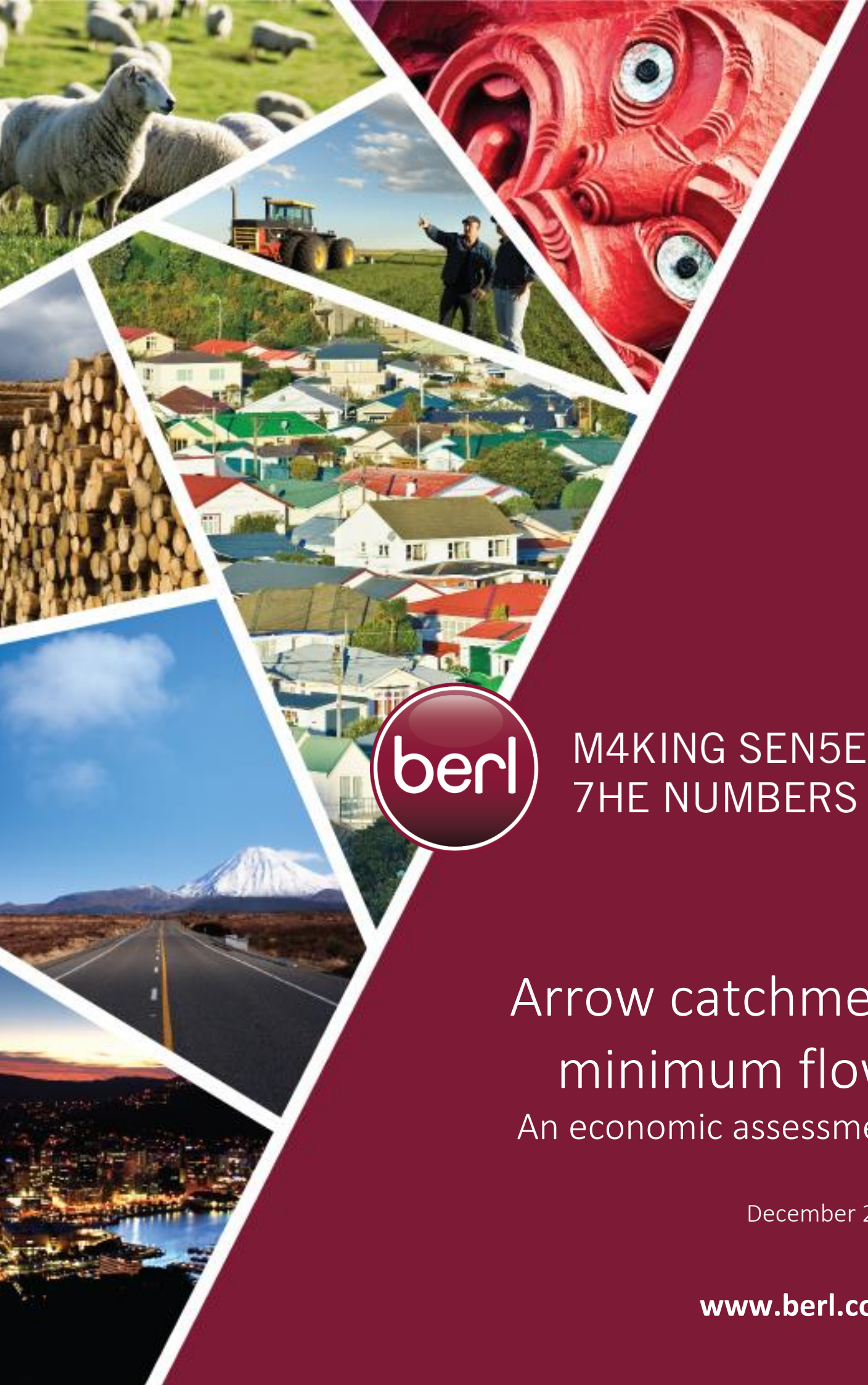

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Arrow catchment minimum flows

An economic assessment

December 2017

www.berl.co.nz

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Summary of impacts of minimum flows in the Arrow River and their mitigation

Usage of freshwater from the Arrow River and its associated Wakatipu aquifers is mainly applied to land uses in the area known geographically as the Wakatipu Basin. This includes Arrowtown and surrounds and the area around Lake Hayes and towards Frankton. The actual area is shown on the map Figure 1 **Error! Reference source not found.**.

The usage of water in the Wakatipu Basin includes a substantial share used in the development and maintenance of golf courses, their resorts and associated high-level residential accommodation and housing. This is a contrast to the situations in catchments with highly developed irrigation of primary production especially where there is a range of types of pastoral production. In these catchments, farming systems can be modified to adapt to changes in water availability. In the country as a whole it is estimated that the consented water for irrigation makes up 51% of the total however the Ministry for the Environment does not know how much of that is taken up. Water recorded as 'Household consumption' is measured at 14%. This presumably includes drinking and use around the house including watering lawns.

In the Arrow catchment and Wakatipu Basin, a large part of both the irrigation and the household consumption is applied to maintaining the golf courses and the landscapes around the resorts and associated high-level accommodation and housing. These are water uses where production systems cannot readily be adjusted to accommodate reduced water availability in dry periods. This provides a substantial challenge in assessing economic impacts of changes in water availability for water takes, when making water available to maintain minimum flows in the Arrow River.

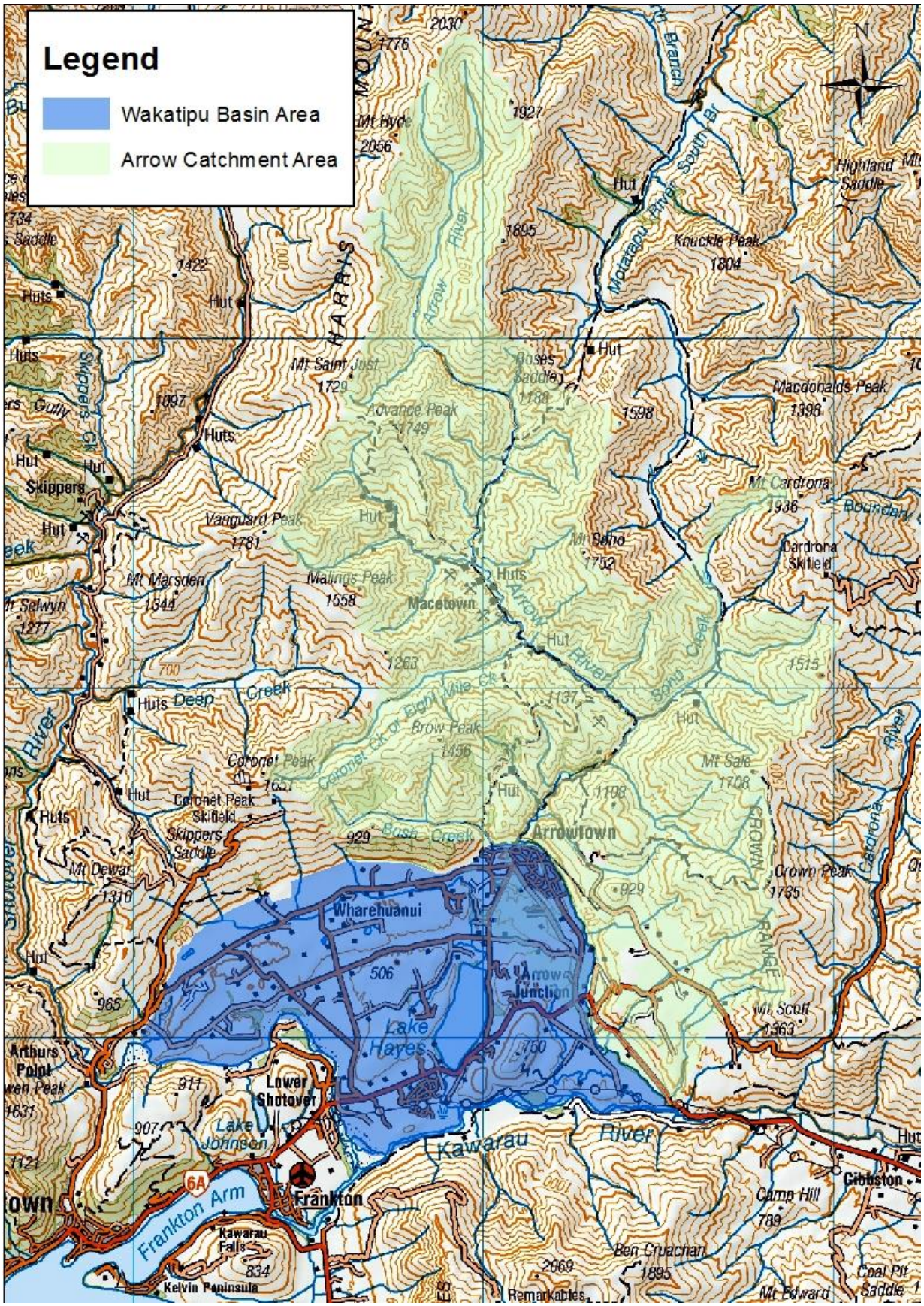
This report provides an economic impact assessment of water management options in the Arrow Catchment and the Wakatipu Basin area. As a large proportion of the Arrow catchment's hill area is not suitable for irrigation, most of the water from the catchment is used in the Wakatipu Basin.

The purpose of this project is to assist the Otago Regional Council and the community understand the potential impacts of various water management options on economic activities locally, within the District, and throughout the Region. This is important because our analysis of the geographic shape and economic function of the Wakatipu Basin over the last 20 years shows there have been major transformations in this area, and that this change is ongoing.

The Wakatipu Basin 15 to 20 years ago

- **Environment:** Hot, dry summers and relatively cold, dry (snow) winters; free-draining soils; hard vegetation with limited lower country development surrounded by the hills covered mainly with tussock, matagouri, or briar.
- **Access/urban form:** Arrowtown was close to the routes from Christchurch and Dunedin to Queenstown and was not too different from other small towns in Central Otago such as Alexandra, Cromwell, or Clyde.
- **Population:** Small resident population that would swell by up to 80 percent with seasonal influxes of crib owners over the summer and winter. Quotable Value data indicates that in 1996 there were approximately 190 rural residential properties, and 260 rural lifestyle properties.

Figure 1. Arrow catchment and Wakatipu Basin (Source: Agribase 29-09-2017 Provided by ORC)



- **Residential water use:** Climate, soil and influx of visitors meant average water usage per head of population was approximately 3,500 to 4,500 litres per day from December to March (2002-2004)[1]. This contrasts with a main centre figure of about 250 litres per head per day[2], and for a nearby place like Queenstown, about 400 litres per head per day.
- **River water use:** We do not have information on irrigated land use in the Wakatipu Basin in the 1990s before the Millbrook golf resort began. The earliest information BERL has is of irrigation in 2004, when the MAF data indicated that in the Arrow Irrigation Scheme there was a total of 900 hectares irrigated of which about 60 hectares was horticulture and crops, 530 hectares in pasture and 310 hectares in non-agricultural use. The MAF data gives no indication of the extent to which these 310 hectares in 2004 includes the already-established golf courses and resort, and how much was on the 660 lifestyle properties which QV data indicates occupied 3,800 hectares in 2004.

The Wakatipu Basin today

- **Environment:** The natural environment is substantially the same but the built environment has changed with a green oasis of golf courses and associated resorts, and additional residential subdivisions such as the Lake Hayes Estate with watered lawns.
- **Access/urban form:** The area is now a substantial part of the greater Queenstown area of influence, and has property prices and a resident population on a par with Queenstown, rather than other Central Otago towns. The urban developments include an extension of the urban capacity to support the Queenstown and Frankton activity.
- **Population:** The resident population is larger and swells for most of year due to tourists to Queenstown and surrounds, including international golf tourists and periodic golf tournaments.
- **Residential water use:** To maintain a high level of amenity there is a need for reliable availability of water when needed at resorts and residences. This high amenity location now includes expensive residences and residents paying these prices for properties expect to have reliable water supplies to maintain their amenity. The Arrow Irrigation Company (AIC) has the largest water allocation and has a consent to take approximately 1.4 cumecs. Other consents in the catchment bring the total of all consents current in the Arrow catchment to just over 2 cumecs. However the relatively limited historical data available shows that in recent seasons the average monthly maximum take at the peak of the irrigation season, namely the month of February, was 0.7 cumecs or just over one-third of the consented take. The ORC has supplied daily naturalised flow series for the period 2013-17 and this has been extended by Opus to give an indicative naturalised flow series from 2010-17 for the Arrow River. These have been analysed by Opus in order to show the mean daily flow of the Arrow River at Cornwall Street, expressed as the 'Naturalised' flow. The minimum such mean daily flow was 0.7 cumecs, and the mean of the average daily flow was 3.7 cumecs. The details of these characteristics are discussed below and will indicate the current pressure on the Arrow River flows, and likely impacts on reliability of access to water takes with the adoption of minimum flow levels.

Use of water from the Arrow catchment compared with other New Zealand catchments

In most New Zealand catchments, the dominant use of fresh water is for irrigation to improve the efficiency and profitability of primary production crops, including pasture. The main ways to reduce water usage in order to

[1] Data from Central Otago District Council quoted in Sanderson, K and Mat Arcus, *Central Otago Population Assessment*, BERL for Central Otago Health Services Ltd, December 2006.

[2] Water New Zealand. *National performance review 2015-2016*. Figure 6.5-1 *Residential water consumption (Litres/person/day)*. Wellington March 2017.

increase the minimum flow of rivers is to improve the efficiency of distribution (pipes compared with canals) and water application (spray rather than flood). Water supply reliability can also be improved by obtaining additional out-of-catchment surface water and/or increasing water storage capacity in-scheme or on-farm. This can substantially maintain the annual gross margins and GDP generated on the farms, vineyards and orchards.

In the Wakatipu Basin, freshwater is used to support primary production activities, however it is also used to create and maintain amenity value in and around golf courses and residential developments. The end use of this water attracts visitors and residents to the area with beautiful greens and their surroundings. In this catchment it is necessary to assess the relative impacts of the primary production and the property enhancing amenity value of water use.

