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Arrow catchment minimum flows

An economic assessment

Summary report December 2017

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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 .

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.

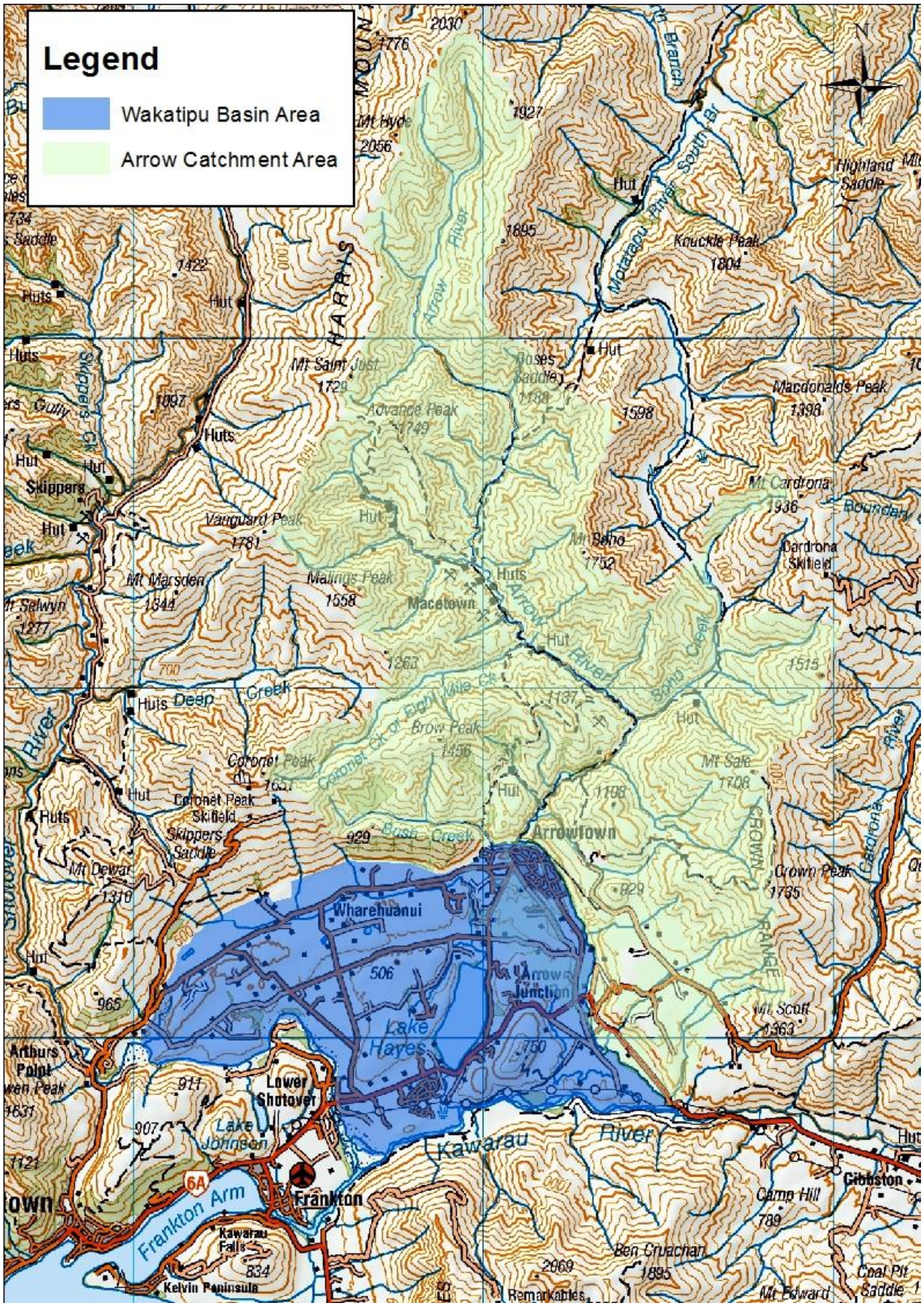
This report provides an economic impact assessment of water management options in the Arrow Catchment and the Wakatipu Basin area. As a large proportion of the Arrow catchment's hill area is not suitable for irrigation, most of the water from the catchment is used in the Wakatipu Basin.

