.42 (5.92-10.91)	8.42 (5.93-10.92)
Total	17,097.24	18,280.18	18,643.19	19,058.27	19,002.33	18,995.32	18,635.41	17,046.75	17,695.08	18,532.75	17,817.79	18,163.07
Total P (tonnes)												
Livestock and cropping farming	270.10	275.60	271.39	276.48	275.58	274.60	262.39	219.78	211.63	213.22	190.83	192.05
Dairy cattle farming	96.77	123.40	138.11	142.70	142.33	143.55	151.08	167.61	198.45	217.41	229.63	239.91
Forestry and logging	2.81	2.88	2.88	2.91	2.99	2.94	2.94	2.81	2.80	2.80	2.77	2.75
Dairy product manufacturing	2.64 (0.01-5.26)	0.09 (0.00-0.17)	12.90 (0.07-25.74)	12.89 (0.07-25.71)	12.89 (0.07-25.72)	12.89 (0.07-25.71)	12.87 (0.07-25.67)	12.86 (0.07-25.65)	12.86 (0.07-25.66)	31.95 (0.17-63.73)	31.94 (0.17-63.72)	19.15 (0.10-38.21)
Personal and other community services	0.46 (0.01-0.80)	0.46 (0.00-0.80)	0.46 (0.07-0.80)	0.08 (0.07-0.14)	0.20 (0.07-0.34)	0.65 (0.07-1.12)	0.65 (0.07-1.13)	1.88 (0.07-3.25)	1.88 (0.07-3.26)	1.88 (0.17-3.26)	1.89 (0.17-3.27)	1.89 (0.10-3.28)
Total	372.77	402.42	425.74	435.06	434.00	434.62	429.93	404.94	427.62	467.26	457.07	455.76

Note: The numbers in brackets show the low and high estimates. These estimates are based on low and high readings from actual abstraction records.

With reference to nitrogen loads, Livestock and crop farming is responsible for the largest nutrient discharges. This sector is estimated to have discharged 11,100 tonnes of N (2011/12). However over time, the N discharged by livestock and cropping has decreased by a fifth (22 per cent) down from 14,200 tonnes in 2000/01. Similarly phosphorus (P) discharged by livestock and cropping has decreased dropping from 270 tonnes in 2000/01 to 190 tonnes in 2011/12. This is a 30 per cent decrease.

Dairy cattle farming's nutrient loads increased from approximately 2800 tonnes of N to close to 6900 tonnes in 2011/12. Dairy farming discharged an estimated 240 tonnes of P – more than double the 96 tonnes discharged in 2000/01. Dairy product manufacturing nutrient loads have been increasing matching the growth in dairy farming (and therefore milk processing) increasing to over 100 tonnes in 2011/12. Similarly the P loads from dairy processing has increased corresponding with higher milk processing.

Forestry's N discharge has remained relatively stable around 55 tonnes per year and its P loads remained at round 3 tonnes per year. Personal and community service's N and P discharges increased. This sector's N loads increased from 2 tonnes in 2000/01 to around 8 tonnes in 2011/12. The P loads from this sector increased from 0.5 tonnes to almost 2 tonnes between 2000/01 and 2011/12.

The total N discharged has increased by 0.5 per cent per year (compounded). Likewise, P discharge has also increased, rising from 370 tonnes in 2000/01 to over 455 tonnes in 2011/11 – this is a compound growth of 1.7 per cent per year.

3.2 Economic and Ecological Multipliers

The idea behind the derivation of ecological multipliers is to demonstrate the extent to which production and consumption of economic goods and services depends on provisioning of different types of ecological goods and services, both directly and indirectly. The method is closely aligned to the popular concepts and tools of life-cycle assessment (LCA) and ecological footprinting. A more detailed description of the multiplier concept and methods used for calculation is given in Appendix 7.

Essentially the multipliers measure the ecological impacts that are 'embodied' in the production of a particular economic good or service i.e. the backward linkages. Importantly, this approach captures economic linkages and does not include the receiving environment i.e. the natural environment. This means that constraints (current or potential) due to environment constraints are not included in this analysis. To take an example, a water abstraction multiplier for a restaurant would measure water used directly by the restaurant (e.g. in washing dishes, preparing food), water used by food manufacturing industries in producing the processed foods purchased by the restaurant (e.g. water used in dairy manufacturing and meat product manufacturing), water used by farmers in producing the raw commodities sold to food manufacturers (e.g. water abstracted for stock, cleaning dairy sheds), and so on.

As the results presented here are an analysis of downstream impacts associated with each industry's output, it can be categorised as a type of 'producer responsibility' measure. Although the producer-centric approach seems to be the dominant form of viewing environmental impacts of industrial production, there are other approaches (see e.g. Gallego and Lenzen (2005)). In particular, many studies point to the role of final consumption and affluence as the main drivers for the level of pressure placed on the environment through production activities. Under this approach, all direct and indirect environmental impacts are traced right through to the point at which goods are finally consumed, rather than just to the point at

which the goods are produced. The consumer and producer approaches reveal very different results when there are significant quantities of goods imported and exported into and out of an economy.

In this study, the following types of ecological multipliers are calculated:

- Water abstraction (m^3)
- Water discharge (m^3)
- Total nitrogen (kg)
- Total phosphorous (kg)

Note that the direct industry water abstraction, discharge and nutrient loadings data used in the calculation of the multipliers is taken from the results calculated for each category under Section 3.1 above.[51] Therefore the limitations relating to data coverage and the assumptions applied in estimating economy-wide water use/ discharge/ nutrient loads outlined above apply equally to the results presented in this section. To begin, Table 3.3 and Table 3.4 provide a summary of the multiplier analysis results for water abstractions and water discharge, respectively. Although the nutrient loading data is subject to the limitations discussed above, summary multiplier analyses results for nitrogen and phosphorus residuals are also included (Table 3.5 and Table 3.6). Envelope 1 describes how to interpret these tables.

Envelope 1: Interpreting the Multiplier Tables

A set of multiplier tables have been prepared. Essentially the tables present four variables showing each sector's *total* water usage. In this instance *total* implies both the *direct* and *indirect* water used i.e. the 'embodied' water resources required by each industry to produce its goods (this information is presented in the columns with the year headings). The total water used then expressed in terms of the value of the goods and services produced by each sector – this shows how much water is used (directly and indirectly) to produce a $1million worth of Value Added and is the average over the last 5 years. (This is shown in the column with heading '(1) Direct and Indirect…'). The next column (heading with Direct and Indirect VA per VA) shows the value added multiplier for each sector. This multiplier shows how each sector is liked with the wider Southland economy and how a $1 change in VA will 'multiply' or ripple through the economy[52]. Finally, these two columns are combined (in the final column with (1)/(2) as heading). This ratio offers a benchmark describing how much *total* water resource is used by each sector during all the stage of production (all the backward linkages). This final column shows the average direct and indirect ecological multiplier for each industry expressed relative to the industry's direct and indirect value added multiplier (i.e. (1)/(2)). The idea behind inclusion of column (3) is to show that while some industries may require (directly and indirectly) a significant quantity of water resources, this may to some extent (at least in a policy context) be countered by the fact that they also produce a significant contribution to the local economy (as measured by direct and indirect value added impact). See Appendix 7 for additional detail.

[51] Where a particular environmental impact is measured as a range of possible results, we use the medium series.

[52] Technically this type of multiplier is referred to as Type 1 multipliers because it excludes households. We use this type of multiplier here because we are interested in the sectoral linkages net of households.

Table 3.3: Water Abstraction Multiplier Analysis for Southland Region, 2001-2011

	Industry	Total direct and indirect abstraction (000 m^3)											(1) Direct & indirect abst. per direct VA[#,¤]	(2) Direct and indirect VA per direct VA[¤]	(1)/(2)[#]
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
1	Hort. & fruit growing	152	103	122	339	246	366	465	539	1,281	248	316	66	2.4	27
2	Livestock & cropping	1,284	1,309	2,259	1,653	3,609	4,813	8,928	10,809	6,159	8,057	10,436	57	3.6	16
3	Dairy cattle farming	563	1,398	3,904	5,374	5,309	8,129	11,240	16,573	17,047	19,062	21,304	77	2.1	37
4	Other farming	48	49	98	82	1,344	1,022	828	5,752	119	118	116	104	2.4	43
5	Agr. services & hunting	45	43	118	89	174	143	155	403	99	106	109	4	1.8	2
6	Forestry and logging	42	38	109	83	78	60	62	70	74	65	88	2	2.7	1
7	Fishing	521	501	1,128	881	1,268	711	625	613	545	528	577	37	2.2	17
8	Mining and quarrying	914	836	1,678	505	869	2,424	2,569	3,710	3,228	3,568	3,982	10	1.2	8
10	Meat & meat product manuf.	17,920	17,530	37,100	31,896	35,643	29,636	30,434	44,479	32,428	34,456	36,102	157	4.9	32
11	Dairy product manuf.	3,194	4,078	7,247	7,608	7,759	12,890	15,605	23,353	18,353	16,423	13,611	286	4.5	64
12	Other food manuf.	229	211	474	325	367	339	370	515	485	438	485	15	2.1	7
13	Bevg, malt & tobacco manuf.	10	16	22	25	20	16	45	38	32	52	109	35	1.8	19
14	Textile & apparel manuf.	148	129	305	165	227	173	187	180	165	83	142	16	1.8	9
15	Wood product manuf.	72	80	262	145	210	374	487	463	475	526	491	8	2.4	3
16	Paper & paper prod. manuf.	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0
17	Printing & publishing	26	27	65	50	72	58	58	64	50	56	61	2	1.6	1
18	Petroleum & ind chemicals	127	113	186	112	169	95	90	151	121	120	143	7	1.6	4
19	Rubber, plastic & other chem.	2	2	5	3	10	12	9	22	16	21	23	6	1.9	3
20	Non-metallic min. products	16	18	48	26	42	82	113	107	128	95	129	6	3.4	2
21	Basic metal manuf.	1,130	1,136	1,988	1,534	1,340	2,349	3,023	3,309	2,849	3,200	3,438	29	5.1	6
22	Metal product manuf.	84	87	200	157	193	179	195	221	175	186	186	5	2.2	2
23	Transport equip. manuf.	6	7	19	19	23	21	24	26	21	26	31	2	1.4	1
24	Machinery & equip. manuf.	38	42	109	86	109	100	97	113	111	112	123	4	1.9	2
25	Furniture & other manuf.	12	12	31	22	27	23	20	19	17	21	22	4	1.9	2
26	Electricity gen. & supply	29	28	53	28	62	65	93	145	104	155	158	2	2.5	1
28	Water supply	17,941	17,799	20,708	21,925	20,175	19,347	16,081	21,433	20,946	20,438	22,162	5,025	3.0	1,676
29	Construction	240	256	686	466	688	753	956	1,117	993	1,032	1,124	5	3.0	2
30	Wholesale trade	1,517	1,674	3,926	2,661	3,202	2,276	2,324	2,481	2,624	2,455	2,670	18	2.0	9
31	Retail trade	487	515	1,395	1,046	1,479	1,017	955	1,026	982	1,078	1,223	4	1.4	3
32	Accomm., restaurants & bars	419	432	860	681	772	793	944	1,065	943	967	1,153	12	1.6	8
33	Road transport	164	172	422	322	461	319	281	310	290	303	327	3	1.7	2
34	Water & rail transport	209	215	651	473	513	345	305	397	358	403	426	7	1.8	4
35	Air transport, transport svs.	28	26	74	59	78	51	48	59	53	65	68	1	1.5	1
36	Communication services	9	9	38	28	37	22	20	18	20	22	25	1	1.4	1
37	Finance	22	27	77	55	87	64	76	80	84	88	100	1	1.2	1
38	Insurance	3	3	7	4	4	7	4	8	7	7	8	2	2.9	1
39	Services to finance & invest.	6	6	19	16	20	14	17	19	21	26	32	1	1.5	1
40	Real estate	2,869	3,273	8,826	5,229	7,192	6,302	5,715	5,699	6,176	7,808	8,333	32	1.6	19
42	Business services	61	63	184	141	214	157	162	195	190	193	216	1	1.3	1
43	Central government	57	64	154	120	154	103	107	135	121	201	184	2	1.3	1
44	Local govt. admin. & civil def.	357	375	1,001	680	1,073	729	690	927	932	1,191	1,387	13	1.7	7
45	Education	27	25	68	51	64	50	68	84	81	95	109	1	1.2	1
46	Health & community servs.	111	112	302	240	365	308	339	445	422	446	510	2	1.4	1
47	Cultural & recreational servs.	25	28	330	160	161	126	220	202	107	281	162	3	1.5	2
48	Personal & other comm. servs.	27	31	82	63	85	56	50	69	67	78	89	1	1.5	1

[#] Units are 000m^3 yr^{-1} $\$_{2007}mil^{-1}$

Table 3.4: Water Discharge Multiplier Analysis for Southland Region, 2001-2011

	Industry	Total direct and indirect discharge (000 m^3)											(1) Direct & indirect dist. per direct VA[#,¤]	(2) Direct and indirect VA per direct VA[¤]	(1)/(2)[#]
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
1	Hort. & fruit growing	0	44	11	22	30	31	34	44	44	45	41	5	2.4	2
2	Livestock & cropping	0	1,210	656	746	795	535	611	1,069	757	1,199	738	6	3.6	2
3	Dairy cattle farming	0	2,740	3,235	3,742	3,860	3,741	3,895	4,238	4,841	6,092	6,269	24	2.1	12
4	Other farming	0	567	522	536	534	47	43	63	92	96	66	4	2.4	2
5	Agr. services & hunting	0	133	60	61	55	43	60	62	77	74	57	1	1.8	1
6	Forestry and logging	0	44	23	31	16	21	33	41	62	56	65	2	2.7	1
7	Fishing	0	123	89	88	37	39	105	83	239	194	164	9	2.2	4
8	Mining and quarrying	0	315	294	316	227	350	323	5,351	554	5,600	805	3	1.2	2
10	Meat & meat product manuf.	0	8,010	7,942	20,524	20,793	15,613	21,332	22,109	26,283	26,300	29,517	105	4.9	21
11	Dairy product manuf.	0	5,028	4,006	11,223	11,229	12,056	11,921	12,667	11,859	11,762	21,543	239	4.5	53
12	Other food manuf.	0	538	495	302	224	62	94	114	2,280	1,767	748	26	2.1	13
13	Bevg, malt & tobacco manuf.	0	3	0	0	0	0	2	3	2	3	5	2	1.8	1
14	Textile & apparel manuf.	0	66	51	57	63	58	75	64	74	46	51	7	1.8	4
15	Wood product manuf.	0	143	54	89	91	103	127	526	547	552	592	7	2.4	3
16	Paper & paper prod. manuf.	0	2,192	0	0	0	0	0	0	0	0	0	567	1.6	348
17	Printing & publishing	0	583	11	16	14	14	19	30	27	40	31	1	1.6	1
18	Petroleum & ind chemicals	0	56	16	28	30	20	21	39	31	42	56	2	1.6	1
19	Rubber, plastic & other chem.	0	3	1	2	5	5	4	10	9	14	18	3	1.9	2
20	Non-metallic min. products	0	27	7	9	8	14	20	121	36	120	38	3	3.4	1
21	Basic metal manuf.	0	2,118	1,709	1,762	1,747	1,817	1,929	2,998	3,571	6,225	3,824	35	5.1	7
22	Metal product manuf.	0	105	48	63	58	59	67	100	104	157	107	3	2.2	1
23	Transport equip. manuf.	0	8	4	7	4	5	9	12	16	21	23	1	1.4	1
24	Machinery & equip. manuf.	0	40	19	27	25	26	27	42	51	71	59	2	1.9	1
25	Furniture & other manuf.	0	19	4	7	6	6	6	8	10	12	13	2	1.9	1
26	Electricity gen. & supply	0	46	16	15	11	15	37	163	82	236	115	2	2.5	1
28	Water supply	0	11	2	3	2	35	43	88	50	95	60	13	3.0	4
29	Construction	0	352	168	203	153	193	342	1,066	734	1,287	751	4	3.0	1
30	Wholesale trade	0	405	111	182	149	143	173	197	261	256	319	2	2.0	1
31	Retail trade	0	130	66	101	83	82	131	140	205	229	231	1	1.4	1
32	Accomm., restaurants & bars	0	253	150	287	280	260	296	290	408	391	538	4	1.6	3
33	Road transport	0	195	85	123	131	173	197	213	246	227	252	2	1.7	1
34	Water & rail transport	0	37	13	16	9	10	17	29	33	43	36	0	1.8	0
35	Air transport, transport svs.	0	30	4	6	5	4	6	8	11	14	14	0	1.5	0
36	Communication services	0	24	4	4	3	3	4	4	8	8	8	0	1.4	0
37	Finance	0	36	10	11	7	9	24	25	49	50	51	0	1.2	0
38	Insurance	0	5	1	1	0	1	1	2	4	4	4	1	2.9	0
39	Services to finance & invest.	0	14	2	3	1	2	4	5	10	12	12	0	1.5	0
40	Real estate	0	302	33	30	19	38	65	98	115	186	139	1	1.6	0
42	Business services	0	274	42	48	27	34	80	86	187	175	171	0	1.3	0
43	Central government	0	109	32	30	18	19	40	46	80	120	96	1	1.3	1
44	Local govt. admin. & civil def.	0	116	67	68	36	44	110	134	286	350	335	3	1.7	2
45	Education	0	229	86	101	70	47	72	70	106	122	115	1	1.2	1
46	Health & community servs.	0	134	57	72	44	58	139	168	325	353	345	1	1.4	1
47	Cultural & recreational servs.	0	114	75	71	63	64	138	163	193	191	191	3	1.5	2
48	Personal & other comm. servs.	0	1,638	1,593	1,598	280	685	2,245	2,263	6,500	6,510	6,513	72	1.5	48

[#] Units are 000m^3 yr^{-1} mil^{-1}

Table 3.5: Nitrogen Multiplier Analysis for Southland Region, 2001-2011

	Industry	Total direct and indirect N (tonnes)											(1) Direct & indirect N per direct VA[#]	(2) Direct and indirect VA per direct VA[#]	(1)/(2)[#]
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
1	Hort. & fruit growing	10	12	17	20	16	16	17	15	16	15	17	2,062	2.4	856
2	Livestock & cropping	17,619	18,158	18,019	18,312	18,266	18,208	17,471	14,951	14,646	14,846	13,545	2,989	3.6	830
3	Dairy cattle farming	3,081	3,920	4,353	4,612	4,571	4,621	4,942	5,378	6,420	7,240	7,556	1,070	2.1	515
4	Other farming	38	40	48	56	49	43	42	42	56	54	45	1,438	2.4	588
5	Agr. services & hunting	23	24	34	36	35	37	41	36	29	30	26	140	1.8	78
6	Forestry and logging	84	86	89	90	89	88	88	84	84	83	83	855	2.7	314
7	Fishing	11	11	13	14	14	12	12	9	8	7	7	199	2.2	89
8	Mining and quarrying	32	31	31	32	24	27	15	20	20	17	18	18	1.2	14
10	Meat & meat product manuf.	8,124	7,899	11,871	13,443	11,875	11,703	12,640	13,266	13,073	13,748	12,818	818	4.9	167
11	Dairy product manuf.	4,725	4,867	5,416	4,670	4,522	5,752	5,693	6,583	5,752	5,109	3,646	6,277	4.5	1,397
12	Other food manuf.	33	33	41	36	27	36	38	40	38	36	36	266	2.1	130
13	Bevg, malt & tobacco manuf.	0	0	0	0	0	0	1	1	0	1	1	3,784	1.8	2,092
14	Textile & apparel manuf.	81	73	93	69	65	66	78	54	61	29	31	5,523	1.8	3,017
15	Wood product manuf.	34	42	51	45	65	73	66	68	51	51	46	156	2.4	66
16	Paper & paper prod. manuf.	0	0	0	0	0	0	0	0	0	0	0	4,563	1.6	2,799
17	Printing & publishing	4	5	6	7	7	7	7	6	5	5	5	69	1.6	44
18	Petroleum & ind chemicals	19	18	16	12	13	10	8	11	10	8	9	313	1.6	191
19	Rubber, plastic & other chem.	1	1	1	1	2	3	2	3	3	3	3	1,924	1.9	1,033
20	Non-metallic min. products	2	2	3	3	3	4	4	3	4	3	3	118	3.4	35
21	Basic metal manuf.	88	95	118	103	102	121	115	107	104	99	98	31	5.1	6
22	Metal product manuf.	12	13	17	17	16	19	18	17	14	14	12	68	2.2	31
23	Transport equip. manuf.	1	1	2	2	2	3	3	2	2	2	2	96	1.4	71
24	Machinery & equip. manuf.	5	6	8	9	8	10	9	8	9	8	8	80	1.9	42
25	Furniture & other manuf.	2	3	3	3	3	3	2	2	2	2	2	845	1.9	435
26	Electricity gen. & supply	3	3	3	3	4	4	4	5	4	6	5	11	2.5	5
28	Water supply	1	1	0	1	0	1	0	1	1	0	0	279	3.0	93
29	Construction	35	40	53	55	58	65	64	64	60	55	54	14	3.0	5
30	Wholesale trade	210	253	301	289	234	257	270	229	255	216	212	115	2.0	58
31	Retail trade	28	32	45	48	46	49	48	41	41	41	42	12	1.4	8
32	Accomm., restaurants & bars	81	89	133	127	122	137	127	122	109	100	104	206	1.6	132
33	Road transport	16	18	24	25	26	27	23	21	21	19	19	24	1.7	15
34	Water & rail transport	6	7	11	11	8	8	8	8	8	8	7	28	1.8	16
35	Air transport, transport svs.	2	2	3	3	3	3	3	3	3	3	3	36	1.5	25
36	Communication services	1	1	2	2	2	1	1	1	1	1	1	15	1.4	11
37	Finance	2	2	3	3	3	4	4	4	4	4	4	5	1.2	4
38	Insurance	0	0	0	0	0	0	0	0	0	0	0	139	2.9	49
39	Services to finance & invest.	0	1	1	1	1	1	1	1	1	1	1	25	1.5	17
40	Real estate	8	11	14	12	11	15	15	12	13	15	14	3	1.6	2
42	Business services	12	14	20	22	23	24	24	23	25	23	23	8	1.3	6
43	Central government	4	5	6	6	5	6	6	6	6	8	7	14	1.3	10
44	Local govt. admin. & civil def.	10	12	16	15	16	17	17	17	19	22	23	42	1.7	24
45	Education	4	4	5	5	5	5	6	6	7	7	7	8	1.2	6
46	Health & community servs.	11	12	18	18	20	24	25	26	26	26	27	7	1.4	5
47	Cultural & recreational servs.	3	3	4	5	5	6	6	6	6	6	7	24	1.5	16
48	Personal & other comm. servs.	5	5	7	5	5	7	7	13	13	13	13	45	1.5	31

[#] Units are Kg yr^{-1} $Smil^{-1}$

Table 3.6: Phosphorus Multiplier Analysis for Southland Region, 2001-2011

	Industry	Total direct and indirect P (tonnes)											(1) Direct & indirect TP per direct VA[#,¤]	(2) Direct and indirect VA per direct VA[¤]	(1)/(2)[#]
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011			
1	Hort. & fruit growing	0	0	0	0	0	0	0	0	0	0	0	40	2.4	17
2	Livestock & cropping	337	345	340	344	344	342	326	274	264	265	237	54	3.6	15
3	Dairy cattle farming	103	131	146	153	152	154	163	179	213	237	248	35	2.1	17
4	Other farming	1	1	1	1	1	1	1	1	1	1	1	28	2.4	11
5	Agr. services & hunting	0	1	1	1	1	1	1	1	1	1	1	3	1.8	2
6	Forestry and logging	4	4	4	4	4	4	4	4	4	4	4	41	2.7	15
7	Fishing	0	0	0	0	0	0	0	0	0	0	0	5	2.2	2
8	Mining and quarrying	1	1	1	1	1	1	0	1	1	1	1	1	1.2	0
10	Meat & meat product manuf.	161	155	233	260	230	227	242	252	243	252	231	15	4.9	3
11	Dairy product manuf.	159	162	191	165	160	201	197	228	200	192	145	228	4.5	51
12	Other food manuf.	1	1	1	1	1	1	1	1	1	1	1	7	2.1	3
13	Bevg, malt & tobacco manuf.	0	0	0	0	0	0	0	0	0	0	0	102	1.8	57
14	Textile & apparel manuf.	2	1	2	1	1	1	1	1	1	1	1	102	1.8	56
15	Wood product manuf.	1	2	2	2	3	3	3	3	2	2	2	6	2.4	3
16	Paper & paper prod. manuf.	0	0	0	0	0	0	0	0	0	0	0	119	1.6	73
17	Printing & publishing	0	0	0	0	0	0	0	0	0	0	0	2	1.6	1
18	Petroleum & ind chemicals	1	1	1	0	0	0	0	0	0	0	0	10	1.6	6
19	Rubber, plastic & other chem.	0	0	0	0	0	0	0	0	0	0	0	57	1.9	31
20	Non-metallic min. products	0	0	0	0	0	0	0	0	0	0	0	3	3.4	1
21	Basic metal manuf.	2	3	3	3	3	3	3	3	3	3	3	1	5.1	0
22	Metal product manuf.	0	0	0	0	0	0	0	0	0	0	0	2	2.2	1
23	Transport equip. manuf.	0	0	0	0	0	0	0	0	0	0	0	3	1.4	2
24	Machinery & equip. manuf.	0	0	0	0	0	0	0	0	0	0	0	2	1.9	1
25	Furniture & other manuf.	0	0	0	0	0	0	0	0	0	0	0	25	1.9	13
26	Electricity gen. & supply	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0
28	Water supply	0	0	0	0	0	0	0	0	0	0	0	8	3.0	3
29	Construction	1	1	2	1	2	2	2	2	2	2	2	0	3.0	0
30	Wholesale trade	5	6	7	6	5	6	6	5	5	4	4	2	2.0	1
31	Retail trade	1	1	1	1	1	1	1	1	1	1	1	0	1.4	0
32	Accomm., restaurants & bars	2	2	4	3	3	4	3	3	3	3	3	6	1.6	4
33	Road transport	0	0	1	1	1	1	1	1	1	0	0	1	1.7	0
34	Water & rail transport	0	0	0	0	0	0	0	0	0	0	0	1	1.8	0
35	Air transport, transport svs.	0	0	0	0	0	0	0	0	0	0	0	1	1.5	1
36	Communication services	0	0	0	0	0	0	0	0	0	0	0	0	1.4	0
37	Finance	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0
38	Insurance	0	0	0	0	0	0	0	0	0	0	0	4	2.9	1
39	Services to finance & invest.	0	0	0	0	0	0	0	0	0	0	0	1	1.5	0
40	Real estate	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0
42	Business services	0	0	0	0	1	1	1	1	1	1	1	0	1.3	0
43	Central government	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0
44	Local govt. admin. & civil def.	0	0	0	0	0	0	0	0	0	1	1	1	1.7	1
45	Education	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0
46	Health & community servs.	0	0	0	0	1	1	1	1	1	1	1	0	1.4	0
47	Cultural & recreational servs.	0	0	0	0	0	0	0	0	0	0	0	1	1.5	0
48	Personal & other comm. servs.	1	1	1	0	0	1	1	2	2	2	2	7	1.5	4

[#] Units are Kg yr^{-1} mil^{-1}

Among the key messages described by these tables are:

- If we trace the production chains of manufacturing industries responsible for immediate processing of raw primary products (particularly Meat and meat product manufacturing and Dairy product manufacturing), large quantities of water use and discharge are involved. This is because these industries are both significant direct users of water, and major purchasers of primary goods *that are also produced* with significant water inputs.
- Once processed, much of Southland's meat and dairy products leave the region as interregional and international exports, rather than being consumed by other local industries and sources of final demand. In this way Southland is an 'exporter of embodied environmental goods'.
- The quantity of water required directly and indirectly to produce outputs from the Water supply industry is very high relatively to the industry's value-added contribution (5million m^3 per year per $\$_{2007}$mil). This is, however, not a surprising result and reflects a significant level of market intervention to ensure that water is widely available at a relatively low cost to industry and consumers. It is also worth noting that the multiplier analysis presented here traces only economic activity induced through *backward* linkages along supply chains. If it were possible to also trace *forward* linkage value added impacts, then the results for this industry would look different. Potable water is a very important input (i.e. enabler of production) for businesses with reticulated supply and essential for residents in an area.
- Although service industries generally require relatively little direct water resources (measured in terms of water abstraction, discharge and nutrient production), some of these industries appropriate, through their production chains, relatively substantial water resources. The Real estate industry, for example, has an estimated direct and indirect water abstraction requirement of over 7.8 million cubic metres for 2011 – almost equivalent to that of livestock and cropping. The high embodied water abstraction for Real estate services reflects the nature of the Real estate industry as some water demand reflect here actual represents a portion of commercial and household water demanded from the water supply industry. This is because Real estate as used here includes residential property body corporates, operations as well as commercial property operators. Through its production chains it therefore appropriates significant quantities of water abstracted directly by a whole range of different industries within the Southland economy. Other services industries exhibiting quite significant appropriation of water resources include Construction, Wholesale trade, Retail trade, Accommodation, restaurants and bars and Local government.

3.3 Business As Usual Water Scenario

In this section we describe possible future water impacts within the Southland region under a business as usual economic scenario. The estimates of future water impacts by economic sector are derived essentially by multiplying estimates of future output by the estimated rate of environmental impact per unit of production.

More specifically,

$$EI_j^z(t) = EI_j^z(2011) \times \frac{output_j(t)}{output_j(2011)} \times \left(1 - r_j^z\right)^{t-2011},$$

where $EI_j^z(t)$ is the ecological impact of type *z* (*z* refers to water abstraction, water discharge, total N or total P) produced by sector *j* at time *t*, *output*(*t*) is the estimated industry *j* output at time *t* ($\$_{2007}$mil) and r_j^z is the assumed rate of efficiency change for ecological impact *z* by sector *j*.

The estimates of sector level ecological impacts during 2011 (i.e. $EI_j^z(2011)$) are taken directly from the results described in section 3.1. Thus the limitations associated with those results (e.g. non-inclusion of impacts classed as 'permitted activities', omissions in data reporting) flow through into the future impact estimates.

To derive estimates of future economic output by sector we apply M.E's Economic Futures Model (EFM). The EFM uses a multi-regional input-output framework to capture impacts of future economic changes on the Southland and the rest of New Zealand, based on future demographic and econometric projections of demand for goods and services by households, international exports and capital formation. The initial BAU scenario is derived as follows:

- *Household consumption* – it is assumed that household and government future consumption grows in line with population growth. This study applies Statistics New Zealand's medium sub-national population projections.[53]
- *Export consumption* – the export growth projections for the BAU scenario were derived econometrically using time series data, covering the period 2005-11. The export projections were based on customised data from Statistics New Zealand's 10 digit level New Zealand Harmonised System (NZHS) export data for physical goods commodities and the Balance of Payments export data for service type commodities.

[53] Note, however, that adjustments are made to the future household consumption estimates to account for the effects of (1) changing consumption patterns of people as they age, and (2) the general trend of increasing consumption per person over time.

- *Gross fixed capital formation* – Time series data of Gross Fixed Capital Formation extracted from Statistics New Zealand's National Accounts was utilised to model the future growth rates for capital growth, again using econometric techniques.

Once these final demand projections are entered into the EFM, the model calculates the flow-on implications throughout the New Zealand economy using input-output mathematics. Thus, estimates of future economic output and value added by economic sector are derived. Finally, we calibrate the model so as to ensure that its outputs for key sectors are consistent with the sector outlooks as described in Section 2 above.

Referring now to the r_j^z coefficients, these describe the annual percentage reduction in the ratio of ecological impact per unit of economic output. In other words, this shows how the relationship between ecological inputs (e.g. water) and economic activity (e.g. 10kg of milk solid) changes over time. There is some evidence world-wide, and for a variety of different types of economic goods and services, that growth in economic production and population need not always be met by equal growth in environmental pressure (Behrens *et al.* 2007). However projecting the rates at which economic growth might be decoupled from use of water resources is very difficult. Not only do these rates of efficiency change depend on the rate at which new technologies are invented and adopted, but also more far-reaching structural changes occurring within the economy. In particular, diversification of economic production with the addition of new types of value added improvements during production chains will act to increase the r_j^z coefficients.