Measuring potential impacts of setting minimum flows in the Arrow River

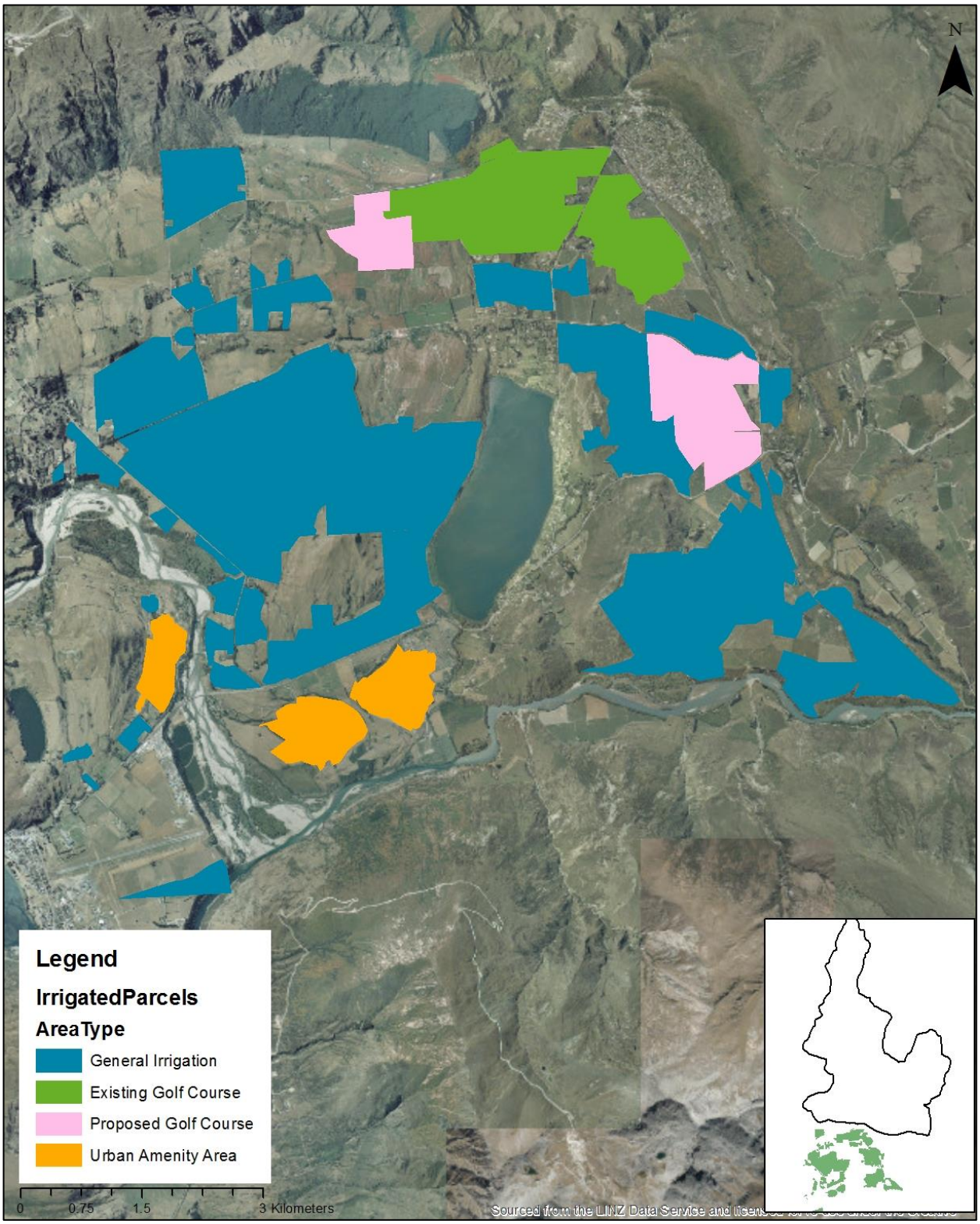
To determine the potential impacts of setting minimum flows on the Arrow River it is necessary to know in some detail the nature and extent of water use. This includes the land uses in which the water is currently used; the amount of water currently taken or abstracted from the river; the naturalised flow if no water was taken and the expected fluctuations in the river flows. With this knowledge of current uses it is then necessary to obtain data on, or to estimate the amount of water needed for each use, and the impact of constrained water availability on those uses. It is the last measure of impact which can be converted to an economic measure of impact.

As in many studies of this nature there is not comprehensive data for all of the measures desirable, however there is sufficient data to arrive at assessment of impacts of the options.

To provide a background to the assessments made, the shortcomings of the main data sets are outlined.

- Land uses: This data is constantly being updated because there are ongoing substantial changes in land use in this catchment. The AgriBase 2016 data does not fully reflect current land use and must be interpreted with judgement. The main changes in land use that could occur in this catchment in the future relate to population growth and tourism. There are currently new residential subdivisions and the establishment and extension of golf courses supplanting primary production land uses like deer, beef and sheep farming as shown in the map at Figure 2.
- Arrow River flows: The Arrow river flows are measured at the Cornwall Street recorder. It has 10 years of record, but only four years for which takes can be estimated to derive the estimated naturalised flow. To provide a longer term context, these records were extended by reference to the correlation with Cardrona River flows at the Mt Barker flow site. The purpose is to provide a perspective as to whether the four years should be thought of as drier than usual, wetter than usual or relatively normal years. These extensions over the longer time period showed higher flows than those in the past four years alone, due to the drier summers the Otago region has been experiencing over these years. Hence conclusions based upon the flows of the last four years will be conservative.
- Arrow river abstractions / water use: The level of water use for the main consents are known for a few years. The volume of nearly 70% of the total consents are held by Arrow Irrigation Company, and they do not have detailed data on the irrigated land uses by the various members. However the data that ORC does have indicates that between 2010 and 2017 the average monthly take during the four peak months of the irrigation season, namely from December to March, was 0.6 cumecs over a month. The maximum average monthly take from the same dataset was 0.7 cumecs over a month, and the minimum average take from December to March was 0.45 to 0.5 cumecs over the month. These details are shown below.

Figure 2. Irrigation within the Wakatipu Basin, lower Arrow catchment (Source: ORC 2017)



- **AquaLinc water use parameters:** The parameters for efficiency of water use in areas of Otago Region are available from the AquaLinc reports[3]. However their assumption is that if a user requires some water in any day, they will take the full amount of their consented allocation. This is unlikely to be the case, as shown by comparing the actual maximum monthly average daily take in the month of February of 0.7 cumecs with AquaLinc-based estimate of the total required abstraction for efficient pasture production of 1.47 cumecs. This latter figure is obtained by Opus using the AquaLinc parameters applied to pastures on the 2,850 hectares of soils on consented irrigation blocks. The AquaLinc parameters were applied to the soils of different Plant Available Water (PAW) characteristics. The water use parameters given in the AquaLinc report are for pasture and vineyards. These crops will have different volumes and timing of water requirements than golf courses and urban amenity lawns.

Hydrological assessment of impacts of minimum flows

In general, the impacts of setting minimum river flows at different thresholds depends upon three main things, in a hydrological sense:

- the levels and temporal distribution of the normal or naturalised flow of the river before any water is taken from the river;
- the levels and temporal distribution of the demands for water to be taken out of the river; and
- the temporal distribution of the times at which the level of demand taken from the river reduces its actual flow to the prescribed minimum flow level.

In terms of the value to the water users, the reliability of availability of water will depend not only on the percentage of days on which water can be taken, but in particular the periods of consecutive days on which water will not become available due to the minimum flow being reached.

In order to explore this in the case of the Arrow River, Opus constructed four scenarios for the level of water demand for irrigation, and tested those against the daily distribution of flows in the ORC four year and seven year series of naturalised flows. Rather than percentages, this method shows the actual days in which the full abstraction rate could not be taken. It also therefore shows, importantly the number of consecutive days on which the full abstraction rate could not be taken.

There are a range of estimates of the potential irrigation demand within the Wakatipu Basin, depending on which data are used. The four estimates chosen as a basis for irrigation demand are:

- The average abstraction during the month with the average or mean measured abstraction as recorded by ORC. These averages for the four main 'irrigation season' months December to March fell in the relatively narrow range from 0.54 cumecs to 0.6 cumecs;
- The average abstraction during the month with the highest measured abstraction as recorded by ORC i.e. the 0.7032 cumecs in the February months;
- The maximum modelled rate of irrigation demand (Aqualinc, 2017) i.e. 1.4712m³/s; and
- The estimated daily abstraction rates needed for efficient irrigation based on Aqualinc (2017).

For the purpose of the economic impact assessment we believe that the second scenario, namely the average monthly abstraction with the maximum or highest measured abstraction, i.e. the month of February will provide a conservative estimate of the number of actual days and consecutive days on which full abstraction rates could

[3] AquaLinc (2006) Water requirements for irrigation throughout the Otago Region, a report prepared for Otago Regional Coiuncil by AquaLinc Research Ltd. Report No L05128/2. October 2006
AquaLinc (2017) Guidelines for Reasonable irrigation water requirements in the Otago Region. a report prepared for Otago Regional Council by AquaLinc Research Ltd. Report C15000. July 2017

not be taken. Opus have also carried out these calculations for the average monthly abstraction with the average measured abstraction.

We assess that particularly for the water use necessary to maintain the amenity of the locality, catering only to the average measured abstraction will be of limited use in maintaining the economic activity and viability in particularly dry periods. The point is that for these uses, reliability is really essential.

It is worth noting that whereas February has an average maximum measured abstraction of 0.7032 cumecs, the months of January and March have average maxima which are very close to the same. The average or mean of the average monthly take in January is 0.6 cumecs. The track of these averages and also the average minima are illustrated well on the chart.

Figure 3. Arrow consented takes 2010 to 2017

This pattern of water demand as shown by the average maximum monthly take, when combined with the naturalised flow over the four year and seven year periods gave the estimates of the total number of days, and the consecutive number of days or the longest run on which the full abstraction rate could not be taken. There is still water available at those times but it would be less than the full amount currently being taken, and water would be shared at such times.

These estimates were made of the number of days when the full abstraction rate could not be taken due to each of the three minimum flow thresholds being reached. These thresholds are respectively 0.8 cumecs, 0.9 cumecs and 1.0 cumecs. There are also estimates shown below of the very small number of days on which no water could be taken when the naturalised River flow is below the minimum flow threshold.

At this level of abstraction of 0.703 cumecs, the number of consecutive days when the full abstraction rate could not be taken, and water takes would need to be reduced, in each of the seven years 2012 to 2017 were as follows:

Threshold 0.8 cumecs: There were three years with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 6, 20 and 22 days.

Threshold 0.9 cumecs: There were two years with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 2, 13, 21 and 22 days.

Threshold 1.0 cumecs: There was only one year with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 5, 11, 21 and 22 days.

Table 1. Minimum flow thresholds and days with abstraction below full rate 2012-17

Year	Threshold 0.8 cumecs		Threshold 0.9 cumec		Threshold 1.0 cumec	
	Total days	Longest run	Total days	Longest run	Total days	Longest run
2012	22	20	28	21	38	21
2013	8	6	23	13	34	21
2014	0	0	0	0	6	5
2015	0	0	3	2	22	11
2016	59	22	72	22	87	22
2017	0	0	0	0	0	0

Source: ORC, Opus and BERL

The 2016 season was considered a very dry season. Also, as noted above analyses of longer time series show these to be drier than normal years, and so the number of consecutive days will be above that to be expected in the long term. Generally it would seem that water users and managers would wish to plan for a system of water availability and use which was able to cover continuous periods of up to 20 days when full abstraction from the Arrow River could not be taken.

In most catchments the irrigation companies work amongst their members to arrive at acceptable methods of rationing water as flows in the rivers reduce. Some purely announce a set percentage of allocation allowed for all members. We are not aware of a specific rationing protocol operated by the Arrow Irrigation Company. The graph of consented takes by the AIC for the years 2014 to 2017 shown in the body of this report indicates that at certain times, e.g. in February 2016, the AIC has been able to reduce takes as necessary. It presumably was the case that the full abstraction rates of water were not available at that time. This is the rationing behaviour that will become necessary again from time-to-time due to the requirement for the minimum flow.

The table below shows that it is only in particularly dry years like 2015/2016 when the flow in the river is below the minimum flow threshold, and no water would be taken from the river.

Table 1. Minimum flow thresholds and days with minimum flows below the threshold 2011-2017

Year	Series origin	Threshold 0.8 cumecs		Threshold 0.9 cumec		Threshold 1.0 cumec	
		Total days	Longest run	Total days	Longest run	Total days	Longest run
2011/2012	Opus	0	0	0	0	0	0
2012/2013	Opus	0	0	0	0	0	0
2013/2014	ORC	0	0	0	0	0	0
2014/2015	ORC	0	0	0	0	0	0
2015/2016	ORC	5	4	6	5	10	6
2016/2017	ORC	0	0	0	0	0	0

Source: ORC, Opus and BERL

Mitigating estimated impacts of minimum flows

The indication from these dry years is that a period of 20 consecutive days with restricted access to abstraction could be expected from time-to-time. A relatively conservative daily requirement for water in the soil conditions in the Arrow, according to the AquaLinc data would be 4 mm of water per day. If this was applied to 100 hectares, this is a total of 4,000 cubic metres per day. Over the period of 20 consecutive days requiring water from sources other than the Arrow River, the total requirement would be for 80,000 cubic metres.

The options to mitigate the reduced water availability are as follows.

- Storage: In some regions the main source of this additional water would be from established water storage facilities. In that instance it is found that a capital cost of about $5 per cubic metre of storage capacity is invested. For this example, an area of 100 hectares wishing to achieve 100% reliability of irrigation supply could have to invest $400,000 in a storage facility. The creation of storage requires there to be accessible land available. The hilly areas around the Wakatipu Basin indicate that it may be possible to create a small storage lake in a gully reasonably close to the water demand areas.
- Access to non-Arrow water: The possible sources of water in these relatively small volumes, in the Arrow catchment could be from the Kawarau River. This would require investigation and costing. It could be relevant and economic for those irrigators obtaining a high value from maintaining the reliability of water available for their use. The Kawarau River solution could be appropriate if feasible and not excessively expensive, because from an environmental / hydrological point of view it is purely a shift of the point of take from the Arrow River to the Kawarau River before the confluence of the two.
- Potential opportunity to obtain water from within the Basin Aquifers: There is some capacity within the aquifers, based on the proposed options of setting limits at 50% of Mean Annual Recharge.

Economic impacts of reduced abstractions

The requirement is to estimate the potential economic impacts at District and Regional level of the adoption of a given level of minimum flow in the Arrow River. These levels of environmental flows are required by the National Policy Statement (NPS) for Freshwater to be set by the Regional Councils.

The economic impacts of reduced abstraction can be fairly readily estimated for areas of primary production, as they adjust by adopting more efficient water use, or a partial move to less-intensive production systems. Those changes can be readily measured by changes in gross margins earned at the farm- or vineyard-gate, and the District and Regional value chain impacts estimated. The impacts can be mitigated by investing in increased water storage on-farm or in–scheme and/or investing in bringing additional water into the catchment.

For the Wakatipu Basin area, a reduction in abstraction could have a very different effect. It could reverse the transformation of improved amenity, with substantial consequences for the catchment and the current and future capacity of the Queenstown Lakes tourist node. There may be some small opportunity to increase the efficiency of water use in golf courses, urban amenity and residential use by water re-cycling and other measures. However the main opportunity to mitigate the impact of reduced water availability from the Arrow is to invest in storage or to bring additional water into the catchment.

In the Wakatipu Basin, the water has been an integral part of transformation of the landscape and amenity and it could be argued that without access to freshwater to facilitate these developments, they could not have taken place. However perhaps some similar development could have taken place elsewhere in the general District which may have had a similar impact. If that were possible it cannot be claimed that the access to Arrow water **caused** the development.

Nevertheless it is useful, in order to consider the possible impact of water reduction, to estimate the economic magnitude of the area developed.

Estimated economic magnitude of Arrow-based development

This section develops an order-of-magnitude estimate of the increase in economic activity in the catchment with recent developments based on irrigated golf courses, resorts and high-end residential precincts, having attracted unusually high increases in the population. Such an estimate of the increased economic activity, and the potential for further increase can be germane to considering a comprehensive case for a minimum flow Plan Change and associated investment to improve replacement water reliability and to thus maintain or increase the amenity and economic activity in the area.

The main components of changes in economic activity have been the value of tourism and recreation in the Wakatipu Basin; the value of specific golf tourism in the Wakatipu Basin, and the activity generated by spending by the additional population in the Wakatipu Basin.