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

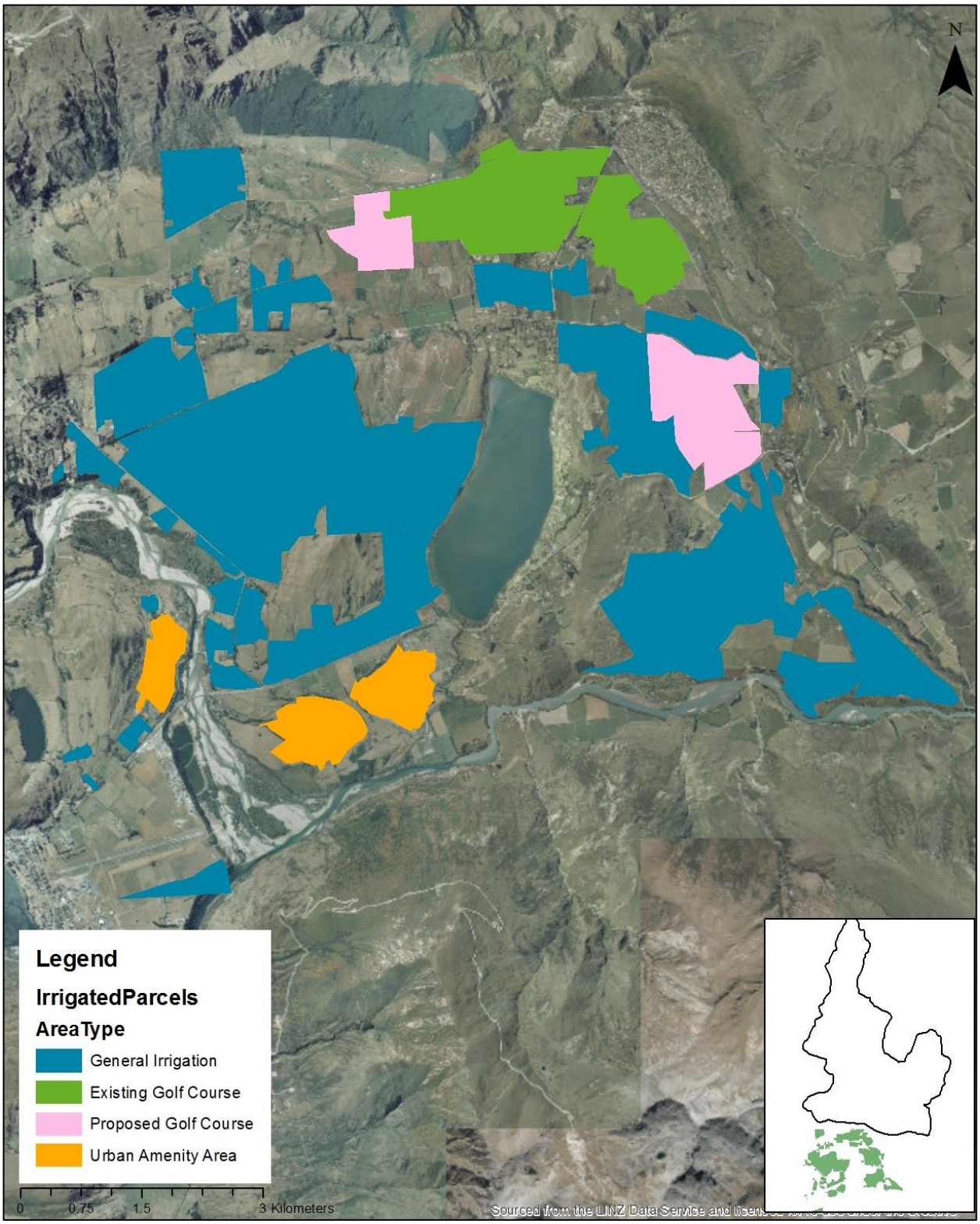
To determine the potential impacts of setting minimum flows on the Arrow River it is necessary to know in some detail the nature and extent of water use. This includes the land uses in which the water is currently used; the amount of water currently taken or abstracted from the river; the naturalised 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 aquifers.