Given the severe time constraints of this project, it has not been possible to undertake a detailed analysis of the likely future efficiency changes across all sectors under a BAU scenario. For water abstraction and discharge, we have therefore relied on an assumed average global rate of efficiency change of 0.5 per cent per annum, as adopted by Hejazi *et al.* (2013) in their BAU scenario of future global municipal water-use demand. As water discharge is directly related to water use, the same rate of efficiency change is also adopted across all sectors for future water discharges. For the three principal agriculture sectors, we have derived r_j^z values for N and P loads so as to achieve some consistency with the future nutrient levels calculated by NZIER in their baseline scenario. In the case of N, the adopted rates of efficiency improvements are just less than 0.8 per cent annum for both the dairy cattle farming and livestock and cropping sectors. The adopted efficiency changes for phosphorus are for these two sectors are a little higher at 1.3 and 0.9 per cent per annum, respectively. A zero rate of efficiency change is adopted for both N and P in the case of the forestry and logging sectors. For secondary and tertiary sectors, a universal rate of efficiency change of 0.5 per cent per annum is adopted for both N and P.

The business as usual value added, water, abstraction, water discharge, N production and P production results are presented in Table 3.7 and Table 3.8. Appendix 8 shows each sector's value add, abstraction and discharge and loadings as well as the percentage of total. Note that the water information presented here reflects consented activities and does not consider activities which draw on municipal water. The water drawn by the water supply sector is however included.

Table 3.7: Business As Usual Value-Added, Water Abstraction and Water Discharge for Southland Region, 2011-2031

Note: the growth rate in the 'Total rows' is the Average Annual Percentage Growth for the total economy

	2011*	2016	2021	2026	2031	Annual average % growth
Value Added ($2012mil)						
Livestock and cropping	278	283	289	294	298	0.35%
Dairy cattle farming	363	420	479	548	645	2.9%
Other farming	62	67	71	76	81	1.3%
Other primary	94	113	132	153	172	3.1%
Meat & meat prod manuf	653	674	695	713	730	0.6%
Dairy prod manuf	96	113	130	146	163	2.7%
Metals, transport & mach manuf	366	403	449	493	539	2.0%
Other manufacturing	162	173	179	189	197	1.0%
Electricity, gas & water supply	85	92	100	106	114	1.5%
Construction & trade	475	529	581	633	684	1.8%
Other services	1,296	1,382	1,463	1,535	1,601	1.1%
Total	3,930	4,247	4,567	4,887	5,226	1.4%
Water Abstraction ($000m^3$)						
Livestock and cropping	7,299	7,255	7,221	7,173	7,099	-0.1%
Dairy cattle farming	18,222	20,505	22,818	25,603	29,359	2.4%
Other farming	235	249	261	273	284	0.9%
Other primary	4,930	5,379	5,802	6,279	6,652	1.5%
Meat & meat prod manuf	11,509	11,598	11,645	11,668	11,660	0.1%
Dairy prod manuf	2,736	3,124	3,517	3,889	4,249	2.2%
Metals, transport & mach manuf	388	418	454	490	523	1.5%
Other manufacturing	321	313	309	314	310	-0.2%
Electricity, gas & water supply	15,237	14,860	15,527	16,153	16,737	0.5%
Construction & trade	0	0	0	0	0	n/a
Other services	567	576	581	581	579	0.1%
Total	61,445	64,276	68,137	72,422	77,452	1.2%
Water Discharge ($000m^3$)						
Livestock and cropping	34	34	34	33	33	-0.1%
Dairy cattle farming	5,629	6,335	7,049	7,910	9,070	2.4%
Other farming	44	46	47	49	51	0.8%
Other primary	2,829	3,086	3,329	3,602	3,817	1.5%
Meat & meat prod manuf	26,551	26,757	26,866	26,918	26,899	0.1%
Dairy prod manuf	15,878	18,128	20,411	22,570	24,659	2.2%
Metals, transport & mach manuf	2,845	3,063	3,332	3,594	3,833	1.5%
Other manufacturing	1,150	1,168	1,189	1,200	1,208	0.2%
Electricity, gas & water supply	46	45	47	49	51	0.5%
Construction & trade	19	22	24	27	29	2.0%
Other services	6,560	6,817	7,134	7,355	7,484	0.7%
Total	61,585	65,500	69,463	73,306	77,134	1.1%

* So as to reduce the impact of data anomalies occuring during one year, the base year (2011) data is derived from an average of the estimated values for 2010 and 2011

Table 3.8: Business As Usual Nitrogen and Phosphorus for Southland Region, 2011-2031

	2011*	2016	2021	2026	2031	Annual average % growth
Nitrogen (tonnes)						
Livestock and cropping	10,988	10,783	10,596	10,391	10,154	-0.4%
Dairy cattle farming	6,592	7,316	8,029	8,885	10,049	2.1%
Other farming	0	0	0	0	0	n/a
Other primary	55	69	85	102	119	3.9%
Meat & meat prod manuf	0	0	0	0	0	n/a
Dairy prod manuf	175	199	225	248	271	2.2%
Metals, transport & mach manuf	0	0	0	0	0	n/a
Other manufacturing	0	0	0	0	0	n/a
Electricity, gas & water supply	0	0	0	0	0	n/a
Construction & trade	0	0	0	0	0	n/a
Other services	8	9	9	9	10	0.7%
Total	17,818	18,376	18,944	19,637	20,603	0.7%
Phosphorus (tonnes)						
Livestock and cropping	191	182	174	166	158	-0.9%
Dairy cattle farming	230	253	275	303	340	2.0%
Other farming	0	0	0	0	0	n/a
Other primary	3	3	4	5	6	3.9%
Meat & meat prod manuf	0	0	0	0	0	n/a
Dairy prod manuf	32	36	41	45	50	2.2%
Metals, transport & mach manuf	0	0	0	0	0	n/a
Other manufacturing	0	0	0	0	0	n/a
Electricity, gas & water supply	0	0	0	0	0	n/a
Construction & trade	0	0	0	0	0	n/a
Other services	2	2	2	2	2	0.7%
Total	457	477	497	522	556	1.0%

* So as to reduce the impact of data anomalies occuring during one year, the base year (2011) data is derived from an average of the estimated values for 2010 and 2011

Looking mainly at the water abstraction and discharge results, for which there is significantly more comprehensive base-year data available, we can note that over 70 per cent of the total additional water demand in Southland under the BAU scenario is associated with increased demand by the dairy cattle farming sector. A further 7 per cent and 10 per cent is associated with growth in demand respectively by the other primary and dairy product manufacturing sectors. The former sector includes forestry as well as a number of agricultural support activities. Only around 10 per cent of total future water demand under this scenario relates to demand from the water supply industry (i.e. municipal demand).

One of the clear findings from this analysis is that, at least under the BAU scenario as constructed, Southland is not showing any significant decoupling of economic growth from water demand. Notice that the annual average growth rate in water abstraction and water discharge is only slightly less than the annual average growth in value added. This occurs despite adopting an economy-wide rate of efficiency change of 0.5 per cent per annum. Thus under this BAU scenario, the Southland economy is becoming relatively more dependent on industries with comparatively high water demand.

4 Concluding Remarks

A key finding of this study is that the economic future of the Southland region, under a business as usual demand driven scenario, is closely aligned to economic activities with high water abstraction, discharge and nutrient loadings. Under this trajectory it is likely that future economic growth will place increasing pressure on Southland's freshwater resources. This includes not only pressure on surface and groundwater systems to meet future economic development needs, but also on the assimilative capacity of the environment to deal with discharges and nutrient loadings. To ensure that future economic demands for freshwater are fulfilled will require careful management, efficient and equitable allocation, and increasingly the implementation of mitigation measures which result in reduced loadings per unit of production. Ultimately, if Southland is to achieve its full economic potential the region needs to ensure that it continues to invest in and grow its welfare generating capital (both natural and human-derived). By challenging the people of Southland to look for new and innovative ways of adding value to production processes the economy may continue to evolve and prosper, without reaching environmental limitations.

Central to the future will be the need to understand clearly the socio-economic and ecological trade-offs for decision making. It is important to note that these trade-offs will need to be assessed not only for the short term, but also (for the protection of future generations) over the longer term. Our analysis has considered the period 2000 to 2012, projected forward what this might look like under a business as usual scenario, and quantified through the use of ecological multipliers the environment-economy interface. It is however important to recognise that this future is not set in stone and is, in fact, only of many plausible futures which could prevail. Independent of the future path that Southland takes, it is essential that it is informed by relevant and high quality information. In this regard our research provides a stepping stone, with significant future research required.

4.1 Key Research Findings

Economic profile

- Population is expected to decline over the next 20 years from the current level to around 88,000 by 2031. Compared to the national average of 86 per cent, the proportion of the Southland population living within urban areas is low, at 70 per cent. Twenty five per cent of Southland residents are classified as living within rural areas and 5 per cent within rural centres.
- Agricultural sectors, with their combination of high employment, export focus and value added contributions to the region dominate the list of key sectors in Southland. The dairy sector is expected to continue to show growth as more farms undergo conversion to dairy. The primary sectors of the economy employ 23 per cent (or 13,780 MECs) of Southland's total labour force. Livestock and cropping farming account for almost 6,000 MECs, although this is decreasing because of the number of dairy farm conversions, with many workers switching jobs between farming industries.
- Southland has a well-established manufacturing base, although the economic recession has placed pressure on manufacturing industries. Meat and meat product manufacturing had a value added

contribution of $652m_{2012}$, and is a key sector in Southland, although it is facing pressure from pricing trends and the conversion from livestock to dairy farming. Basic metal production and Metal related machinery and equipment manufacturing, although less dominant, represents another important cluster of industrial activity. These industries, which include the NZAS Tiwai Aluminium Smelter, make up a relatively small proportion of the economy in value added terms, but have strong linkages to other economic sectors and play an important support role in the Southland economy.

- Tourism is also important as reflected by the Water and rail transport and Accommodation, restaurants and bars sectors.

Water abstraction, discharge and nutrient loadings

- There has been a large increase in consent numbers and allowable abstraction maximums (increased more than three fold in the last 12 years). Dairy farming has been a key driver of this growth; accounting for more than three quarters of consents granted. In terms of abstraction, the ratio of maximum allocation to estimated abstraction varies across sectors. Dairy farming, for example, uses around 45 per cent of its water abstraction, compared to an average of 28 per cent across all sectors. Over the period 2000 to 2012 water take by sector has in increased for most sectors as a share of the allowable consented maximums.

- Water discharges are dominated by dairy farming, with non-dairy discharges characterised by a few consents with very large volumetric flows. In particular, meat processing and dairy processing are responsible for an increasing share of regional discharge. Importantly, dairy cattle farming discharges are growing through time. Mining and quarrying discharges are another key discharger, but this includes mine de-watering.

- Due to lack of volumetric flow, and limited timeframes for the study, our analysis has relied on the NZIER study to capture the nutrient loadings within farming. We also have included N and P for large scale dairy processing industries and wastewater plants where compliance monitoring flow data was available. In this regard, we have covered most of the major consented discharges, but recommend that further work be undertaken to provide a comprehensive picture of nutrient loading. This will require engineering input and industrial site specific knowledge of the technological apparatus and processes employed and, in turn, appropriate standard values to calculate loadings. Substitution between livestock and cropping, and dairy cattle farming is leading to a slightly higher N (some substitution effect with dairying discharging less N/unit compared to livestock and cropping). Total N discharged to the environment has been growing at 0.5%/y. P loads have increased by 1.7% per year.

Economic and ecological multipliers

- The goods produced by the manufacturing sectors responsible for immediate processing of raw primary products (particularly Meat and meat product manufacturing and Dairy product manufacturing) embody the greatest demands on water resources. This is because these industries are both significant direct users of water, and major purchasers of primary goods that are also produced with significant water inputs.

- All economic sectors within the Southland economy depend on the provision of water and water-related services – even those for which no consented abstraction, discharge and residual production data is available. While service industries generally require relatively little direct water resources, some of these industries (particularly Real estate services, Construction, Wholesale trade and Retail trade and Accommodation, restaurants and bars) appropriate relatively substantial water resources. This occurs through their production chains.
- Through the supply of raw and manufactured dairy products, it is likely that Southland is a significant exporter of embodied water-related ecological services, both to the rest of the New Zealand and other nations.

Business as usual water impact scenarios

- Under the business as usual scenario, growth in water abstraction (and discharge) is only marginally lower than the rate of value-added growth (1.1 per cent per annum compared with 1.3 per cent per annum). This highlights that a significant movement away from the business as usual pathway is required if Southland is to achieve a noticeable decoupling of economic growth from water demand.
- More than 70 per cent of the additional demand for water under the business as usual scenario is associated with additional agricultural demand, and a further 11 per cent to additional demand for dairy product manufacturing. Around 10 per cent is associated with additional municipal demand.

4.2 Recommendations for further work

This work has formed part of a wider Joint Venture project lead by Ministry for the Environment. The work has been undertaken within a limited timeframe and thus several key areas of research remaining unaddressed. These are considered below:

- *Mismatch of consented maximums and actual takes, discharges and residual loadings*. As with many regional councils, there is a clear need to establish information collection protocols that will enable policy and decision makers to better understand the extent of the mismatch between consented maximum allocations and actual abstractions, discharges and residual loadings. This will, in turn, help to develop allocation mechanisms which are efficient and equitable. This is a complex issue requiring careful consideration of not only environmental and/or economic outcomes, but systemically all of the four well-beings (social and cultural to be included). It is worth noting that several other regional councils have considered the use of economic instruments including environmental charging (tradable permits, subsidies on products or practices) and compensation mechanisms (payments for ecosystem services).
- *Regional versus local or catchment level analysis*. This study has been undertaken at a regional level. Water related issues, by their very nature, are often specific to catchments and, in turn, to the communities residing within them. In this regard, there is a clear need to develop an evidence base whereupon not only national and regional, but community decisions can also be made. Most of the analysis of water issues in Southland region has focused on a few key catchments, but other catchments face similar pressures. It is therefore recommended that economic and water profiles be developed for other hotspot catchments and communities.

- *Other scenarios*. This study has quantified the economic, water and water related economic interdependencies which exist in the Southland economy under a business as usual economic growth scenario. Ideally, other scenarios of economic development would also be tested.
- *Water footprinting*. The method used in this report to calculate the ecological multipliers may be used to determine a water footprint of the Southland economy. Specifically this would separate pressure on Southland's water resources into that which originates from domestic demand, that which comes from other regions and that demand from other nations. This would provide further insights into the dependence on water of the Southland economy; particularly the quantification of the degree to which the Southland economy has a net ecological balance of trade surplus or deficit.
- *Dynamic economic-ecological feedbacks.* The research in this report provides some insight into the scale of the issues Southland region may face in water terms. This analysis has focused on the economy-environment interface in terms of abstraction, discharge and nutrient loadings, but has not considered dynamic feedbacks which exist between the economy and environment. These feedbacks are characterised by non-linearities (and potential tipping points), lags and complex cause effect relationships which may produce emergent behaviour not captured in business as usual trends. In the New Zealand context, the study of these dynamics is currently the arena of research projects. One particularly promising approach is the Multi-Scale Modelling of Ecosystem Services (MIMES) approach. This approach is currently being explored within the Manawatu-Wanganui Regional Council, by a collaborative research group based out of Massey University, but its findings and approach may be of interest.
- *Implications from an economic development perspective*. It is clear from the analysis that the Southland economy is experiencing growth in sectors which are dependent on water. Over time the economy will become more concentrated and reliant on activities relying on the water resource. Further research is needed to fully understand the implications of the increasing concentration from an economic development perspective. Examples of the type questions that the research would need to address include, but aren't limited to: the long-term sustainability of the economy, identifying optimal activity (agriculture) levels (considering ecological-environment feedbacks and thresholds) and ways to mitigate the potential impacts of adverse environmental events, for example droughts. The additional economic development research will need to identify ways through which all costs (including environmental externalities) can be recovered while maximising the four well-beings.

4.3 A note on the Environment Southland resource consents database and compliance monitoring records

Regional Council resource consent databases and compliance monitoring records are constructed primarily for the purpose of fulfilling legislative requirements and are, thus, often overlooked in terms of their analytical value in contributing to strategic policy development. The resource databases and monitoring records do however contain valuable information on the quantity of direct use, discharge and residual loadings associated with economic activity. To facilitate future policy analysis and development (in an

Environment Southland context, and potentially in other Councils) several improvements to these databases could be made:

- *Coding of resource consents to the Australia New Zealand Standard Industrial Classification (ANZSIC) system*. The consent database provides only limited ability to categorise resource consents according to economic activity. In this study, this was achieved by referring to the database's type, sub-type, purpose, holder name and condition fields – a laborious and time consuming task. Directly linking resource consents with economic activity would enable the resource implications (use, extraction, discharge) of alternative economic development pathways for the region to be easily evaluated. Furthermore, it would facilitate the consideration of economic-environment trade-offs in policy development.

- *Establishing a direct linkage between the Resource Consents Database and Compliance Monitoring Records.* Significant work was required to link resource consent with their corresponding compliance monitoring records. Specifically, this required extracting, when available, the resource consent number from 'First Synonym' and 'Second Synonym' monitoring fields, or alternative, searching for consent numbers based on the 'File Number' field within the consent database. Once again, this laborious task inhibits the use of monitoring data in the assessment of economy-environment trade-offs of alternative economic development pathways. It is recommended that the Regional Council directly record consent numbers with compliance monitoring records by site.

- *Compliance monitoring volumetric flows*. The bulk of the compliance monitoring data provided by Environment Southland (>15,000 records) could not be used within our assessment. While concentrations of residuals were recorded upstream and downstream of monitoring sites, flow readings (discharges) were not typically taken. This prohibited the estimation of nutrient and sediment loadings. While it is acknowledged that recording of flow data is not generally required for compliance monitoring purposes, and that monitoring is undertaken irregularly (typically annually as a consent condition or as a result of a breach), information on larger scale discharges is invaluable for the calibration of catchment models. Implementing measures to address this issue will require a rethink of the rationale for monitoring. According to Environment Southland the present focus is on monitoring direct effects. The approach suggested may be helpful in terms of managing cumulative effects, at least at the policy level. It is worth noting that for several larger point source industrial discharges, with dairy and meat processing along with municipal wastewater flow, data was available.

- *Accuracy of data.* For the most part the resource consent database, telemetered and compliance monitoring data was of a high quality. Nevertheless, several instances of erroneous recording were identified. While is difficult to eliminate all data errors, further work on data handling and recording protocols could greatly improve the usefulness of the underlying data.

PART 2: REGIONAL WATER ISSUES

This part presents Nimmo-Bell's work

The Ministry for the Environment is undertaking an economic study of Southland's water quality and quantity issues. The objective is to enable more accurate forecasting of the impacts of different policy scenarios on quality and quantity limits for freshwater. This work will also help inform Environment Southland and other regional councils about the potential economic impact of policy choices within regional plans.

As part of this economic study, Nimmo-Bell has been asked to help the Ministry prepare a report assessing Southland regional water issues which includes:

- An overview of the significant water quality and quantity issues that currently exist and may possibly exist in the future.
- A summation of the evidence that already exists on water quality and quantity issues
- The geographic scope and potential economic and environmental impacts of currently identified issues (now detailed in the Market Economics section on Economic Impacts).

This Ministry for the Environment study is a separate exercise to Environment Southland's work on addressing water quality issues however Environment Southland has assisted with the study.

Information for the study has been obtained from Environment Southland and the Ministry for the Environment. A survey of key stakeholder representatives (undertaken over 11-15 February 2013) is used to engage with the community on issues of concern around water quantity and quality in Southland. Based on these sources and Nimmo-Bell's own experience key points are made around existing knowledge and gaps in knowledge that other parts of the study may be able to address.

The report is set out in three sections. The first section reviews the evidence of water quantity and quality trends in the region. This followed by a brief review of values, issues and concerns expressed in the region over water quantity and quality. The third section reports on a limited sample survey of stakeholder representatives aimed at providing a broad assessment of their current and future concerns, Environment Southland's response to these concerns, and the values people hold and their preferences on the balance of wellbeing related to water in the region.

5 Water Quantity & Quality Change

5.1 Water availability and use

The total volume of water available for use is relatively well known, but because of poor reporting or gaps in reporting, plus data management issues actual use data has not been very reliable (although improving in recent years). This means it is not possible to accurately determine whether the observed changes in the environment reflect natural variability or result from changes in water used. Regulations to improve reporting (National Environmental Standards – Measurement and Reporting of Water Takes Regulations 2010) mean that by 2016 it will be compulsory for any water permit larger than 5 L per second to be recorded and supplied electronically to councils.

Cultural use of freshwater including customary, recreational and commercial cultural values are defined in Southland Water 2010 as that used by Maori. Non-Maori cultural use is not considered under culture. Cultural use is mainly site-specific and the majority of Mahinga Kai (food from water) gathering occurs in the lowland waters of the region. These are the waters that are most at risk from increases in faecal contamination, nutrients and sedimentation.

If the Waiau River was in its natural state, availability from this source would dwarf all other sources in the region. As it is Waiau flows are only 3-4% of that before the Manapouri Power Scheme supplying power to the Tiwai Point aluminium smelter was commissioned in 1976. Flows were initially reduced from 400 cumecs down to 1 cumec, but 21 years later restored to 12-16 cumecs to bring the river back to life. Summer recreational flows of 35-40 cumecs for jet boating are made when water is available. This means that the availability of water for agriculture and other productive uses is limited.

The total volume of water allocated by resource consents in 2009/10 was approximately 65.7 million m^3. Just over half of this was allocated for use from the region's groundwater resources.

Of the 43.3 million m^3 of water allocated in the high demand aquifers, recorded water use in 2009/10 totalled 11.96 million m^3 or 28% of the total allocation. The remaining 72% was considered to be either unused (54%) or unknown (18%).

In 2009/10 74% of consented water takes from surface and groundwater was for dairy shed supply with irrigation 11%, industry 5%, community supplies 4%, mining 2% and other 4%. The majority of water allocated in the region is sourced from the Mataura catchment at 50%, with a further 30% sourced from the Oreti catchment.

Between 2000/01 and 2009/10 groundwater allocation has more than trebled, while surface water allocation has remained relatively stable.

Discharges, which are the release of contaminated water to the environment, include point source and non-point source discharges. At mid-2010 the majority of discharge consents in Southland were to land (88%) (Environment Southland, 2011). There were 128 consented discharges to freshwater and 13 to estuaries. Total discharges have increased by 46% over the 10 years to 2009/10.

Comment: Defined limits for nutrient discharges have not yet been established at the regional, catchment or farm levels. Once limits have been estimated this will allow those farmers who are uncertain about what will be required of them to better assess their management systems and to make the changes to management necessary to achieve targeted reductions in run-off and leaching.

5.2 Groundwater availability

Environment Southland has estimated that the groundwater volume in the Southland region exceeds 35,800 million m^3 and each year approximately 6,300 m^3 of rainfall recharges the system. At the same time approximately 78.8 million m^3 of groundwater per year has been consented for abstraction. The peak daily consented groundwater allocation has increased from 18,000 to 472,000 m^3 per day over the last 15 years. Most of this has taken place in the Mataura and Oreti catchments. A survey in 2009/10 indicates that water usage was 28% of the total consented groundwater allocation with dairy making up 56% of the available allocation (Wilson 2011).

On an average annual basis over 50% of the groundwater allocation is recorded as not used by consent holders. Underutilisation appears to occur for a range of reasons including pumping restrictions during times of low flow, equipment or on-farm issues such as pump failure and under-reporting. In addition, consent holders typically applied for the amount of water they need to get them through dry spells and critical periods, which only occur infrequently.

Analysis of monthly groundwater level data with at least five years of records found that 31% of sites had statistically significant decreasing trends, 5% had an increasing trend, and 63% showed no trend (of a total of 94 sites). The majority of sites with decreasing trends are located in the Mataura and Oreti catchments. 90% of sites in confined aquifers showed decreasing trends. Because Southland has experienced drier than normal climate during the last 10 years coupled with increased growth in groundwater allocation and water use there is doubt whether the decrease in groundwater level trends are indicative of potential on-going decline as opposed to increasing groundwater level variability.

It appears that the North Range Aquifer is the only system that has an environmentally significant decline in aquifer storage. This implies that aquifer discharge exceeds recharge. Despite being only 33% of the total available allocation water use appears to exceed the aquifer's sustainable limit.

The potential significance of gradual long-term changes in aquifer storage was not able to be assessed due to the short duration of the monitoring data.

Springs which are surface barometers of the state of aquifer storage show that only one of 22 sites located on seven of Southland's major spring-feed streams had a statistically significant decreasing trend. However this particular spring was not in hydraulic connection to the underlying aquifer and therefore does not represent a decline in groundwater levels.

Because of the uncertainties Environment Southland has adopted an adaptive management framework and this has created some further uncertainties around availability. In the view of Council staff, availability is rarely limited by long-term availability issues because of reliable recharge events and relatively short residence times of aquifers and reliability is mostly limited by hydraulic connection to surface water or naturally limited by low yields.

Comment: The overall conclusion is that the evidence of declines in groundwater availability is strong enough to keep this on a regular monitoring watch.

5.3 Scale of the water quality problem

As of 2012 there are 93,000 people in Southland. On the basis that they each produce raw effluent containing 4 kg N and 0.89 kg P per year this means the population produces 372 tonnes of nitrogen and 83 tonnes of phosphorus per year (Moran, personal communication). This must be processed through one of the 12,000 septic tanks or through community sewerage schemes.

On the other hand there are an estimated 615,000 dairy cows, 174,000 beef cattle, 4.1 million sheep and 244,000 deer in the region. Combined, these animals produce 128,091 t of N and 31,108 t of P (ES 2013h). As this is deposited straight onto the ground (pasture, yards, races and irrigated from effluent ponds) there is a heavy reliance on nature through sunlight to kill any pathogens, and recycle the nutrients to produce more grass. It should be noted at this point that urine patches are nitrogen hotspots where the greatest leaching occurs regardless of the system. This is particularly significant during cold wet periods when the pasture is not growing.

Comment: As land-use intensifies the ability of the natural system to do its job becomes more and more challenged. There are clear indications that this point has been reached in certain intensive farming systems in Southland.

Also the direct activities of the human population contribute to the problem through industrial discharges, stormwater events, urban runoff and failures of septic tanks and sewerage schemes. To date there is no definitive or estimated quantification of attribution among the various sources of the water quality problem.

There are clear signs that natural and manufactured systems (waste water treatment) for water quality as currently managed are being challenged and action is needed to ensure the decline in key environmental outcomes is reversed and over time made to improve.

In the next section the evidence relating to the current status and trends in water quality and quantity are set out with the objective of identifying key issues and gaps that need to be addressed in the modelling of future scenarios of different policy settings.

5.4 Surface water quality

State of Environment monitoring over extended periods shows that the majority of sites have no trend in the key indicators of water quality (see Table 1). Phosphorus, faecal coliforms and black disc readings (for water clarity) all show a greater number of sites with improving conditions compared with deteriorating conditions. This is not so for nitrates however with major deterioration in nitrogen for 47% of sites along with 24% of sites showing a deterioration in ammonia.

Table 5.1, which highlights the deteriorating situation with nitrogen, does not really indicate the magnitude of water quality problem where phosphorus is considered by Environment Southland as an emerging fundamental issue in lowland regions where intensive agriculture occurs on wetland soils.

Table 5.1: Water quality trends in Southland over 5-10 years (to June 2010)					
Percent of sites	Nitrogen	Phosphorous	Faecal coliforms	Black disc	Unionised ammonia
Deteriorating	47	7	1	4	24
Improving	**6**	**25**	**11**	**10**	**10**
No Trend	47	68	88	86	66
Source: adapted from ES 2013b					

Also the summary information in Table 5.1 covers up significant issues around pathogens. Out of the 71 State of Environment (SOE) sites monitored for faecal coliforms 11 showed meaningful improvement, 36 showed no trend in only two showed a meaningful deterioration (see Table 5.2). Both the sites with a meaningful deterioration had median readings well below breaching the stock water guideline, however 5 sites exceeded the stock water guideline on a median basis (all were in the no trend category). Of particular significance is that only 4 sites had maximum readings below the stock water guideline (1 Hill, 1 Mataura 3, 1 Mountain Lake and 1 Natural state). In other words, 94% of sites had maximum readings for faecal coliforms that exceeded the stock water guideline.

Table 5.2: Monitoring trends of faecal coliforms on 71 SOE sites		
Zone	**No. of sites**	**Trend**
Hill	10	5 meaningful improvement 5 no trend
Lake fed	3	No trend
Lowland hard bed	18	2 meaningful improvement, 16 no trend
Lowland soft bed	13	13 no trend
Mataura 2	1	meaningful improvement
Mataura 3	22	3 meaningful improvement, 11 no trend, 1 meaningful deterioration, 7 N/a
Mountain lake	1	No trend
Natural state	2	1 no trend, 1 meaningful deterioration
Spring fed	1	No trend
Source: Adapted from Environment Southland 2011c		

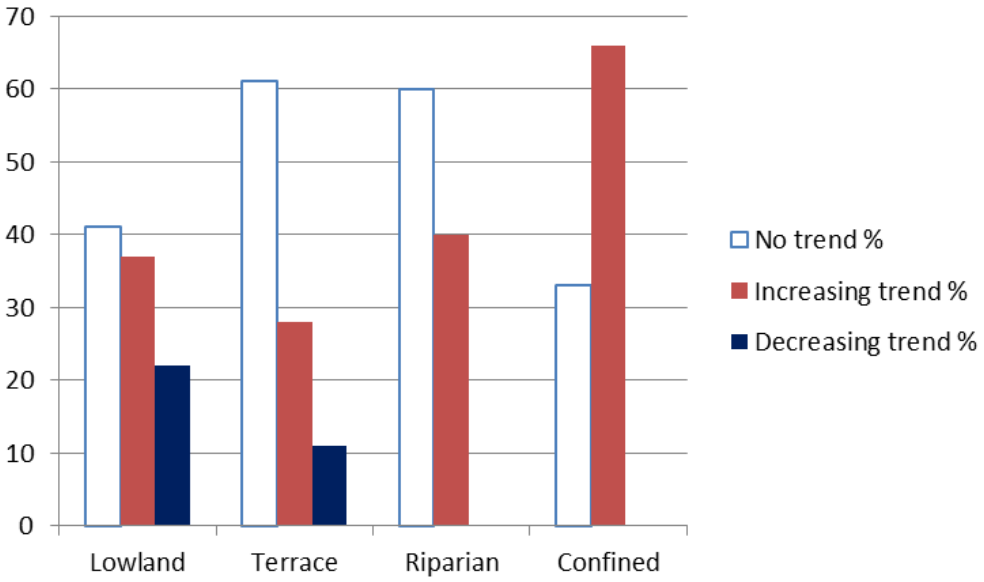
5.5 Groundwater quality

Groundwater is a valuable resource for the region and has significant influence on aquatics systems and riverine and wetland habitats. Significant use is made for domestic, municipal, industrial and farm water supplies, particularly the shallow aquifers whose water quality is most affected by overlying land use. In addition, the assimilative capacity of groundwater systems plays an important role in the treatment and disposal of point and non-point source contaminant discharges.

Groundwater quality in the region is influenced by a range of factors including geology, the nature and source of aquifer recharge and the overall rate of groundwater circulation within an aquifer system.

Human influence on groundwater quality shows up as elevated nitrate concentrations found on the more intensively farmed parts of the region. Trends show significantly more sites have increases in major ion concentrations than show decreasing concentrations (see Table 5.1). This is interpreted as the result of accelerating pastoral land use intensification (see Figure 5.1 for nitrogen). The contrary situation of a greater number of surface water sites with water clarity improving (black disc readings) is not able to be explained as yet.

Figure 5.1: Trends in groundwater nitrogen by aquifer type (% of sites)



* Note: the trend for confined aquifers should be interpreted with caution due to the small sample size (3 only)
Source: Adapted from Liquid Earth 2010, Table 2, p50.