- Value of tourism and recreation in the Wakatipu Basin: Estimates derived from the Statistics NZ/BERL databases are that there are 620 people employed in tourism and recreation-related activities in the Wakatipu Basin. This would generate about $40 million direct GDP in the area and $70 million in the value chain in the Region.
- Value of golf-based tourism in the Wakatipu Basin: From estimates derived from national and local sources as to the number of 'golf-tourists', the figures for the amount they spend at the local resorts and in the rest of the District have been generated. Millbrook Resort has had an economic impact assessment completed by *Insight economics* on potential expansion of their resort[4]. Since Millbrook Resort was established in the 1990s, there have been further developments and there are now four golf courses in the Wakatipu Basin. The economic assessment by *Insight economics* has provided some information on value generated by golf tourism. The study indicated that there are about 13,000 rounds played per year, and these directly generate 9,100 visitor nights, 55% at Millbrook and 45% elsewhere in the District. Other parameters are that there is a direct spend of $420 per person per day, the 9,100 'staying' visitors stay 5.5 nights in the District, and one-third are accompanied with non-playing partners. This gives a total direct spend in the District of $20 million per year, which would generate $8 million GDP in the local economy. As an order-of-magnitude this $8 million direct GDP could be thought of as the 'golf share' of the $40 million direct GDP from tourists in the catchment
- Value of spending by additional population in the Wakatipu Basin: The population in the two Statistics Census Area Units of Wakatipu (around Lake Hayes, Millbrook and up the Arrow River) and Arrowtown had a usually resident population totalling 2,780 in 2001, and by 2013 Census it had doubled to 5,505 people. Wanaka had similarly nearly doubled from 3,300 to 6,470, and Queenstown's population of about 8,000 had increased by about 30% or by 2,400. The Central Otago towns of Alexandra, Cromwell and Clyde had a combined population of 7,900 in 2001, and had increased to over 9,900 by 2013 an increase on average by about 26% or 685 people.

  The additional spending by the increased population in Wakatipu is increased by the fact that 40% of those in that area in 2013 are in households with incomes greater than $100,000 per annum. This contrasts with 22% in Wanaka and 24% of households in Queenstown. Taking the spending patterns from the 2013 Household Expenditure Survey (HES), the estimate is that the additional spend in the District as a consequence of the additional high-end households in the District could be of the order of

[4] Insight economics, *Economic analysis of development options for Millbrook*, Millbrook Country Club Limited. March 2015. 21pp

$10-$12 million more than had the additional households have spent at the average Central Otago level. In turn this spending would be expected to increase the District GDP by $4-$5 million per year.

The total impact of spending by increased tourists and spending by the increased population is estimated to result in an increase in GDP in the District by about $44 to $45 million per year.

An alternative measure of amenity value created

The changes in real estate values reflect the increase in amenity as perceived by the people in the real estate market. Hence the relative value which people place on a site to locate their residence can be seen to reflect the amenity which they attach to that site compared with an alternative site.

This concept is used in economic assessment to compare the value of residential sites in different locations to reflect the amenity values attached to those locations. This methodology is called Hedonic Valuation. Applying this at a high level in the Wakatipu Basin, we can measure the average value of land in residential sites in the area and compare these values with those in towns in Central Otago which have not had this recent transformational development.

These figures derived from the CoreLogic (QV) database are that in the Wakatipu / Arrowtown area the average land value per residence site is approximately $350,000, whereas the average value in the Central Otago towns is approximately $150,000. The people appear to place an increased amenity value of $200,000 on siting their residence in the Wakatipu / Arrowtown area.

There are approximately 4,000 residences in the Wakatipu / Arrowtown area. The implication is that the total value of additional amenity is 4,000 residences times $200,000 additional land value per residence. The 'willingness to pay' annually for this amenity could be estimated as the additional perceived finance cost for the additional value. As an indication it could be that the perceived finance cost could be 5% per annum. If that were the case the willingness of these 4,000 households to pay annually for the increased amenity would be of the order of 4,000 households to each finance $200,000 at 5% interest which is $10,000 each per year.

This Hedonic valuation approach arrives at an estimate of the total perceived value of the amenity of the 4,000 households in the Wakatipu /Arrowtown area of $40 million per year more than were they located in the Central Otago towns.

This approximate value is of the same order-of-magnitude as the value generated annually by the tourists and residents in the area.

Economic impact of primary production

The estimate of the direct 'farm gate' contribution of the primary production in Wakatipu Basin to the District GDP is a total of $8.5 million per annum, of which $1.4 million is generated from irrigated production. Allowing for the value chain contribution, the total contribution to the District GDP from irrigated production is estimated at about $2.5 million per year.

Conclusions on Minimum Flow impacts and mitigation options

The initial conclusions are that the transformation of the Wakatipu Basin is facilitated by supply of freshwater to develop the amenity of the area for tourism, recreation and high-end residential development. This has expanded the economy of the Queenstown Lakes area by an annual GDP level of about $40 to $45 million per year.

While it is true that these developments could conceivably have taken place in another part of the broader Queenstown hinterland area, the fact is that they have taken place in the Wakatipu Basin.

This being the case there is a strong justification for investigating the potential options to continue a reliable supply of freshwater to the area to compensate for any water reduction due to maintaining a minimum flow in the Arrow River. It should be noted that the amount of additional water required is not particularly large. The hydrological assessment is conservative, i.e. shows a higher than expected number, because the data originates from recent years which have been drier than the longer term expectation. Even so, for an area of 100 hectares requiring fully reliable water, the maximum storage requirement would be 80,000 cubic metres.

There are a number of aspects that require investigation and assessment to arrive at a situation where the availability of water can be reliably provided at an acceptable level to maintain the landscape at times when the flow of the Arrow River declines towards the minimum flow level. The management of reduction in the volume of individual takes as the flow reduces is one process which will avoid erratic variations in flow. This approach is supported by provisions within the Water Plan.

Three options in addition to management approaches and which water users could investigate are the following:

- Provision of water storage to ensure close to 100% reliability of water supply. Especially for those uses which can afford to fund the storage;
- Abstracting water from the Kawarau River to supply to users in the Wakatipu Basin; and thirdly
- A possibility to obtain water from within the Basin aquifer

Economic assessment of Arrow catchment
December 2017

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1 Introduction

The Otago Regional Council (ORC) is committed to obtaining the best outcomes for the Otago Region from the taking and use of freshwater. The Council is also required to set allocation limits and minimum water levels/flows for all freshwater management units to ensure efficient water use in compliance with the National Policy Statement on Freshwater. To achieve this, the ORC is developing a series of water plan changes in consultation with the community.

This report provides an economic impact assessment of water management options in the area served by the Arrow catchment and the Wakatipu Basin aquifers. This is to assist the ORC and the community to understand the potential impacts of various water management options on economic activities locally, within the District, and throughout the Region.

The recent history and current changes in land use and use of water from the Arrow catchment and Wakatipu Basin aquifers are very different from most other catchments in New Zealand.

The developments in this catchment have been a major component of tourism growth in the Queenstown Lakes and Central Otago Districts. This area has changed from being a largely dry, tussock catchment typical of Central Otago to be part of the main growth node in New Zealand tourism. Here, water irrigation has been applied to develop golf courses and associated resorts such as Millbrook and The Hills. The cribs around Lake Hayes and Arrowtown have been largely replaced from the late 1990s by more permanent residences and wealthy vacationers as the size of these golf courses and their associated resorts and residences continues to grow strongly. Over this period the number of rural lifestyle and rural residential properties in the broader area have also increased strongly. There are now additional residential subdivisions such as Lake Hayes Estate which have been established in this catchment as an extension of the urban capacity to support the Queenstown and Frankton activity.

This report provides an economic impact assessment of water management options in the Wakatipu Basin. This is to assist the Otago Regional Council and the community understand the potential impacts of various water management options on economic activities locally, within the District, and throughout the Region. This is important because our analysis of the geographic shape and economic function of the Wakatipu Basin over the last 20 years shows there has been major transformations in this area, and that this change is ongoing.

The Arrow catchment compared with other New Zealand catchments

In most New Zealand catchments, the dominant use of freshwater is for irrigation to improve the efficiency and profitability of primary production crops, including pasture. The main ways to reduce water usage in order to increase the flows in rivers is to improve the efficiency of water distribution (pipes compared with canals) and water application (spray rather than flood). Water supply reliability can also be improved by obtaining additional out-of-catchment surface water and/or increasing water storage capacity in-scheme or on-farm. This can substantially maintain the annual gross margins and GDP generated on the farms, vineyards and orchards.

In the area served by water from the Arrow catchment, freshwater is used to create and maintain amenity value in and around golf courses and residential developments. The end use of this water attracts visitors and residents to the area with beautiful greens and their surroundings and it provides household water supplies.

2 Population changes 2001-16 in the Wakatipu Basin

The area served by water from the Arrow catchment includes Arrowtown, the hills to the north of Arrowtown, the Wakatipu Basin around Arrowtown and Lake Hayes.[5] There is also an increasing amount of suburban growth in the south of the area originating from the expansion of Queenstown Figure 2.1 shows the area within the Arrow catchment and Wakatipu Basin.

Since 2001 there has been an increased residential, recreational and tourism land use development in the Wakatipu Basin area. In this section, the population and employment growth since 2001 is examined, along with changes in residential real estate that are occurring due to the population changes, including the growth in Millbrook Resort.

2.1 Population growth since 2001

There has been very strong population growth in the Queenstown Lakes District in the last twenty years. Between the last three Census periods, 2001, 2006, 2013 the usually resident population increased by 65 percent. This compares with an increase in the population in the rest of the Otago Region of just seven percent, and in New Zealand as a whole increased by 17 percent.

Looking at population growth in the Queenstown Lakes District in more detail, Table 2.1 shows the growth in population between the 2001 and 2013 Census periods for the Wakatipu area (this area includes the land between Queenstown and Arrowtown townships), Arrowtown, Wanaka, Queenstown, and an average central Otago township as a comparison.

In these analyses the area called Wakatipu area includes the Census Area Units called Wakatipu Basin, Lake Hayes and Lake Hayes South. The three townships included in the Central Otago average are Alexandra, Cromwell and Clyde.

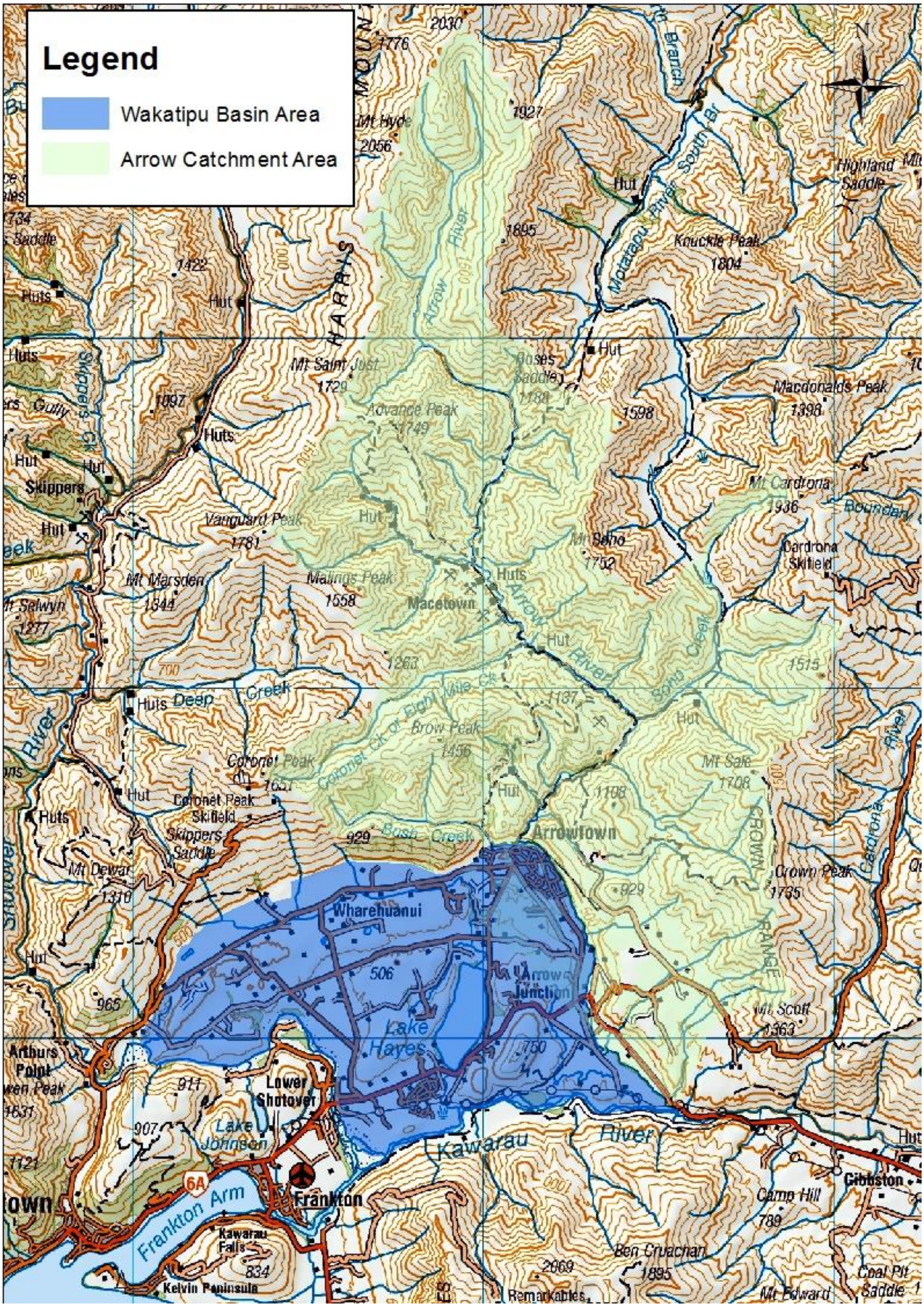
Table 2.1 Population growth for selected township and areas, 2001 and 2013 Census periods

Otago townships and areas	2001 population	2013 population	% growth in population
Wakatipu area	1,086	3,060	182%
Arrowtown	1,692	2,445	45%
Wanaka	3,330	6,471	94%
Queenstown	8,280	10,692	29%
Average Central Otago town	2,633	3,318	26%

The population shown here is the usually resident population. Note that the area described as Wakatipu area in the Statistics NZ data is for the three Census Area Units listed above. The tables show that the population in the Wakatipu area has risen by 182 percent, from just over 1,000 residents to just over 3,000 residents. The growth in this area has superseded the strong population growth seen in Wanaka and Arrowtown. The growth in the Wakatipu area and the Wanaka and Arrowtown townships far exceeds that seen in neighbouring Central Otago townships.

[5] There is some difficulty defining the geographic areas included in various analyses with absolute clarity because databases such as the QV database refer to the relatively flat area west of the lower Arrow River, and north of the Kawarau River as Wakatipu, whereas Statistics NZ has this area broken into three: Wakatipu Basin, Lake Hayes, and Lake Hayes South.

Figure 2.1 Arrow catchment and Wakatipu Basin (Source: AgriBase 29-09-2017 Provide by ORC)



It is therefore clear that the District and these particular areas within the District are seen as ones with high amenity values which attract new residents and visitors, and thus grow the economy. We have indicated that a key driver appears to have been the use of the relatively flat land in the area to develop golf course resorts with associated dwellings. We also indicate that much of the promotion relies on the nature of these places as oases in the dry Central Otago landscape. This attraction of high amenity values is dependent upon the availability of water for irrigating the fairways, and landscaped lawns in the resort complexes.