While overall groundwater quality is suitable for potable supply, Environment Southland considers it is not suitable for healthy ecosystem functioning. The main issue is the high incidence of microbial contamination which can have immediate and acute impacts on human health. In the majority of incidents these are localised issues that can be significantly reduced by better well head protection and ensuring bores are located away from contaminated sources. Also, relatively low cost treatment devices can ensure contamination does not affect potable water supplies.

There are naturally elevated manganese and iron concentrations in many aquifer systems in Southland, particularly around the Gore lignite aquifers in Eastern Southland. These have significant negative aesthetic effects and typically make water unpalatable before concentrations exceed health standards.

Nitrate concentrations exceed standards in 7 percent of bores sampled. These bores are in known 'hot spots' subject to localised contamination, but have effects that are not localised with some being very extensive with at least 3 of four bores showing elevated NO_3. That NO_3 values are high in these aquifers reflect the lower transmissivity and lack of flushing of these aquifers. Those areas with intensive land use with low nitrate concentrations are not necessarily receiving less nitrate it is just that they have a higher degree of flushing (dilution) by riverine recharge.

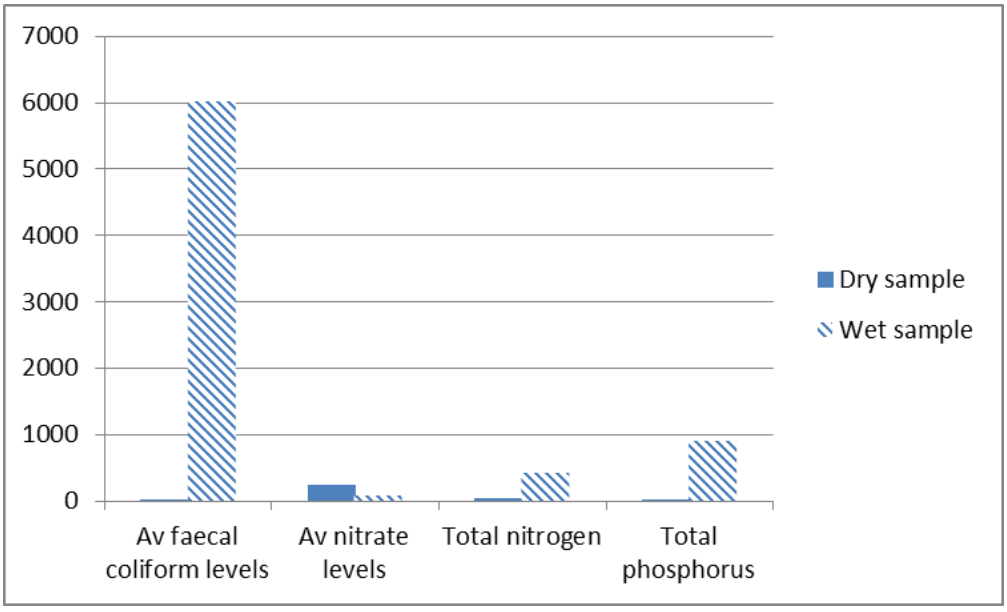
5.6 Hot spot – Waihopai catchment septic tanks

Evidence of declining water quality has shown up most clearly at the bottom end of intensively farmed lowland zones.

Data from the State of the Environment monitoring site at Queens Drive which is at the lower end of the Waihopai catchment bordering the outskirts of Invercargill shows that nutrient levels, sediment and faecal bacteria in the water were high, and tended to increase above water quality guidelines after rainfall. Over the period 1995 – 2005 faecal coliforms exceeded the guideline/standard in 28% of samples, total nitrogen 100% and total phosphorus 80%. In addition, a recent study of contaminant levels found that concentrations of nickel and zinc were greater than the low trigger values (indicating concern) for the lower reaches of the Waihopai.

A study in 2005/06 instigated to identify which the sub catchments were contributing to poor water quality in the Waihopai was undertaken at Spurhead Creek. After rainfall events it found extremely high levels of faecal coliforms, and elevated levels of nitrates, phosphorus and suspended sediments compared with readings taken during dry periods (see Figure 5.2).

Figure 5.2: Spurhead Creek - example of septic tank failure (% above acceptable guideline)



Source: Adapted from ES 2013i Figures 1-4

August 2009 samples were tested at the boundaries of properties and E. coli registered 6,900, well above the 1000 level for stock drinking. Sample testing for faecal source confirmed human sewerage was the issue. Land owners were advised to have their septic tanks cleaned in November 2009 and by December 2009 the two tanks of concern had been cleaned. Tests in late 2010 and 2011 suggested that water quality in the creek had returned to normal levels with E. coli of 50 – 60 recorded. There is no sign of on-going contamination from septic tanks in this area.

A possible solution to leaking septic tanks is to switch to a community sewerage scheme. This can be an expensive proposition with the proposed extension of the foul-sewer into Kennington costing in the range of $15,000-$18,500 plus GST per household (Hoffmann 2012). However, an extension could be considered

to be “cheap” compared to the cost of installing a scheme from scratch for small communities, which according to Environment Southland is typically impractical.

(The above is based on information from Environment Southland (2013i) and personal communication with Pat Hoffmann 2013).

5.7 Water quality in Lakes and lagoons

Regular water quality monitoring occurs in three key water bodies: Lake Te Anau, Lake Manapouri and Waituna lagoon.

Both Lake Te Anau and Manapouri have very clean water and their water quality is in the top 10% of lakes monitored in New Zealand. Trends in water quality for both Lake Te Anau and Lake Manapouri show declining levels, but many of the usual quality variables monitored are below detection levels reflecting the relatively small human population and small number of farms adjacent to the lakes and rivers feeding in to them. Waituna lagoon has high nutrient levels and is classified as eutrophic. Water clarity is in breach of the water plan standard, but Chlorophyll *a* concentrations are relatively low compared to the nutrient concentrations, suggesting that some other unknown factor apart from nutrient levels is limiting algal growth in the lagoon.

Water quality spot sampling in other small coastal lakes indicates that these are in a eutrophic to super trophic condition, with high concentrations of nutrients. All water quality variables in the Waituna lagoon respond to whether it was open or closed. Opening the lagoon to the sea improves water quality.

There is a deteriorating trend in Waituna lagoon and because it is probably P limited this needs to be carefully monitored. Concentrations of nitrate during winter have increased in some sites independent of the ‘open and close’ regime. Summer nitrate concentrations are still often low, probably due to plant and algae utilisation.

There are also concerns that Waituna lagoon may shift from a macrophyte-dominated clear water state to a de-vegetated, turbid water state. This would have serious implications for the native aquatic plants (macrophytes) that dominate the lake. This process will also cause sediment re-suspension from the bottom increasing the load of phosphorus and nitrogen in the water column, potentially favouring phytoplankton growth over macrophytes. The likelihood of Waituna lagoon changing in this way increases if phosphorus concentrations continue to increase, the percentage of pasture in the catchment increases, increased intensity of land use, or loss of native plant cover in the lagoon due to increased salinity or reduced light from increased turbidity.

Comment: Farming is likely to continue to intensify and concerted action on a catchment wide scale is yet to be undertaken voluntarily. This means a high likelihood of continued deterioration in water quality in the short to medium term particularly because of the lags in groundwater and for the time it takes mitigation measures to show results. The recent work to highlight the problems at Waituna and engage the local community in working towards solutions will help, particularly in the long term.

(Based on Hamill 2011)

5.8 Fresh water fish

A survey of freshwater fish conditions in 1,135 sites over the period from 1970 to 2010 showed that Southland pastoral sites are significantly better as a habitat for fish using the Index of Biotic Integrity (IBI) than indigenous forest sites. This is the reverse of that found in all other regions in New Zealand where this comparison has been made. Over time the pastoral and tussock sites showed a significant decrease while indigenous forest sites showed no change. When compared with the national average, Southland pastoral and tussock sites were significantly better than the national average. The other classes had similar values to the national averages. These results are meaningful for three of the nine River Environment Classification classes in Southland due to the limited number of sites that were able to be sampled. (Based on Joy 2013)

Comment: Given Southland's unusual situation for fish on pastoral sites there is a clear need to understand why this is occurring as it may have implications for other sites around New Zealand.

5.9 Natural hazards related to water

At different times of the year Southland is threatened by natural hazards involving both too much water, i.e. floods, heavy snow, rainfall and hail, and by events resulting from too little water, i.e. drought. In terms of economic impact drought is regarded as the most serious with Northern Southland most prone to drought conditions in summer and autumn.

Traditionally, Maori view natural hazards as natural processes. In their world view, everything is connected and if the environment is mis-managed events such as severe floods or droughts are a natural consequence of actions.

Much of developed Southland is exposed to risk from flooding and hail. The Mataura and Waimea Valleys and Lumsden are more prone to these events than other areas. Southland is more exposed to risk from rain based flooding in summer and winter, and hail damage is more common in late spring and summer than in winter.

Climate change projections suggest Southland will experience increased likelihood of natural hazards such as flooding and drought. Long term change will be superimposed on natural variations in weather with the potential for increased climatic extremes.

Comment: New Zealand is a young country geologically and landforms can be expected to change over time including redirection of streams and rivers due to natural forces. The increasing removal of tussock and replacement with exotic pasture species is expected to increase run-off with downstream consequences not only for farmland, but also towns and cities as the majority are located close to waterways.

(Based on ES 2011d)

5.10 Mataura catchment: water quality and quantity issues

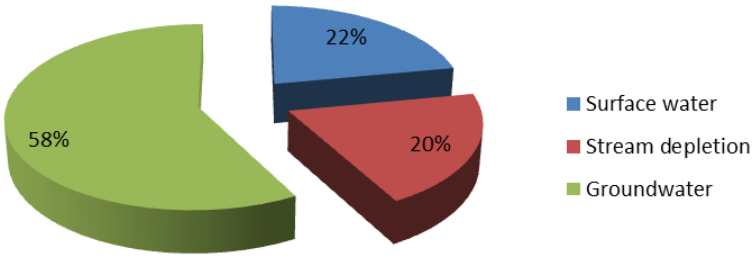
The Mataura catchment extends over 5,400 km² and experiences climatic conditions ranging from marine dominated near the south-east coast to sub alpine in the upper catchment. The median discharge is approximately 70 m³ per second in the lower reaches. Highest discharge typically occurs in spring and lowest flows during late summer. There is also a significant groundwater resource in association with the river and extensive interaction occurs between the river and its aquifers. Base flow groundwater discharge

to the river helps maintain river flows during periods of low rainfall and exerts a significant influence on surface water quality (particularly in terms of nutrients) during periods of low flow.

The Water Conservation (Mataura River) Order 1977 (MCO) established the "nationally outstanding" character of the fisheries and angling amenity of portions of the river. It provides a basic framework for management of water quality and quantity in the catchment in conjunction with the Regional Water Plan (RWP). Under the MCO provisions the Mataura River is considered to be fully allocated at flows below the mean annual low flow. This means that further allocation of water is only available at moderate to high river flows. Analysis of storage options suggests that water storage will only be economically viable when established on a very low unit cost basis (i.e. most likely on a per farm basis) or where water provides a sufficiently positive net benefit (e.g. under sustained high agricultural commodity prices or higher value alternative uses).

Recent years have seen significant increases in water allocated in the catchment primarily for the irrigation of pasture. Total allocation has increased from 100,000 m^3 per day in 2000 to around 300,000 m^3 per day in late 2010, almost exclusively from groundwater which comprises 85% of the allocation. It should be noted however that when the effects of groundwater extraction on surface water are taken into account 42% of the total allocation is attributed to surface water (see Figure 5.3).

Figure 5.3: Water allocation 2010 Matura catchment

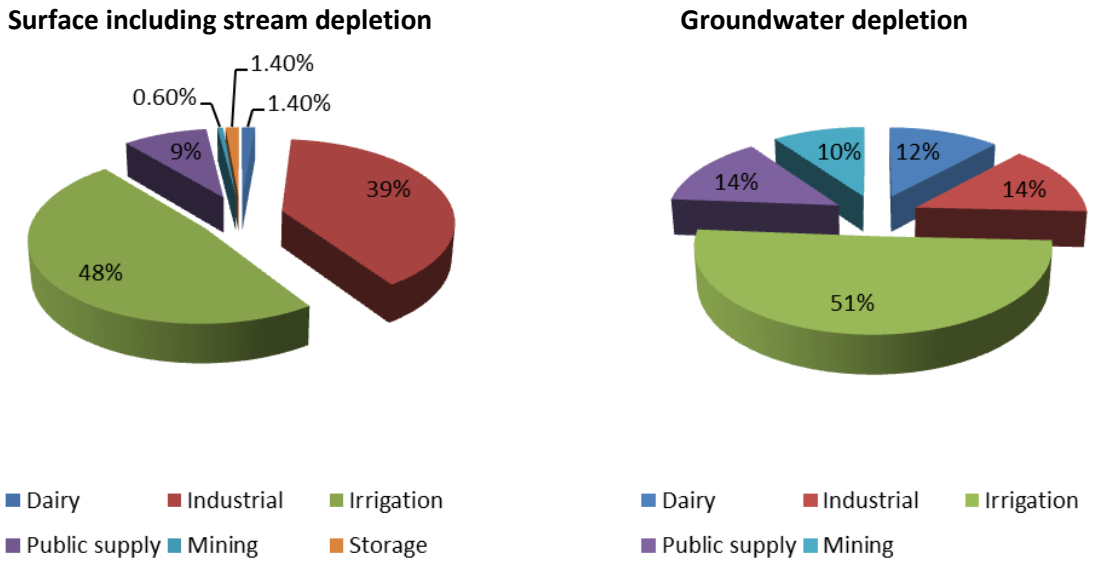


Source: adapted from Liquid Earth *et al* 2011, p24.

The increase in allocation is associated with increases in farming intensity and the conversion of dry stock farming to dairy. Irrigated pasture has grown from approximately 200 ha to 5,400 ha over the decade to 2010. Water taken for pasture irrigation comprises around 50% of both surface water and groundwater allocations (see Figure 5.4).

Actual water use is significantly lower than allocated rates and volumes. Typical use is in the range of 30 to 50% of seasonal allocation. Daily take, which is proportionally higher than seasonal take, is also significantly less than that allocated.

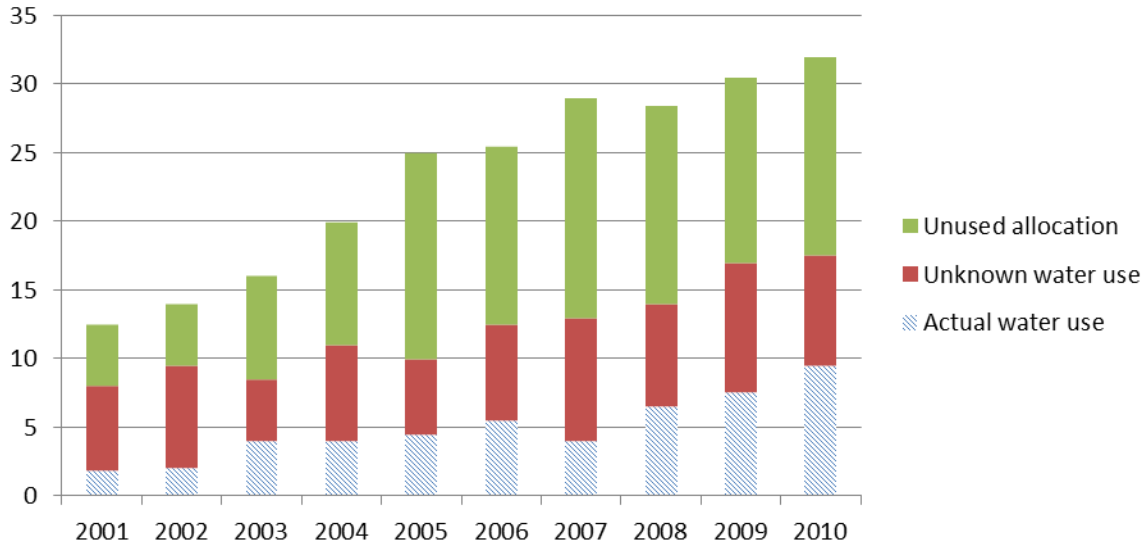
Figure 5.4: Seasonal water allocation 2010 by use Mataura catchment



Source: Adapted from Liquid Earth *et al* 2011, pp 30 and 31.

Over the decade to 2009/10 recorded actual groundwater use increased from 1.8 million m³ per year in 2000/01 to 9.5 million m³ per year in 2009/10 (see Figure 5.5). The average use was 22% of the seasonal allocation of those consents where water use was recorded. Actual water use peaked at around 30% of seasonal allocation in 2009/10. Over the decade unknown water use ranged from 25 to 60% of total allocation. Unknown use refers to consents for which no usage records were supplied to Environment Southland and comprises a proportion of actual use and unused allocation.

Figure 5.5: Groundwater use in the Matura catchment 2000/01 – 2009/10 (million m^3/year)



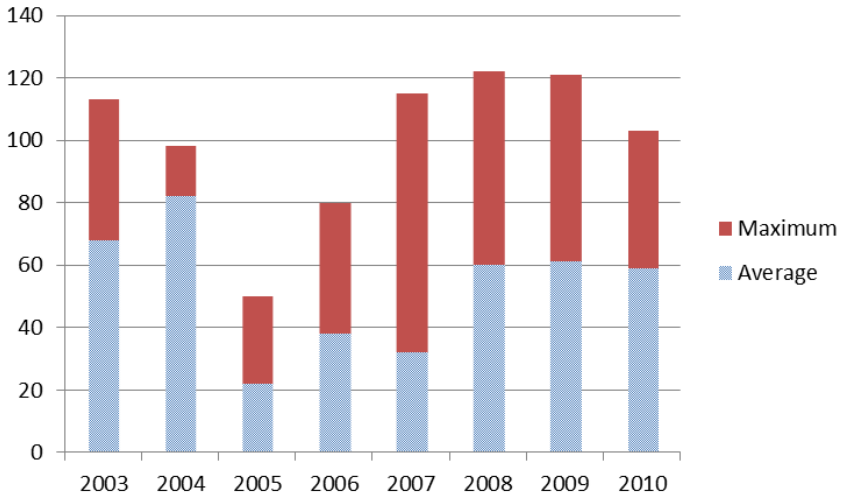
Source: Liquid Earth *et al* 2011, Figure 21, p32.

Irrigation for high value enterprises including dairy, cropping and horticulture is likely to be the primary driver of future water demand in the catchment. Based on estimates of future irrigation, industrial and municipal demand growth, potential supply shortfalls in 2030 are estimated to range between 400,000 and 800,000 m³ per day. Future possible lignite mining would also have a significant but unknown water

demand, although in the short to medium terms this now seems remote given the problems faced by Solid Energy.

Natural climate variability, particularly rainfall, has a significant influence on water demand and availability of water in the catchment. Over the last decade the average number of days irrigated for resource consents in the Mataura catchment varied from a low of 22 days in 2005 to a high of 82 days in 2004. Maximum days irrigated also varied greatly ranging from 50 days in 2005 to 122 days in 2008 (see Figure 5.6).

Figure 5.6 Days irrigated for resource consents Mataura catchment (June year ending)



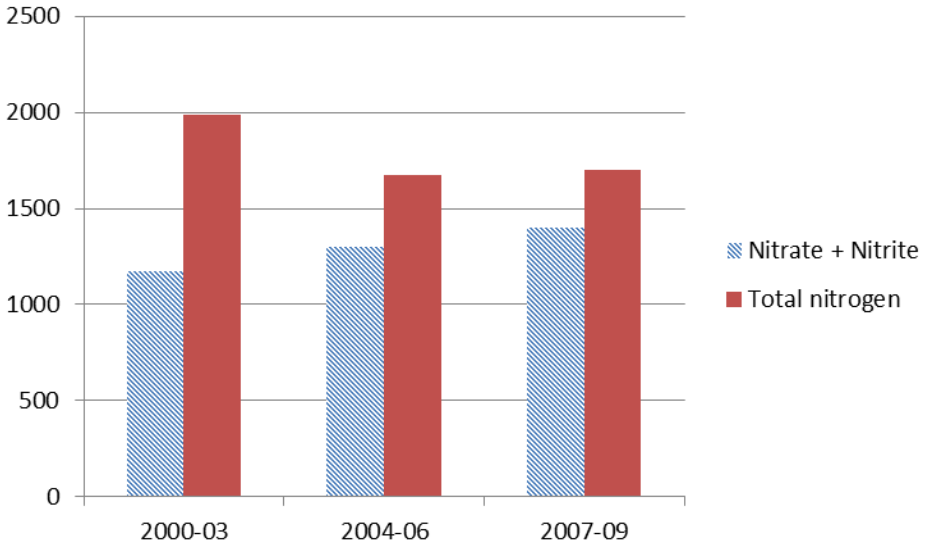
Source: Adapted from Liquid Earth *et al* 2011, Figure 24, p35.

Climate records suggest a cool phase since 2000 with a corresponding increase in the frequency of dry summer conditions compared to the two preceding decades. However conditions since 2000, while relatively dry, remain appreciably wetter than that experienced in the early 1950s to late 1970s. Based on climate change modelling, long term changes in water demand and availability resulting from climate change are likely to be significantly less than natural annual variability.

Changes to the quality and quantity of water available for abstraction in the catchment arise from changes in the river flow and nutrient loadings. There are potentially some changes in biodiversity, landscape and aesthetic values with land use changes, but because most of the impact will be from intensification of existing systems such impacts are likely to be minimal (Liquid Earth 2011, P2).

Given the changes in land use and intensification with conversions of dry land to dairy an expected outcome would be an increase in nitrate loadings, but records on the changes in nitrogen loadings over the last decade at Gore do not appear to support this. Total nitrogen has actually declined between 2000 and 2009 (see Figure 5.7), showing that groundwater quality change does not always appear to be correlated with changes in land use. Given this outcome, it is likely that the impact of future land-use change and intensification may be similarly difficult to estimate. Clearly, further work is needed in this area, including research on time-lags between the leaching of nitrogen to groundwater and its subsequent arrival into sensitive waterways .

Figure 5.7: Changes in Nitrogen loadings over the last decade at Gore



Source: Liquid Earth *et al* 2011, Figure 69, p94.

Despite the evidence, the increases in land intensification are likely to lead to increases in groundwater nitrate concentrations (Liquid Earth 2011, p93). The adoption of mitigation measures such as stock exclusion from streams, herd shelters, improved dairy farm effluent management and constructed wetlands may in fact lead to a decrease in surface water nutrient concentrations despite an overall intensification in land use (Liquid Earth 2011, p94).

Comment: Uncertainty surrounding the impact on water quality of land use intensification under different mitigation measures may be a significant reason for the lower than desired uptake of such measures. There is a public good argument for incentives to increase adoption of mitigation measures as, while the direct costs will be met largely by farmers, the indirect costs will end up being met by the community at large.

5.11 Summary of Evidence on Causes of water quality issues

5.11.1 Agriculture

In recent years dairying in Southland has grown rapidly and there are now over 800 dairy farms in the region covering 155,436 ha. A key issue is the application to land of milking shed effluent particularly using the older style of travelling irrigators where there are mole drains. Field studies and modelling assessments of farms in the Bog Burn catchment suggest that the irrigation of farm dairy effluent to pastures may account for about two thirds of the faecal contamination generated on-farm. The winter grazing of forage crops is also identified as having a relatively large nitrogen loss on a per hectare basis. Stock access to waterways can also cause erosion of stream banks resulting in sediment accumulating on stream beds, as well is discharging animal waste directly to water. While stock are in water the concentrations of indicator microbes temporarily can rise to 100 times normal levels and reach levels at least 50 times greater than the

guidelines for contact recreation. If deer have access to water, they form mud baths (wallows). Studies show that very high levels of faecal contamination result when the wallows are linked to waterways, including groundwater.

Intensive horticultural operations such as bulb production or vegetable growing also has the potential to leach large amounts of nitrogen, however there is limited scientific data available documenting losses from these operations.

(Based on Environment Southland, 2011c)

5.11.2 Human waste water

Community sewerage schemes treat most human waste water collected in Southland and Environment Southland says the schemes have improved over recent years. In addition there are approximately 12,000 septic tanks in the region, which are a significant but declining source of contamination issues. In 2012 23% of bores in the region were subject to faecal contamination down from 55% in 2003. Problems such as wastewater ponding, run-off to surface water, or groundwater contamination from the failure of septic tanks, results in lakes, rivers, estuaries and beaches becoming unfit for swimming, food gathering and marine farming. Poor protection of bores and wells from waste water is the cause of most of contaminated groundwater.

5.11.3 Stormwater drains

Stormwater drains generally discharge directly into waterways without any filtering or treatment of the liquid contents. Ignorance and unintentional discharges of such pollutants as paint, waste oil, spilled petrol and detergents wash into waterways. Sediment can also be washed into stormwater when ground is cleared for construction.

Environment Southland has estimated that 60 – 70% of industrial sites in Southland do not have adequate stormwater controls permitting pollution is to wash directly into drains. But very few of the industrial sites are currently required to have a consent.

In recent times, i.e. since 2009, much more stringent policies have been put in place and stormwater is now being monitored as part of compliance of consents along with monitoring through investigations.

Both Gore District Council (GDC) and Invercargill City Council (ICC) have current consents.

In 2011 the ICC was granted 5 short term consents (5 year) to discharge stormwater to the Clifton Channel, Kingswell Creek, Otepuni stream, Waikiwi Stream and Waihopai River. One of the main reasons for these consents being granted was to ensure that the ICC generated data to determine the stormwater in Invercargill to assist with the granting of a longer term consent (due in 2016). Monitoring results are available and highlighted a number of issues in some of these catchments. Environment Southland is currently working with the ICC with their monitoring programme.

The GDC has 3 consents to discharge stormwater from: Gore township to Cronins Creek, the Mataura River Waikaia Stream and an unnamed stream; the Mataura Township to the Mataura River and Waimumu Stream; and the Pukerau township to the Pukerau Stream, and to discharge stormwater from the Waikaia township to an unnamed tributary of the Waikaka Stream. These consents were granted in 2010 and expire in 2035.

Southland District Council (SDC) has taken some time to provide the monitoring data necessary to progress its consent applications, but Environment Southland expects all the townships to be consented within six months.

The stormwater systems that discharge directly to the coastal marine area are permitted by the Coastal Plan, subject to a few conditions, so have not needed consents.

Other than basic sediment traps and oil interceptors, there is little treatment of the reticulated stormwater discharges with Invercargill and the other townships. Where a new subdivision is being built, improvements are built into the new stormwater networks.

Comment: Stormwater events cause spikes in pollution that rely on high water flows to flush the problem material out to sea. It is still not clear how much of a problem this to the lower ends of catchments or to the coastal waters.

5.11.4 Tile drains and mole – pipe drainage systems

Microbes are a particular a problem in tile and mole drains since low temperatures and lack of exposure to sun light or filtration means that they carry contaminants untreated into nearby creeks and streams. Tile drains are also important conduits for phosphorus and sediment flowing into some waterways.

Comment: The high use of tile and mole drains on dairy farms in Southland compared to other regions creates a unique set of problems for the region. In particular phosphorus and pathogens have a much more direct route to waterways than without such drains. This means increased pressure on sensitive waterways such as the Waituna Lagoon.

5.11.5 Landfills

Leachate from landfills which contain a variety of contaminants can cause severe health risks if it gets into waterways. The closure of a number of landfills and the opening of a central regional landfall has greatly reduced current and future environmental risks in Southland through improved leachate control and monitoring safeguards.

5.11.6 Farm dumps and offal pits

Many of the 3800 farms in Southland bury waste in farm dumps. Most farms continue to bury carcasses and offal. When sited near dwellings, bores, wells and surface waterways such sites can cause microbial contamination of water with associated health risks, there are rules to prevent this happening however.

5.12 Water quality mitigation

Environment Southland undertakes a range of activities to mitigate the effects of changes to the environment, which are summarised below. That said, efforts to improve water quality in Southland are a community effort involving many different individuals, groups and organisations. This section is informed by Environment Southland information (ES 2011c).

5.12.1 On-farm extension and advice

Land Sustainability Officers provide advice on soil capabilities, environmental farm plans, nutrient budgeting and land development. They provide individual advice, hold Field days and participate in Landcare groups. Southland is fortunate in having "Topoclimate" soil data which is a unique dataset having a much finer detail and scale to the Land Use Capability dataset (ES 2013j). Topoclimate can be used to assess the level of risk of converting land from drystock to dairy using the assessment guideline for the New Dairy Farming policy and rule.

A Soil Moisture Network identifies and classifies soil conditions so effluent application can be carried out when it is most likely to be absorbed by pasture and not flow into tile drains or waterways. The network includes 20 monitoring sites (ES 2013k).

A specialist Dairy Liaison Officer helps dairy farmers with resource consents, effluent systems and other aspects of environmental management.

The Living Streams program provides free on-farm advice and financial incentives for fencing and riparian planting in selected catchments. A 50% subsidy to fence off streams is provided under the Living Streams program.

5.12.2 Urban

Environment Southland introduced a Pollution Prevention Program in 2008 to provide advice and assistance on reducing pollution in industrial and urban areas. The program has also registered approximately 680 sites on an electronic database (Sites Associated with Hazardous Substances Register) which is used to manage information relating to properties that have been used for activities involving hazardous substances.

Walkways have been created along the Waihopai River, Kingswell Creek and the Invercargill estuary. A river-based recreation event the WaiTri has been held annually since 2004 with numbers of participants increasing from 167 in 2004 to 635 in 2010.

Communication and planning activities support improvements in water quality through dissemination of best practice guidance to the community.

A bathing beach response group monitors bathing water quality in freshwater marine areas and shellfish sites with the following trends:

- Out of 11 bathing sites monitored only one showed a meaningful deterioration, two showed meaningful improvement with the remainder showing no trend
- Out of 8 shellfish sites monitored only one was compliant with the guideline, four of sites showed a meaningful improvement and the remainder showed no trend.

The Regional Policy Statement has been reviewed; the Water Plan became operative in 2010; and a 'Water and Land 2020 and Beyond' project is underway to assess the effect of discharges to land from agricultural, industrial, human sewerage and various land use activities including the cumulative effects of intensive land use. Consideration is being given to extending non-regulatory methods to address land-use impacts on water quality to a more regulated approach.

Research on water quality issues includes work by Te Ao Marama Inc. into mahinga kai species in conjunction with the Cultural Health Index, and risks related to microbes from farm based activities.

Regulatory activities in the area of water quality include:

- a focus on dairy farm effluent discharge resource consent holders who are not performing well
- a tightening up of dairy effluent consents covering minimum storage requirements and fail safe measures
- a toll-free pollution Hotline for the public to report pollution incidents
- continued issuance of infringement and abatement notices to environmental offenders with prosecutions where necessary.

Education programs supported by Environment Southland include:

- Stream Connections a school curricula based program including field trips
- a partnership to support schools with the Royal Society of New Zealand's through its Environmental Monitoring and Action Project
- the "Bruce C Gull" mascot and Buddies club which has 2000 members aged 4 – 14
- Enviro-schools which encourages school to adopt and plant the banks of local waterways to help improve water quality had 17 participating schools in 2010.

5.12.3 Targeted action – Living Streams (ES 2012b, 2013d and 2013i)

The Living Streams program is one of Environment Southland's catchment-targeted programmes aiming to reduce point source and non-point source pollution. It is active in the Waihopai, Sandstone and Waituna catchments (and more recently in the Waikawa catchment too) and focusses on phosphorus, sediments and faecal coliforms, rather than nitrogen. Under the program scientists regularly collect water quality information within these selected catchments to monitor changes. Landowners are visited to provide free information and advice, and to help landowners implement sustainable land management practices. The program also provides financial assistance for voluntary activities that will enhance water quality.

Since the program began in 2005, over 70 km of riparian fencing have been completed, six failing septic tanks discharging directly into waterways of the Waihopai have been stopped, three Bridges, one culvert, two stock water schemes and one leaking silage pad have been upgraded. Survey data has been collected on riparian and in-stream features including fencing, erosion, sediment and habitat. Also a survey was undertaken across the entire Waihopai catchment to generate data on community members' interests, concerns, values and community commitment to taking action. It is intended to resurvey the community at the end of the project.

As an example of the work, activities undertaken on 21 properties of Spurhead Creek resulted in 19 water quality improvement proposals being prepared by Living Streams of which 13 were completed (62% of properties) and grants paid totalling $92,000 for an average of around $7000 per property where a plan has been implemented (note the average cost is currently more like $8,000). The full program runs to 2017 and will involve a total of 177 properties.

Lessons learned and key strengths of the program include:

- a clear focus on the issue (poor water quality in the Waihopai)
- a catchment focus
- engagement with landowners one-on-one and face-to-face
- development of site specific solutions
- cross divisional/multi-skilled advice
- generation of long-term water quality monitoring programs
- provision of financial incentives for good environmental practice
- community engagement and social learning.

To date analysis of water quality data from the Waihopai River does not show significant trends, however in time Environment Southland expects that data will demonstrate an improving trend.

Comment: Of concern must be that 38% of the properties have not completed the implementation of water quality improvement programmes as it will take only a small percentage of non-performers to undo all the good work of the majority.

5.12.4Information gaps

While water monitoring focuses on faecal bacteria little is known about the range of other potential pathogens such as viruses in the region's waterways due to the high costs for testing for these pathogens. Also little is known about the sources of faecal bacteria be they agricultural effluent, offal pits, human waste or feral animal and bird population based. Little is known about how safe it is to harvest and consume food from fresh and marine sources.

Actions taken to improve knowledge include more frequent monitoring and reporting on the state of the environment and a refinement of such reports to include desired outcomes and compliance standards, and more frequent monitoring of faecal contamination on high risks sites.

5.13 Compliance (Environment Southland 2012)

Environment Southland's environmental compliance monitoring report (2011-12) indicates there may have been improvements in compliance by the dairy industry over the past 12 months, but this cannot be confirmed as controls are not part of the monitoring. While the percentage of discharge permit inspections showing full compliance improved by over 60% and there was an even greater percentage improvement in full compliance with wintering pad inspections this does not mean that overall compliance has improved even with the number of non-compliant inspections dropping by 281, for the reason above. Improved performance is considered by Environment Southland to be the result of upgraded effluent systems , an increase in more complex and stringent consent condition requirements and an increase in support by industry stakeholders to individual farmers.

The pollution Hotline received 960 call is in the last year similar to the previous two years. In the last year 455 calls fell into the high priority category.

Compliance by industry has been generally good to excellent with individual instances of non-compliance dealt with expeditiously.

In contrast compliance by the territorial authorities has not reached the required level of compliance across the various sewerage treatment systems. Meeting the compliance standard will require significant capital expenditure on a number of the non-compliant sewerage treatment systems over the next few years. The aim is to have 100% compliance with all schemes.

The compliance action summary report shows that out of 959 incidents, 450 required no further action, 74 resulted in abatement notices, 154 payments were received from infringement notices, two sets of enforcement orders were issued, three search warrants executed, and eight prosecutions taken (Environment Southland 2012 p71). Seven of the prosecutions were for agricultural related incidents and the remaining one was for a fish processing plant. Of the agricultural prosecutions only two were for dairy effluent discharge.

Enforcement decisions are made with reference to a complex set of criteria including the severity of the adverse environmental effects, personal circumstances, history of offending, intent and foreseeability. For most instances of non-compliance there is a level of education and advice to both the alleged offender and the complainant.

Meeting the Water Plan target of 10% improvement in water quality in degraded areas by 2020 will require improved performance and commitment from the entire Southland community.

Comment: Based on the information from compliance monitoring there may have been considerable improvement in compliance in the agricultural sector. This needs to be confirmed so the agricultural sector and the public at large are informed over whether there is actual progress or not.

6 Values, Issues and Concerns

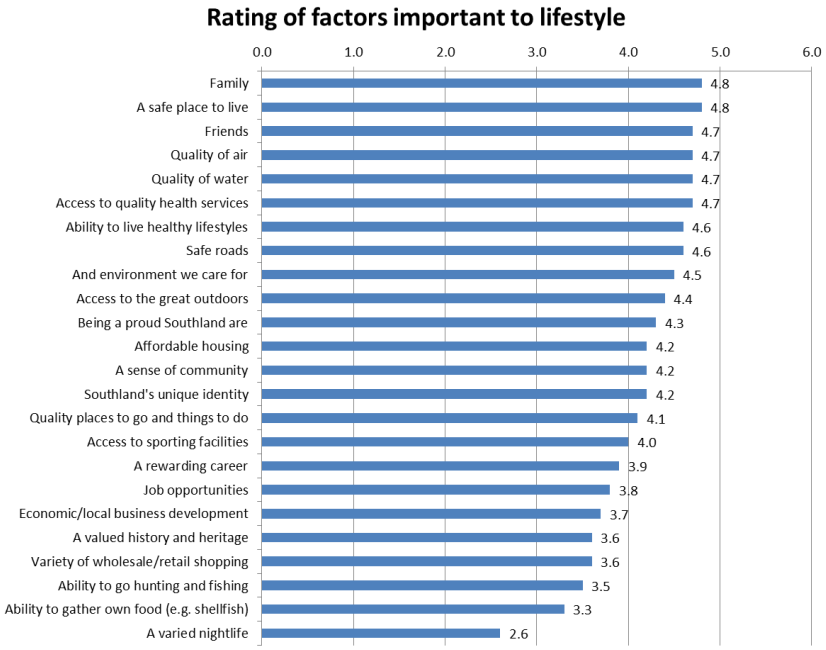
6.1 Importance to the community of different lifestyle factors

Our Way Southland, a regional community outcomes project supported by Southland's four Councils (including Environment Southland; Our Way Southland 2010), commissioned a Quality of Life report to deepen the understanding of residents' perceptions of social, economic and environmental conditions in Southland. This was a broad ranging survey of residents, and replicated the national 12 Cities Quality of Life project for the region. Data was collected during May 2010 using a computer assisted telephone interview design. A total of 1,522 completions were achieved. Respondents were generated based on a quota in line with Southland's population, based on age, gender and location. The resulting data set provided a maximum margin of error of +/-2.5%.

Among other things survey respondents were asked to rate a range of lifestyle factors on a scale of 1 to 5, where 1 = not at all important, 5 = very important. The mean scores of each factor were used to rate the level of perceived importance of each factor. Out of 24 factors, the leading factors (both averaging 4.8 out of 5) were "family" and "a safe place to live" (see Figure 6.1). The least important factor identified was "varied nightlife" with a score of 2.6. Three factors related specifically to water: "quality of water" rated fifth with a score of 4.7, "ability to go hunting and fishing" rated 22 with a score of 3.5 and "ability to gather own food (e.g. shellfish)" rated 23 with a score of 3.3.

Comment: Hunting and fishing rates relatively lowly on a community wide rating of the factors important to lifestyle. Despite this angling always rates highly at workshops and with steering groups, perhaps this is a function of the lobbying power of this interest group.

Figure 6.1: Rating of factors important to lifestyle



Source: Our Way Southland 2010, p62

6.2 Trends in environmental monitoring

A whole of community and whole of regional approach to monitoring the sustainable economic, social, environmental and cultural well-being of the community (Our Way Southland 2012c) summarised trends from annual surveys over the period 2009 - 2012. It highlighted the following in regard to water issues:

- There has been an increase in the number of school and school initiatives relating to the regional Enviro-Schools program
- While there are continuing breaches of regional and national standards for bathing and drinking water, monitoring undertaken by Environment Southland indicates that more of the region's groundwater resources are now free of E. coli compared to a decade ago
- The majority of Southland residents are generally satisfied with the overall condition of the physical environment in the region. Their main specific concerns are dairy effluent run-off to rivers, water quality, waterway pollution, air pollution and rubbish disposal.

6.3 Comparing residents' opinion on environmental issues – 2012 with 2011

Among other things, Environment Southland commissioned a survey to measure residents' awareness and understanding of Environment Southland; and their perceptions of key environmental issues and water quality in the region. Interviews were carried out by the computer assisted telephone method with a final sample size of 600. Findings of the survey were compared with the 2011 residents' Opinions Survey.

On awareness, understanding and performance of Environment Southland the majority (75%) of residents were aware (unprompted) of Environment Southland and its responsibility to manage Southland's natural resources. When prompted 97% of residents are aware of Environment Southland, down from 100% in 2011. Unprompted awareness was highest among older residents and lowest among younger residents.

Environment Southland is mostly associated with water quality monitoring, which achieves the highest recall, both unprompted (59%) and prompted (92%). Pollution prevention is the second activity most associated with Environment Southland at 25% (unprompted) and 88% prompted.

Agreement that Environment Southland effectively manages environmental issues increased slightly to 60% from 57% in 2011.

In regard to the main environmental issues and water quality in the region, unprompted respondents stated that dairy farming and its impact on the waterways and land is the main environmental issue (45%), a significant reduction from 2011 (51%). Water quality was the main issue with 27% of respondents, which was slightly down from 2011 at 29%.

When specifically asked about concerns for water quality 80% agreed the key issue is changes in land use in 2012 up from 73% in 2011. In both years dairy intensification/effluent/fertilisers are given as the main impacts on water quality, but significantly down at 63% in 2012 from 76% in 2011.

The majority of residents (81%) personally care a lot about water quality and a further 15% state that they care a little, leaving only 4% who say they don't care about this issue. Overall the proportion of residents who care about water quality did not change from 2011 at 96%, but a higher proportion said that they cared a lot at 81% compared with 75% in 2011.

Fewer residents in 2012 (39%) have seen something of concern in the last 12 months, compared with 46% in 2011. Nearly half of respondents (45%) mentioned water pollution compared with 47% in 2011. However, only 17% of these residents actually reported their concerns to Environment Southland. The main reasons they did not report any issue was because they think Environment Southland is already aware (21%) or they didn't think of it (70%), or they didn't know they could (16%).

Overall perceptions of how well Environment Southland is protecting and managing regional water quality remained consistent with 2011. While 30% of residents (27% in 2011) feel Environment Southland is achieving this protection well or very well, there is a larger proportion who were neutral (44% vs. 42% in 2011) with significantly less (20% vs. 25% in 2011) who feel performance was poor or very poor. This is a good result for Environment Southland.

(Based on Versus Research 2012)

6.4 Values, issues and concerns of Ngai Tahu

Six councils of Southland/Otago have entered into a Charter of understanding with Ngai Tahu Ki Murihiku (Southland's iwi). This document defined the process for facilitating Ngai Tahu involvement and consultation in the resource consent and planning processes of which water is a key one. There is also an iwi representative on the hearing committee for the Regional Water Plan for Southland.

Relevant to this process is that Section 6 (B), 7 (a) and 8 of the RMA recognises the principles of the Treaty of Waitangi, kaitakitanga and matters of importance to Iwi. The RMA allows a resource consent application to be processed non-notified providing written approval of affected parties is obtained and the adverse effects of the activity are minor. The RMA requires a copy of any notified application to be served on the Iwi. In addition, the fourth schedule of the RMA requires that in assessing the effects of an application the applicant has identified those persons interested in, or affected by the proposal, undertaken consultation with any affected parties and responded to the views expressed by those consulted.

An iwi representative is a member of Environment Southland's hearing committee for the Regional Water Plan for Southland.

(Based on Te Ao Marama Inc. 2013)

6.4.1 Issues, policies and outcomes

Te Tangi a Tauira – The Cry of the People, Ngai Tahu Ki Murihiku, Natural Resource and Environmental Iwi Management Plan 2008 (Ngai Tahu 2008, pp 136-162) describes in detail Ngai Tahu issues, policies and their desired outcomes regarding resource use activities and impacts.

Imbedded in the values, issues and policies is the Maori holistic view of their cultural and traditional relationship with their ancestral lands, sites, water, wahi tapu and other taonga. The key issues affecting Iwi values include (Te Ao Marama Inc. 2013):

Water and water related activities that impact on:

- Mauri (life – sustaining capacity)
- Quality and flow
- Habitat (e.g. shellfish beds, fish passage and aquatic plants)

- Taranga Waka (canoe landing areas) or similar wahi tapu
- Water bodies, waterways or wetlands, especially kohanga (breeding areas)
- Mahinga kai (traditional food gathering areas) and access to them
- Disturbance of beds

Land activities that impact on:

- Mahinga Ki and access to it
- Habitat (both flora and fauna)
- Mauri (life sustaining capacity of land)
- Riparian margins within 20 m of low water way or body of water
- Significant natural features (e.g. monuments, spiritual sites)
- Wahi tapu (sacred places such as burial or battle sites)
- Wahi taonga (special places such as village or pa sites)

Other activities relevant to Iwi include:

- Discharges and abstractions
- High altitude burning
- the Construction of dams and converts
- Coastal space occupation
- Land disturbance for forestry
- Activities within "Statutory Acknowledgement" areas

Section 3.5 *Te Tangi a Tauira* sets out in detail the activities, issues, ecosystems and places of importance to be addressed. The water related ones include: farm effluent management, wastewater disposal, solid waste management, industry, forestry, stock transport, general water policy, rivers, discharges to water, water quality, water quantity – and abstractions, activities in the beds and margins of rivers, mahinga kai, Nga Pononga Tane a Tangaroa, wetlands, riparian areas, freshwater fisheries and protection of sites of significance.

Evidence of cultural health

A case study: Te Ahuatanga O Te Waiau – State of the Takiwa (Ngai Tahu 2008, p. 151) describes an environmental monitoring approach developed by Te Runanga o Ngai Tahu as part of the Ki uta ki tai – mountains to the sea natural resource management framework, first outlined in 'Ngai Tahu 2025'. This approach aims to assist tangata whenua gather information, assess and report on the cultural health of significant sites, natural resources and environment within their particular takiwa, and thus to understand

changes over time and make good management decisions. State of Takiwa monitoring uses both Maori cultural values and Western science measures.

The Waiau River Catchment Cultural Health Baseline Report 2005 was one of the first reports using this approach (now being adopted in Canterbury and other regions). The project assessed the cultural health of 12 sites in the Waiau river catchment. Overall the assessment found that the Waiau river catchment was in a state of good cultural health, but with the mid-catchment and areas near settlements scoring lowest. The high-scoring sites were relatively unmodified, with an abundance of native vegetation and good access to mahinga kai. Lower scoring sites were associated with the negative impacts of settlement, agriculture, pests, weeds and areas of low flow due to abstractions related to hydro-generation.

Comment: Ngai Tahu has a comprehensive and holistic approach to environmental sustainability with a significant focus on water quantity and quality. The cultural health index is an innovative and useful way of monitoring trends in all aspects of the iwi life. Because the index utilises both Maori and Western science the approach has relevance to the total community. The ground breaking work in Southland is a step forward for the environment and New Zealand is likely to see the adoption of similar approaches much more widely.

6.5 Value of environmental impacts in Mataura catchment

Potential environmental impacts associated with increased water use in the catchment are expected to be mainly non-market impacts (i.e. they are not traded and in any market place). Such impacts are more difficult to estimate compared with market values. An analysis of 92 valuation studies from 1974 to 2005 showed that the nonmarket value of water quality change was typically three times higher than use values (Yao and Kaval 2007). This conclusion is supported by Kerr (2004) and Sharp and Kerr (2005), who conclude that in some cases existence (non-market) values for water resources in New Zealand could exceed use values by a substantial margin.

Cultural values are another category of nonmarket value. In this context Maori cultural values are pertinent. These values are summed up within the concept of mauri. Mauri describes the life force that flows from the wairau and its value can be represented by “the qualities of health, abundance, vitality, the unpolluted nature of the water and the presence of indigenous flora and fauna”. Quantifying cultural non-market values is sensitive and is the subject of on-going research.

In the summary to their report Liquid Earth (2011, p 99) stated that “there are very significant environmental values associated with the Mataura River. While it appears that the extent of any impacts could be relatively small, this needs to be confirmed by further modelling and technical work. It does appear that land management rather than land use have the greatest of impact on nutrient associated environmental values, so additional irrigation will not necessarily result in negative environmental outcomes”.

Stakeholder weightings were obtained for different values for the Mataura River at a workshop held in 2010. They indicate that environmental outcomes make up 50% of the overall ranking with economic scoring 20% and social and cultural both scoring 15% (see **Table 6.1**). In particular, angler values associated with the river were considered very important in both the environmental and social categories, particularly for the environmental stakeholders. In modelling future scenarios for water use the marginal value from irrigation is expected to be relatively small with the most significant trade-off expected between

environmental impact and the social benefits associated with increased wider economic activity, employment and taxation impacts resulting from land use intensification.

Table 6.1: Summary of values associated with the Mataura catchment

Environmental	Economic	Social	Cultural
Healthy ecosystems	***Regional economic prosperity***	***Strong communities***	***Cultural and spiritual well-being***
• Fisheries • Water quality • Habitat diversity and connectivity • Water quality • Flood control • Biodiversity • Assimilative capacity	• Jobs/employment • Commercial fishing • Tourism (including Angling) • Viable local communities • Diversified viable businesses • Reliability of supply • Quality of supply (suitability for use) • Clean green image • Gravel extraction • Electricity generation	• Angling amenity • Recreational amenity • Drinking water supply • Community amenities • Mahinga kai • Aesthetics • Education and health care • Social order	• History and tradition • Food gathering • Mauri • Ability to participate in decision-making • Access • Cultural identity
50%	**20%**	**15%**	**15%**

Identified at the steering group workshop held in October 2010
Note: average weighting between the four well-beings is shown in the last row
Source: liquid earth *et al* 2011, table 9, p77.

Outcomes from the stakeholder workshop held in October 2010 may or may not represent the view of the wider community and as such are considered to be only a useful starting point for considering the future management of water resources in the Mataura catchment. Key observations from the workshop included:

- There are a wide range of values associated with the river. These include a range of values not explicitly recognised within the existing regulatory framework ranging from environmental values such as biodiversity to economic and social values associated with out-of-stream water use
- The relative weightings assigned to the four well beings reflect the diversity of views regarding water resource management. A common goal appears to be "*strong, prosperous communities within a healthy environment*"
- Opinions regarding the current condition of the values varied widely between individual sector groups (and individual participants). This highlights the need to disseminate information regarding the current state of the environment in a clear and concise manner to enable informed community participation in the resource management process.

Comment: The detailed work carried out in the Mataura catchment makes sense considering that 50% of Southland's available allocated water resource is in that catchment (after taking into account of the take from the Waiau for the Manapouri Power Scheme). The research shows that most of the environmental impacts will be non-market related with economic impacts on the wider community through changes to

employment and economic activity outside agriculture. Meeting environmental targets on farms will involve a range of mitigation measures rather than changes in land use away from dairying where the major concerns are. While innovators have adopted many of the best management practices the majority of farmers are waiting to see how regulations will be imposed before adopting the more costly measures.

Information obtained from workshops of stakeholders provides a starting point for community decision-making on the environment. As the participants were not necessarily representative in a statistical sense of the community the outputs should be treated with caution.

7 Southland Stakeholder Survey

In the week of 11 – 15 February a series of 20 interviews were undertaken[54] in Southland by Nimmo-Bell. The objective of the survey was to elicit views about concerns, values and gaps in knowledge around water quantity and quality. While respondents were chosen from various stakeholder groups they were asked to represent their own views and not necessarily those of their group. Also, where they considered they did not have facts or specific knowledge to voice their perceptions.

The questionnaire master is provided in Appendix 1.

An initial list of 32 names was provided by Emma Moran of Environment Southland (see Appendix 2 for the list of interviewees). The lessor number of people able to be interviewed was constrained by the one week available to do the interviewing. The people interviewed were chosen from leading members of six key stakeholder groups as follows: conservation, farming, industry, iwi, professional advisors, and urban.

This was not a random survey, rather the people put forward by Environment Southland were chosen for their knowledge of the issues and to represent a broad cross-section of views. Because of the limited number of interviews and the selection process used caution needs to be exercised when drawing conclusions from what respondents have said.

Each potential respondent was sent an email from the Ministry for the Environment (see Appendix 3) which introduced Dr Brian Bell of Nimmo-Bell who would be conducting the interviews and outlined the line of research being undertaken, the purpose of the survey, key points to be covered and timing issues.

Each person was contacted personally by phone to arrange the time and venue. An analysis of the responses is provided below.

7.1 Chief concerns

Chief concerns on current and potential water quantity and quality show no clear stakeholder convergence. Concerns seem to be held personally irrespective of stakeholder group (see Table 7.1).

7.2 Degree of Concern by Zone

Respondents showed a clear progression of concern for both water quantity and quality which goes from the upper zones to the lower zones, but does not appear to escalate very much from a current concern to a potential concern (see Table 7.2). There is also not very much difference between stakeholder groups apart from Iwi whom stated an increased level of concern particularly for the In-land Basins and Lowland areas including estuaries and low land lakes. Natural State and Mountain zones generally were not of concern, Hill country was not really a concern to a concern, with the Inland Basins and Lowland zones scoring concerning two very concerning.

[54] In the case of Ngai Tahu where 5 people attended the interview and later another 2 had input into the questionnaire we counted 7 under the iwi stakeholder group. One consolidated questionnaire was completed and analysed.

Table 7.1: Current concern on Quantity by stakeholder group	
Current Concerns regarding Quality	
Conservation	Total catchment relatively small, aquifers unknown Supply can be a bit erratic, N Southland can be really dry Decreased availability, more dry spells and effect on forests Major issue is meridian - lasts until 2034
Industry	Managing fine, concerns when drought though Meridian doesn't let enough water go to flush didymo Limitations for horticulture and agriculture
Iwi	More pressure to extract water, particularly in dry periods
Advisor	None Not enough info on groundwater. Policy of 1st in, use or loose Low flows and management of farming systems Over-allocation from confined aquifers, risk to potable supplies
Urban	People in Southland think there is plenty of water Water for Gore, Mataura There is enough water for everyone
Chief Potential concern on Quantity by stakeholder group	
Conservation	Ongoing increased demand from Ag, Ind & Urban No different to current concern Water won't be available to small towns e.g. Dipton Demand for irrigation
Farming	How to store water and make available efficiently Increasing demand, more extreme weather and pressures, Capex Unknown storage factor, economics of smart storage Decreasing availability of good water, already an issue Possibility of go to Horticulture will need more water
Industry	Processing stock in a drought - a welfare issue With Meridian's control no water for irrigation Access to potable water paramount, in worst case capacity constraints
Iwi	Increased efficiency of extraction, unsustainable extraction
Advisor	Last 10 yrs large on-farm abstractions, Meridian impact on Waiau When distribution of rights uneven, how do you allocate it? Increased irrigation, residual flows during extremes Needs of primary industries, over-allocation
Urban	Supply of good clean water is exhaustible No different to current concern If smelter closes there is plenty of water
Chief Current concern on Quality by stakeholder group	
Conservation	Level of pollutants, faecal and others Hotter temps leading to algal growth from sewerage in Mataura Manapouri water chlorinated, giardia in National parks Increase in N in ground and surface water
Farming	Fertile sediments settling in coastal lakes and estuaries Flow-on effect to health. Perception its all the farmers fault Farm smarter for Environment w/o affecting profit N & E coli in water - not all from farming N an issue
Industry	Slightly reduced quality now - needs treatment Stay diligent in National parks, Knock on effect from dairying
Iwi	Thin soils, N hot spots in groundwater
Advisor	Visual aspect, particularly 1st & 2nd order streams - algal blooms Trade-offs, Dairy Green solves a lot of problems Dairy + dairy support - leaching of N, winter grazing permitted Surface water discharges to rivers impacting down stream

Urban	Inland development causing dirty water near coast Growing level of N & P from dairying General degradation of waterways, potable water
Chief Potential concern on Quality by stakeholder group	
Conservation	Further increase in dairy, small community sewerage discharges Climate change? Increased dairy. Is land use appropriate to soil type Degradation getting quicker and quicker - overall pollution of waters N a big problem with no good way to deal with it
Farming	Limiting N loading in rivers Proposed remedies have the desired outcomes over what timeframes Technology needed to manage nutrients and effluent better Can't keep doing the same things, looking for improvement Understanding N reducing effect, more cropping in N Southland
Industry	Standards being raised, will require major capital investment N and human waste marginal now Quality issue has to be mitigated
Iwi	Trends the wrong way for nutrients and pathogens (viruses)
Advisor	N leaching from dairy cows, need lower stocking rate N legacy from cropping, increasing levels of N from dairy Degrade further and don't know how effective mitigation will be N in aquifers, effect on potable water, remediation incredibly difficult
Urban	Something has to be done to restore water quality to what it was Declining river values due to dairy Will there be the population to pay for needed upgrading

Table 7.2: Degree of concern over water quality and quantity by Zone

	Zones																			
	Current										Potential									
	Quantity					Quality					Quantity					Quality				
	NS	Mo	H	IB	L	NS	Mo	H	IB	L	NS	Mo	H	IB	L	NS	Mo	H	IB	L
Conservation	2	1	2	3	3	1	2	3	3	3	1	1	2	2	3	1	1	2	3	3
Farming	1	1	3	3	3	1	1	4	4	4	1	1	2	3	3	1	1	3	4	4
Industry	1	1	1	3	3	1	1	2	3	4	1	1	1	3	4	1	1	2	3	5
Iwi	1	1	3	4	4	4	4	3	5	5	1	1	3	4	4	3	3	3	5	4
Advisor	1	1	2	3	3	1	1	4	3	4	1	1	3	3	3	2	1	3	3	4
Urban	1	1	2	3	4	1	1	2	2	4	1	1	2	3	4	1	1	2	2	4
Combined	1	1	2	3	3	2	2	3	4	4	1	1	2	3	3	2	2	3	4	4

Zones: NS = Natural State, Mo = Mountain, H = Hill country, IB = Inland Basins, L = Lowland

Degree of concern

- 5 Extremely concerning
- 4 Very concerning
- 3 Concerning
- 2 Not really a concern
- 1 Not a concern

Deviations from the combined scores by stakeholder show a distinct division between Iwi and other stakeholders (see Table 7.3).

Table 7.3: Overall Degree of concern over water quality and quantity by Zone

	Zones																			
	Current										Potential									
	Quantity					Quality					Quantity					Quality				
	NS	Mo	H	IB	L	NS	Mo	H	IB	L	NS	Mo	H	IB	L	NS	Mo	H	IB	L
Stakeholder Group	**Deviation from Combined**																			
Conservation			-1	-1	-1	-1			-1	-1			-1	-1	-1				-1	-1
Farming					-1	-1	-1	1							-1	-1	-1	1		
Industry			-1			-1	-1	-1	-1				-1			-1	-1	-1	-1	1
Iwi			1	1	1	2	2		1	1			1	1	1	1	1		1	
Advisor				-1	-1	-1	-1	1	-1						-1				-1	
Urban			-1		1	-1	-1	-1	-1						1	-1	-1	-1	-1	
Combined	1	1	2	3	3	2	2	3	4	4	1	1	2	3	3	2	2	3	4	4

Zones: NS = Natural State, Mo = Mountain, H = Hill country, IB = Inland Basins, L = Lowland

Deviation from Combined

- 2 states worse
- 1 state worse
- Neutral
- -1 state better

7.3 Degree of concern by catchment

On a whole of catchment basis respondents were more concerned than is indicated by the analysis by zones (see Table 7.4). All four catchments were a current concern by quantity with the Aparima, Oreti and Mataura all very concerning on quality basis. There appears to be little change over potential concerns overall.

Again Iwi show a one degree of concern greater than the other stakeholder groups with extreme concern for the Aparima and Oreti on a quality basis for the 'current' and 'potential' basis and 'potential extreme concern' for the Oreti on a quantity basis.

Table 7.4: Concerns over water quantity and quality by catchment

	Catchments															
	Current								Potential							
	Quantity				Quality				Quantity				Quality			
	W	A	O	M	W	A	O	M	W	A	O	M	W	A	O	M
Conservation	2	2	2	2	2	3	3	3	3	2	2	2	2	2	3	2
Farming	2	2	3	3	2	3	4	4	2	2	3	3	2	3	3	3
Industry	3	2	3	3	2	3	4	4	3	2	4	4	2	3	4	4
Iwi	3	4	4	3	4	5	5	4	3	3	5	3	4	5	5	4
Advisor	3	3	3	3	2	4	3	3	3	3	3	3	2	3	3	3
Urban	3	2	2	4	2	2	3	4	3	2	3	4	2	3	4	4
Combined	3	3	3	3	3	4	4	4	3	3	4	3	3	3	4	4

Catchments: W = Waiau, A = Aparima, O = Oreti, M = Mataura

Degree of concern

- Extremely concerning
- Very concerning
- Concerning
- Not really a concern
- Not a concern

Stakeholder Group																
Conservation		-1	-1	-1		-1	-1	-1		-1	-1	-1	-1	-1	-1	-1
Farming	-1	-1	-1		-1	-1			-1		-1			-1	-1	
Industry					-1	-1						1	-1			1
Iwi		1	1		1	1	1			1	2		1	2	1	
Advisor							-1	-1			-1		-1		-1	-1
Urban		-1	-1	1	-1	-1	-1			-1	-1	1		-1		1
Combined	3	3	3	3	3	4	4	4	3	3	4	3	3	3	4	4

Deviation from Combined

- 2 states worse
- 1 state worse
- Neutral
- -1 state better

7.4 General comments on concerns by zone and by catchment

Similar to the chief concern, when asked to elaborate on concerns respondents stated a number of other significant concerns that were not easily categorised by stakeholder group.

Most respondents regarded the Waiau as a compromised river because of the major diversion of water by Meridian for hydro-electricity purposes.

The general comments on current and potential concerns by stakeholder group are summarised in Table 7.5.

Table 7.5: Comments on Current concerns by stakeholder group

	Current Concerns
Conservation	Need to keep an eye on abstraction - not just dairy there are a whole range of uses Conversion of Hill tussock to ryegrass: run-off P and sediment. IB depletion of groundwater Huge change in farming over last 25 years, more and more concerned for ecosystems Mataura limits reached in mid to upper reaches. Conservation Order didn't specify groundwater
Farming	N does not accumulate Tussock to ryegrass on Hills not getting water retention with downstream impacts Tussock to ryegrass on Hills, getting the message across to improve quality ES not tough enough in the past, now getting their head around it. Farmers had plenty of time Wintering dairy cows on hills naïve, Inland Basins legacy issue from cropping
Industry	Concerns because of upstream increased use Inland Basins is where problems start. Waiau constrained already
Iwi	Mountains to the sea - problems accumulate, drawing on aquifers which don't understand
Advisor	Trying to hold the line in upper catchment and lift the bar in the lower catchment Waiau no water for irrigation, land intensification, Gore connects storm-water to sewerage Dairy pushing the limits, now hill country the biggest issue, increased deterioration towards sea Diary displacing sheep, cultivating to high altitude. Discharge and replenishment of aquifers
Urban	Waiau halved quantity, didymo right through Waiau Land intensification especially dairy Waiau compromised because of hydro
	Potential Concerns
Conservation	Increased watching brief on Inland Basins and Hills Won't get 10% quality improvement if carry on as is - need a change in policy 10% target is achievable, 20% achievable if committed to it, optimistic it can improve Storm Water an issue in Invercargill, first steps now being taken - not stringent yet
Farming	Accumulation of fertile sediments is a long term problem Time lags, reluctance to put time and money in until see results Not too much more development on the Hills, get on top of quality otherwise regulation Inland Basins: like to think it will get better. Added pressure from more intensive farming Need more science to deal with N, small town sewerage, situation should improve
Industry	Not confident the science is there to be well informed - maybe worse than we think Waiau controlled by Meridian Have to do more
Iwi	Choose 10% improvement as considered easy to achieve, Waituna 5 for potential Quantity & Quality
Advisor	Waiau - 50% diversion for hydro, major impact on habitat and recreation All issues will get worse due to dairy, wont attain targets under current policy Huge consequences from increased hill country development, farmers don't care More focused use of suitable soils. Optimistic policy will have a positive effect
Urban	Careful not to over-allocate, cannot expect a quick fix, rates will go up if nothing happens Economic drivers to intensify land use We don't understand the lags between effort and results, particularly dairy conversions

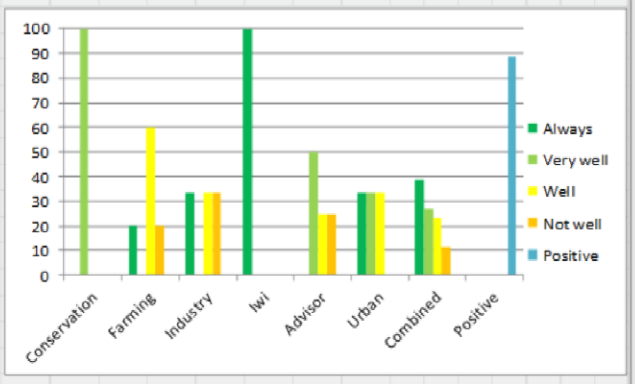
7.5 Environment Southland response to concerns

Respondents were asked to comment on Environment Southland's performance in three key areas regarding concerns (see Table 7.6). Firstly, how well are their concerns taken into account in policy discussions, secondly, how well are their concerns taken into account in decision-making, and thirdly, how well are their concerns taken into account in communications with the public. Overall the response was positive with 88% of responses indicating the response was well very well always for policy discussions, 77% in decision-making and 63% in communications with public.