2.1.1 Household income change growth since 2001

In addition to the growth in population, Table 2.2 shows a significant variation in the average incomes of households in occupied dwellings at Census time in 2001 and 2013. In most of these places the Census Night population was similar to the Usually Resident population indicating that most of the residences were probably occupied on Census night. The exception was in areas like Queenstown where Census Night population was about twice the Usually Resident level reflecting that visitors were in the area. The median household income of those living in the Wakatipu area is in 2013, $20,000 higher than that seen in Arrowtown and Queenstown. Also 40 percent of households in the Wakatipu area earn over $100,000. This compares to the twenty to thirty percent of households who earn over $100,000 in Arrowtown, Wanaka and Queenstown. This 40 percent is significantly higher than the 14 percent of households in an average Central Otago township who would earn more than $100,000.

This shows that a substantial number of the new households in the Wakatipu area are high-earning households. On average each of these households would spend around $70,000 per year in the local district, according to the 2013 Household Expenditure Survey (HES).

Table 2.2 Median household income, selected areas, 2011 and 2013

Otago townships and areas	2001 Median Household Income	2013 Median Household Income	Absolute growth in Income	% of households with $100,000+ income
Wakatipu area	67,210	97,690	30,480	40%
Arrowtown	45,200	75,800	30,600	27%
Wanaka	38,000	66,700	28,700	22%
Queenstown	48,685	73,996	25,311	24%
Average Central Otago town	29,141	53,336	24,195	14%

It should be noted that if the percent of households earning $100,000 or more in the Wakatipu area was to fall to a similar level as Arrowtown, Wanaka and Queenstown, we would expect to see $2.3 million less in expenditure in the district each year, and if it was to fall to that of an average Central Otago township that loss in expenditure would rise to around $4.8 million per year.

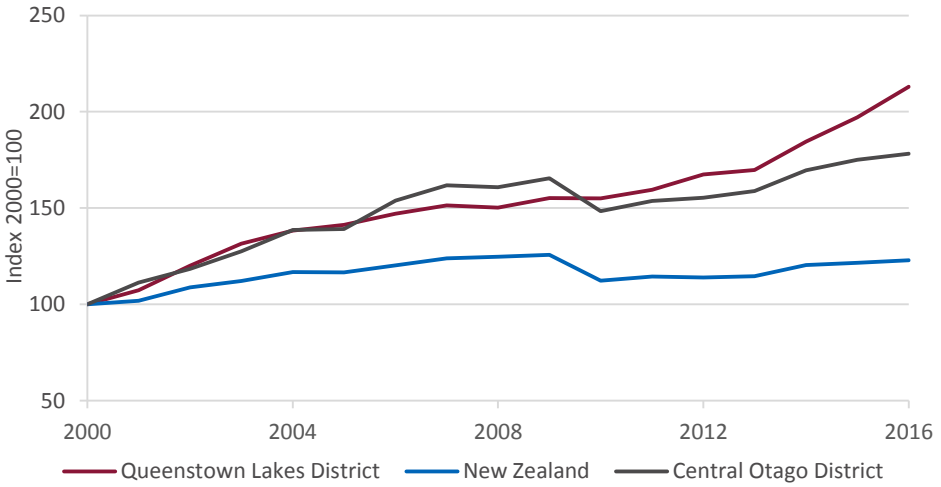
This shows the value to the district of attracting higher earning or higher wealth households to the area.

2.2 Employment growth since 2001

In the Queenstown Lakes and Central Otago districts approximately 20 percent of all employment is in the tourism and outdoor recreation industries, compared with 10 percent throughout the rest of Otago, and eight percent nationally. Employment in tourism and outdoor recreation is also twice the size of employment in agriculture and horticulture in the Wakatipu Basin, which is currently 10 percent.

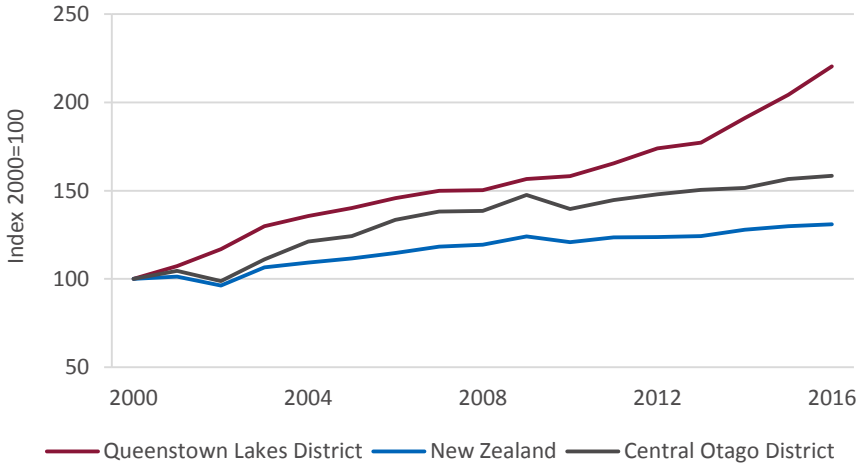
Between 2001 and 2016, employment in the outdoor recreation and tourism industries in the Queenstown Lakes District has grown by 99 percent, while employment in these industries in Central Otago has grown by 60 percent, and employment in New Zealand has only grown by 21 percent, as shown in Figure 2.2.

Figure 2.2 Tourism-related employment growth, Queenstown Lakes, Central Otago and NZ, 2000-2016



In addition, examining the employment related to population growth, as shown in Figure 2.3, reveals that again Queenstown Lakes District has been growing at a much stronger pace than Central Otago District or New Zealand. Overall employment related to population has grown by 105 percent in Queenstown Lakes since 2001, while Central Otago District has grown by 52 percent, and New Zealand by 29 percent.

Figure 2.3 Population-related employment growth, Queenstown Lakes, Central Otago and NZ, 2000-2016



In 2016 population-related employment comprised 53 percent of employment in the Queenstown Lakes District, in comparison 26 percent of Central Otago District employment is population-related, and 39 percent of New Zealand's employment is population-related.

This reflects the importance of tourism and population services to the Queenstown economy, with over half of the economy dependent on tourism and the resident population for their businesses and employment. This also reflects Queenstown place as an important tourism node in New Zealand, and that the international and domestic tourism to Queenstown has been and continues to grow rapidly.

3 Current land and water use in the Wakatipu Basin

Resident population growth has impacted on land and water usage, and changed the economic activity that occurs in the Wakatipu Basin. The resident population of the Queenstown Lakes and Central Otago districts grew by 47 percent between the 2001 and 2013 Census.[6] Much of this population growth has been driven by an increase in visitor numbers to the districts, and the associated growth in businesses that provide goods and services to the outdoor recreation and tourism industries.

The Wakatipu Basin has therefore changed from being a relatively intensive agriculture area, where water has been used to irrigate land for a range of primary production uses, to include more lifestyle and recreational activities. These activities include golf courses and their associated resorts and residences, and subdivisions that are the satellite areas for Arrowtown, Frankton and Queenstown. This also means that water is now more used by residents, and that the land that is irrigated is increasingly land within golf courses and the resorts associated with the golf courses.

The main parcels of irrigated land shown in the map at Figure 3.1 overleaf indicate the current extent and expansion of land uses from the previously dominant 'General irrigation' to the current and proposed golf courses and the 'Urban amenity areas' which are in fact urban subdivisions under development.

This creates a complexity because it is difficult to value this change in land use activity and the creation of an attraction which results in more people living in the catchment, District and Region. In this situation more visitors cannot be readily valued at "golf course gate" in the same way as primary production activities are valued at the "farm gate".

For this research, it means that unlike other catchment areas, where the primary and main focus is on the agricultural use of the land, in the Wakatipu Basin there needs to be a focus on two main types of land use, which are:

1. Tourism and residential land uses.
2. Agricultural land use

3.1 Tourism and residential land and water use

From Table 3.3 it can be determined that according to the AgriBase 2016 classification, 623 hectares of irrigated land within the Wakatipu Basin is currently used for tourism and residential. Of this 623 hectares, 153 hectares are comprised of golf courses including Millbrook and The Hills, 77 hectares of land is used for residential properties, and the last 393 hectares is used by lifestyle blocks.

In this subsection we examine the importance of water to these land uses.

3.1.1 Importance of water to tourism and amenity in the Wakatipu Basin

The Wakatipu Basin is one of few areas in New Zealand which relies on land, water and the surrounding landscape to generate major value, and economic activity from recreation activities and the amenity of the environment. The Wakatipu Basin is an important part of the hinterland of two main tourist regions in New Zealand, those covered by the Queenstown Regional Tourism Organisation (RTO) and the Lake Wanaka RTO.

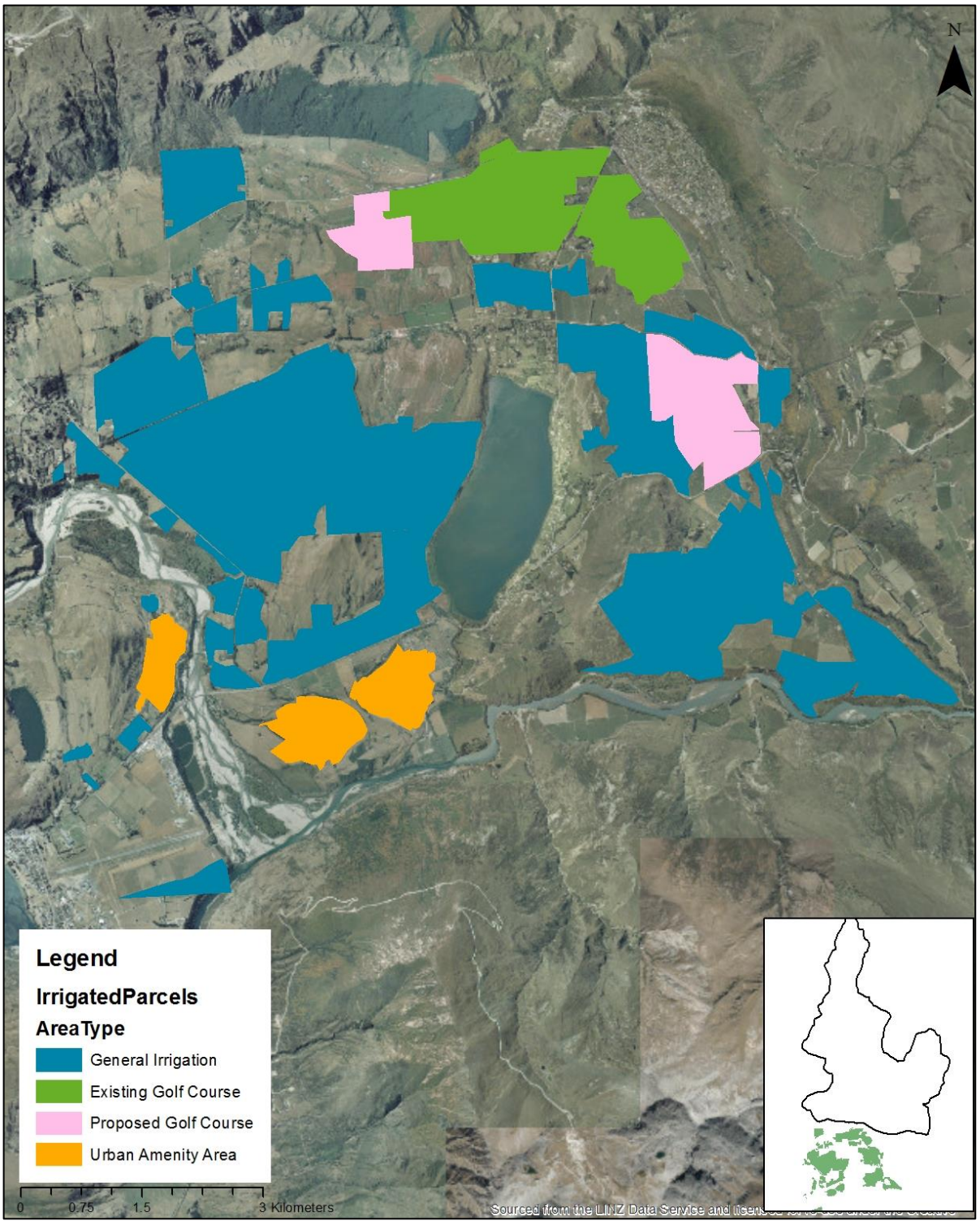
The map shows the main parcels of irrigated land. The exiting golf courses occupy a significant area, with a proposed extension to an existing course shown, and also a further proposed course. The parcels to the south of the area, shown as Urban Amenity Areas receiving irrigation are additional residential subdivisions such as

[6] Over this period the resident population of the rest of Otago grew by seven percent, while nationally the population grew by 17 percent.

Lake Hayes Estate which have been established in this catchment as an extension of the urban capacity to support the Queenstown and Frankton activity.

The area of 'General Irrigation" is being reduced as these higher-value land uses expand.

Figure 3.1 Irrigation within the Wakatipu Basin, lower Arrow catchment (Source: AquaLinc 2017)



3.1.2 Real estate changes

Reflecting the change in population between 2001 and 2013, there has been a strong surge in the number of residential properties in Wanaka and the Wakatipu area, as shown in Table 3.1. In particular the number of residential properties in the semi-rural Wakatipu area has increased 10 fold from just under 300 properties in 2011, to almost 2,900 residential properties in 2016.

Table 3.1 Residential property counts, selected areas, 2001 and 2013

Otago townships and areas	2001 Residential residence	2016 Residential residence	Ratio between 2001 and 2016
Wakatipu area	288	2,878	10.0
Arrowtown	1,049	1,358	1.3
Wanaka	2,496	5,361	2.1
Queenstown	4,313	5,785	1.3
Central Otago townships	3,877	5,977	1.5

In the Wakatipu area there is almost as many residential properties as there is resident population, and given there are substantial numbers of lifestyle blocks (which are not included in residential property counts), and farms for people to live in, this indicates that in this area there are likely to be a high number of one or two person households, along with absentee owners. Absentee owners are property owners who are normally resident elsewhere outside the district.

3.1.3 Millbrook Resort development 1993 to the present

The main resort developed initially was Millbrook, which was opened in 1993. The number of dwellings in the resort has increased strongly since then, as has the value of the properties.

A 2003 article by Richard Willis on the subject of golf courses in New Zealand[7] provided some information on New Zealand golf courses including Millbrook. Combining this information with that on the Millbrook website gives a picture of the development of the resort from when it was opened in 1993, to the status in 2002, and today.

1993	Few residences	Residence cost $80,000
2002	120 residences	Residence cost $200,000
2017	200 plus residences	Residence cost $2.75 mn to $3.8 mn.

These parameters indicate that the amenity created in and around this golf course and resort commands a considerable market premium. The resort currently has a 27-hole golf course with the intention to add a further 9 holes. It has a number of dining venues, The Spa and wellness centre, walking and cycling trails, swimming pool, conference centre, tennis court and playground.

This indicates that a key driver of growth and development associated with tourism in the Wakatipu Basin in the last twenty years has been development of courses to play golf on, and the amenity of associated resorts. The characteristics of golf-based tourism as it has developed in the Wakatipu Basin give it a central place in considering the potential impacts on tourism activities were water supply to be reduced.

[7] Willis, RW. *Golf course capitalism: does New Zealand follow the Asian model*. New Zealand Geographical Society Conference, Auckland, 2003.