Table 7.6: Environment Southland: Response to concerns

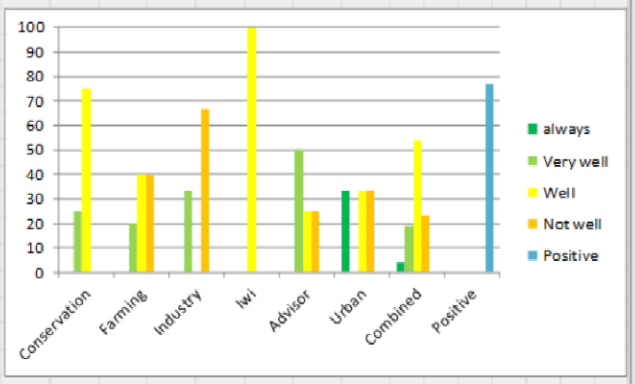
Environment Southland: How well concerns are taken into account in policy discussions (%)

Conservation		100			
Farming	20		60	20	
Industry	33		33	33	
Iwi	100				
Advisor		50	25	25	
Urban	33	33	33		
Combined	38	27	23	12	
Positive					88



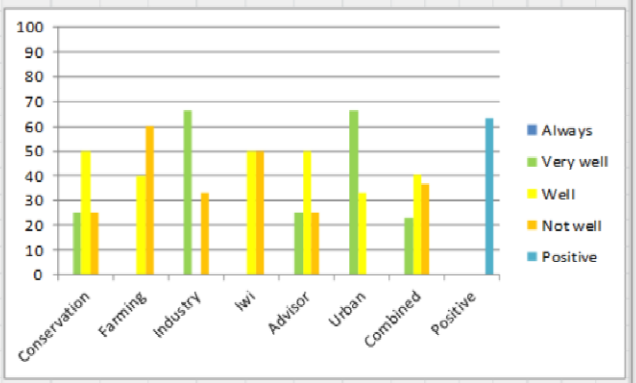
Environment Southland: How well concerns are taken into account in decision making (%)

Conservation		25	75		
Farming		20	40	40	
Industry		33		67	
Iwi			100		
Advisor		50	25	25	
Urban	33		33	33	
Combined	4	19	54	23	
Positive					77



Environment Southland: How well concerns are taken into account in communications with the public (%)

Conservation		25	50	25	
Farming			40	60	
Industry	67			33	
Iwi			50	50	
Advisor		25	50	25	
Urban		67	33		
Combined		23	40	37	
Positive					63



	Always
	Very well
	Well
	Not well
	Never
	Positive : Well or better

7.6 Values and the balance of well-being

Respondents were asked to allocate their preferences for the four pillars of well-being namely Cultural (Maori culture), Economic, Environmental and Social areas when decisions are to be made by Environment Southland on matters relating to water quantity and quality in the region. The percentage allocation by the four pillars and by stakeholder group is set out in Table 7.7. This table is divided into two sections, in the first section preferred responses are registered and in the second section the end niche next best option is registered. The next best option relates to how they would allocate resources if they had to make a trade-off from their highest preference. When the scores were combined there was a distinct preference for Environment (31%) and Economic (30%) pillars compared with Social (23%) and Culture (17%).

Table 7.7: What should be the balance between the pillars of wellbeing?

Balance of Wellbeing (% allocation)								
Stakeholder group								
	Preferred				Next Best			
	C	Ec	En	S	C	Ec	En	S
Conservation	20	29	26	25	18	25	27	31
Farming	15	31	31	23	14	35	31	20
Industry	10	43	27	20	8	38	30	23
Iwi	25	25	25	25	30	20	30	20
Advisor	14	28	39	19	11	31	36	23
Urban	12	27	42	20	12	30	33	25
Combined	17	30	31	23	18	28	31	23
Difference compared with Combined								
Conservation	3	-1	-4	2	1	-4	-4	8
Farming	-2	2	0	0	-4	7	0	-3
Industry	-7	14	-4	-3	-9	10	-1	0
Iwi	8	-5	-6	2	12	-8	-1	-3
Advisor	-3	-2	8	-3	-6	2	5	-1
Urban	-6	-3	11	-3	-6	2	2	2
Combined	17	30	31	23	18	28	31	23
Pillars of Wellbeing			**Difference compared with Combined**					
C = Culture				11 - 15% higher				
Ec = Economics				6 - 10 % higher				
En = Environment				within + or - 5%				
S = Social				6 - 10% lower				

When comparing the responses by stakeholder group the differences were mainly in the range of plus or minus 5%. The greatest difference was a 14% favouring of the Economic pillar by Industry stakeholders compared with the combined score and an 11% favouring of Environment by the Urban stakeholder group.

As could be expected Iwi showed a positive preference for Maori culture (+8%) compared with the combined scores and a lower score for Environment (-6%). This latter score appears to be a reflection of the balanced approach (i.e. the preference for 25% for each pillar) shown by Iwi compared with distinct preferences for different pillars shown by the other stakeholder groups. Respondents were then asked to reconsider the allocation of the four pillars if they had to make a trade-off on their most preferred allocation. While there were distinct changes to by individual stakeholder groups when combined the scores were little different. Economics decreased by 2% to 28% and Culture increased by 1% to 18%. There was no change to the allocation to Environment or Social.

The most significant change in the next best allocation by a stakeholder group was Iwi with a 12% positive allocation to Culture compared with the other stakeholders and a 8% decrease for Economics. The view of Iwi was that there needed to be a greater focus on Culture and Environment to restore balance of well-being. Once this balance has been achieved then the allocation should revert to their preferred allocation of 25% to each of the four pillars. The other significant deviations from the combined scores for the next best allocation were a positive increase of 10% to Economics by Industry along with a 9% lower rating than the combined score on Culture. The Conservation stakeholder group also had an 8% positive rating compared with the combined scores for Social.

Stakeholder comments regarding the reallocation of preferences to the four pillars for the next best option are provided in Table 7.8.

Table 7.8: Reasons for reallocating to the next best option

Conservation	Need a good understanding of the levers, work hand in hand with iwi. Culture and Environment jointly 30% Economic growth a big risk, do other things less damaging than farming, leave options so can change With Environmental depletion needs more emphasis, with healthy Environment and Social can make money - holistic If out of kilter community will suffer, need to restore balance
Farming	The community hasn't taken into account the Environment, but if swing too far will have a huge cost to social structure A lot of depression on farms about being sustainable, women time for kids, both parents stressed Emphasis on balance of Economic and Environment, Economics and Social go together Economy is vital for health and Social issues along with Environment - go hand in hand Really need more income, don't need more Social, already a lot of Culture in Environment
Industry	With Economy if no money then nothing, can't kill the economy to improve other pillars If Economics it can only be a cost to Social, concentration of wealth in the hands of a few (local or Overseas) is a concern Social very important. In order to achieve that need a sound Economic base. Culture important, but need healthy Social first
Iwi	Holistic approach, have to look after the people, address concerns first (Next Best) and then can move to the Preferred balanced situation
Advisor	Environment covers culture (interlinked), pressure from a dollar perspective, Cultural affinity for water (ethos) There is a shortage of labour - put people first. Have to be Economically sustainable or won't have the Environment Pillars are intertwined, Economics and Environment are one and the same - sustainability Emphasis on Environment as effects Social and Cultural dramatically. Move from compliance to enabling/empowering
Urban	To do no harm and restore Environment. Need to move forward all the time Increase Environment as important for Economic, put more emphasis on Social to get people involved Sacrifice Environment to improve Economic and Social

General comments

During each interview, notes were taken on issues that were important to the respondent but did not fit precisely with the questionnaire. These are recorded by stakeholder group in the following Table. Also at the end of the questionnaire there was a chance for respondents to make any other points they considered were important that had not been covered up to that point. These comments are also recorded as "Additional points" at the end of each stakeholder section.

7.7 Additional Points/Issues

In addition to the above some general comments and additional points were uncovered during the interviews.

7.7.1 Conservation

The Department of Conservation (DoC) is an advocate for fresh water fish and habitat which are sometimes in conflict e.g. Seasonal flows affecting river nesters such as black bill gulls.

There is a marked decline in water quality in estuaries, which is a wake-up call for stormwater management. Southland needs to make use of lessons elsewhere in New Zealand e.g. Manakau harbour.

Small town sewerage and stormwater are significant issues even though dairy gets all the focus. There is a general pressure from human population.

Additional points

- DoC is looking at sustainability in a new way. By generating revenue out of conservation to fund programmes.
- DoC is workings with Fonterra and Iwi on eight or nine projects around wet land options.
- The conservation strategy "Freshwater Place" is about to be released.
- A key issue is around Southland's of lowland plains.
- Water management is a lot greater than just rural and urban. There needs to be an overall package and not compartmentalisation of the issues.
- There is a need to improve resilience as right now the region is very vulnerable to drastic changes. We won't get back to pristine water but what is the next threshold? Estuaries flipping? There is a need to find out.
- People must be able to swim in rivers and for stock to take water to drink
- lignite is a big potential risk
- New Zealand is subsidising dairying through the hidden subsidy on environmental degradation.

7.7.2 Farming

Farmers need more science to understand better what is happening to water quantity and quality.

There is a lot that can be done to improve energy and water efficiency e.g. avoid wasting energy by individuals pumping out a river to a pond and then onto land. For every 2 L of effluent deposited in the yards 50 L of water is used in the wash down. Effluent pond management is a key issue with a need to keep the pond empty – "keep it low is the motto".

A distinction needs to be made between fertile sediment and natural sediment.

Nutrients need to be harvested or flushed from the system.

Two thirds of town water supply in the region doesn't comply with consents. There is a problem as the towns cannot keep to the consented levels, particularly for Phosphates. Farmers can eliminate phosphate from the system and be more efficient but with Nitrates it is very hard.

Work on the Waikato Peat lakes may be pertinent to Southland. They have taken out the Willows and installed sediment traps on every drain. These are very simple, made by taking 2 digger scoops out at the start of the main drain.

Every town in Southland should have stormwater drain sediment traps.

Riverton has a community scheme for sewerage but the stormwater runs straight into it. Every house should have a tank for water to stop wastage and improve environmental outcomes.

The majority of farmers are environmentally conscious. Around 50% of farmers spent more than $100,000 over the last five years or will be over the next two years for effluent management, ponds and irrigation. The other 50% of farmers will be forced to get a new consent. The consenting process means that all farmers will have to improve.

AgResearch (David Houlebrook, Pond Calculator, see DairyNZ website) has worked out a risk matrix for farm dairy effluent and the application to soils. "Characterisation of dairy manures and slurrys" October 2011, in 2020 Science.

A major breakthrough was the development of low rate irrigation application systems. The old travelling irrigators put on 100 mm/hour and the drains would run green even when the soils were dry.

Farmers don't make money losing phosphorus and nitrogen out of the system, more precision is needed. Farmers need to break their farm into blocks and use Overseer to calculate water needs by soil type.

A key task is to reduce the transfer of fertility from the paddock to the race and the art is to stop cows waiting around. A poor manager can more than double the effluent created compared with a good manager. Cows will deposit about 90% of the effluent in the paddock and of the remaining 10%, 90% is deposited within 100 m of the shed. Cows hate concrete and hate walking in shit. Whenever they aren't happy they will let go. Effluent management needs to target walkways near and around the shed. Cows love soft surface pads.

The biggest problem is the amount of water used under current management systems. About 1000 L is used inside the shed compared with 20,000 L outside the shed per milking. With green water recycling for outside concrete the amount of water could be halved. Current management budgets on 120 L per car per day but of this the cow drinks only 50 to 70 L per day and the rest is used for wash down. In other countries farmers either scrape the yard or use green water recycling. Because we in New Zealand have so much

water there is a tendency to waste it. There are huge efficiencies to be made. For example roofing yards and stopping rainwater getting into effluent ponds would make a major difference.

Many dairy farmers are under financial stress. At $5.50 per kilogram of milk solids half the dairy farmers were not making a profit. Currently the payout is $5.70 per kilogram of milk solids.

Answers on farm environmental sustainability come from the Ballance Award recipients e.g. sediment traps on hill country, the streams that need to be fenced, and the management that goes with it.

Farmers need black and white answers, but that is not possible so there needs to be flexibility in policies e.g. Fonterra initially resisted green water for wash down, but now accepts the practise. If there is good science behind proposed policies farmers will get behind it. The high level of emotion around sustainability has turned many farmers off. The concern is that all farmers will be required to put in wintering sheds and it will turn out to make no difference. It is better to move a bit slower, work with farmers and increase the element of education.

Living Streams found a major source of pollution in the Waihopai catchment was a point source discharge from a small meat processing factory. Once fixed it made a big difference.

Environment Southland's Water Plan is focused on Dairy, but all farmers should be included. From the publicity one would surmise that no progress has been made. Farmers have done a huge amount with some on their third solution. Farmers need flexibility.

Federated Farmers are often critical of those farmers who are letting the side down, but this doesn't seem to get publicity.

Additional points

- Policy needs to put emphasis on what is limiting i.e. the environment and economics.
- Instead of monitoring bores, monitoring systems should focus on surface water and water quality.
- Farmers can't improve nutrient outcomes if they don't know what they are contributing – if they know then they can change their management.
- There is a lot of depression (partly due to dirty dairying campaign) around being sustainable. Where there is a big mortgage both parents are stressed. Working women don't have time for kids, aged care is less accessible and farm workers are less able to shift locations so both parents can work. With financial constraints the ability to spend more on environmental things is limited. Better support networks are needed.
- When the sustainable people feel better.
- There are concerns around where the conversions to dairy will occur such as around Te Anau because of the thin soils.
- Dairy can have negative impacts on tourism as people don't want to see cows on hills.
- Dairy can have negative impacts on the community (where share milkers shift after 2 to 3 years in the district) as there is not enough spare time in the day to get involved with the school and other community activities.
- Events aimed at dairy farmers need to be run around the middle of the day to get attendance.

- One-on-one over a cup of tea is the best way to start building relationships.
- There is a general lack of understanding of Maori culture as it is not a focus in Southland.
- Policies once set are hard to change and there needs to be the ability to change and have better effluent regimes.
- The farming community has to be tougher, busier and work harder which doesn't allow time to focus on community concerns.
- Pleasantly surprised at the collaboration between culture and business.
- The problem is not only dairy effluent but also small town sewerage schemes which are not compliant.
- Stormwater is unregulated and not monitored – a big issue e.g. Queenstown stormwater goes directly into the lake, untreated and not monitored
- Really concerned about the estuaries especially Waituna and the little streams that feed it.
- Everyone has a responsibility for better water.
- Water storage is good.
- Rivers need flushes to keep them healthy.
- Really concerned when polluted water gets into the oceans.
- While Federated Farmers is a voluntary organisation, Fish and Game hide behind their statutory levies. Farmers feel they are on an uneven playing field.
- In the future with Climate Change the expectation is for increased weather extremes, which will make it more difficult for farmers to manage environmental outcomes.
- the global financial crisis has been a big issue for the region.
- Southland's temperate climate is good and people should question the need to automatically house stock. New Zealand's maritime climate is its competitive advantage.
- A special feature of Southland is that "we all talk to each other". The ability to get around the table is very important.

7.7.3 Industry

Additional points

- There is a new breed of Council staff who are sometimes naive and forget that the RMA is about overarching sustainability, not all about saving the environment. This view is very hard to counter
- When land is wet discharge to land is not possible as the land is unsuitable to receive it. Council staff sometimes struggle with this type of management issue.
- Science is not adequate particularly around groundwater.

- It is hard work to uphold Mataitai. There is a lot of tokenism. It works well with Maori, but largely a waste of time for others.
- If National Parks are to remain as is there is a need for public education and the siting of toilets away from waterways in order to keep giardia out.
- There is a need to look at infrastructure beyond 2020 to deliver the water resources needed by the region e.g. a pipeline from the Waiau. There will be water constraints if not addressed.

7.7.4 Iwi

Additional points

- We owe it to future generations to fix the environment or they will have to do it at greater cost, which is not right.
- Public health issue – now is the time to address the pollution problems.
- Ngai Tahu's approach is on behalf of the wider community.
- It is not about stopping development
- More weight is given to Culture because it is broad based
- We expect our rightful place in decision making
- We feel water quantity and quality go hand in hand
- In the Aparima catchment we have elevated our concerns to 4 for quantity as issues of over-allocation are starting to appear in dealing with consents
- In the inland and lowland zones we have elevated our quantity concerns to 4 as current policy won't address the Water Plan objective of a 10% improvement in water quality. Water quantity goes hand in hand with water quality and won't address claw back requirements in the inland basins in regard to water quantity
- Waituna Zone and Catchment have been added to concerns - currently very concerning and potentially extremely concerning because the opening regime doesn't leave enough fresh water in the lagoon for in-stream values and associated ecosystem services. There are serious water quality issues from nutrient and sediment loadings, increasing phytoplankton growth and salt water intrusion.
- In the Mataura Catchment white-baiters complained about water quality, taste and smell. There is a lot of kai harvested from that river
- In Environment Southland decision-making and public communication we are a bit unsure how well our concerns have been provided for.

7.7.5 Professional Advisors

Environment Southland's land sustainability officers provide advice and information to farmers. There are six people in the field team working on soils water, riparian planting, siting race ways, best management practice, erosion control and general farm plans (not nutrient plans). Officers have resource management degrees from Lincoln or Massey and have attended the Advanced Nutrient Management course at Massey.

There is a land sustainability levy, which means farmers can approach the team at no cost for advice. The team has developed good relations with farmers through radio talks and Field days. In addition to Environment Southland, DairyNZ has two officers, as does Fonterra. DairyNZ provides the on-farm advice particularly with the effluent calculator the Fonterra provides off farm advice.

The inland basins of Southland have particular sustainability issues because of the flat to rolling slope and light gravel soils. Key basins are: Five rivers/Mossburn, Te Anau, Waimea and Upper Mataura.

Even with intensification of agriculture water quality can be held and improved. Around 80% of the managers desire to do better. The remaining 20% of farms have managers who don't have recourse to the cheque-book (i.e. absentee landowners) or don't have long term tenure with around three years to build equity and move on. This latter group when they buy their own farm perform much better environmentally. It is very difficult to engage with the boards of corporate farms but they will be caught under the consent process.

Consents only apply to dairy farmers not sheep and beef farmers. The growth of the dairy industry in Southland has provided a major boost to the remaining sheep and beef farmers in the region. Winter grazing of dairy cows has provided a major boost to incomes that has created a new issue with increasing development of the hill country to higher and higher altitudes. Also on the cultivatable land, winter cropping for dairy farmers as part of the re-grassing program provides a good income stream.

The storm water issue is hard to quantify. Councils are aware of the issue but they are financially strapped. People in towns seem happy to tip oil and paint into drains while criticising farmers for dairy effluent. All over the region there are small towns with sewerage systems that don't comply. In addition there are many septic tanks including on every farm that are not well managed. Generally people are aware but the issue needs more emphasis. Over 80% of septic tank systems are old, not functioning properly and not checked out. The impact of this on the environment will be significant.

Plantation forestry has a forest code of practice. Compliance is very good including around harvesting. Overseas operations have brought in good practice.

In general, dairy farms in Southland are overstocked and over fertilised. DairyNZ is aware of this.

In 1995 it became mandatory for land disposal of effluent, but drainage design meant that drains were running green. The old travelling irrigators put on 15 to 20 mm in 20 minutes which is equivalent to torrential rain. Dairy Green pioneered low rate irrigation where 3 mm/h reduced P run-off from 80% to 5%, ammonia from 45% to 2.5% and bacteria from 100% to 25%. It is the difference of going from a bucket to a watering can. Two irrigations of pond effluent per year to a depth of 10 mm per hectare results in around 30 to 40 kg of K (total annual potash requirement), 30 to 35 kg of N and 35 kg per hectare of P. Farmers need to test pond effluent to determine the concentration of nutrients, and optimise additional fertiliser applications.

At the dairy shed water is used for cooling milk and for washed down. Demand can range from 40 to 140 L per cow per day with two thirds used at the shed, mostly for wash down. Water is not managed until it becomes short.

Cow management is the key to reducing the amount of effluent for disposal. Solid effluent in the shed can double with one KG per cow per day to two with poor management. In general women are more considerate of the cows than men, it is a matter of better education.

Within the last 3 to 4 years it became mandatory to report industrial water use electronically on a daily basis. Permitted takes for water are 10,000 L per day of surface water and 20,000 L per day for groundwater.

A lot of structural damage is done to soils in spring and to compensate farmers put on more fertiliser.

Winter cropping is a big problem for nitrogen, sediment and phosphate and every time there is a flood the river turns brown. Didymo is a problem for stock water and irrigation because it blocks jets.

Wintering barns and the use of imported feed and silage means that irrigation of effluent has to be cut back on a per hectare basis because the amount of potash will be too high.

Waiau catchment soils are ideally suited to dairy but the water is locked up by Meridian for Hydro. If the smelter shuts then Meridian has a stranded asset. Due to weaknesses in the distribution system for power it will be very difficult to shift the 750 MW of supply north. If the smelter closes there will be a six month period before production stops and a three-year decommissioning process to clear the site. Potentially in the long-term there could be extra water available for agriculture from the Waiau.

Agriculture needs to get much more efficient at water application. Current use is inefficient. It is irresponsible use particularly by dairy farmers who assume is their right to use unlimited water. They use 4 to 5 times more than they need to. Greater awareness will cause this to change. Younger farmers understand the need and about 20% of farmers are really switched on.

Of the 840 dairy farms, 500 are up for re-consenting over the next 2 to 3 years (one consent every 3.5 days). This is a huge risk to the export sector and dairying as quite a proportion are noncomplying over take and effluent management with the rule changes. Water treatment problems are a product of overuse.

The farmers who are lagging on the environment are not great farmers anyway or are overcapitalised on land and/or structures that are inappropriate.

Soil-based consents make sound policy.

It is only over the last year that Environment Southland has changed for the good.

There is a need for pathways and options that are empowering. Currently the balance is completely wrong. There needs to be a willing party committed to a changed approach. Technical advice from commercial firms is heavily conflict that by having to push product. Farmers don't know what pumps to buy. As a consequence poor decisions are made because most so-called technical people don't have the knowledge. It is impossible to get independent specifications for dairy infrastructure relating to concept plans, specifications and builders. In 2008 there were 105 conversions so builders were running flat out to keep up with demand. There is no integration of different aspects of dairy development. There needs to be the development of overall farm systems. Builders are put under difficult milestones e.g. sheep farm bought in November and has to be up and running as a dairy conversion by 1 August the next year.

Increases in productivity in Southland are constrained by poor infrastructure e.g. weight restricted bridges.

The council has endorsed Venture Southland's Water Strategy but has not has not yet applied it. Similarly the Southland Aquaculture Strategy was not accepted by the Council for a long time and has only recently been supported.

A Water Mapping and Assessment tool is available to everyone but is underutilised. There is too much guessing when there needs to be more concrete data such as available through Future Farms from AgResearch.

Additional points

- Can't be green if in the red.
- Surface water quality is much easier to deal with compared with groundwater – once groundwater is adversely impacted it's a long road back.
- We know through science that water quality (nutrients, bacteria, sediment) is not looking that pretty, but general uses don't appear to bad.
- We are going through dry period but people are still Swadling in the rivers.
- A lot of the point source discharges have been cleaned up and are now very well managed.
- Now it's the nonpoint source issues on land.
- The consents process is okay, it is the permitted activities where the goalposts keep moving.
- Farmers, on environmental issues, are guilty until proven innocent.
- Compliance people write out infringement notices, but the rules are open to interpretation and the goalposts keep shifting. Farmers get mixed messages. They get judged on things they are not aware of e.g. the engineer tells them to put the race next to the drain but the compliance officer tells them to move it away.
- Going forward there will have to be carrots in regard to water to get better results. Environment Southland has 25 compliance officers and only six sustainability officers – what does this say about the emphasis currently?
- It takes 15 years to see the benefits of environmental improvements.
- Living Streams is not dealing with the bigger issue. The problem is in the hills where cultivation is moving to higher and higher altitudes, removing tussock which provides slow release of water, to ryegrass and increased run-off.
- All water consents should have a real time monitoring. It is a one off $1200 cost.
- Issue should be dealt with as they are identified and then rectified.
- There is a need to turn around the ratio of sustainability to compliance officers - 6:25 is the wrong way round.
- The region needs to look to its natural advantages and promote competitive land-use where not suitable for dairy e.g. taking oats (which is Southland has a competitive advantage), from a breakfast cereal to pharma and nutraceutical products.

7.7.6 Urban Communities

Southland is a great place to raise kids with access to the great outdoors to get messy and mucky and to develop minds. To question whether it is safe to swim or get water from the local creek changes all that. People are starting to question.

People don't understand their water systems of which rivers are a vital part.

It is easy to blame dairy but sewerage schemes don't comply and haven't had the money spent on them that is required. There is a need to put things into perspective. Dairy is a small percentage of the ratepayer base and a small percentage of the problem. The urban issue is not getting attention. Stormwater is minor compared with Auckland because of population, density of population and setting are important. A joint approach to sewerage, stormwater and dairy is needed.

For most people drinkable water comes out of the tap and waste water goes down the drain – end of story.

Urban people don't understand rural cycles.

Federated farmers are war mode to protect a minority of farmers. Fonterra represents the dairy industry for the majority and won't deal with farmers not up to their standard.

The world is in the third industrial revolution based on services and information technology. The second revolution for Southland was Te Wai Point (the aluminium smelter). Southland is largely in the first revolution i.e. agriculture. [Note: this is a common misperception as modern agriculture and dairy in particular employs a huge amount of third phase industrial revolution technology.]

Council's interface with agriculture is largely through the compliance regime which is a policing unit. The council needs to turn this around to help farmers work together with councils to achieve the changes that are necessary. There is a need for more R&D, innovation and trialling new ways of doing things, looking at new options.

Concerns have been raised over the last few years about water and people know things aren't good, but haven't got around to doing something about it. Enviro Schools and Living Streams are good initiatives and the region needs more of them.

Use agents of influence – kids are great for promoting Living Streams.

Bore water is loosely connected to the river through the aquifers. The Conservation Oder on the Mataura River triggers conservation and set limits, which are not physically met yet, however there is a growing problem and councils will need to buy land around their wells to secure good water in the future.

People in towns resent seeing irrigation on farms upstream when they have to conserve water themselves.

Forty years ago water quality in the Mataura was disgusting. Point source discharges have been tidied up and overseas visitors still speak highly of the river for angling.

The change in chief executive at Environment Southland has resulted in a more cooperative culture and better connections with other local authorities. There is a better understanding of what needs to be done, previously there was a complete sidelining of the territorial authorities, now there is an understanding of the need to work together.

Additional points

- There is a need to consider the historical context because the rivers were worse in the 60s than they are now with faecal contamination of groundwater and surface water and consequent potable water problems. Overall water quality is better and less of a problem for most people.
- Consider the lifestyle aspect: imagine you can canoe and fish and thus enjoy the outdoors wherever you want to, so not safe water is an issue.
- The biggest problem is dealing with other councils when they do things illegally as they resent it.
- Communications are very important.
- People need to be convinced that the quantity of water is finite and needs to be carefully managed
- Something has to be done about water quality. The biggest blockage to progress are the towns. Sewerage issues are not being dealt was well enough. Councils have to be threatened with prosecution to get action. It is all about money. No one wants to pay for it. City people don't care about estuaries and don't know that anything can be done.
- The biggest challenge for the community is communicating with the public around perception and reality. There are not a lot of easy to read signs for the lay person. People need to understand the resource, what has happened and what needs to change e.g. separating reality and perception for stormwater – it may be a concern or may be not
- Sewerage is a major issue with non-compliant discharges.

8 References

MARKET ECONOMICS

Beef and Lamb New Zealand, 2013. Mid-Season Update 2012-13. Wellington: Beef and Lamb New Zealand.

Beef and Lamb New Zealand, 2012. Compendium of NZ Farm Facts: for the year at 30 June 2010. Wellington: Beef and Lamb New Zealand.

Behrens, A., Giljum, S., Kovanda, J. and Niza, S. 2007. The material basis of the global economy worldwide patterns of natural resource extraction and their implications for sustainable resource use policies. Ecological Economics 64. Pp. 444-453.

Dairy New Zealand, 2012. NZ Dairy Statistics 2011-12. Date accessed: 20/03/2013. Accessed from: http://www.dairynz.co.nz/file/fileid/45159

Environment Southland (undated) Resource Consents for Dairy Farming Background Information. Accessed: 21/03/2013. Accessed from http://www.es.govt.nz/media/4825/dairy-discharge-to-water.pdf

Environment Southland, 2013. Farmer's rough guide to environment southland's rules. (Updated January 2013) Accessed: 21/03/2013. Accessed from http://www.es.govt.nz/media/4964/farmers_rough_guide_to_environment_southland_s_rules-web.pdf

Environment Southland, 2011. State of the Environment: Groundwater Quantity Technical Report. Report prepared by Karen Wilson for Environment Southland. February, 2011. Accessed 21/03/2013. Accessed from: http://www.es.govt.nz/

Environment Southland, 2010. Our Uses, Southland Water 2010: Part 3. Invercargill: Environment Southland. Date accessed: 21/03/2013. Accessed from: http://www.es.govt.nz/environment/monitoring-and-reporting/state-of-the-environment/water-2010/

Gullego, B. and Lenzen, M. 2005. A consistent input-output formulation of shared producer and consumer responsibility. Economics Systems Research, 17 (40) pp. 365-391.

Hejazi, M., Edmonds, J., Chaturvedi, V., Davies, E. and Eom, J. 2013. Scenarios of global municipal water-use demand projections over the 21st century. Hydrological Sciences Journal.

Jensen, R.C. and West, G.R. 1988. An operational hybrid or partial survey system for the construction of regional and interregional input-output tables: the 'GRIT' system. Paper presented at the Conference on the Construction and Use of Input-Output Models, Alpine Lake Resort, WV.

Miller, R.E. and Blair, P.D. 2009. Input-Output Analysis: Foundations and Extensions. Cambridge University Press, Cambridge, UK.

Ministry for Primary Industries, 2012. Briefing note to the Incoming Minister

New Zealand Aluminium Smelters Ltd, 2012a. Media Statement - New Zealand Aluminium Smelters Limited completes 2012 organisational restructure. 3rd December 2012. Date accessed: 19/03/2013. Accessed from: http://www.nzaluminium.co.nz/index.php?pageLoad=134

New Zealand Aluminium Smelters Ltd, 2012b. Media Statement - New Zealand Aluminium Smelters Limited halts $70 million in capital expenditure, 29th October 2012, Date accessed: 19/03/2013. Accessed from: http://www.nzaluminium.co.nz/index.php?pageLoad=134

OECD, 2011. OECD-FAO Agricultural Outlook 2011-2020. OECD Publishing and FAO

Peterson, S. and Klepper, G. (2007): Potential impacts of water scarcity on the world economy, In: Lozá, José L., Grassl, H., and Hupfer, P. (eds.): Global change - enough water for all?, ISBN 3-9809668-2-8, Wiss. Auswertungen [u.a.], Hamburg, pp. 263-267, http://hdl.handle.net/10419/4143.

Russell, S., Frame, B. and Lennox, J. (eds.) 2011. Old Problems New Solutions. Integrative research supporting natural resource governance. Lincoln, New Zealand: Landcare Research.

Statistics New Zealand: Subnational Population Estimates as at 30 June 2012. Date accessed: 19/02/2013.
http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/SubnationalPopulationEstimates_HOTPYe30Jun12.aspx

Tertiary Education Commission, 2012. 2011 Labour market and economic profile: Southland (Revised June 2012). Wellington: Infometrics Ltd.

Venture Southland and Southland NZ (undated) Economic Profile.

West, G.R., Wilkinson, J.T. and Jensen, R.C. 1980. Generation of Regional Input-Output Tables for the Northern Territory GRIT II. Report to the Northern Territory Department of the Chief Minister. St Lucia, Queensland: Department of Economics, University of Queensland.

NIMMO-BELL

ENVIRONMENT SOUTHLAND 2010. Regional water plan for Southland (amended in accordance with Council and Environment Court decisions), March 2010. Publication No 2011-04.

ENVIRONMENT SOUTHLAND 2011a. Our Health. Southland Water 2010: Report on the state of Southland's freshwater environment, Part 1. 60p.

ENVIRONMENT SOUTHLAND 2011b. Our Ecosystems. Southland Water 2010: Report on the state of Southland's freshwater environment, Part 2. 95p.

ENVIRONMENT SOUTHLAND 2011c. Our Health Water 2010. Southland wide results: Faecal coliforms – State and trends SOE sites http://www.es.govt.nz/media/10086/water-2010-our-health-southland-wide-results.pdf downloaded 11.01.13

ENVIRONMENT SOUTHLAND 2011d. Our threats: how safe are we from floods, droughts and other extreme climatic events?, part 4 of Southland Water 2010, report on the state of Southland's freshwater environment ES 2011/6, 47p.

ENVIRONMENT SOUTHLAND 2011e. Our Uses: How do we use our water and is there enough for our different needs? Part 3 of Southland Water 2010: Report on the State of Southland's Freshwater Environment.

ENVIRONMENT SOUTHLAND, Invercargill, publication number 2011/13, 69p.

ENVIRONMENT SOUTHLAND 2011f. Reference list for Our Health: Is our water safe to play in, drink and gather kai from? Part 1 of Southland Water 2010: report on the State of Southland's Freshwater Environment. http://www.es.govt.nz/media/10077/water-2010-our-health-reference-list.pdf

ENVIRONMENT SOUTHLAND 2013a. E. coli – Trends freshwater bathing sites. http://www.es.govt.nz/media/10080/water-2010-our-health-freshwater-bathing-sites.pdf

ENVIRONMENT SOUTHLAND 2013b. Water quality trends at Southland SOE monitoring sites over 5-10 years (to 30 June 2010). http://www.es.govt.nz/media/14052/10_year_water_quality_trends_2.pdf

ENVIRONMENT SOUTHLAND 2013c. Faecal coliforms – state and trends shellfish gathering sites. http://www.es.govt.nz/media/10083/water-2010-our-health-shellfish-sites.pdf

ENVIRONMENT SOUTHLAND 2013d. Living streams. http://www.es.govt.nz/environment/water/living-streams/. Downloaded 14.1.13

ENVIRONMENT SOUTHLAND 2013e. Guidelines for dairy farm effluent irrigation. http://map.es.govt.nz/Departments/LandSustainability/fde/guidelines/index.aspx. Downloaded 17.1.13.

ENVIRONMENT SOUTHLAND 2013f. Farmers rough guide to Environment Southland's rules, 4p. www.es.govt.nz/environment/land/summary_of_rules. Downloaded 17.1.13

ENVIRONMENT SOUTHLAND 2013g. Dairy Conversion Farm Environmental Plan (2, Draft), Environment Southland, 18p.

ENVIRONMENT SOUTHLAND 2013h. Nutrient comparison-raw effluent produced, 1p, pers comm. Emma Moran 18.1.13.

ENVIRONMENT SOUTHLAND 2013i. Best practice Guide: Freshwater Quality Non Statutory Tools (Living Streams), 13p.

ENVIRONMENT SOUTHLAND 2012. Environmental Compliance Monitoring Report 2011/12. Report by Environment Southland Compliance Division, Environment Southland Publication No 2012/17, 113p

ENVIRONMENT SOUTHLAND 2012b. Waihopai Alive, newsletter of the Living Streams program and the Waihopai catchment, July 2012.

ENVIRONMENT SOUTHLAND 2012c. Southland's community outcomes: monitoring report 2009-2012, August 2012, 74p. http://www.ourwaysouthland.org.nz/documents/ows-community-outcomes-report-2009-12.pdf. Downloaded 24.1.13.

Hoffmann, P. 2012. Proposed extension of Foulsewer into Kennington. Letter re invitation to meeting, 26 September 2012, 2p.

Hamill, K. 2011. Southland Water 2010: Our Ecosystems Technical report for lakes and lagoons. Prepared for Environment Southland by Opus International Consultants Limited. Http://www.es.govt.nz/media/13926/our_ecosystems_-_technical_report_for_lakes_and_lagoons.pdf

Hudson, H.R. 2013. Sustainable drainage management Field guide. NZ Water Environment Research Foundation, 26p. www.es.govt.nz/environment/land/sustainable_drainage_management downloaded 17.1.13.

Joy, Mike 2013. Freshwater fish in the Southland Region: spatial distribution in relation to landcover and temporal trends. A report prepared for ES by Wairesearch Limited. http://www.es.govt.nz/media/13938/freshwater_fish_in_the_southland_region_-_index_of_biotic_integrity.pdf

Kerr, G.N., Sharp, B.M.H. and Leathers, K.L. 2004. Instream Water Values: Canterbury's Rakaia and Waimakariri Rivers, Research Report No. 272, Agribusiness and Economics Research Unit, Lincoln University, Canterbury.

Liquid Earth 2010. State of the environment: Groundwater Quality Technical Report. http://www.es.govt.nz/media/18168/soe-groundwater-technical-report.pdf

Liquid Earth, Aqualinc Research, Harris Consulting 2011. Mataura catchment strategic water study. A report prepared for Environment Southland, May 2011, 184p.

Ngāi Tahu 2008. The Cry of the People Te Tangi a Tauira. Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008, 316p.

NIWA 2011. Impacts of land use and farm mitigation practices on nutrients, application of CLUES to the Mataura Catchment. Prepared for Environment Southland, March 2011, 40p.

Research First Limited 2010. Quality of life research report. Prepared for Our Way Southland, September 2010, 83p. Downloaded 24.1.13. http://www.ourwaysouthland.org.nz/documents/2010-southland-qol-report.pdf

Robertson, B and L. Stevens 2012. New River Estuary Fine Scale monitoring of highly Eutrophic Arms 2011/12. A report prepared for Environment Southland, July 2012, 29p.

Robertson, B and L. Stevens 2012. Jacobs River Estuary Fine Scale monitoring of highly Eutrophic Arms 2011/12. A report prepared for Environment Southland, October 2012, 29p.

Sharp, B. and Kerr, G. 2005. Option and Existence Values for the Waitaki Catchment. Report. Prepared for the Ministry of Environment, Wellington.

Southland District Council 2013. Resource consent application process – consultation process with iwi, brochure 2p. http://www.southlanddc.govt.nz/assets/Uploads/Consultation-with-Iwi.pdf. Downloaded 15.1.13.

Te Ao Marama Inc. 2013. Resource Consent Application, Consultation Process with Iwi agreed between Environment Southland, Invercargill City Council, Southland District Council, Gore District Council and Te Ao Marama, 2p.

Topoclimate 2013. http://gis.es.govt.nz/topoclimate/index.aspx Downloaded 17.1.13

Versus Research Limited 2012. Environment Southland residents' opinion survey main results 2012. A report prepared for Michele Poole, Communications Officer, Environment Southland, 114p.

Wilson, K. 2011. State of the Environment: Groundwater Quantity Technical Report, ES February 2011, 91p.

Wilson, K., Meier, K., Larkin, G. and Hicks, A. 2012. Water Quality Methodology for

Southland Water 2010 Report, ES, 1 June 2012.
http://www.es.govt.nz/media/20900/state_of_the_environment_water_2010_water_quality_methodology_report_final_version_pdf.pdf

Yao, R. & Kaval, P. (2007). Non market valuation in New Zealand: 1974 through 2005. (Department of Economics Working Paper Series, Number 17/07). Hamilton, New Zealand: University of Waikato.

9 Appendices

Appendix 1: Process, Assumptions, Limitations and Caveats

The project relies heavily on Environment Southland's consent and monitoring datasets to provide information about the scale of water use in the region. As such it was necessary to work through the consent and monitoring datasets extracting all the relevant information, identifying any gaps and issues and then implementing measures to overcome/address the gaps. The mains steps followed to set-up a dataset fit for our purpose are outlined below. Where applicable, important assumptions, limitations and caveats are highlighted.

Base data was obtained from Environment Southland. This data contained over 11,000 records (consents). We received the following:

- A dataset with all consents e.g. water take and discharge n >11,000),
- A dataset showing actual takes over time (n = 848),
- A dataset with telemetered data showing water takes per day (n = 42),
- A dataset showing nutrient concentrations for 11 sites (n = 11).

The first step was to extract all water related consents out of the full list. This reduced the number of consents dealt with to around 6,000. These datasets were reviewed and, where possible, related to each other using consent numbers.

The data contained within the resource consent databases was then filtered using a number of 'rules' to ensure that only relevant details were used in the analysis. The following exclusions were made during the filtering process.

- Occurrences of storm water discharges were excluded from the water accounts because it was not possible to determine reasonable estimates of discharge volumes. Caveat: In some cases storm water and wastewater were included in a single consent. In these cases the consent was left in the dataset.
- There are a number of hydroelectric power schemes that tend to account for large water takes and discharges. Caveat: These were left in the dataset and are included when 'counting' the number of consents but are excluded from calculations where water take/discharge volumes are used.
- Diversions, and consents for the damming and boring of water, were excluded because water was not actually taken for a use but simply diverted.
- Resource consents for herbicide spraying (weed control) and bait drops were excluded because insignificant amounts of water were being used, and because of difficulties associated with calculating annual water quantities.
- Resource consents for intermittent uses, such as for flood control, fire fighting and construction, were also omitted. Caveat: Some consents appear to allow of 'emergency' take or discharge. These were left in the dataset because they represent ***a potential take/discharge.***
- When core information concerning a particular consent was missing then the consent was also removed from the database. Such details included a distinction between abstracted or discharged or time data.

- The Resource Consent databases were checked for duplicate records, and where duplicates existed they were eliminated. This check was required when consents were replaced by a new consent and references to both old and new consents were still stored in the database.
- The consent descriptions were reviewed and the water values were extracted so that the maximum consented value could be used in the calculations. In some cases Environment Southland had already supplied maximum annual water take and discharge totals and for these consents, so there was no need to carry out this stage. However, for most consents where only daily take and discharge data was available the following method was employed to convert daily allocations to a yearly total:
    - [Maximum daily value] x [active days]: for the majority of resource consents maximum daily values were multiplied by the number days in the year to give an annual water flow total.
    - [Maximum daily value] x [active days] x [frequency estimate]: for other resource consents the maximum daily quantity variable was multiplied by the number of active days and a frequency estimate to fully reflect fluctuations in water use over the year (we noted that in cases where seasonal limits were associated with the consents the consent was written in a way that clearly stipulates the implied annual maximum.
- The consents were put on a timeline with full years (using year ending 31 March). Consents active between 1/04/2000 and 31/03/2012 were included in the analysis.

***Caveat**: if a consent covered only part of year (e.g. it expires in then it was excluded from that year. This means that in some instances the annual consented maximums and abstractions might be understated.*

Next the consents were linked to one of 48 economic sectors. These sectors correspond to the sectors used in M.E's Economic Futures Model. This was done by considering the five consent fields:

- Purpose (n=5096),
- Type (n=2),
- SubType (n=7),
- Contaminant (n=199),
- Type_purpose (150).

Caveat: We used our own interpretation of the above fields, meaning that in some cases our sectoral classification might differ from Environment Southland's classification. This could be the case where the Type_purpose field states that a consent is for pasture irrigation but the 'Contaminant' might be dairy shed. In such cases we assigned 'dairy cattle farming' to the consent (as opposed to livestock and cropping).

With the economic sectors known/assigned to consents, it was possible to compile the missing data by estimating/deriving estimates on a per sector basis. This was done as follows:

- **Water take permits (abstractions):** We used information from consents where consent maximum and actual abstraction volumes were known. This was used to estimate the share of consented

maximum actually used each year. Next we looked at each sector individually and determined the percentile distribution (percentage of consent actually used for each year). We used the 70th percentile because this resulted in an 'average use consented maximum of 28% in 2009/10' – this is on par with the Environment Southland's finding as published in its Groundwater Quantity Technical Report. A table with the resulting 'percentage of consent used for each year was prepared and some gaps were found. These gaps were addressed on a case-by-case basis and removed using statistical methods. With the resulting dataset abstractions for all sectors were estimated (by multiplying the consented maximum with the estimated share of consent used). The estimated abstractions (addressing consents with unknown values) were added to known abstractions resulting to give a full picture of abstractions. This processes covered both groundwater takes and surface water takes.

***Caveat**: Some sectors had limited coverage with few 'complete' consents. While using the percentile approach yielded better results than using averages the smaller number complete consents reduces the robustness of the estimates. In some instances, abstractions were more than 150 per cent of the consent maximum. These cases were excluded when we estimated the percentile distribution.*

The only consents not included in our analysis relate to hydro-electric power generations. However, the consent counts associated with this sector is captured but the associated volumes are excluded from the 'water take' calculations.

- **Water discharge data:** Over half of discharge consents (1645 out of 2018) are related to dairy cattle farming. These consents included a maximum threshold expressed in terms of cow numbers. The cow numbers were translated into discharge volumes using 50 litres per cow per day for dairy shed use (we included a seasonal use pattern) and up to 70 litres per cow per day as stock water. A discharge total was estimated (using the dairy shed allowance).

***Caveat**: Changing the dairy shed allowance will affect the estimated discharge and nutrient loads*.

The number of cows (maximum allowed) was multiplied with the water requirement per day giving a maximum discharge figure. However the consented maximum cows (per year) was reduced to match the total number of cows in Southland as estimated by the Livestock Improvement Corporation and Dairy NZ. Between 2000/01 and 2011/12 the estimated number of cows was 91 per cent of the maximum number of cows (as per consents and in-line with Environment Southland estimates). This can be seen as a proxy for how much of the consented discharge is used.

***Caveat*: Stock water is not included in the discharge calculated but it is possible to include stock water into the discharge (using 73 per cent of the 70 litres per cow per day to reflect the average use).**

With reference to the non-dairy cattle farming consents, these consents are concentrated in mining and quarrying (74), meat and meat product manufacturing (30) personal and community services (61) and the rest of the economy. Gaps in the discharge data were addressed using a similar approach as that used to address the gaps in the water take consents. The main difference is that instead of the 70th percentile, this analysis used the 50th percentile. Essentially this uses the median (as opposed to the average) observation mitigating the effects of large outliers.

Caveat: The number of situations where consented maximum and actual discharges were known was limited with average sector coverage of 38 per cent – we used available information to address the gaps in the wiser dataset. Better or more comprehensive data will improve the underlying robustness of the analysis.

- In three cases all discharges were covered with actual data (i.e. 100 per cent coverage) but in five sectors (covering 22 consents) no data was available. In 2011/12 the maximum consented discharge associated with these problem areas captured 48,000 cubic metres of discharge of a possible 62 million cubic metres.

- **Nutrient loads**: To complete the water accounts it was necessary to insert water quality information. We received nutrient load information from Environment Southland's monitoring dataset but this set contained ten useable records. We use the nutrient concentrations contained in this data to estimate the total nutrient loads for meat and meat product manufacturing and personal and community services. We modelled the nutrient loads (N and P) for these sectors using the nutrient concentrations combined with the estimated discharge volumes and reported the results of the low and the high concentrations in addition to the median. We note that the monitoring data did not cover total flows and therefore we relied strictly in the nutrient concentrations as contained in the monitoring dataset.

Caveat: While meat and meat product manufacturing's nutrient concentrations are likely to be similar it is possible that smaller operators could have higher nutrient concentrations in their discharges meaning that total N and P could be understated. The nutrient concentrations for personal and community services as extracted from the monitoring dataset mostly covers town treatment plants and treated sewerage discharges. Some activities associated with this sector could be of a smaller scale with different nutrient concentrations meaning that the estimated nutrient loadings might of over or understated.

With reference to dairy cattle farming, livestock and crop farming and forestry, information from NZIER was used to derive the N and P loads. The nutrient loads for these sectors were based on activity (and not discharges). We used stock numbers from Beef and Lamb NZ, the LIC/Dairy NS and information form the Ministry of Primary Industry (MPI) to estimate the level of activity between 2000/01 and 2011/12. NZIER's 2012 nutrient loads for these sectors were applied to estimate sectoral nutrient loads in preceding years.

Limitations

As mentioned earlier, this study relied heavily on Environment Southland's resource consent and monitoring datasets. Throughout the analysis phase initial results were compared against published information. In most cases our results and the findings correspond broadly with the published values but in some cases large variances are evident. This is particularly evident in the case of surface water abstractions.

In our analysis we relied solely in the information in the database – we applied a set of 'rules' across all sectors and did not remove sectors or consents on an *ad hoc* basis. It will be necessary to verify our results with Environment Southland since local knowledge may result in some consents being excluded from their analysis – for example, we recognise that:

- A valid consent might be contained in the dataset but due to local forces the consent might not be exercised (e.g. a business may have closed and the consent record still active),
- Data recording issues e.g. wrong unit recorded i.e. cubic metres per day vs. litres per day, and
- Environment Southland may have applied a specific rule(s) when estimating surface and ground water takes. These rules might reflect specific knowledge about individual consents which are not necessary reflected in the consent database.

In addition to the above points, it is important to note that:

- Our analysis does not include the abstractions, discharges and nutrient loads of permitted activity. Under Environment Southland's policies some activities do not need consent to abstract and/or discharge (comparatively) small volumes. An extract of Environment Southland R2D2 database contains a list of 1,800 permitted activities (consented). However only 13 of these would be included in our study if we applied an approach similar to when we cleaned the resource and monitoring consent data.
- The Regional Water Plan (Section 2.1) provides a useful guide to identify permitted activities. In general these relate to smaller abstractions (up to 20,000 litres per day for ground water and up to 10,000 litres per day for surface water; with restrictions on the rate of take for dairy farms) and discharges with conditions applied to the takes/discharges. The exact scale of permitted activities taking place is unknown and excluded from the analysis.
- In our analysis we did not distinguish between individual catchments. It is possible to extend our analysis to run at a catchment level. However, given data paucity in some sectors in some catchments, it might be necessary to use average regional water use and discharge figures to address catchment level gaps. According to Environment Southland, such a catchment-based analysis may not be necessary if catchment-based limitations are taken into account. For example, the Conservation Orders on the Mataura and Oreti catchments, and the over-allocation in the Waiau catchment due to the Manapouri power scheme negates the need for detailed catchment level analysis in these two catchments.
- We looked at abstractions and discharges individually and did not attempt to reconcile/relate individual users' water takes and discharges. Such reconciliation could provide additional insights into sectoral water balances (water in vs. water out).
- We did not audit or check the R2D2 dataset. We assumed that the dataset was accurate and without any errors. As such we assumed that any seasonal limits (and maximum takes) were reflected in the consents.
- Our analysis looked at the nutrient loads discharged, via water, to Southland's environment and did not include:
    - Nutrients embodied in the goods and services imported into, and exported from, Southland;
    - Nutrients discharged in solid or gaseous formats.

This study used an Input-Output model to show the economic linkages within and between sectors in Southland, the rest of the South Island and the rest of New Zealand. IO models have a number of limitations and in the context of this study the main limitations are:

- The results are based on approximations of Southlands economic/sectoral input-output results and it is assumed that these relationships are constant.
- The economic structure and relationships are based on the 2006/7 Supply-Use tables. This is the best available data but it is getting dated,
- The IO model does not account for price changes that may result from increased competition for scarce resource.
- We assumed that all firms within a sector have common production processes.
- In the context of this study we assumed that the all resources needed to operate are available i.e. the model is demand driven and not constrained.

Appendix 2: Sector list

$'2012	Value Added 2007 NZ$m	Value Added 2011 NZ$m
Horticulture and fruit growing	8.7	9.9
Livestock and cropping farming	316.5	277.9
Dairy cattle farming	200.2	362.7
Other farming	13.9	16.8
Services to agriculture, hunting and trapping	49.8	35.7
Forestry and logging	31.0	35.4
Fishing	30.5	21.6
Mining and quarrying	28.1	37.3
Oil and gas exploration & extraction	-	-
Meat and meat prod manufacturing	567.5	652.6
Dairy prod manufacturing	131.4	96.0
Other food manufacturing	40.0	43.2
Beverage, malt and tobacco manufacturing	1.6	2.0
Textile and apparel manufacturing	13.0	5.9
Wood production manufacturing	57.8	47.4
Paper and paper production manufacturing	-	0.0
Printing, publishing & recorded media	25.1	21.1
Petroleum and industrial chemical manufacturing	13.4	16.5
Rubber, plastic and other chemical manufacturing	3.0	6.2
Non-metallic mineral prod manufacturing	15.8	15.1
Basic metal manufacturing	284.1	275.9
Sheet and fabricated metal prod manufacturing	57.7	44.6
Trans equipment manufacturing	15.4	16.1
Machinery and equipment manufacturing	28.9	29.3
Furniture and other manufacturing	5.1	4.5
Electricity generation and supply	57.7	81.5
Gas supply	-	-
Water supply	3.7	3.9
Construction	208.0	199.9
Wholesale trade	143.8	127.7
Retail trade	146.2	147.2
Accommodation, restaurants and bars	62.0	57.7
Road transport	67.5	62.2
Water and rail transport	43.3	46.6
Air transport, services to transport and storage	17.5	19.4
Communication services	29.7	29.7
Finance	78.1	80.4
Insurance	5.3	9.0
Services to finance and investment	14.1	21.0
Real estate	170.2	190.2
Owner-occupied dwellings		
Business services	108.5	116.9
Central government	42.3	57.5
Local government	44.7	70.7
Education	57.3	74.2
Health and community services	134.3	163.4
Cultural and recreational services	36.7	42.9
Personal and other community services	30.1	42.3

Appendix 3: Key sector alignment with Southland Economic Profile report

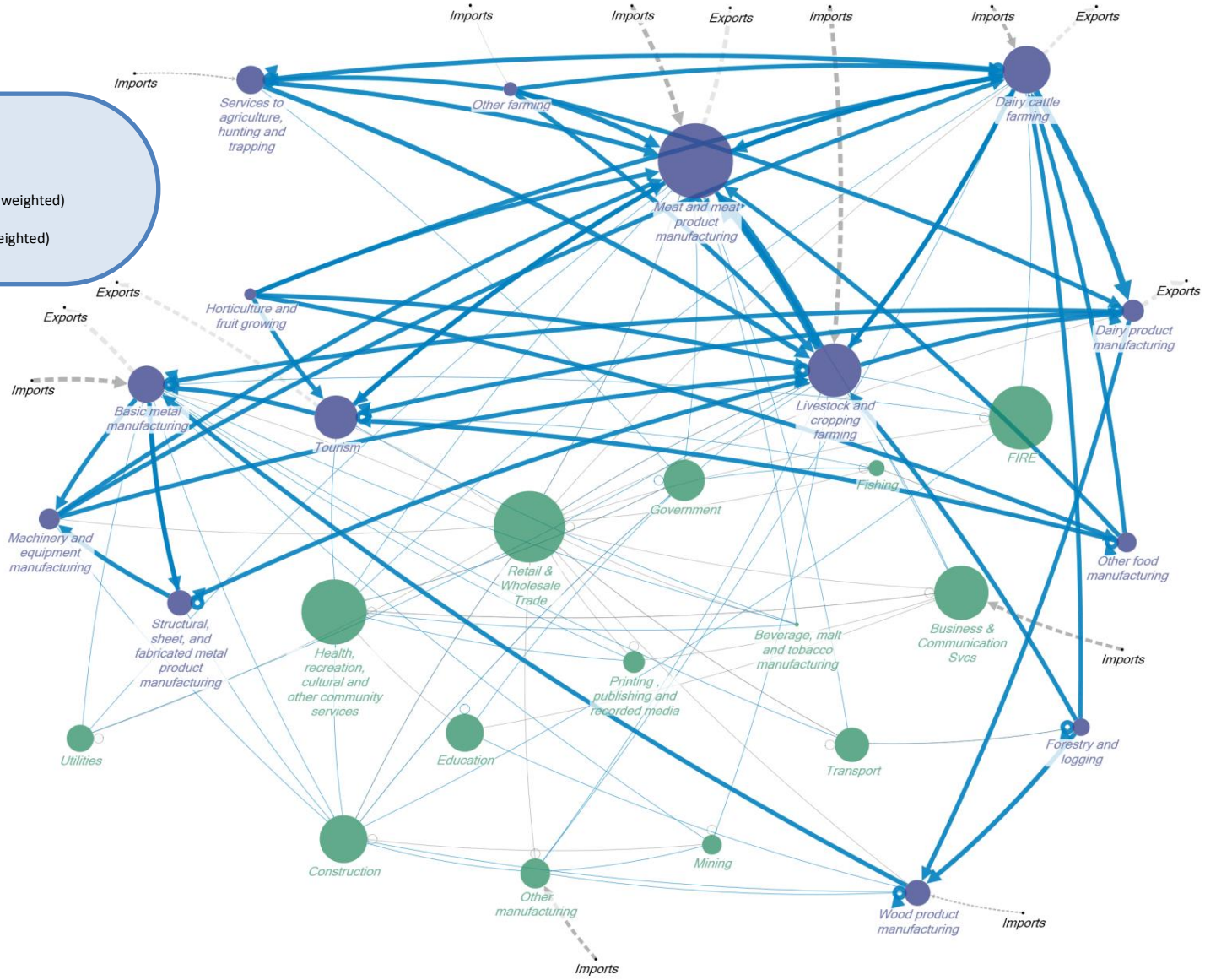
M.E Sectors	Southland Economic Profile Sectors
Dairy product manufacturing	Food processing
Meat and meat product manufacturing	Meat and wool
Other food manufacturing	Food processing
Sheet and fabricated metal product manufacturing	Manufacturing
Basic metal manufacturing	Manufacturing
Livestock and cropping farming	Food processing
Dairy cattle farming	Food processing
Accommodation, restaurants and bars	Tourism
Wood product manufacturing	Manufacturing
Forestry and logging	Forestry
Machinery and equipment manufacturing	Manufacturing
Services to agriculture, hunting and trapping	Primary industries
Other farming	Crops and horticulture

Sectors not directly included in M.E process, but included in Southland Economic Profile are:

- Energy
- Science and Research
- Education
- Infrastructure
- Business and Professional Services.

Appendix 4: Key Sectors' Forward Linkages

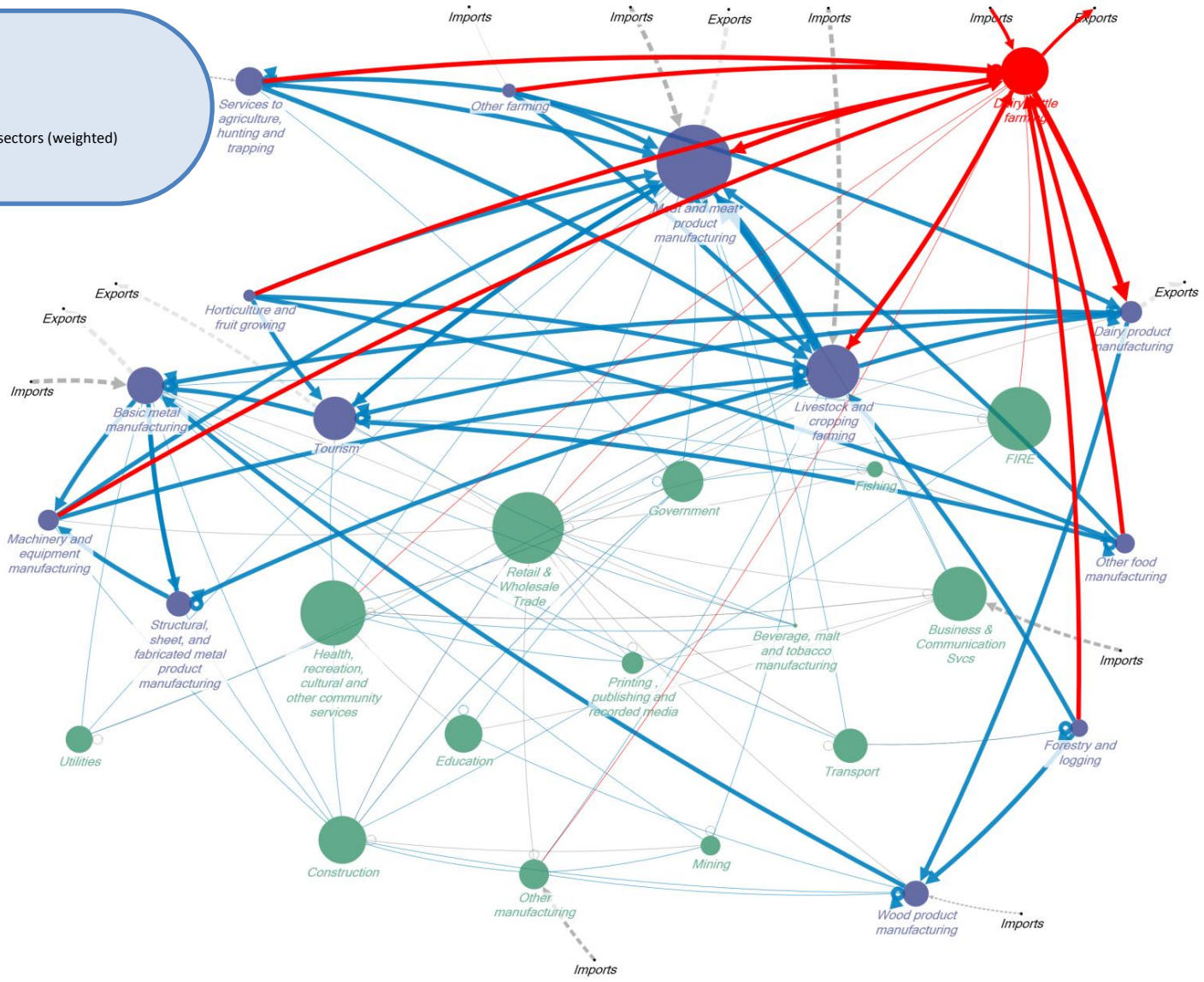
Legend:
Size of Bubble – Value Added (2011)
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy
Grey lines – backward linkages of other sectors (not weighted)