The characteristics of golf-based tourism in the catchment were originally similar to courses elsewhere in New Zealand which have mainly attracted domestic players. In the last twenty years this has changed in the Wakatipu Basin with the development of a new course with associated facilities as follows:

- It is of international standard
- It was developed with a lush look, and is pictured as an oasis in dry Central Otago[8]
- Full resort facilities have been developed along with the golf course
- Very high quality homes, apartments and villas have been sold around the course
- There are now over 200 dwellings for use by owners and by visitors.
- These dwellings and more being developed attract owners and visitors to the Millbrook 'five-star, four season' Country Club.
- The resort has been integrated into the historic and dramatic landscape creating a destination in itself.
- The very successful Millbrook Resort has been joined by The Hills golf destination in the Wakatipu Basin, and by Jack's Point golf course and village in the nearby Remarkables area.

From this viewpoint, it becomes difficult to determine what share of the tourist and golf activity in the Lakes area should be ascribed to attraction by these golf courses and resorts, and the extent to which adequate water supply for lush greens, fairways, and resort lawn landscapes are necessary to continued success. Nevertheless they are a core part of the tourist attraction to the two Lakes regional tourism areas.

3.1.4 Scale of Lakes tourism activity

Some idea of the scale of the activity generated by tourism in the area is gained by referring to the tourist spend in the Queenstown and Wanaka Regional Tourism Organisation (RTO) area in the year to September 2017, and the annual guest nights in each RTO

	Total Tourist spend (12 mths)	Total Guest nights (12 mths)
Queenstown RTO	$2,216 million	3,500,000
Wanaka RTO	$529 million	850,000
Queenstown and Wanaka	$2,745 million	4,350,000
New Zealand RTOs	$27,306 million	39,000,000

These numbers indicate that this region may account for about 10% of total New Zealand tourist activity at specific destinations. Given the large amount of activity around tourist gateways, trunk tourist transport etc, a high level approximation could be that one-half of activity is at destinations. This implies that perhaps 5% of New Zealand total tourist activity is at destinations in the Queenstown and Wanaka RTOs.

With $2,745 million being spent by tourists in the areas surrounding the Wakatipu Basin, it could be expected that some of the tourism-based land uses in the area will generate GDP at least of the level of that generated by the primary production land uses.

The primary production is the subject of the following section.

[8] Remarkable Golf Tours: *Queenstown's premier golf specialists*: Brochure online.

3.2 Agricultural land and water use

ORC provided Geographic Information System (GIS) Shapefiles that display the amount of and farm type of agricultural land use in the Wakatipu Basin, from the Agribase Database for land use in 2016. The contents of the file *ArrowAgribaseUpdated* are shown in Figure 3.2. This figure shows the extent of agricultural land use in the Arrow catchment and the Wakatipu Basin, and the main type of use of that land.

From this dataset, the largest agricultural land use in the Wakatipu Basin is mixed sheep and beef farming (marked in purple on the map), with just over 14,000 hectares, followed by beef cattle farming (marked in dark blue on the map), with just over 6,200 hectares. The majority of the land used for sheep and beef farming is hill country to the north and north-east of Arrowtown. This hill country land is ill-suited to irrigation, and will not be impacted by changes in water availability.

The total irrigated area within the Arrow catchment and the Wakatipu Basin accounts for about eight percent of the total recorded land area. The areas irrigated shown in Figure 3.2 are derived from information provided in the *IrrigatedParcels* shapefile. Deer farming (marked in red on the map) is currently the largest user of irrigation, with 30 percent of the irrigated farm land. There are also smaller amounts of viticulture, flowers and other plantings in the catchment. Together, these land uses comprise 128 hectares, of which 94 hectares are irrigated.

The rest of the agricultural production is across a range of land uses, which is more diverse and comprehensive than in most regions of New Zealand. Compared with other New Zealand regions, there is a stronger presence of deer, and mixed sheep and beef farming, while at the same time there is no dairy farming and limited arable production in the catchment. As noted above, approximately 10 percent of all employment in the Wakatipu Basin is in agriculture and horticulture.

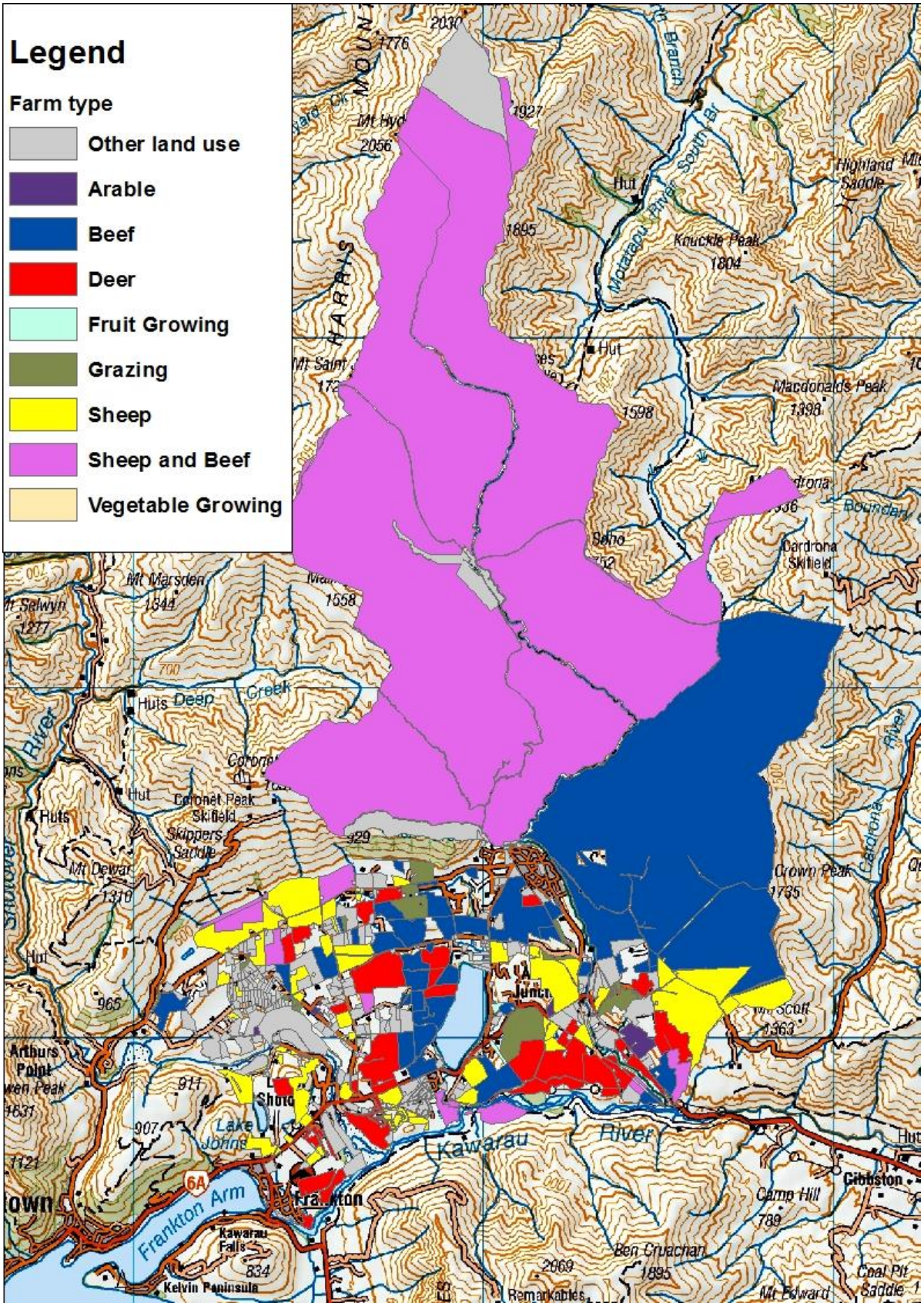
Lifestyle blocks, which comprise 865 hectares in the catchment, also use irrigation with 311 hectares irrigated.

Table 3.2 Main land uses by hectare, dryland and irrigated in the Arrow catchment and Wakatipu Basin

Land Use	Current Land Use (Ha)		
	Total	Dryland	Irrigated
Dairy cattle farming	0	0	0
Beef cattle farming	6,214	5,772	442
Mixed Sheep and Beef farming	14,122	14,019	103
Sheep farming	1,627	1,310	318
Arable cropping or seed production	75	67	8
Deer farming	1,232	642	590
Grazing other peoples stock & dairy dry stock	319	234	85
Vegetable and Fruit Growing	24	24	0
Forestry	68	60	8
Viticulture	33	4	28
Lifestyle blocks	865	554	311
Other uses	1,381	1,311	70
Total	**25,961**	**23,998**	**1,963**

Source: ORC and BERL

Figure 3.2 Main farm types located in the Arrow catchment and Wakatipu Basin (Source: Agribase 29-09-2017 provided by ORC)



Different land uses have different water requirements and different economic impacts on the catchment area. It is therefore important to capture what the land within the area served by water from the Arrow catchment is being used for, and how this could potentially change in the future. This assists ORC to better understand the potential impacts of setting a minimum flow on the Arrow River.

The Agribase database contains information on approximately 142,000 New Zealand farms, and is owned and operated by AsureQuality. The Agribase database has been used to determine land use in the Arrow catchment and Wakatipu Basin. However, the data in this database is heavily reliant on farmers updating their own details when a land use change occurs. In the case of the Wakatipu Basin, the Agribase database has not been able to keep up with the speed of land use changes occurring in this catchment area.

Over the last few years there have been a number of changes in the Wakatipu Basin, and land use has shifted from agriculture production to lifestyle blocks, golf courses, and residential land uses. BERL has identified within the Agribase database an estimated 924 hectares of agricultural land, including 507 hectares of irrigated land, which is no longer used for agricultural purposes. This includes:

- 157 hectares of sheep farming land just south of The Hills golf course that is being developed into a new golf course
- 191 hectares of beef cattle farming land that has been developed into The Hills golf course
- 57 hectares of beef cattle farming land that has been incorporated into Millbrook golf resort
- 108 hectares of grazing land that is now owned by Millbrook and is tagged for development.
- 412 hectares of land in the south west corner of the Wakatipu Basin that is a subdivision.

There is also 1,224 hectares of land that has an unconfirmed farm type. This land is either unspecified by the farmer, land not currently being farmed, or land for tourism or outdoor recreation ventures.

3.3 Irrigated land use

ORC provided a GIS shapefile that displayed the amount of irrigated land in the area served by the Arrow catchment, from ORC records which are based on the AIC records, and all of which is in the Wakatipu Basin.

Irrigated parcels of land in the Wakatipu Basin get their water from one of three sources:

1. Arrow Irrigation Company (AIC),
2. one of eight aquifers in the catchment, or
3. from a local bore.

In total, there is 2,860 hectares of irrigated land within the Wakatipu Basin. Of this total land area, 981 hectares are supplied by AIC, and the rest of the land (1,879 hectares) has its water for irrigation from the two other sources of water. In addition by combining the *IrrigatedParcels* and *ArrowAgribaseUpdated* shapefiles there is 1,963 hectares of land in both datasets. Of this land around 1,600 hectares is in agricultural land uses, with a further 311 used for lifestyle blocks and the remaining 28 hectares used for viticulture.

The current extent of the main parcels under irrigation is probably best illustrated by the high-level uses indicated on the map Figure 3.1 in section 3.1.1.

This land use data from Agribase has been combined with the land use data provided by the AIC, and is shown in Table 3.3 below. The table shows there is a difference of approximately 1,000 hectares in the amount of land that is irrigated.

Table 3.3 Irrigated land use by hectares, Wakatipu Basin

Land Use	AIC irrigated area Hectares	Agribase irrigated area Hectares	Composite Irrigated area Hectares
Agriculture	343	1,624	1,624
Viticulture	15	28	28
Golf courses	153	0	153
Residential	77	0	77
Lifestyle blocks	393	311	393
Other uses	*0*	*0*	*585*
Total irrigated area	**981**	**1,963**	**2,860**

Source: Arrow Irrigation Company and BERL

Information from AIC does not include the land area and location of land being irrigated from water provided by the AIC. It is therefore impossible to assess how much of the irrigated agricultural and lifestyle block land uses from Agribase database is provided by the AIC. Therefore we have assumed all the land is included in both datasets, and have therefore taken the highest number for each of the different land uses, to determine in the table the final amount of land being irrigated by different land uses. This has resulted in 585 hectares of land unaccounted for and listed under other uses.

As we note later the accuracy of the land use and irrigation information in this catchment is not at a high level of accuracy or of a comprehensive nature at this stage. This is partly because of the relatively rapid changes in land use with new irrigated golf courses and urban areas taking over from general irrigation as shown in Figure 3.1.

3.4 Lifestyle blocks

As noted in Table 6.1, there are 265 lifestyle blocks comprising 865 hectares in Wakatipu Basin, with 311 hectares irrigated. This is 36% of the 865 hectares of lifestyle blocks, as well as representing 16% of the total irrigated area served by the Arrow catchment.

The average size of a lifestyle block is 3.3 hectares in size, with the largest recorded block measuring 43 hectares. The distribution of the size of lifestyle blocks is shown in Table 3.4 and in Figure 3.3. The figure shows that lifestyle blocks dotted widely across the Wakatipu basin, with clusters around Dalefield in the north-west and Arrow Junction in the south-east. The table shows that 139 or just over half of the lifestyle blocks are under two hectares in size. These small lifestyle blocks are mostly clustered around the western side of Dalefield. With properties this size the land consists of a house surrounded by trees, gardens or empty land.

Table 3.4 Distribution of lifestyle blocks by size in hectares

Land size	Size of lifestyle block count
Under 1 hectare	75
1 to 2 hectares	64
2 to 3 hectares	24
3 to 5 hectares	63
5 to 10 hectares	25
10 to 20 hectares	10
Over 20 hectares	4

Of more interest is the 39 lifestyle blocks of over five hectares in size. These lifestyle blocks are more spread across the Wakatipu basin, and have greater potential given the size of the land to contain or potentially contain productive agricultural land that is not accounted for in the Agribase dataset.

As shown in Table 3.5 the land value of these lifestyle blocks has surged over the last fifteen years, from between $100,000 in Arrowtown to $240,000 in the Wakatipu area in 2001, to in 2016 $900,000 in Wanaka and $1.5 million in Arrowtown. At the same time the number of lifestyle blocks across these areas has surged from 573 in 2001 to 1,250 in 2016, with the largest growth being in the Wakatipu area which has seen the lifestyle blocks almost triple over the last fifteen years.

Table 3.5 Land value of lifestyle blocks, 2001 and 2016, selected areas.

Otago townships and areas	2001 lifestyle land value per block	2016 lifestyle land value per block	Ratio between 2001 and 2016
Wakatipu area	238,636	917,890	3.8
Arrowtown	100,000	1,468,750	14.7
Wanaka	193,216	902,640	4.7
Queenstown	206,520	970,333	4.7
Average Central Otago towns	137,162	492,654	3.6

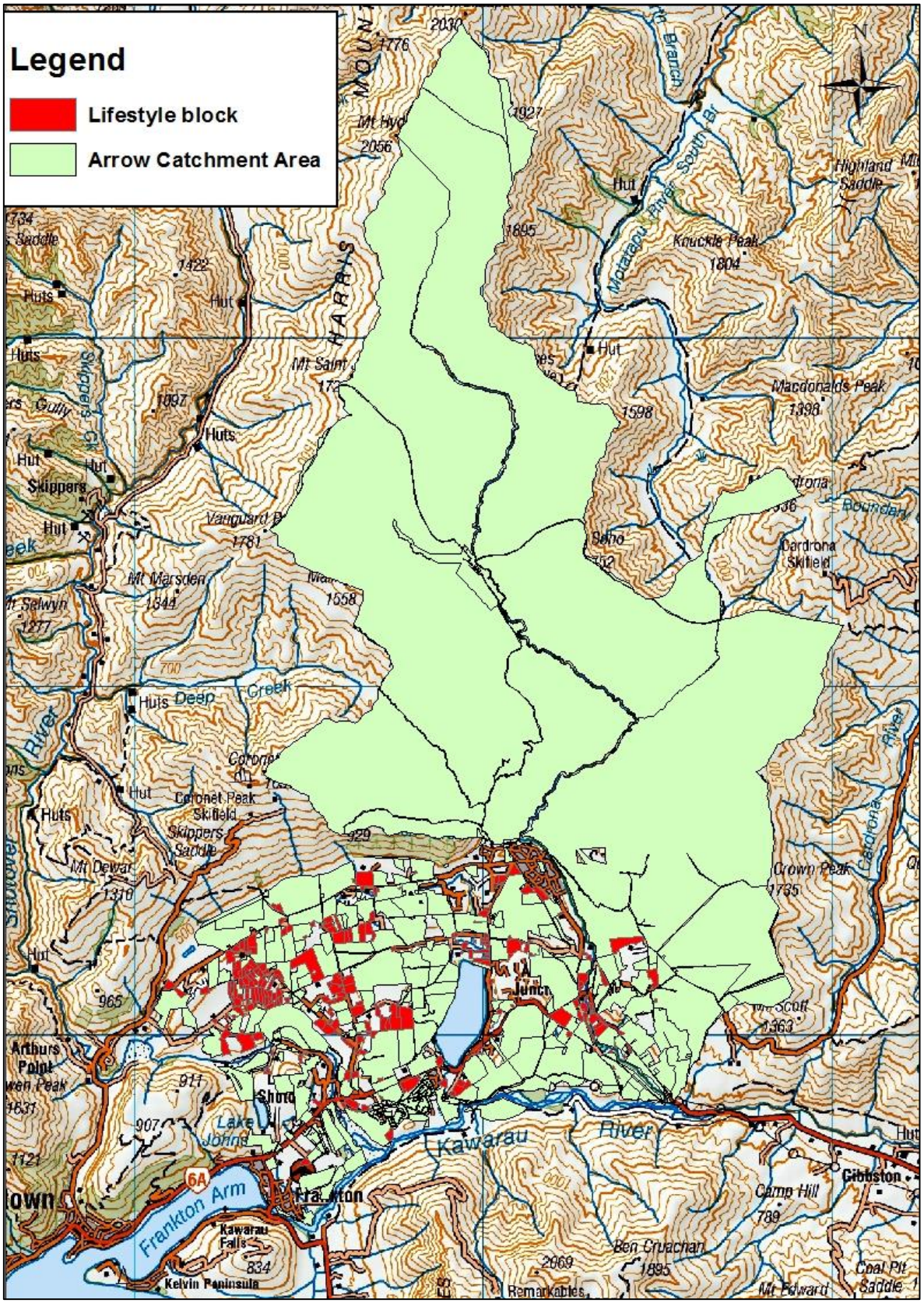
The table also shows that like residential land, there is a higher amenity value on lifestyle blocks in and around Queenstown, Arrowtown, Wanaka and the Wakatipu area, compared to an average Central Otago township. This higher amenity value has grown from $50,000 on average in 2001, to around $500,000 in 2016.

There have been a number of surveys of activity on lifestyle blocks around New Zealand especially those by Landcare Research NZ Ltd[9]. These surveys show a broad range of factors including environmental, lifestyle, family and others behind decisions made on lifestyle blocks. There is not, to our knowledge information sufficient to enable an estimate to be made of specific levels of production on these blocks.

Therefore in accordance with treatment agreed with Regional Councils in other catchments, there has been no specific value of primary production estimated for these lifestyle blocks.

[9] Brown P. *Survey of Rural Decision Makers*, Landcare Research NZ Ltd, 2015.

Figure 3.3 Lifestyle blocks located within the Arrow catchment and Wakatipu Basin (Source: Agribase 29-09-2017 provided by ORC)



4 Economic value of current land uses

4.1 Tourism and population economic impact

Analysis of the figures indicate that tourism generates a lot more activity than the land-based primary production. Tourism and recreation appears to employ 620 people, or about six times as many as the 95 employed in land-based primary production. Tourism and recreation also appears to generate direct GDP of about $40 million per year or about five times the $8.3 million generated by the land-based primary production.

As tourism appears to have a substantially higher economic value, this report will consider the economic impact of tourism in the Wakatipu Basin first.

4.1.1 Top-down and bottom-up estimates of Lakes tourism value

Tourism New Zealand estimates that tourism generates a direct contribution to GDP of approximately $13 billion per year and a total value chain contribution of about $23 billion a year. The direct employment is estimated at 188,000 people.

Taking the above indication that the Lakes area accounts for about 5% of New Zealand tourism activity this implies that the Lakes area may receive a direct contribution to GDP of $600 million per year, have direct employment of about 9,000 people, and a total contribution to the value chain of about $1,100 million per year.

A bottom-up cross-check is possible on the workplace employment shares in the main tourism-related industries in the CAUs in the Lakes area at the time of the 2013 Census. This bottom-up cross-check indicated that this employment was about 6,000 people. This is in a similar order of magnitude to the top-down estimate of 9,000 employed.

4.1.2 Implications for value of tourism and recreation in the Wakatipu Basin

In the bottom-up cross-check, a little over 10% of those employed, namely 620 were in the Wakatipu Basin.

As a very high-level estimate this could indicate that tourism in the Wakatipu Basin has direct employment of about 620 people, and generates direct GDP of $40 million per year. This is a substantial contribution to the District's direct GDP. When value chain impacts are added, it implies a contribution of $70 million to the Region's GDP.

4.1.3 Contribution of golf tourism

Insight economics completed an analysis of current activities and development options at Millbrook in support of a submission for resource consent to add an additional 9-holes of golf on a property adjacent to the current Millbrook resort[10]. The Insight estimate is that the direct spend of golf tourism is $420 per person per day. For the 9,100 'staying' visitors who then stay 5.5 nights in the general area, and one-third accompanied by non-golf playing partners, implies a total of about 50,000 guest days and nights, for total direct spending of about $20.0 million per year. This would generate about $8 million in direct GDP contribution each year.

The green fees for Millbrook in 2002 were $65 for NZ affiliated players and $110 for non-affiliated players. Currently they are still $65 in winter, and $125 for a house guest, and $170 for a casual visitor in summer. These green fees are low compared with The Hills, $550, and Jack's Point $225.

[10] Insight economics, *Economic analysis of development options for Millbrook*, Millbrook Country Club Limited.March 2015. 21pp.

Scale of general golf tourism

Currently there are about 13,000 rounds of golf played at Millbrook each year, and these directly generate about 9,100 visitor nights. Of these nights about 55 percent, or 5,000 are at Millbrook and 45 percent or 4,100 are at other accommodation providers in the District. Note that these are the strictly golf-related visitor nights, and many will spend an additional night or two in the District, as they experience other tourist activities. A golf working group of New Zealand Tourism in 2013 estimated that 44,100 visitors to New Zealand per year were visitors for whom golf is a significant motivating factor. They projected that by 2016 this number could be increased to over 70,000 visitors[11].

As an average over all visitors, the national data shows visitor arrivals into Queenstown and Wanaka RTOs total 1.75 million per year, and the total guest nights are 4.4 million which indicates that guests stay on average about 2.5 nights in these RTOs. Research has shown in New Zealand and elsewhere that golf tourists tend to stay longer and spend more than tourists in average[12].

In the year to June 2017, an estimated 106,500 international visitors played golf in New Zealand, of these 34,250 visited the Queenstown-Lakes District, and stayed on average for 5.5 nights in the district. This information comes from the Ministry of Business, Innovation and Employment (MBIE) International Visitor Survey (IVS). This information allows us to be confident that international visitors coming to play golf at Millbrook will stay for 5.5 nights in the district, rather than the average 2.5 nights average stay for all visitors.

Contribution of golf tournament tourism

A detailed analysis of the economic impact of the NZPGA Pro-Am Championship also held at The Hills golf course in the Wakatipu Basin, was completed in 2012 by BERL completing an assessment for the Major Events Development Fund of the Ministry of Business, Innovation and Employment (MBIE). The tournament was held over four days from 28 March 2012.[13]

The estimate of the economic impact in the Queenstown Lakes District economy was that there was increased expenditure by $4.2 million, and the GDP generated was $2.0 million. This created work for the equivalent of 29 Full Time Equivalent workers (FTEs) for one year. Approximately 45% of people attending the tournament came from outside Queenstown Lakes District, but a smaller share came from overseas. Hence the direct impact on the New Zealand economy's GDP was only $0.3 million, and employment net increase just 5 FTEs.

The *Strategic Plan 2014-2018* by New Zealand Golf indicates that the New Zealand Men's and Women's Open Championships have a combined turnover of $5 million[14].

The 2017 New Zealand Men's Golf Open attracted 123 international playing professionals, along with a further 68 amateur players for the Pro-Am. In addition to the international players, around 700 international spectators come to New Zealand to watch the event, along with 2,100 domestic visitors from outside the Queenstown district. In total international players and spectators spent 5,060 nights in the district and spent on average $283 per night, for a total spend in the district of $1.4 million. At the same time domestic visitors spent 11,400 nights in the district and spent $2.1 million.

Overall the 2017 New Zealand Men's Golf Open saw around 16,500 guest nights and $3.5 million of visitor expenditure in the district. This would generate about $1.7 million in direct GDP added to the District each year.

[11] Golf Working Group, Greg Turner Chair, *New Zealand International Golf Tourism Strategy*. New Zealand Tourism. August 2013. 41pp.

[12] Gazley, Chris. *A slice of tourism: the nature, dimensions and geographies of international golf tourism in New Zealand*. Victoria University, 2010. 103pp.

[13] BERL Leung-Wai, Jason and Kelly Dustow. *The economic impact of the NZPGA Pro-Am Championship*. BERL, August 2012. 52pp.

[14] New Zealand Golf. *Strategic Plan 2014-2018*. 11pp.

4.2 Amenity attraction value in the Wakatipu Basin

Population growth in Queenstown Lakes and Central Otago Districts have been strong in recent Census periods, which coincides with increased amenity in the Districts, including golf courses, cycle trails and the like. It is possible to observe the phenomenon, but difficult to ascribe a defensible value to it.

The nature of change of population and employment in the Queenstown Lakes and Central Otago Districts has two main characteristics:

- The resident population has grown by 47% between 2001 and 2013, compared with7% in the rest of Otago Region and 17% for New Zealand as a whole; and
- The pattern of workplace employment is strong on areas servicing recreation and tourism with these industries employing 19% of the employed in Queenstown Lakes, and Central Otago compared with 10% in the rest of the Otago region, and 8% in New Zealand as a whole
- Employment in agriculture and horticulture is strong at 10% compared with 7% for New Zealand, but processing and manufacturing is only 5% compared with 10% for New Zealand as a whole.

The creation of an attraction which results in more people living in the catchment, District and Region, and in more visitors cannot be readily valued at 'golf course gate'.

It is clear that the District is seen as one with high amenity values which attracts new residents and visitors, and thus grows the economy. We have indicated that a key driver appears to have been the development of golf course resorts with associated dwellings. We also indicate that much of the promotion relies on promoting these places as oases in the dry Central Otago landscape. This attraction of high amenity values is dependent upon the availability of water for irrigating the fairways, and landscaped lawns in the resort complexes.

The need here is to obtain an approach to measuring the economic impacts of them.

4.2.1 Millbrook Resort development 1993 to the present

The main resort developed initially was Millbrook, which was opened in 1993. The number of dwellings in the resort has increased strongly since then, as has the value of the properties.

A 2003 article by Richard Willis on the subject of golf courses in New Zealand[15]contained a table with some parameters of ten golf courses in New Zealand. In this paper Willis notes that Millbrook had 72 homes and 50 villas. Originally (presumably in 1993) the houses cost $80,000 and in 2002 cost $200,000.

Currently there are approximately 200 properties in the resort, with more being developed, and further spaces designated for future development. Recently homes are being advertised by Millbrook Real Estate at prices ranging from $2.75 million to $3.8 million. Fairway fronting building sites are advertised at prices equivalent to about $1,150 per square metre, or about $2 million for an average sized 1,760 square metre site.

These parameters indicate that the amenity created in and around this golf course and resort commands a considerable market premium. The resort currently has a 27-hole golf course with the intention to add a further 9 holes. It has a number of dining venues, The Spa and wellness centre, walking and cycling trails, swimming pool, conference centre, tennis court and playground.

4.2.2 Real estate changes reflecting amenity increase

The economic analysis approach to measuring amenity level, or in the extreme, measuring the value of a view or vista as a resource is to find the amount people are willing to pay for an hotel room for an overnight, or a dwelling

[15] Willis, RW. *Golf course capitalism: does New Zealand follow the Asian model*. New Zealand Geographical Society Conference, Auckland, 2003.

to purchase where that view can be had, compared with the price they are willing to pay for a similar room or dwelling with no such view. The difference can be thought of as the resource rental generated by the view. Alternatively it can be called the amenity value generated by the view.

There is a process of analysis called Hedonic Valuation, which determines what that amenity value is.[16] That process can be quite complicated, and takes account of the distance to main urban areas, main attractions like the coast etc.[17]

At a high level it is possible to obtain a very rough indication of the residential amenity in the Wakatipu Basin area compared with in the urban areas of the relatively nearby Central Otago towns of Alexandra, Cromwell, and Clyde. The town size as reflected in the number of residential titles is similar for Alexandra and Cromwell as for the Wakatipu area. It is also possible to compare the Wakatipu Basin residences in Arrowtown, and surrounds (including Millbrook) with perceived higher amenity in Wanaka, as well as Queenstown suburbs Frankton, Queenstown Bay and Queenstown Hill.

Surprisingly the CoreLogic data for 2016 indicated that the amenity value as reflected in the land value of the residences in each of those two groups had similar averages.

Table 4.1 Number of residential properties, average size and land value, selected areas, 2016

Otago townships and areas	Number of residences	Average size of residences in meters	Average land value per residence
Wakatipu area	2,878	2,707	365,994
Arrowtown	1,358	697	354,133
Wanaka	5,361	1,815	324,720
Queenstown	5,785	738	321,955
Central Otago townships	5,977	1,232	146,893

For the 6,000 residences in Alexandra, Cromwell, and Clyde, the average land area in each place was about 1,000 square metres, and average land value of $147,000.

For the 7,150 residences in Queenstown and Arrowtown the average land areas in each area were around 700 square metres, and the average land value was $320,000 to $350,000. While the 8,239 residences in Wanaka and the Wakatipu area the average land areas were 1,800 to 2700 square meters, and the average land value was again around $320,000 to $365,000. This data tend to indicate that the amenity enjoyed in Wanaka, in Arrowtown and in Arrowtown surrounds such as Millbrook is perceived to be similar to that in Queenstown. In turn it is perceived to be worth approximately $200,000 additional for land to place a dwelling, compared with the other towns nearby.

A similar picture emerges by comparing the rate of increase of residential land values over the last fifteen years. The Census Area Unit with the greatest increase in resident titles is the Wakatipu CAU which includes Millbrook and surrounds.