Appendix 5: Individual Key Sectors' Linkages

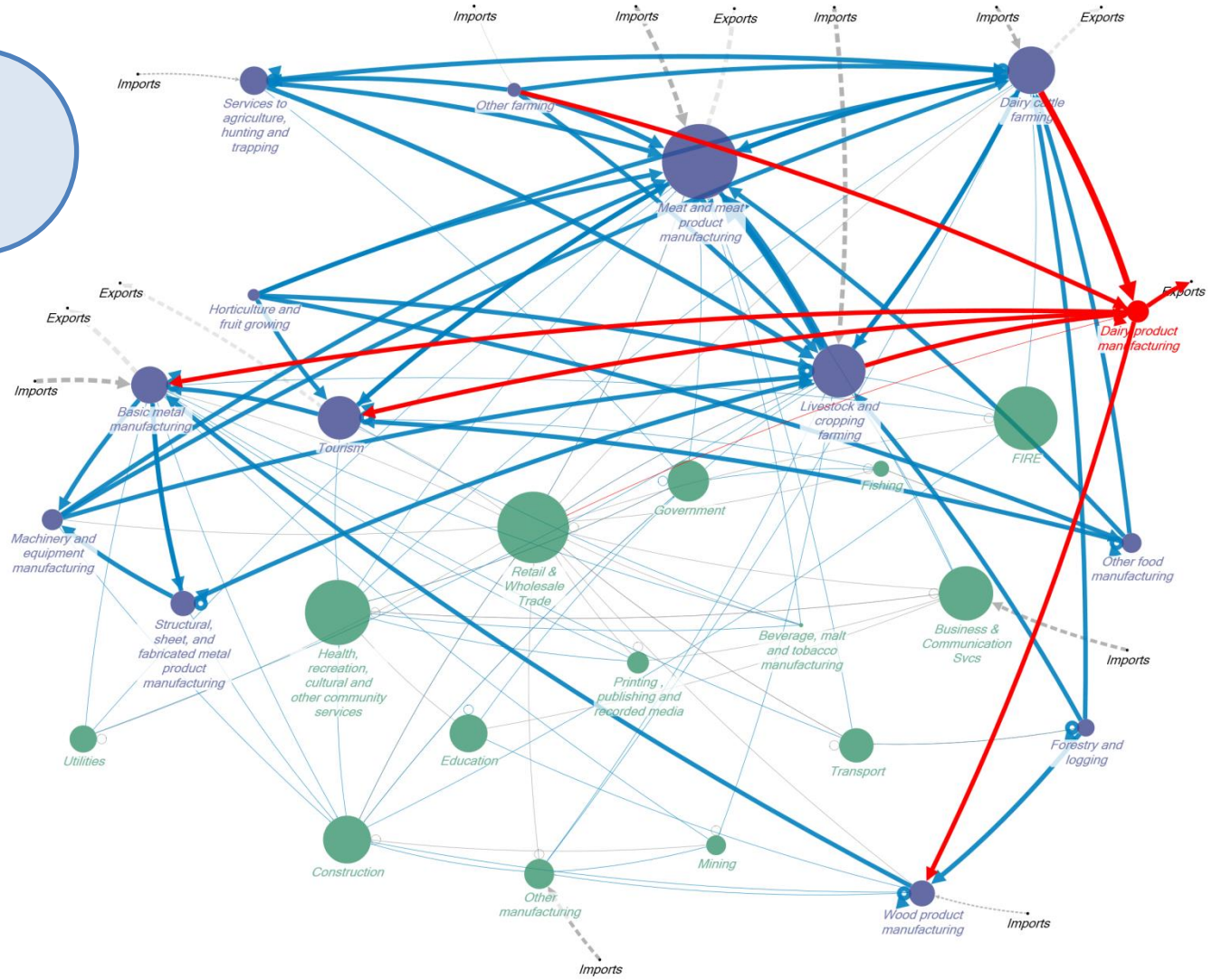
Dairy Farming: Top Forward and Backward Linkages

Legend:
Size of Bubble – Value Added (2011)
Red bubble and lines – selected sector
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy



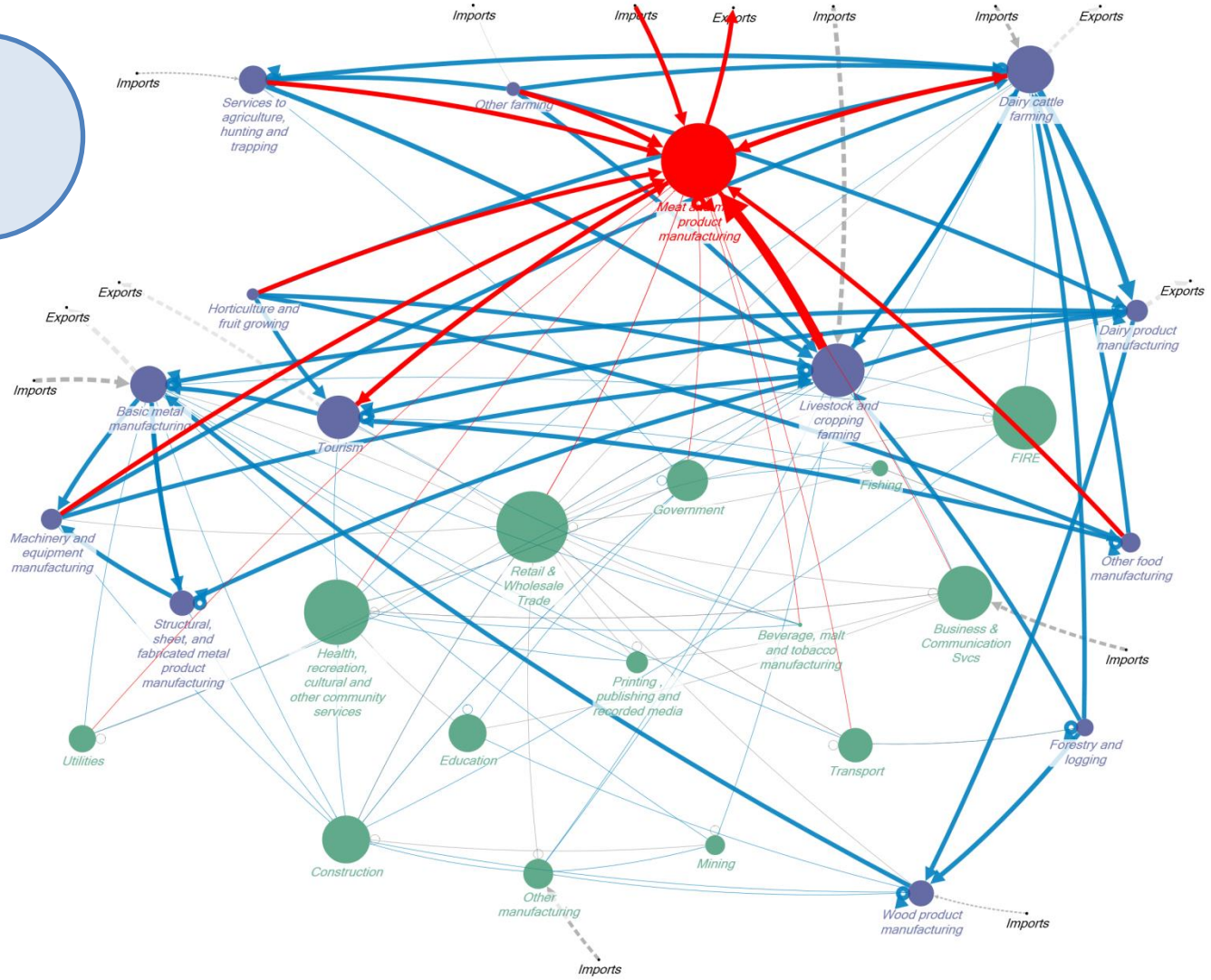
Dairy Product Manufacturing: Top Forward and Backward Linkages

Legend:
Size of Bubble – Value Added (2011)
Red bubble and lines – selected sector
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy



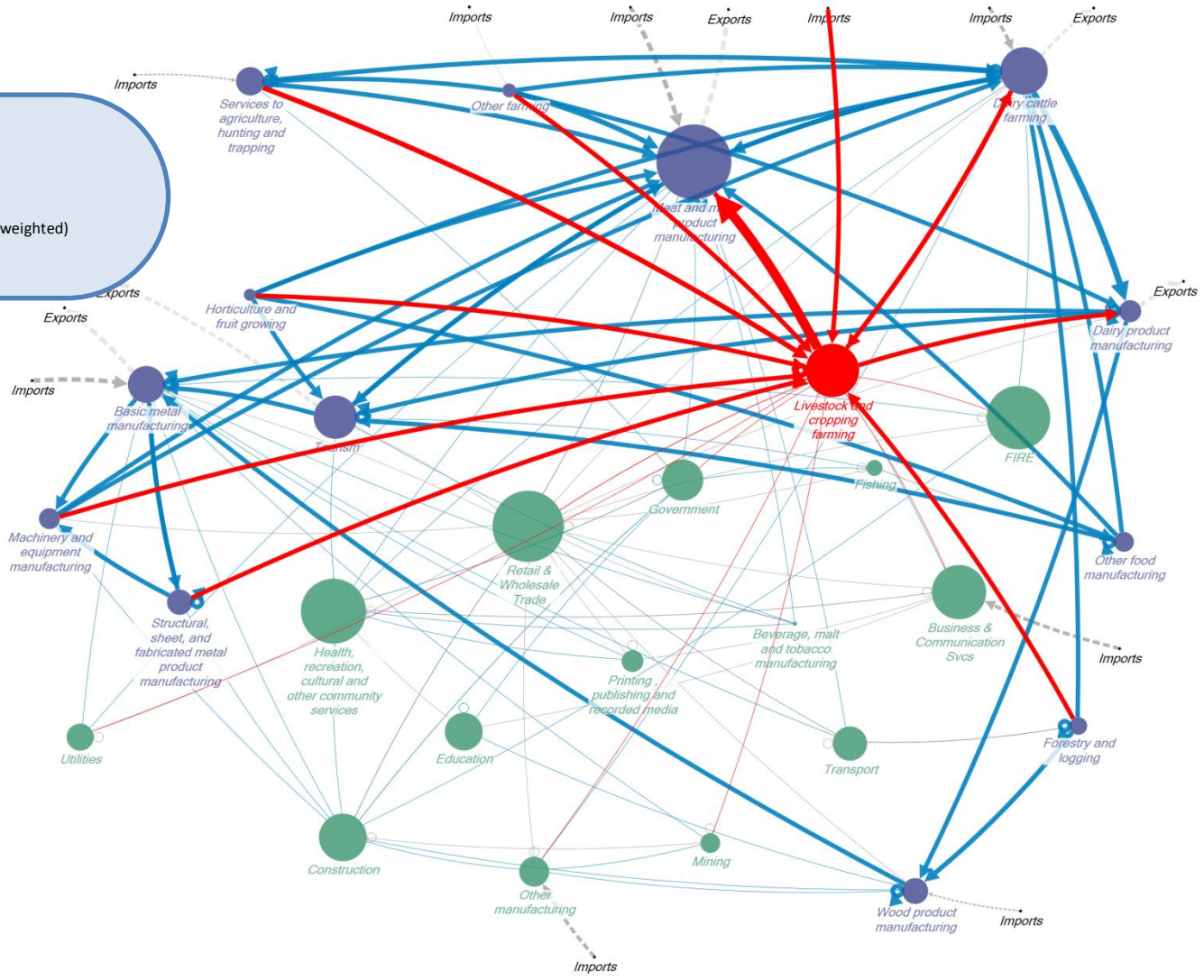
Meat and Meat Product Manufacturing: Top Forward and Backward Linkages

Legend:
Size of Bubble – Value Added (2011)
Red bubble and lines – selected sector
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy



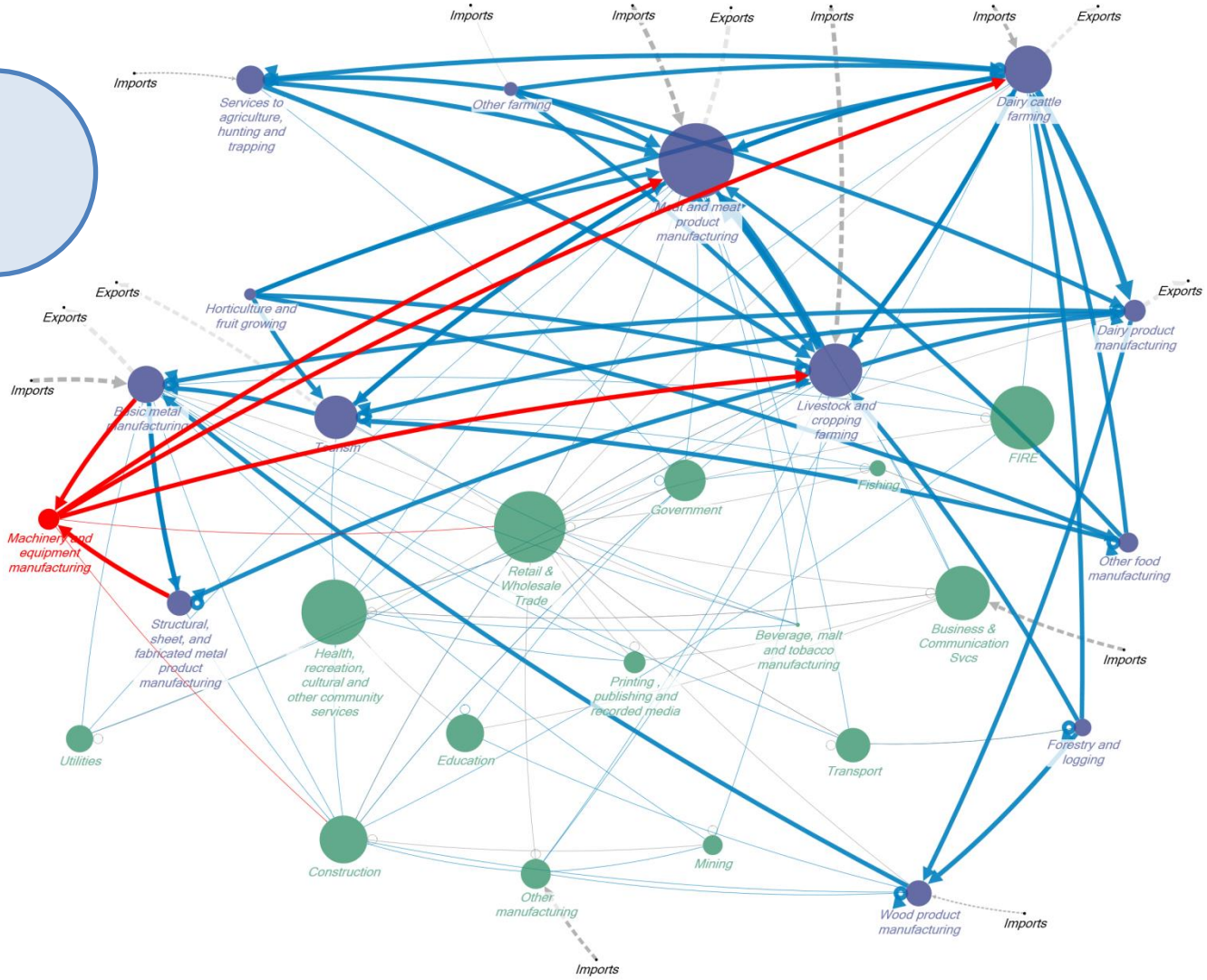
Livestock and Crop Farming: Top Forward and Backward Linkages

Legend:
Size of Bubble – Value Added (2011)
Red bubble and lines – selected sector
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy



Machinery and Equipment Manufacturing: Top Forward and Backward Linkages

Legend:
Size of Bubble – Value Added (2011)
Red bubble and lines – selected sector
Blue bubbles – Key Sectors
Blue Arrows – Top 5 backward linkages of key sectors (weighted)
Green Sectors – rest of the economy



Appendix 6: Low and High Estimates

Share of allocation used (Low) – Selected Sectors.

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Livestock and cropping farming	3%	3%	3%	3%	16%	33%	2%	2%	4%	24%	45%
Dairy cattle farming	16%	16%	16%	16%	13%	17%	16%	18%	18%	29%	31%
Other farming	0%	0%	0%	0%	15%	11%	9%	72%	65%	28%	65%
Meat and meat product manufacturing	23%	23%	34%	16%	20%	18%	15%	0%	23%	7%	8%
Dairy product manufacturing	26%	26%	8%	35%	36%	36%	32%	39%	40%	45%	51%
Beverage, malt and tobacco manufacturing	51%	51%	55%	61%	38%	53%	94%	18%	79%	121%	92%
Wood product manufacturing	3%	3%	3%	3%	2%	1%	2%	4%	6%	50%	44%
Basic metal manufacturing	17%	17%	17%	42%	12%	4%	9%	14%	10%	33%	45%
Accommodation, restaurants and bars	13%	6%	17%	15%	12%	16%	26%	29%	32%	40%	36%
Cultural and recreational services	35%	35%	87%	33%	10%	9%	27%	28%	0%	45%	8%

Source: Calculations based on ES Consent Database

Share of allocation used (High) – Selected Sectors.

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Livestock and cropping farming	21%	21%	21%	21%	18%	43%	16%	14%	27%	28%	53%
Dairy cattle farming	45%	42%	53%	39%	35%	43%	45%	52%	48%	66%	64%
Other farming	0%	0%	0%	0%	30%	23%	18%	131%	130%	56%	130%
Meat and meat product manufacturing	16%	64%	81%	80%	45%	61%	72%	14%	41%	38%	30%
Dairy product manufacturing	24%	12%	31%	27%	17%	38%	39%	53%	53%	62%	66%
Beverage, malt and tobacco manufacturing	46%	46%	55%	46%	38%	53%	94%	18%	79%	121%	92%
Wood product manufacturing	0%	0%	0%	19%	14%	9%	17%	29%	41%	58%	48%
Basic metal manufacturing	25%	25%	25%	54%	15%	6%	12%	18%	12%	43%	58%
Accommodation, restaurants and bars	40%	32%	51%	37%	39%	48%	64%	63%	61%	66%	80%
Cultural and recreational services	56%	56%	120%	56%	27%	15%	34%	33%	9%	72%	33%

Source: Calculations based on ES Consent Database

Appendix 7: Calculation of Water Multipliers

Impact models can measure the effect an industry's production has on other industries in the economy in two ways. If an industry increases its production, there will be increased demand on the industries that produce the inputs into the first industry's production processes. Models that measure impacts based on this type of relationship are called backward-linkage models. If an industry increases its production, there will also be an increased supply of output for other industries to use in their production. Models that measure impacts based on this type of relationship are called forward-linkage models however they are rarely used because an industry's sales pattern changes considerably faster than its input structure.

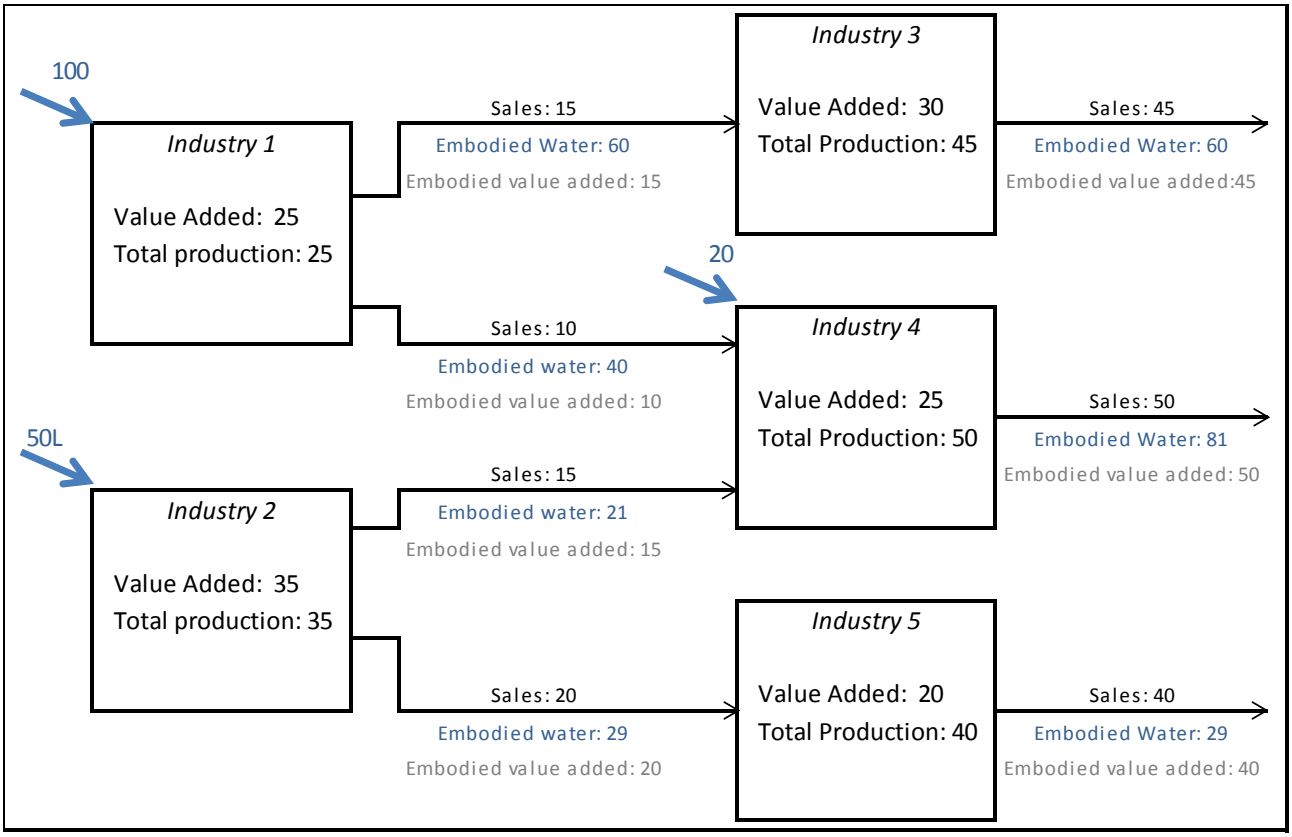
In this study water multipliers are calculated for water use, water discharge and residuals (nutrients) discharged in water. There are a variety of ways that the information obtained from these calculations can be expressed. Initially all multipliers are calculated at the level of 48 economic industries and expressed relative to economic output. For example, a water use output multiplier of 1 million cubic meters per $1 million for a hypothetical industry means that for every million dollars of economic output produced by that industry, 1 million cubic meters of water is consumed both directly and indirectly. As value added is generally considered a more meaningful measure of economic activity than output, the water output multipliers are converted to water: value-added multipliers. Thus in the example just given, if the industry generates (on average) 50 cents value added) for every one dollar of output sold, then the water multiplier expressed relative to value added is 2 million cubic meters per $1 million (1x 1/0.5).

In order to demonstrate the process for calculating ecological multipliers (and economic multipliers in general), reference can be made to the example economy shown in the figure below. Here it is assumed, for simplicity, that only Industries 1, 2 and 4 are direct users of water, at $100m^3$ $50m^3$ and $20m^3$ respectively. Although industries 3 and 5 do not use water directly, these industries do purchase goods from water using industries and these inputs to their production, as well as the goods eventually produced by these industries themselves, contain a level of 'embodied' water.

Further, Industry 4 produces $50m of goods embodying $81m^3$ of water. Around three-quarters of the total water embodied in Industry 4's output can be traced to purchases of inputs from Industries 1 and 2, and the remainder is derived from the Industry's direct water use.

A direct and indirect value added multiplier for Industry 4 in the above example can be calculated as 2.00 ($50m/$25m). Using the same approach, the direct and indirect water multiplier for the same industry is calculated as 3.24 m^3/$ value added (i.e. $81m^3$/$25m).

Example Calculation of Water Multipliers for Economic Industries



* All monetary values are in $million, water values are in 10,000 litres

Of course real world economies are more complex than the example. Economic supply chains are interconnected, with all industries ultimately involved in the supply chain of every other industry. Commodities are also introduced and removed from the system by way of interregional and international imports and exports. Reference is therefore made to a standard methodology derived from Input-Output analysis to calculate both economic and ecological multipliers. Persons who wish to learn more about the method can refer to authors such as Miller and Blair (2009).

In short, a vector of ecological (output) multipliers for any *n* number of industries, ε^{output}, is calculated as,

$$\varepsilon^{output} = e\left(I - A\right)^{-1},$$

where e is the vector of direct water use or residual production by each *n* industry. The matrix $(\mathrm{I-A})^{-1}$, commonly termed the 'Leontief Inverse Matrix' is calculated from an identity matrix (I) of dimensions *n* x *n*, as well as a matrix of technical coefficients, A, with an element a_{ij} describing for every one dollar of output produced by industry *j*, the value of purchases necessary by industry *j* from industry *i*. Note that these a_{ij} technical coefficients are derived from a multi-regional input output table (MRIOT) produced by M.E using the Generating-Regional-Input-Output (GRIT) procedure (see, for example, West et al (1980), Jensen and West (1988)). The Southland MRIOT is for the financial year 2006-07 and is based predominantly on Statistics New Zealand's Input-Output Tables and Supply-Use Tables table for New Zealand, which is for the 2006-07 year.

Once an ecological (output) multiplier is derived for a particular j industry, this can be converted into an ecological (value-added), multipliers using the equation,

$$\varepsilon_j^{va} = \varepsilon_j^{output} \times \frac{output_j}{valueadded_j},$$

where $output_j$ and $valueadded_j$ are the estimated total regional output and value added estimated for that industry.

In order to generate the time series of ecological multipliers, the vectors of industry output, value added, direct water use and residual creation are updated for each year. The underlying structure of the economy in terms of industry sales and purchases patterns is however assumed to remain constant over the entire study period. This amounts to assuming that the A matrix remains constant. Unfortunately, there is very limited hard data available on the creation of economic output and value added that is at both the regional and industry level. The output and value added data used in this study is therefore derived out of national economic statistics, as well regional level employment data.[55] Very broadly, we use data predominantly at a detailed 6-digit ANZIC level from the Annual Economic Survey (AES),[56] but also at a more aggregate industry level where the AES data is unsuitable, to determine national rates of change in output and value added per worker. These trends are then applied to regional estimates of employment by industry for Southland, and then calibrated against the 2006-07 base data from the Southland MRIO data.

[55] M.E has developed a regional employment series using the Modified Employment Count (MEC) measure. MECs are based on Employee Counts (ECs) data from Statistics New Zealand's Business Frame. According to SNZ, the number of ECs is a head count of ll salary and wage earners for a reference period. This includes most employees but does not capture all working proprietors – individuals who pay themselves a salary or wage. The MEC statistics developed by ME thus include an estimate of the number of working proprietors.

[56] http://www.stats.govt.nz/browse_for_stats/businesses/business_finance/annual-enterprise-survey-info-releases.aspx

Appendix 8: Detailed Breakdown of BAU Scenario (Value-Added, Abstraction and Discharge) 2011-2031

Sector	VA (2012mil)					Water Abstraction					Water Discharge (000 m3)					% of VA in the year					Water Abstraction (% of Total)					Water Discharge (% of Total)				
	2011	2016	2021	2026	2031	2011	2016	2021	2026	2031	2011	2016	2021	2026	2031	2011	2016	2021	2021	2026	2011	2016	2021	2026	2031	2011	2016	2021	2026	2031
Horticulture & fruit growing	9.9	10.8	11.7	12.6	13.5	239.4	253.0	265.7	277.6	288.8	24.4	25.8	27.0	28.3	29.4	0.3%	0.2%	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Livestock & cropping farming	277.9	283.2	288.6	294.0	298.0	6,265.7	6,228.2	6,199.0	6,157.4	6,094.1	31.9	31.7	31.5	31.3	31.0	7.1%	6.5%	6.1%	5.7%	5.3%	0.5%	0.4%	0.4%	0.4%	0.4%	0.5%	0.4%	0.4%	0.4%	0.4%
Dairy cattle farming	362.7	419.6	478.6	548.2	645.2	17,993.0	20,247.2	22,530.8	25,281.4	28,989.7	5,495.1	6,183.6	6,881.0	7,721.0	8,853.5	9.2%	8.5%	7.9%	7.4%	6.9%	0.6%	0.6%	0.5%	0.5%	0.5%	0.6%	0.6%	0.5%	0.5%	0.5%
Other farming	16.8	18.0	18.0	19.2	20.4	-	-	-	-	-	11.7	12.0	12.2	12.2	12.6	0.4%	0.4%	0.4%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Svcs to agriculture, hunting & trapping	35.7	38.1	41.1	44.1	47.7	6.0	6.3	6.5	6.8	7.2	6.2	6.6	6.8	7.1	7.6	0.9%	0.8%	0.8%	0.7%	0.7%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%
Forestry & logging	35.4	44.0	54.9	65.9	76.9	-	-	-	-	-	-	-	-	-	-	0.9%	0.8%	0.8%	0.7%	0.7%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%
Fishing	21.6	26.0	30.5	35.0	39.5	-	-	-	-	-	-	-	-	-	-	0.5%	0.5%	0.5%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mining & quarrying	37.3	42.7	46.7	52.0	56.0	3,165.6	3,453.5	3,725.2	4,031.2	4,271.1	574.6	626.9	676.2	731.7	775.3	1.0%	0.9%	0.8%	0.8%	0.7%	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%
Oil & gas exploration & extraction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Meat & meat prod manuf	652.6	674.4	694.6	713.2	730.3	12,421.2	12,517.8	12,568.5	12,592.7	12,584.1	26,546.9	26,753.4	26,861.8	26,913.5	26,895.0	16.6%	15.4%	14.3%	13.4%	12.5%	1.1%	1.0%	1.0%	0.9%	0.9%	1.1%	1.0%	0.9%	0.9%	0.8%
Dairy prod manuf	96.0	112.8	129.6	146.4	163.2	2,984.7	3,407.6	3,836.7	4,242.6	4,635.2	18,324.4	20,920.5	23,555.3	26,046.9	28,457.2	2.4%	2.3%	2.1%	2.0%	1.8%	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%
Other food manuf	43.2	46.1	47.5	50.4	51.8	16.2	16.7	17.2	17.5	17.7	637.7	658.1	677.1	687.9	697.7	1.1%	1.0%	0.9%	0.9%	0.8%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Beverage, malt & tobacco manuf	2.0	2.0	2.0	2.0	2.0	50.8	49.5	48.3	58.9	57.4	-	-	-	-	-	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Textile & apparel manuf	5.9	5.9	5.3	5.3	5.3	23.1	20.1	19.6	19.2	18.7	19.2	16.7	16.3	15.9	15.5	0.2%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wood prod manuf	47.4	47.4	48.4	48.4	49.4	263.4	258.7	255.9	253.1	250.3	308.8	303.3	300.0	296.7	293.4	1.2%	1.1%	1.0%	1.0%	0.9%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Paper & paper prod manuf	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Printing, publishing & recorded media	21.1	22.8	23.9	25.6	27.3	-	-	-	-	-	-	-	-	-	-	0.5%	0.5%	0.5%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Petroleum & industrial chem manuf	16.5	17.9	19.2	20.6	23.4	1.3	1.4	1.5	1.5	1.6	-	-	-	-	-	0.4%	0.4%	0.4%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rubber, plastic & other chem manuf	6.2	9.2	9.2	9.2	9.2	-	-	-	-	-	-	-	-	-	-	0.2%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-metallic mineral prod manuf	15.1	16.8	19.3	21.8	23.5	-	-	-	-	-	-	-	-	-	-	0.4%	0.4%	0.3%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Basic metal manuf	275.9	304.4	340.1	375.8	411.4	582.0	626.5	681.7	735.2	784.2	2,845.2	3,062.6	3,332.2	3,593.7	3,833.3	7.0%	6.5%	6.0%	5.6%	5.3%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Sheet & fabricated metal prod manuf	44.6	49.1	54.6	59.1	64.6	-	-	-	-	-	-	-	-	-	-	1.1%	1.0%	1.0%	0.9%	0.9%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Trans equipment manuf	16.1	17.0	18.9	19.9	20.8	-	-	-	-	-	-	-	-	-	-	0.4%	0.4%	0.4%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Machinery & equipment manuf	29.3	32.1	35.7	38.5	42.2	-	-	-	-	-	-	-	-	-	-	0.7%	0.7%	0.6%	0.6%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Furniture & other manuf	4.5	4.5	4.5	5.3	5.3	-	-	-	-	-	-	-	-	-	-	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Electricity generation & supply	81.5	87.7	95.6	101.8	109.7	-	-	-	-	-	5.7	6.0	6.3	6.6	6.9	2.1%	1.9%	1.8%	1.7%	1.6%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Gas supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Water supply	3.9	3.9	4.6	4.6	4.6	15,111.4	14,737.4	15,399.2	16,019.3	16,599.2	37.8	36.8	38.5	40.0	41.5	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	199.9	233.6	266.0	299.8	332.2	-	-	-	-	-	20.4	23.1	25.7	28.2	30.6	5.1%	4.7%	4.4%	4.1%	3.8%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Wholesale trade	127.7	137.3	147.8	158.3	168.8	-	-	-	-	-	-	-	-	-	-	3.2%	3.0%	2.8%	2.6%	2.4%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Retail trade	147.2	157.6	166.9	174.9	182.9	-	-	-	-	-	0.8	0.9	0.9	0.9	0.9	3.7%	3.5%	3.2%	3.0%	2.8%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Accommodation, restaurants & bars	57.7	59.9	62.1	63.6	64.3	467.5	471.5	475.1	472.2	469.2	49.0	49.4	49.8	49.5	49.2	1.5%	1.4%	1.3%	1.2%	1.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Road trans	62.2	67.1	72.0	76.8	81.7	19.2	20.0	21.0	21.9	22.7	136.4	142.2	149.2	155.8	161.2	1.6%	1.5%	1.4%	1.3%	1.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Water & rail trans	46.6	48.8	51.8	54.1	57.1	-	-	-	-	-	-	-	-	-	-	1.2%	1.1%	1.0%	1.0%	0.9%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Air trans, svcs to trans & storage	19.4	20.1	20.9	21.6	23.1	-	-	-	-	-	-	-	-	-	-	0.5%	0.5%	0.4%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Communication svcs	29.7	31.6	33.5	35.4	36.7	-	-	-	-	-	-	-	-	-	-	0.8%	0.7%	0.7%	0.6%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Finance	80.4	85.8	91.8	97.2	103.2	-	-	-	-	-	-	-	-	-	-	2.0%	1.9%	1.8%	1.6%	1.5%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Insurance	9.0	9.0	9.9	10.7	10.7	-	-	-	-	-	-	-	-	-	-	0.2%	0.2%	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Svcs to finance & investment	21.0	23.0	24.0	25.0	27.0	-	-	-	-	-	-	-	-	-	-	0.5%	0.5%	0.5%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Real estate	190.2	203.5	216.8	227.5	238.1	-	-	-	-	-	-	-	-	-	-	4.8%	4.5%	4.2%	3.9%	3.6%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Owner-occupied dwellings	212.0	225.0	234.4	242.7	248.5	-	-	-	-	-	-	-	-	-	-	5.4%	5.0%	4.6%	4.3%	4.1%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Business svcs	116.9	125.5	133.6	142.2	150.9	-	-	-	-	-	-	-	-	-	-	3.0%	2.8%	2.6%	2.4%	2.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Central government	57.5	60.8	63.2	65.6	67.3	-	-	-	-	-	6.1	6.2	6.4	6.4	6.4	1.5%	1.4%	1.3%	1.2%	1.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Local government	70.7	75.4	80.0	84.6	88.1	-	-	-	-	-	5.7	5.9	6.1	6.3	6.4	1.8%	1.7%	1.5%	1.4%	1.4%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Education	74.2	76.3	78.3	79.0	79.0	-	-	-	-	-	12.5	12.6	12.6	12.4	12.0	1.9%	1.7%	1.6%	1.5%	1.4%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Health & community svcs	163.4	180.1	195.5	209.5	222.0	-	-	-	-	-	-	-	-	-	-	4.2%	3.8%	3.6%	3.3%	3.1%	0.3%	0.3%	0.2%	0.2%	0.2%	0.3%	0.2%	0.2%	0.2%	0.2%
Cultural & recreational svcs	42.9	45.3	47.0	48.6	50.2	117.0	121.5	123.3	125.0	125.3	109.4	113.6	115.4	116.9	117.2	1.1%	1.0%	0.9%	0.9%	0.8%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Personal & other community svcs	42.3	44.8	48.2	50.7	53.2	-	-	-	-	-	6,220.0	6,465.2	6,772.2	6,984.1	7,107.4	1.1%	1.0%	0.9%	0.9%	0.8%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%

Appendix 9: Response to External Reviews

The table summarises the comments received and how they have been addressed. The reviewers' comments have been reduced to reflect relevant points/issues.