[16] Sheppard, S. *Hedonic analysis of housing markets*. In Handbook of Regional and Urban Economics, eds E.S.Mills and P. Cheshire. 1999

[17] Nunns, Peter, et al. *The value of land, floorspace, and amenities: A hedonic price analysis of property sales in Auckland 2100-2014.* Auckland Council Technical report 2015/012. 2015 31pp

4.2.3 Economic value of amenity

As a high level estimate of the amenity enjoyed by the residents in Millbrook, Arrowtown and surrounds, it can be suggested that the people in these 4,000 residences perceive an amenity value about $200,000 land value greater than were they to live in nearby towns.

This is an additional value on the land of those 4,000 residences of $800 million. The means of obtaining a measure of the level of these peoples' willingness to pay an annual amount is to apply an interest rate charge to service the additional cost of the land. A first estimate would be a weighted average cost of capital of 5% per annum, which means their combined willingness to pay for the increased amenity is $40 million per year.

It is somewhat reassuring that this high-level assessment of the annual value of the increased amenity value of $40 million per year, is similar to the $40 million per year estimated as the approximate contribution to GDP from the tourists and residents attracted by the high amenity of the area.

The remaining analysis needed is to address whether or not all of this additional amenity would be lost were the landscape to revert to parched lawns and some mainly dry tussock. This will be explored in the final section of the report.

4.3 Agricultural land use

The previous section has shown that the current land-based tourism production in the Wakatipu Basin has a direct contribution to GDP of approximately $40 million per year, and direct employment of 620 FTEs. Taking account of the Region's value chains the total GDP contribution from agricultural use is estimated at $17 million per year, and total employment of 195 FTEs.

The direct value of the actual current land use with the current available water, is estimated in terms of the total gross margins or value added earned at farm gate or orchard gate. The prices and costs are generally based on the 2015-2016 year.

The direct value is estimated based on the land use shown above. In the area served by the Arrow catchment the largest land use is mixed sheep and beef farming, with just over 14,000 hectares, followed by beef cattle farming, with just over 6,200 hectares. The majority of the land used for sheep and beef farming is hill country to the north and north-east of Arrowtown. This hill country land is ill-suited to irrigation, and will not be impacted by changes in water availability.

The rest of the agricultural production is across a range of land uses, which is more diverse and comprehensive than in most regions of New Zealand. Compared with other New Zealand regions, there is a stronger presence of deer, and mixed sheep and beef farming, while at the same time there is no dairy farming and limited arable production in the catchment.

This indicates that the land-based direct gross margin, and thus contribution to regional and national GDP totals over $8 million per annum. Of this amount almost 70% came from dryland and irrigated mixed sheep and beef production, with the remaining 30% from other land uses. The most important of the other land uses are beef farming and deer farming, each generating around $1 million in direct GDP.

Table 4.2: Direct value of current irrigated and dryland production in the Arrow catchment and Wakatipu Basin

Total Gross Margin ($m)	Current Land Use		
	Dryland	Irrigated	Total
Dairy cattle farming	$0.0	$0.0	$0.0
Beef cattle farming	$0.9	$0.2	$1.1
Mixed Sheep and Beef farming	$5.5	$0.1	$5.6
Sheep farming	$0.2	$0.2	$0.4
Arable cropping or seed production	$0.1	$0.0	$0.2
Deer farming	$0.2	$0.6	$0.9
Grazing other peoples stock & dairy dry stock	$0.0	$0.0	$0.1
Vegetable and Fruit Growing	$0.1	$0.0	$0.1
Forestry	$0.0	$0.0	$0.0
Viticulture	$0.0	$0.1	$0.2
Lifestyle blocks	$0.0	$0.0	$0.0
Other uses	$0.0	$0.0	$0.0
Total Gross Margin ($m)	**$7.1**	**$1.4**	**$8.4**

4.3.1 Economic impact on the Queenstown-Lakes District

The direct value-added contribution to the economy is estimated at $8.4 million per year and taking account of the backward and forward value chain impacts the total contribution to the districts economy is valued at $14.6 million per year as shown in Table 4.3.

Table 4.3: District value chain contribution of current land-based production in Arrow catchment and Wakatipu Basin

District economic contribution	Value added GDP $Mn		Employment (FTEs)	
Current Use	Direct	Total	Direct	Total
Dairy cattle farming	$0.0	$0.0	0	0
Beef cattle farming	$1.1	$1.9	11	20
Mixed Sheep and Beef farming	$5.6	$9.7	58	101
Sheep farming	$0.4	$0.6	4	7
Arable cropping or seed production	$0.2	$0.3	2	3
Deer farming	$0.9	$1.7	17	28
Grazing other peoples stock & dairy dry stock	$0.1	$0.2	2	3
Vegetable and Fruit Growing	$0.1	$0.2	2	3
Forestry	$0.0	$0.0	0	0
Viticulture	$0.2			
Lifestyle blocks	$0.0			
Other uses	*$0.0*	*$0.0*	*0*	*0*
Total Economic Impacts	**$8.4**	**$14.6**	**95**	**163**

The contributions to the broader value chain impacts come from across the spectrum of land uses. The value chain impacts come from the upstream supply of goods and services to the farm level production and the

downstream economic activity and employment in processing and manufacturing based on the primary products.

The Statistics NZ databases obtained at a detailed 506-industry level annually by BERL show that in the Queenstown-Lakes district, upstream there are just under 100 FTEs employed in shearing and other agricultural support services. Downstream, there are only 12 FTEs in the meat, dairy, fruit and vegetable processing industries in the district in 2016. This shows that goods and items produced on farm land within the district are moved outside the district for processing, and that services that input into farming are also generally sourced from outside the district.

In summary, the modelling shows that the direct employment on the land is estimated at about 95 Full Time Equivalent (FTE) employed. Together with the value chain employment of 68 FTEs, the total employment generated is estimated at 163 FTEs employed.

4.3.2 Economic impact on the Otago Region

The direct value added contribution to the economy is estimated at $8.4 million per year and taking account of the backward and forward value chain impacts the total contribution to the districts economy is valued at $17.2 million per year as shown in Table 4.4.

Table 4.4: Regional value chain contribution of current land-based production in area served by water from the Arrow catchment

Regional economic contribution	Value added GDP $Mn		Employment (FTEs)	
Current Use	Direct	Total	Direct	Total
Dairy cattle farming	$0.0	$0.0	0	0
Beef cattle farming	$1.1	$2.2	11	23
Mixed Sheep and Beef farming	$5.6	$11.3	58	119
Sheep farming	$0.4	$0.7	4	8
Arable cropping or seed production	$0.2	$0.3	2	4
Deer farming	$0.9	$2.2	17	33
Grazing other peoples stock & dairy dry stock	$0.1	$0.2	2	3
Vegetable and Fruit Growing	$0.1	$0.2	2	3
Forestry	$0.0	$0.0	0	0
Viticulture	$0.2			
Lifestyle blocks	$0.0			
Other uses	*$0.0*	*$0.0*	*0*	*0*
Total Economic Impacts	**$8.4**	**$17.2**	**95**	**192**

The value chain impacts come from the upstream supply of goods and services to the farm and the downstream economic activity and employment in processing and manufacturing. In the Otago region, approximately 2,000 FTEs were employed in shearing and other agricultural support services in 2016, while 3,420 FTEs were employed in the meat, dairy, fruit and vegetable processing industries.

In summary, the modelling shows that the direct employment on the land is estimated at 95 FTEs. Together, with the value chain employment of 97 FTEs, the total employment generated is estimated at 192 FTEs.

5 Measuring potential issues of setting minimum flows

To determine the potential impacts of setting minimum flows on the Arrow River it is necessary to know in some detail the land uses in which the water is currently used; the amount of water currently taken or abstracted from the river; the naturalised flow if no water was taken and the expected fluctuations in the river flows; and the amount of water needed for each use, and the impact of constrained water availability on those uses. It is the last measure of impact which can be converted to an economic measure of impact.

5.1 Information on water supply and demand

As in many studies of this nature there is not comprehensive data for all of the measures desirable, however there is sufficient data to arrive at assessment of impacts of the main options.

To provide a background to the assessments made, the shortcomings of the main data sets are outlined.

- Land uses: This data is constantly being updated because there are ongoing substantial changes in land use in this catchment. The latest AgriBase data does not reflect current land use and must be interpreted with judgement. The main changes in land use that could occur in this catchment in the future relate to population growth and tourism. There are currently new residential subdivisions and the establishment and extension of golf courses supplanting primary production land uses like deer, beef and sheep farming.
- Arrow River flows: The Arrow river flows are measured at the Cornwall Street recorder. It has 10 years of record, with only four years of naturalised flow. To provide a longer term perspective, these records were extended by reference to the correlation with Cardrona River flows at the Mt Barker flow site. These extensions showed higher flows than those in the past four years alone, due to the drier summers the Otago region has been experiencing over these years. Hence conclusions based upon the flows of the last four years will be conservative – ie: present a worst case scenario.
- Arrow river abstractions / water use: The level of water use for main consents are known for a few years. The volume of nearly 70% of the total consents are held by Arrow Irrigation Company, and they do not have detailed data of use by the various members and land uses. However the data that ORC does have indicates that between 2013 and 2017 the average monthly take between December and March was 0.6 cumecs over the month. The maximum average monthly take from the same dataset was 0.7 cumecs over the month, and the minimum average take from December to March was 0.45 to 0.5 cumecs over the month. These details are shown below.
- AquaLinc water use parameters: The parameters for efficiency of water use in areas of Otago Region are available from the AquaLinc 2006 and 2017 reports. However their assumption is that if a user requires some water in any day, they will take the full amount of their consented allocation. This is unlikely to be the case, as shown by comparing the actual maximum monthly average daily take in the month of February of 0.7 cumecs with AquaLinc-based estimate of the total required abstraction for efficient pasture production of 1.47 cumecs. This latter figure is obtained by using the AquaLinc parameters applied to pastures on soils of different Plant Available Water (PAW) characteristics. The water use parameters given are also for pasture and vineyards, which will have different, presumably greater water requirements than golf courses and urban amenity lawns.

5.2 Hydrological assessment of impacts of minimum flows

Greater detail on the assessment of the hydrology of the Arrow catchment and Wakatipu aquifers is given in the companion report by Opus : *Arrow Catchment - Hydrological analysis to support EIA of proposed minimum flows, November 2017.*

The impacts of setting minimum river flows at different thresholds depends upon three main things, in a hydrological sense:

- the levels and temporal distribution of the normal or naturalised flow of the river before any water is taken out;
- the levels and temporal distribution of the demands for water to be taken out of the river; and
- the temporal distribution of the times at which the level of demand taken from the river reduces its actual flow to the prescribed minimum flow level.

In terms of the value to the water users, the reliability of availability of water will depend not only on the percentage of days on which water can be taken, but in particular the periods of consecutive days on which water will not become available due to the minimum flow being reached.

5.2.1 Scenarios of water demand

In order to explore this, Opus constructed five scenarios for the level of water demand for irrigation, and tested those against the daily distribution of minimum flows in the ORC four year and seven year series of naturalised flows. Rather than percentages, this method shows the actual days in which abstraction ceases, as well as therefore showing, importantly the number of consecutive days on which abstraction has ceased.

There are a range of estimates of the potential irrigation demand within the Wakatipu Basin, depending on which data is used. The four estimates chosen as a basis for irrigation demand are:

- The average abstraction during the month with the average or mean measured abstraction as recorded by ORC. These averages for the four main 'irrigation season' months December to March fell in the relatively narrow range from 0.54 cumecs to 0.6 cumecs;
- The average abstraction during the month with the highest measured abstraction as recorded by ORC i.e. the 0.7032 cumecs in the February months;
- The maximum modelled rate of irrigation demand (Aqualinc, 2017) i.e. 1.4712m^3/s; and
- The estimated daily abstraction rates needed for efficient irrigation based on Aqualinc (2017).

For the purpose of the economic impact assessment we believe that the second scenario, namely the average monthly abstraction with the maximum or highest measured abstraction each month, will provide a conservative estimate of the number of actual days and consecutive days on which full abstraction rates could not be taken. Opus have also carried out these calculations for the average monthly abstraction with the average measured abstraction.

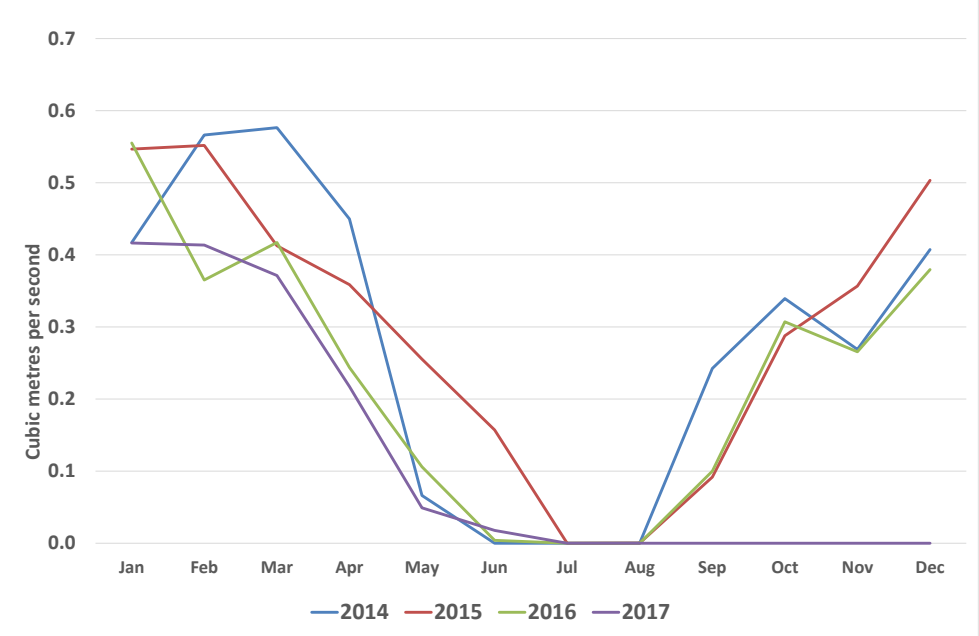
We assess that particularly for the water uses necessary to maintain the amenity of the locality, catering only to the average measured abstraction will be of limited use in maintaining the economic activity and viability in particularly dry periods. The point is that for these uses, reliability is really essential.

It is worth noting that whereas February has an average maximum measured abstraction of 0.7032 cumecs, the months of January and March have average maxima which are very close to the same. The track of these averages and also the mean and the average minima are illustrated well on the chart.

Figure 5.1: Arrow consented takes 2010 to 2017

This pattern of demand for water over each irrigation season is displayed for recent years in a chart of the takes by the Arrow Irrigation Company from 2014 to 2017.

Figure 5.2: Consented takes by the Arrow Irrigation Company 2014 to 2017



5.2.2 Minimum flow impacts on water availability

This pattern of water demand as shown by the average maximum monthly take, when combined with the naturalised flow over the four year and seven year periods gave the estimates of the total number of days, and the consecutive number of days or the longest run on which abstraction would be ceased and water become unavailable.