Note: During the process of incorporating the reviewers' comments, the page numbers changed meaning that the page and paragraph numbers in the table below are outdated.

MPI Set 1

Comment	How addressed
In assessing the current and future levels of water allocation, it would have been useful to have an appreciation of the supply side limitations / constraints. Page 22 comments that the report does not take into account supply-side constraints, or the impact they may have upon the economic forecasts.	The paragraph on page 22 was expanded to highlight the implications of focusing on the demand side.
Environment Southland prepared a paper on water quantity issues as part of their 2012 review of the Regional Policy Statement. A summary of the findings from this paper (particularly on groundwater abstraction) would help to set the context for the discussion in this report. The 2012 paper, and others commissioned by Environment Southland, emphasise the variation in water availability across the region. It would be useful to comment on the water availability in one or two of the key catchments that may experience land use change under the projections in the report.	We used available reports to triangulate our findings. We quote some of Environment Southland's figures in our report. For example, we refer to Environment Southland's 'Groundwater Study' (Environment Southland, 2011. State of the Environment: Groundwater Quantity Technical Report. Report prepared by Karen Wilson for Environment Southland. February, 2011). We also used Environment Southland's report titled 'Our Uses (Southland Water 2010: Part 3). With reference to catchment level comment, this level of detail was outside the scope of our brief, while we acknowledge that this level of detail is important.
Page viii In addition to the value added estimate for meat processing, it would be useful to include the dairy production / manufacturing figure.	We included the manufacturing figure in the report and updated the Executive Summary with a figure for total manufacturing.
Estimated Discharges and Nutrient Loadings For clarity, it would be useful to add a comment in the opening sentence about the sector(s) with the largest discharge volumes	Volumetric data is presented in the subsequent paragraphs and we have clarified the difference between consent numbers and volumetric data.
In the final paragraph, the authors need to include the year in which dairy production accounted for 9 per cent of discharges.	This relates to the third paragraph under the heading 'Estimated Discharges and Nutrient Loadings' on page ix. The 9% relates to 2000/01. The executive summary has been updated to reflect this period.
Page x While the third paragraph describes the content of the table, it is important to provide a heading for the table. The table should also have a footnote saying that the bracketed figures show the low and high estimates.	Noted A table heading has been included and a footnote explaining the values in brackets has been included.
Page 5 The Figure 2.1 numbers for the proportion of New Zealanders in rural centres and rural areas have been incorrectly recorded. Rural centres are 2% not 12% and Rural (other) is 12% not 2%.	Corrected.
Page 6 The population assumptions behind Table 2.1 should be given.	A footnote with a link to Statistics New Zealand's website explaining the population projections and the assumptions has been included.
The linkages between employment, labour force activity and future economic activity (particularly in areas such as dairying) is not made. For example, the continued growth in dairy farm activity is likely to require in-migration of staff (and their families), as the aging of the	It was not our brief to describe all the labour force dynamics and forces influencing Southland's economy. We did however consider these forces and labour force (and skills) requirements and trends. We considered available reports covering Southland's labour market

Southland population means there is likely to be labour shortages in key areas. Another demographic factor which is not covered is age structure, particularly of the farming community.	ensuring that we captured important features in our modelling. For example we considered a 2012 report on Southland's Labour Force (prepared for the Tertiary Education Commission).
Page 7 In comparing regional incomes, it is important to consider disposable income, as much as total income. With relatively low house and rental costs in Southland, individuals and families generally have a higher disposable income than in other regions, and compared to the national average.	Disposable income is another metric of regional income. While the reviewer correctly states that rentals (and housing costs) in Southland are lower, incomes are also lower (as indicated in our report). We did not investigate the relationships between gross income and disposable income as this was beyond our brief. A quick scan of available data does not reveal estimates of regional disposable income levels and estimating regional disposable differentials that capture housing affordability would need additional research.
Page 10 The value added for the dairy sector (particularly dairy production / manufacturing) appears low, compared to other published data. A 2010 NZIER report calculated that the dairy sector (covering both the farming and processing elements of the supply chain) accounts for 2.8% of New Zealand's GDP or $5 billion (Report: Dairy's Role in Sustaining New Zealand). The report looked specifically at the regional contributions of the sector. The figure for Southland was estimated at $710 million.	The NZIER report referred to (by the reviewer) uses revenue and we're using Value Added – two very different indicators. 'Revenue' is similar to sales – this is close to "gross output". However gross output includes the value of all goods and services used by a sector during its production process. We used Value Added which is closer to GDP (not revenue). In the past (i.e. other projects) we have compared our results with results reported by other economic consultancies (including NZIER, BERL and Infometrics) and have found our results to differ less than 5 per cent. With reference to this study we triangulated our results with an earlier report from Infometrics and have found that at an aggregate level the estimates differ less than 2 per cent.
Page 19: Table 2.4 (First Sector Listed - Dairy Product Manufacturing) The fourth bullet point refers to 'Forward linkages to local milk product manufacturing sector'. Should this actually say 'Backward linkages to the Dairy farming sector'?	Corrected
Page 27: Final Paragraph - Sawmilling I would suggest a rewording of the sawmilling section as the pattern of processing activity has varied from mill to mill (with some maintaining production but shedding staff, while others have reduced production and a few have closed	We have updated the paragraph to better reflect the key issues.
Pages 40, 43 and 55 There are references to paper and paper product manufacturing. The region only had one paper mill, at Mataura in the Gore District. This mill closed in 2000/01 year.	M.E identified this issue during the initial stage of this project. We discussed this with Environment Southland and found that the consents are still active. We have updated the report to better reflect this issue.
Pages 50 to 55 - Tables 3.3 to 3.6 (Economic and Ecological Multiplier Analysis) While the explanation of water multipliers in Appendix 7 is helpful, it would be useful for the authors to work through the figures they calculated for several of the key sectors	We feel that the non-technical description in Appendix 7 is sufficient. However we have added to the description in the report.
Page 57 While recognising the time constraints on this work, there would be value in assessing the opportunities for improving water use efficiency (and minimising discharges) in the key sectors under review.	This is beyond the scope of the project. It might be possible to include these suggestions as a next stage or project extension if the MfE wishes.

MPI set 2

Comment	How addressed
Based on the MS word pagination, not the page numbers as labelled throughout the doc – i.e. cover page is "pg 1" – Again, these page references have changed.	
Pg 49 – Fig 3.1 - What is the legend for the dark blue in the pie graph.	We have changed the graph and have added additional descriptors to make it clearer and more intuitive.
Pg 61 – Para 3 – should be dairy.	Updated.
Page 74, It would have been good to understand a bit more about this bullet point and to delve deeper into its implications.	We have expanded the explanation marginally and we have included some of the reviewer's suggestions in the section dealing with future research.
The first part of the report provides a lot of data and context but the back section dealing could be expanded.	Noted The back section addresses all the requirements of the RfP. It is possible to include additional/further research if required. However this is beyond the scope of this research.
Did the scenario modelling consider the issues being faced by rural councils (e.g. aging labour force, labour force availability etc.)	Yes, we considered these and built the aging population into the model. As our model is a demand driven model it assumes that the necessary resources (including labour) will be available when required. It is possible to develop a 'constrained model' that would limit growth.
Some of the scenario data appears to have been run from information over the period when the global financial crisis resulting in a skew BAU picture.	Our modelling starts off by identifying the underlying patterns and trends. This includes trends and growth periods before the Global Financial Crisis as well as the GFC. We allow for a recovery in the short term and apply long term growth rates in five year 'blocks' from 2011 out to 2031. Importantly, our projections should not be viewed as forecasts – our projections show one potential future if growth trends continue creating a business as usual future.

External Peer Reviewer

Comment	How addressed
Southland – Strategic Perspective	
Page 6: Relative to the national average, unemployment is shown to be lower as is the proportion of people under 15 not within the labour force. Whether this translates into "... Southland makes slightly better use of its available labour force..." depends; better use may not indicate productive use, etc.	Clarified by inserting a footnote.
Page 7: Income levels are marginally below the national average in 2012 for most cohorts. Is this related to the dominant role of agriculture in the economy? Comparing Figure 2.4 and 2.5, the spike associated with cohort 50-54 is interesting, as is 35-39. These conclusions are based on 2012 data, it would be interesting to see if income/cohort has changed in recent years, reflecting perhaps changes in the structure of the regional economy.	It was not our intention to complete a trend analysis of income levels and therefore we used the latest available information to provide a snapshot of income levels. We suspect that the mentioned spikes align with the economic structure (farming) and the age of farmers in the region (as suggested by the reviewer).
Figure 2.6 shows major contributions to VA based on primary. Are the data in real terms? This is not surprising given the dominance of the rural sector.	These values are presented in constant $NZ\$_{2012}$ terms.
Page 15, reference to high electricity prices in NZ is based on newspaper articles – NZ electricity prices are relatively low by international standards.	The sentence was reworded.
Important Sectors	

Does SLQ tell us something about "revealed comparative advantage" (RCA).	SLQ and RCA analysis use the same mathematical formula but different variables. SLQ focuses on a region's production structure (using employment, value added or GDP) and compares it with a benchmark economy (typically a larger region or the country). This gives an indication of the 'locational advantages' enjoyed by industries in that region. RCA on the other hand uses exports trade as indicator proving an indication of a region's 'trade advantages'.
The reference to MCA (at footnote 18) is misleading in this context and I don't see the need for MCA – SLQ is useful.	The footnote was amended removing the reference to MCA.
Key Sectors - Outlook	
Little analysis of dairy data has been undertaken in NZ	We analysed dairy data and used these to inform the Southland water use and nutrient discharges. We have included a section in the report highlighting the main points from this analysis.
Compound growth rates around 3% might be stretching it, but that is only a hunch on my part. I would expect most of the growth in VA to come from conversions as opposed to increased efficiency of existing operations.	These growth rates align with NZIER's work and are inclusive of any technological/productivity gains as well as dairy conversions.
Economy – Water Relationships	
These data, of course, do not tell us "water use" as it would appear consent use is not monitored and reported	The consented maximums were linked to available information covering actual abstraction and discharges. We used these relationships to estimate water abstracted and discharges and present our results in Section 3.1.2 and 3.1.3.
Interestingly, (page 39) states that 53% of the region's water was allocated. The data suggest that abstracting water for use is not constraining in Southland.	This is the region wide pattern. During discussions with Environment Southland representatives it emerged that some catchments are fully allocated. A catchment analysis was however beyond our brief.
Use of the term "medium" is not helpful, it could be read as "median" but obviously is not meant to read as such.	We prepared low, medium and high estimates. The medium estimates are presented in the report and Appendix 6 shows the low and high estimates.
No mention is made of municipal discharge.	Local government discharges are included under the local government administration and civil defence sector. Water takes are included under the water supply sector.
Assumptions used to derive the estimates of N & P loadings are not listed so it is difficult to comment on the method used to estimate loadings.	We used Environment Southland's monitoring data and nutrient loadings from the NZIER analysis. We did not estimate the nutrient concentrations and relied on available information.
Given the dominance of land-based agriculture in the economy, a time series on livestock numbers and land use would provide insights into both structural change and land use intensity	We have included a new section discussing livestock and dairy cattle trends.
It would also help benchmark data against other regions to see if the assumptions made about loadings are reasonable.	This is beyond the scope of our study.
Economic and Ecological Multipliers	
At **page 49** reference is made to "... multipliers measuring all the upstream ecological impacts that are embodied in the production of...". Unless the receiving environment is included in the model the multipliers will not take into account the assimilative capacity of the region's water ways.	We have updated the report commenting on the receiving environment highlighting the reviewer's comment.
Appendix 7 describes the method and points out its limitations. As the authors' are well aware, Input-output models are based on fixed, time invariant, coefficients.	Our analysis focuses on the economy-environment interface looking at it from an economic perspective. The 'within environment' flows are beyond our brief and the

Thus technological change, such as advances in irrigation technology, is not captured. It is not clear whether an assumption was made about consumptive use of water – all water (and for that matter N & P) applied to pasture does not end up in milk. A proportion of the applied water (and N & P) will work its way back to the surface water and/or aquifer.	reviewers comment about the environment's capacity correctly states that we do not consider the water ways' ability to assimilate the nutrient discharges.
We read in Table 3.2 that N loadings from dairy are 6,591 tonnes; Table 3.5 shows total direct and indirect N is 7,541 tonnes. We don't know how much N was applied (purchased and dairy shed effluent), but where does the extra 1,000 tonnes come from? Turning to dairy product manufacturing, total direct and indirect N is 3,616 (Table 3.5) in 2011 & 174 tonnes (Table 3.2). Presumably, the larger figure includes N embodied in milk and 174 tonnes relates to discharge, leaving the balance to be exported.	Some of these comments might be due to incorrect interpretation of the tables. We have included an envelope outlining how to interpret the tables. The additional 1,000 tonnes is the difference between the direct use and the 'direct and indirect use' –for example if the farmer purchases feed then that feed will have embodied water (and N and P) that was used to grow it. The embodied nutrients are introduced via the sector's supply chains and are included in the 'indirect' use.
Turning to the far right column – how is the reader to interpret (1)/(2)?	We have included additional descriptions, interpretations and an example of how to interpret the tables.
BAU Water Scenario	
It is important that readers are made aware of the model limitations.	These are covered off in the appendix dealing with limitations.
In my opinion, this type of model will cannot show decoupling. Decoupling comes about through technological change, innovation, price adjustments, resource constraints, etc.	The point about decoupling (or the lack of it) is not based in the modelling. It comes from the water and economic growth trends. The finding suggests that the sectors which are likely to drive future growth are dependent on water. Our modelling includes productivity gains (which reflects underlying/historic technological gains and innovation - it does not include any step-change or disruptive changes).
Overall Comments	
Given the prominence of agriculture, I would have expected greater attention given to historical patterns of land use, livestock numbers & fertiliser use, if available.	A new section addressing this has been included in the report. (this comment was also raised earlier and we have addressed it elsewhere).
Water use appears to be based on consents which must be an over estimate of actual use. Furthermore, it would seem that the model uses consented use, as opposed to consumptive use. Similar comments can be made in respect of the methods used to estimate inputs and discharges of N & P.	We used information about actual water abstractions (actual water taken) and actual discharges to estimate region-wide resource usage (abstractions and discharges). So therefore the modelling is based on estimated (actual) water use and not consented maximums.
A lot of information is in Tables 3.3-3.6, how does one interpret the three right-hand columns? How can these results be used by managers?	Additional explanations have been added.
One final comment, the report is subtitled "Economic Impacts of Water Policy Decisions". The report rarely mentions policy other than describing the RMA as it relates to permits, it is silent on how the outcomes of water policy relate to current use and discharges, and offers little on likely challenges in the future.	The "Economic Impacts of Water Policy Decisions" is the name of the wider MfE project. We have changed the title page to reflect the reviewer's concern.

MFE Set 1

Comment	How addressed
page ix: Paragraph 1 and 2:	
• Is this point source (and/or consented) only?	This is total discharge (to land or water) and is based on consented values as well as actual discharges. Therefore it covers point source.
• Over what period and how	The paragraphs were changed to address the reviewer's comment.
page ix: Paragraph 4	
• Would be useful to have the table that goes with the information in this paragraph.	More detail about this is presented in the report. We do not feel it is appropriate to include such detail in the Executive Summary
• What is behind this increase? Seems like quite a jump.	This reflects a more intensive use of the resource. The specific reasons for this increase are beyond the scope of our brief.
Page x: Paragraph 2 Is this where you are trying to capture diffuse discharges? If it is, be explicit about that.	The paragraph was amended to reflect this comment and footnote a footnote was included.
Page xi: Paragraph 1 How does this relate to land area? Is it higher than dairying because it's much more of the land area?	We have included a section providing livestock and dairy cow numbers to show the relative size of the activity.
Page 34: last paragraph Note that the NPS-FM is also about water quantity which isn't coming through that strongly here. Objectives and limits need to be set for both quality and quantity.	Sentence changed to reflect reviewer's comment.
Page 35: Paragraph 1 It does set some narratives – life-supporting capacity, maintain and improve, protect outstanding water bodies, protect significant values of wetlands.	Sentence changed to reflect reviewer's comment by including the reviewer's text.
Page 35: Paragraph 3 Is this the actual term in the plan? Be careful as 'target' has a particular meaning under the NPS-FM.	We have checked Environment Southland's document and have restructured the sentence.
Page 36: Paragraph 3 Is this capturing diffuse source nutrient loadings? Need to be explicit about whether they are or aren't included.	Sentence changed to reflect reviewer's comment.
Table 3.7 It would be useful to present this so that you can see value add, abstraction and discharge and loadings for each industry, including % of total.	It is not practical to put such a table in the body of the report so we have prepare separate tables showing VA, abstraction and discharge information and included it as an appendix. Note that the nutrient information presented in these tables contains all the information. In other words, we do not have nutrient loadings for the other sectors.

Reviewer – Environment Southland

Comment	How addressed
Page viii: Paragraph 2: How does value added line up with the economic measures used in NZIER's report – i.e. gross margin and total output?	We have added a footnote comparing Value Added and GDP. With reference to the gross margin and gross output, it is important to realise that these relate to the farm operations and differ from economy wide measures such as VA and GDP. We do not have the NZIER report but we assume that gross margin reflects net sales less the cost of goods sold (as defined in accounting). In terms of total output, we assume that this is similar to total sales.
Page x: Paragraph 2 The point about the inclusion of stock water should be moved from footnote to discussion and tables.	Noted and changed in two places. This does however not alter the estimated N and P loads because these are estimated on a 'per cattle' basis.
Page xi: Paragraph 4 On page 49 it is stated that "Essentially the multipliers measure all of the upstream ecological impacts that are 'embodied' in the production of a particular good or service."	We reviewed this and changed how we referred to the upstream/downstream linkages.
Page x11 Paragraph 1 This finding needs to be taken a step further to make its implications crystal clear.	Noted. We have included some additional thoughts.
Page xi: Fourth bullet point I was wondering why sediment wasn't included as well – given its impact at the ends of catchments.	The very limited coverage of available information constrained our ability to include sediment in our analysis.
Page 1: Paragraph 1 These "special features" would be better explained in English.	We have changed the sentence and added a footnote clarifying the meaning of the unique features.
Page 1: Paragraph 2 The link between the first and second halves of this paragraph isn't clear.	This paragraph has been restructured to make the link clearer.
Figure 1.1 The blue shapes in this diagram don't really work.	We have modified the diagram changing the one shape.
Page 2: Paragraph 1 Do the values or people's understanding of them change?	Both. For example, people could place a higher value on the resource if their understanding of its importance grows. Similarly, as water quality improves, the value can also change e.g. more recreational fishing could take place. (no change in the report).
Page 2: Paragraph 1 I think it would be worth noting that MfE used the TEV approach over the Millennium Ecosystems Assessment (MEA) approach (which emphasizes the link between ecosystem services and human well-being) because they wanted to show marginal costs and benefits (trade-offs) in assessing policy options.	We note the reviewer's comment. However the decision to use TEV over any other approach was MfE's and we cannot comment on the rationale and thinking underpinning that decision. Reviewing and commenting on the TEV framework, and its appropriateness for use in the context of this study is beyond our brief.
Page 9: Paragraph 1 It would be useful to have a brief description of this term and why it was used instead of GDP in the exec summary.	We have added a footnote describing VA, compared it to GDP and indicated why we use VA instead of GDP.
Page 10: 2nd Bullet These figures were reported in local newspaper – are they consistent with this report's figures (figures not replicated here).	It is difficult to compare our figures with figures quoted in the newspaper. However, we have triangulated our economic results against reports from other economic consultancies and have found a good match. Overall (total economy) our results are within 5% of the other consultancies.
Page 16: paragraph 1 I think some comment is needed somewhere on what would happen to electricity generated in Manapouri if not used for aluminium smelter.	At this stage we cannot speculate about the future of the smelter and the alternative use of Manapouri electricity.

Page 23: Paragraph This has implications for how much land is available for dairy conversions.	Noted and emphasised.
Page 35: 2nd last paragraph The same rules apply to all farms in Southland.	We have changed the sentence and included the comment.
Page 36: Paragraph 2 How are non-point source discharges dealt with in this report?	We assume that this question relates specifically to dairy farming. We used the nutrient loadings from NZIER's baseline and translated these into nutrients per head of cattle and then linked it to water (abstraction and discharge). In our model we include 'total water' and cover water used in the dairy shed as well as stock water.
Page 47: Last paragraph How dependent are the results of this study on NZIER's modelling of nutrient losses? I think it would be really important to do a sensitivity analysis on this aspect of the study.	We have matched the agriculture (dairying etc) sector outlooks to the NZIER baseline and nutrient loadings. However the other sector's outlooks and analysis is not linked to the NZIER work. It would be better to run a sensitivity analysis on NZIER's Baseline and then rerun our model with the 'adjusted' values.
Table 3.2 Don't quite understand how these loads are calculated – are they inclusive of urine from livestock?	We have included an explanation of how the nutrients have been calculated.
Table 3.3 The dairy product manufacturing water abstraction for 2010 seems anomalous.	We have checked the dairy product manufacturing figures and they reflect the values as recorded in the ES database. We have included a more detailed description about how to interpret these tables.
Page 56: Last bullet Can you describe exactly what is meant by the real estate industry?	We have included a description of the real estate sector.
Page 57: paragraph 2 In other words (something people can relate to like ecological footprint etc.).	We have include an example to explain the relationship.
Page 61 Paragraph 1 The reviewer gives detailed comments about 'economy and water not decoupling' point.	We have included these comments throughout the report as we saw fit.
Appendix 7 This explanation could be clearer.	We have reworded the Appendix. We have also consulted a textbook on how multipliers are explained. However the explanation remains somewhat technical.
Verbal comments from Environment Southland.	We have made some amendments to reflect the verbal feedback. However most of the verbal feedback, while relevant, was beyond the scope of our research and therefore we have included these as further research.
Some additional comments from Stephen West.	Most of the comments are statements about the 'implement-ability' of our recommendations. Where applicable and appropriate we have incorporated the statements into the text. .

Appendix 10: Stakeholder engagement Questionnaire

Name: _____ Organisation: _____

1. In a few words: What is your chief concern:

On quantity?

Currently _____

Potentially _____

On quality?

Currently _____

Potentially _____

2a. Currently, which zone(s)/catchment(s) is this concern most prevalent?

Zone			Catchment		
	Quantity	Quality		Quantity	Quality
Natural state			Waiau		
Mountain			Aparima		
Hill country			Oreti		
Inland Basin			Mataura		
Lowland					

Please score on a 1 to 5 scale where: 5 = extremely concerning, 4 = very concerning, 3 = a concern, 2 = not really a concern, 1 = not a concern

Comment:_____

_____

2b. Potentially in the future assuming current policy[57], which zone(s)/catchment(s) is this concern likely to be most prevalent?

Zone			Catchment		
	Quantity	Quality		Quantity	Quality
Natural state			Waiau		
Mountain			Aparima		
Hill country			Oreti		
Inland Basin			Mataura		
Lowland					

Comment:_____

3. **Environment Southland response to concerns**.

How well are your concerns:	Always	Very well	Well	Not well	Never
Taken into account in policy discussions?					
Incorporated into decision making?					
Incorporated into public communications?					

4. **What should be the balance between the pillars of wellbeing?**

4 Pillars of Wellbeing*	Preferred Percentage	Next Best Percentage
Cultural		
Economic		
Environmental		
Social		
Total	100	100

Note*: Increased economic activity provides the means to pay for increased social wellbeing (health, education, sporting activity, the arts etc) and vice versa

5. What is the next best option to your preferred position on trade-offs? Comment:

_____

6. Are there any other points you would like to make?

_____

._____

_____ **Thank you**

[57] Policy Objective: a 10% improvement in water quality in the region by 2020

Appendix 11: People interviewed by stakeholder group

Conservation	
Craig Carson	Andy Roberts
Ruth Dalley	Maurice Rodway
Farming	
Glenys Dickson	Jane Gregory
Dylan Ditchfield	David Rose
Vaughan Templeton	
Industry	
Tommy Foggo	Frances Wise
Johann Groters	
Iwi	
Stewart Bull	Don Mowat
Shona Fordyce	Michael Skerrett
Murial Johnstone	Dean Whaanga
Jane Kitson	
Professional Advisor	
Steve Canny	John Scandrett
Gary Morgan	Mark Sutton
Urban	
Tracy Hicks	Neville Cook
Aaron Fox	

Appendix 12: Introductory email from MfE

Good morning,

I am a project manager working for the Water Directorate within the Ministry for the Environment.

I would like to introduce Brian Bell of Nimmo-Bell, a research group based in Wellington specialising in the interface between agricultural productivity and environmental sustainability.

Your name was given to us as a key stakeholder representative in Southland by Emma Moran of Environment Southland.

By way of background to this email, the Ministry for the Environment is undertaking an economic study of Southland's water quality and quantity issues. The objective is to enable more accurate forecasting of the impacts of different policy scenarios on quality and quantity limits in freshwater. This work will also help inform regional councils about the potential economic impact of policy choices within regional plans.

As part of this economic study, Nimmo-Bell has been asked to help the Ministry prepare a report assessing Southland regional water issues which includes:

- An overview of the significant water quality and quantity issues that currently exist and may possibly exist in the future.
- A summation of the evidence that already exists on water quality and quantity issues
- The geographic scope and potential economic and environmental impacts of currently identified issues

This is a separate exercise to Environment Southland's work on addressing water quality issues, but Environment Southland is assisting us with this study.

Brian would like to arrange an appointment to meet you at your place in the second week of February to discuss your perspective on this subject. He is specifically interested in your views as a representative of a key stakeholder group in Southland with an interest in water issues. You do not need to undertake any specific preparation for the meeting as all the information he is seeking will be well known to you.

Key points of discussion will be around:

1. Your stakeholder group's concerns and issues related to water quality and quantity in Southland – both current and potentially in the future
2. Identification of specific zones or catchments where current concerns are most prevalent
3. How well your concerns are taken into account by the local authorities and incorporated into decision making and communications with the wider public in the region
4. What should be the balance between the key trade-offs among economic, environmental and socio-cultural goals regarding water

5. What is the next best option to your preferred position on trade-offs
6. Any other points you would like to make

The interview will take around 30 - 40 minutes. If you cannot meet that week perhaps you could schedule a time to talk over the phone? All information discussed will remain confidential, and Brian's report will be prepared without reference to specific names or organisations.

Brian will be in touch directly with you in the near future to arrange the meeting.

Thank you for your time.

Regards

Nigel Bradly

Project Manager, Water Directorate

Ministry for the Environment

Appendix 13: Photographs of Southland's waterways

All photographs by Brian Bell

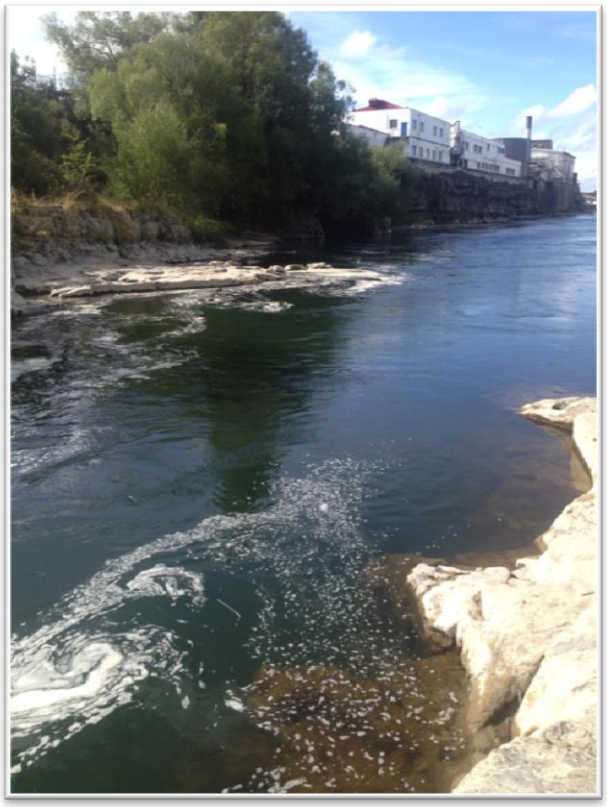
Polluted Mataura tributary (Waimea Plains near Mandeville)

Water sampling: Mataura River near Otamita, Waimea Plains

Sheep farming, Waimea Plains

High stocking rate dairy, Waimea Plains

Pollution in Mataura River at Mataura



Waituna Lagoon

Oreti River north of Lumsden

Urban discharge, Waihopai River at Invercargill

Rakatu Wetlands, off Waiau River

Waiau River at Clifden

Aparima River near Riverton showing whitebait stations

Appendix 14: Nimmo-Bell report reviewers

Basil Sharpe	
Covec:	John Small
Environment Southland:	Aaron Fox, Aaron Leith, Clinton Rissmann, Emma Moran, Helen Meintjes, Karen Wilson, Ken Swinney, Michele Poole, Rachael Millar, Rob Phillips
Ministry of Primary Industry:	Murray Doak, Rebecca Tayler
Ministry for Environment:	Anya Pollock, Tamara Linnhoff

Appendix 15: Disclaimers

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