Table 5.1 Minimum flow thresholds and days with minimum flows below the threshold 2011-2017

Year	Series origin	Threshold 0.8 cumecs		Threshold 0.9 cumec		Threshold 1.0 cumec	
		Total days	Longest run	Total days	Longest run	Total days	Longest run
2011/2012	Opus	0	0	0	0	0	0
2012/2013	Opus	0	0	0	0	0	0
2013/2014	ORC	0	0	0	0	0	0
2014/2015	ORC	0	0	0	0	0	0
2015/2016	ORC	5	4	6	5	10	6
2016/2017	ORC	0	0	0	0	0	0

Source: ORC, Opus and BERL

These estimates were made of the number of days when the abstraction would cease due to each of the three minimum flow thresholds being reached. These thresholds are respectively 0.8 cumecs, 0.9 cumecs and 1.0 cumecs as shown in Table 5.1

At the level of abstraction of 0.703 cumecs, the number of consecutive days when the full abstraction rate could not be taken in each of the seven years 2012 to 2017 were as follows:

Threshold 0.8 cumecs: There were three years with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 6, 20 and 22 days.

Threshold 0.9 cumecs: There were two years with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 2, 13, 21 and 22 days.

Threshold 1.0 cumecs: There was only one year with no days with restricted abstraction. The longest runs of days when full abstraction rates could not be taken in other years were 5, 11, 21 and 22 days.

Table 5.2: Minimum flow thresholds and days with abstraction below full rate 2012-17

Year	Threshold 0.8 cumecs		Threshold 0.9 cumec		Threshold 1.0 cumec	
	Total days	Longest run	Total days	Longest run	Total days	Longest run
2012	22	20	28	21	38	21
2013	8	6	23	13	34	21
2014	0	0	0	0	6	5
2015	0	0	3	2	22	11
2016	59	22	72	22	87	22
2017	0	0	0	0	0	0

Source: ORC, Opus and BERL

The 2016 season was considered a very dry season. Also, as noted above analyses of a longer time series show these to be drier than normal years, and so the number of consecutive days will be above that to be expected in the long term. Generally it would seem that water users and managers would wish to plan for a system of water availability and use which was able to cover continuous periods of up to 20 days when full abstraction from the Arrow River could not be taken. .

In most catchments the irrigation companies work amongst their members to arrive at acceptable methods of rationing water as flows in the rivers reduce. Some purely announce a set percentage of allocation allowed for all members. We are not aware of a specific rationing protocol operated by the Arrow Irrigation Company. The graph of consented takes by the AIC for the years 2014 to 2017 at Figure 5.2 indicates that at certain times, e.g. in February 2016, the AIC has been able to reduce takes as necessary. It presumably was the case that the full abstraction rates of water were not available at that time. This is the rationing behaviour that will become necessary again from time-to-time due to the requirement for the minimum flow.

5.3 Mitigating estimated impacts of minimum flows

The indication from these dry years is that a period of 20 consecutive days with restricted access to abstraction could be expected from time-to-time. A relatively conservative daily requirement for water in the soil conditions in the Arrow, according to the AquaLinc data would be 4 mm of water per day. If this was applied to 100 hectares, this is a total of 4,000 cubic metres per day. Over the period of 20 consecutive days requiring water from sources other than the Arrow River, the total requirement would be for 80,000 cubic metres.

The options to mitigate the reduced water availability include the following.

Storage

In some regions the main source of this additional water would be from established water storage facilities. In that instance it is found that a capital cost of about $5 per cubic metre of storage capacity is invested. For this example, an area of 100 hectares wishing to achieve 100% reliability of irrigation supply could have to invest $400,000 in a storage facility. However storage usually also requires accessible land which often has valuable alternative uses as is likely to be the case in the Arrow area.

Access to non-Arrow water

A possible source of water in these relatively small volumes, in the Wakatipu Basin could be from the Kawarau River. This would require investigation and costing. The Kawarau River solution could be appropriate if feasible and not excessively expensive, because from an environmental / hydrological point of view it is purely a shift of the point of take from the Arrow River to the Kawarau River before the confluence of the two.

These aspects are explored in the following section.

6 Economic impacts of Minimum flow levels on the Arrow River

The purpose and objective of this research is to assess the likely economic impact on the community, District and Region of reducing water takes from the Arrow River to maintain minimum flow levels in the Arrow River.

6.1 Impact on primary production

It is possible to estimate the potential impact of reduction in productivity in current agricultural production, caused by reduction of the level and reliability of water availability in dry times. Given that the estimated total gross margin earned from the 1,650 hectares in irrigated agriculture and horticulture of just $1.7 million per year, the reduction in local economic activity by some reduction of intensity in those farm systems would not have a large impact on community, District or Region's economic activity. The reduced reliability and availability of water for irrigation is expected to impact on the level of primary production and its contribution to the local, District and Regional economy. The actual level of impact is difficult to assess because it will depend upon the approach taken to rationing the water among the primary production uses. However, since the direct GDP contribution is only $1.7 million per year scale of impact on the local, District and Regional economy is not likely to be great.

6.2 Impact on tourism and recreation

It is difficult to formulate a realistic counter-factual to allow for a steadily reduced level of tourism and recreational activity in the Wakatipu Basin if and when the amount of water available for maintaining the amenity of the area was reduced.

There are no other 'natural experiments' we are aware of where something of this nature has occurred which could provide a credible set of parameters to apply in this case.

However, our estimates are that the annual contribution to the local and District economy from the tourism, recreation and residential activity supported by the high level of amenity in the landscaped, watered areas of the Wakatipu Basin contributes annually about $40 million directly to the local and District economy. Were this area to revert in some years to a more-parched landscape for significant periods in the drier seasons, the attractiveness would certainly decline.

The area is then more-likely to attract tourists from predominantly the local District and Region, with some other, mainly New Zealand domestic visitors/ tourists.

In that case a proxy estimate could be to assume a similar number of visitors, and to reduce the per-day spend from the average by international (and high-spending local) tourists to the average per day spend across all local (domestic) tourists. There has not been comprehensive survey data collected for domestic visitor spending collected since 2008. We have considered other sources of information such as the Commercial Accommodation Monitor and other estimates circulated by MBIE. From this assessment, it appears that whereas the average amount spent per day by golf tourists was shown in the Insight study to average $420 per day, and equivalent New Zealand tourist could be expected to spend about $250 per day.

If this were the case, and if the visitation to the Wakatipu Basin remained at current levels, the annual GDP generated could be 250/ 420 or 60% of the current contribution, namely $24 million to direct GDP per year. Taking into account the value chain impacts, this would be $42 million to the Regional economy.

The reduction in the annual economy would thus be a reduction of $16 million in District GDP and $28 million to Regional GDP.

These are accepted to be very approximate estimations. However as a consequence of maintaining a minimum flow in the Arrow River, there will be periods when full abstraction rates cannot be taken. These periods are expected to fall mostly in dry years. At those times when water takes are unreliable there is no doubt that the potential economic impact of loss of amenity would be substantial, and considerably greater than the economic reduction in GDP contribution by the primary production sector.

6.3 Mitigating estimated impacts of minimum flows

The indication from the dry years modelled is that a period of 20 consecutive days with restricted access to abstraction could be expected from time-to-time. The restricted access will undoubtedly be managed partly through a rationing protocol and process especially among users in the AIC. However other measures can be taken to increase availability of water at such times to assist mitigate these impacts.

Three options in addition to management approaches and which require assessment are the following:

- Provision of water storage to ensure close to 100% reliability of water supply. Especially for those uses which can afford to fund the storage;
- Abstracting water from the Kawarau River to supply to users in the Wakatipu Basin; and thirdly
- To obtain water from within the Basin aquifers.

A relatively conservative daily requirement for water in the soil conditions in the Arrow, according to the AquaLinc data would be 4 mm of water per day. If this was applied to 100 hectares, this is a total of 4,000 cubic metres per day. Over the period of 20 consecutive days requiring water from sources other than the Arrow River, the total requirement would be for 80,000 cubic metres.

The options to mitigate the reduced water availability are as follows.

Storage:

In some regions the main source of this additional water would be from established water storage facilities. In that instance it is found that a capital cost of about $5 per cubic metre of storage capacity is invested. For this example, an area of 100 hectares wishing to achieve 100% reliability of irrigation supply could need 80,000 cubic metres of storage, and would have to invest $400,000 in a storage facility. The creation of storage requires there to be accessible land available. The hilly areas around the Wakatipu Basin indicate that it may be possible to create a small storage lake in a gully reasonably close to the water demand areas.

Access to non-Arrow water:

The possible sources of water in these relatively small volumes, in the Arrow catchment could be from the Kawarau River. If this is feasible and economic, it could provide fully reliable water to some key uses, for example those providing amenity and recreational attractions in the Basin. This would require investigation and costing. It could be relevant and economic for those irrigators obtaining a high value from maintaining the reliability of water available for their use.

If such a source of water with 100% reliability was created, then other water users would be able to maintain a higher level of take while still observing the minimum flow. There could still be some need for rationing at times, and also maybe some access to the aquifers.

The Kawarau River solution could be appropriate if feasible and not excessively expensive, because from an environmental / hydrological point of view it is purely a shift of the point of take from the Arrow River to the Kawarau River before the confluence of the two.

Potential opportunity to obtain water from within the Basin Aquifers:

There is some capacity within the aquifers, based on the proposed options of setting limits at 50% of Mean Annual Recharge.

6.3.1 Provision of mitigation measures

Measures to increase water reliability by obtaining water from alternative sources and/or by creating water storage will require investment. Given that in this case the volumes of water do not appear likely to be particularly large, or reticulation distances particularly long, it may well be that the direct costs of investment will generate sufficient benefit to be commercially justified.

However as with most trunk infrastructure, the designation of easements or accessways, the provision and installation of pumps, pipelines, a dam or similar is likely to require significant regulatory support and here the economic assessment indicates a wider participation in this provision.

Our research and assessment has shown that freshwater use over the past 15 or 20 years has assisted in the transformation of the Wakatipu Basin to become an extension of the greater Queenstown area which now has approximately 5% of the total national tourist activity. The activity in the Wakatipu Basin has been shown to generate value chain activity in the District and the Region. There is therefore a Regional public good element and a national public good element to the provision of reliable water, in addition to the environmental and social good of the minimum flow in the Arrow River.

There is therefore an economic justification to Regional and national interests providing support to ensure that regulatory aspects are addressed effectively in order to bring about any adopted mitigation measures.

Appendix A Number and size of farm properties

The ORC provided GIS files to assist with land use analysis. - *ArrowAgribaseUpdated* and *IrrigatedParcels*. The GIS data on *ArrowAgribaseUpdated* shows the number of Farm IDs in each of the main land uses and the average area in each Farm ID. The land uses are referred to as Farm IDs as they could be single farms as stand-alone businesses, or they could be a unit within a larger business.

However, a requirement in this assessment is that the economic measures are at a district and region level, rather than individual farm level. To do this, land uses were categorised into main farm types including: sheep and beef breeding; sheep and beef breeding and finishing; sheep and beef intensive farming plus dairy support; sheep and beef farming and mixed cropping; arable cropping and seed production; deer farming; dairy production; viticulture; other horticulture such as fruit and vegetables. Land uses for lifestyle purposes and recreation and tourism ventures was also categorised.

Table 6.1: Current number and size of properties served by the Arrow catchment

Land Use	Count of farm ID's Number	Average farm ID size Hectares
Dairy cattle farming	0	0
Beef cattle farming	18	345
Mixed Sheep and Beef farming	10	1,412
Sheep farming	31	52
Arable cropping or seed production	4	19
Deer farming	16	77
Grazing other peoples stock & dairy dry stock	7	46
Vegetable and Fruit Growing	3	8
Forestry	4	17
Viticulture	3	11
Lifestyle blocks	265	3

Source: ORC and BERL

As shown in the table almost three-quarters of the Farm IDs are for lifestyle blocks with an average farm size of three hectares. The largest average farm sizes are for mixed sheep and beef farming with 10 farms having an average size of 1,400 hectares. This is helped by the presence of Coronet Peak Station and Mt Soho Station, which are large high country mixed sheep and beef stations comprising of over 5,000 hectares each. The average size of beef cattle farming is also helped in this manner by Glencoe Station which in the Agribase dataset is running beef across its 5,000 hectares or so of hill country land.

Appendix B Gross margins for agricultural land uses

The measures used to assess the land-based economic activity are the gross margins earned per hectare of land across the various uses, and dryland versus irrigated land.

The gross margin measure is the gross revenue per hectare less the variable costs per hectare in producing that hectare of output. The variable costs do not include the fixed costs associated with the ownership of the land or the fixed capital such as buildings and machinery tied up in production. These gross margins are therefore equivalent to the concept in economics of the value added in production.

In turn the value added from a hectare of production is the contribution to Gross Domestic Product (GDP) in the Wakatiupu Basin from that hectare.

Estimation of gross margins for land uses

The estimation of gross margins for different land uses used a range of sources of industry information. The sources give industry-wide averages for cost elements and productivity per hectare or per stock unit; where possible these have been calibrated to known levels of cost and productivity within the Wakatipu Basin.

The main sources of information are:

- NZIER, *Value of Irrigation in New Zealand*, AgFirst and MPI: C1 Canterbury dairy, C2 Canterbury arable
- ANZ Research, ANZ Agri Focus October 2013, *Just Add Water: Investigating the returns from irrigation*. With information on Canterbury dairy; Sheep, beef and dairy support; Arable and processed crops.
- Beef and Lamb NZ; *Sheep and beef farm survey 2015/16*: Class 6: South Island finishing breeding; Class 7: South Island intensive finishing. (Earlier years for comparison.)
- Ministry for Primary Industries: *Farm Monitoring: South Island deer*.
- Lincoln University. *Financial budget manual 2014*.
- AFIC/BERL, *Economic impact assessment of arable production in 2015*. Aug 2016. Table 3.6 Areas of certified and production seed in 2013 and 2015; Table 3.7 Value of seed production 2013, 2015. This publication also provides relevant multipliers.

The gross margins have been estimated as an average expected level for each land use. As necessary, this has applied judgement to the information obtained from the above sources, and reflects realistic value and cost expectations as in 2016/17.

Table 6.2: Current Gross Margins per hectare for dryland and irrigated land use in the Arrow catchment and Wakatipu Basin

Land Use	Gross Margin $ / Ha	
	Dryland	Irrigated
Dairy cattle farming	1,314.7	4,164.2
Beef cattle farming	148.9	526.6
Mixed Sheep and Beef farming	393.0	1,010.6
Sheep farming	148.9	526.6
Arable cropping or seed production	1,900.0	5,740.0
Deer farming	362.1	1,047.7
Grazing other peoples stock & dairy dry stock	148.9	526.6
Vegetable and Fruit Growing	3,442.4	5,143.5
Forestry	0.0	0.0
Viticulture	3,950.0	5,200.0
Lifestyle blocks	0.0	0.0
Weighted average of these uses	**311.2**	**717.9**

Appendix C Methodology to estimate activities' dependence on water use

The high-level estimates indicate that tourism and recreation is particularly important as a generator of economic activity in the Wakatipu Basin. The need now is to develop a methodology to estimate the dependence of this upon the ready supply of water.

Methods to estimate the first dimension, of **land-based tourism activity value**:

1 a: The current value added and employment in tourism and recreation activity on land in the catchment; and

1b: The contribution of water from the catchment and aquifers in creating this activity.

Having estimated the current economic activity the methodology has to estimate:

1c: The reduction in value added and employment in tourism and recreation if water availability is reduced by known amounts.

Methods to estimate the second dimension, **amenity attraction value** to population/ residents:

2a: The impacts on the population of residents and economic activity from water-dependent land development and amenity increase;

And

2b: The impacts on that population, activity and amenity if water availability is reduced by known amounts.