BEFORE THE COMMISSIONERS ON BEHALF OF THE

OTAGO REGIONAL COUNCIL

Application numbers: RM20.003 – Rockburn Wines Ltd; RM20.005 – Pisa Holdings Ltd; and RM20.007 – Smallburn Ltd

UNDER the Resource Management Act 1991

IN THE MATTER of an application for resource consent by **Rockburn Wines Ltd; Pisa Holdings Ltd; and Smallburn Ltd.** to renew deemed permits

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STATEMENT OF EVIDENCE OF CHRISTINA BRIGHT

27 August 2020

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1. QUALIFICATIONS AND EXPERTISE

1.1 My name is Christina Elyse Bright, and I am employed as a Hydrologist at Landpro Ltd, a firm of consulting planners and surveyors. I hold the qualification of a Bachelor of Science (Hons) Geography (2014) from the University of Otago. I submitted my doctoral thesis in December 2019 that is currently under examination. I have been a hydrologist at Landpro Ltd since December 2017, providing consultancy services in the field of hydrology for a wide range of clients. In this time, I have undertaken a variety of hydrology related work, including field assessments, interpretation, and reporting.

1.2 In this matter, I have been engaged by Rockburn Wines Ltd, Pisa Holdings Limited, and Smallburn Limited (referred to collectively as the applicants', unless otherwise stated) to provide independent technical services including the preparation of technical hydrology reports to support the resource consent documentation, liaising with other consultants involved in the preparation of the application, and preparation of this evidence.

1.3 I have visited the site and carried out the hydrological assessments and I am therefore familiar with the proposed scheme.

2. CODE OF CONDUCT FOR EXPERT WITNESSES

2.1 I have read the Code of Conduct for Expert Witnesses within the Environment Court Consolidated Practice Note 2014 and I agree to comply with that Code. This evidence is within my area of expertise, except where I state I am relying on what I have been told by another person. To the best of my knowledge I have not omitted to consider any material facts known to me that might alter or detract from the opinions I express.

3. SCOPE OF EVIDENCE

3.1 As the technical hydrologist for the applicants', I will be presenting on a range of matters as outlined below:

- The hydrological information available for the Amisfield Burn and Park Burn;
- The natural 7-day mean annual low flow (7-day MALF) of the aforementioned waterways;
- Natural hydrology of the Amisfield Burn and Park Burn, including comment on the assessment made to determine the extent of flow loses that occur in the lower reaches of both waterways, including the extent that dry periods occur; and
- Assessment of the appropriate rate of take based on historical abstraction records.

3.2 As the system is interrogated, the hydrology of the Amisfield Burn and Park Burn will be described collectively as the hydrology of each system is applicable for all three applications. Where appropriate under sub-headings matters that relate specifically to certain applications will be discussed.

Hydrological Information

3.3 Hydrological monitoring has been carried out in a number of ways on the Amisfield Burn and Park Burn.

3.4 The Amisfield Burn and Park Burn were assessed in January 2019 by Landpro Ltd where I carried out a longitudinal flow gauging assessment on both waterways.

3.5 The Amisfield Burn has been monitored by the ORC since October 2013 with a continuous flow site maintained upstream from permit 96321.

7-Day MALF for the Amisfield Burn, Breakneck Creek, and Park Burn

3.6 The 7-day MALF has previously been calculated, or estimated using NIWA's SHINY model[1], and by the ORC's[2] Resource Science Unit for the Amisfield Burn, Breakneck Creek, and the Park Burn. Table 1 summarises the hydrological regime for the Amisfield Burn, Breakneck Creek, and the Park Burn.

3.7 SHINY estimates of the 7 day mean annual low flow (7day-MALF) are significantly less than the calculated 7-day MALF for the Amisfield Burn, and there are discrepancies between the 7day-MALF calculated by the ORC and by me. This is likely due to me excluding the 2019/2020 hydrological year as the data provided to from ORCs Hilltop database was incomplete when carrying out my assessment. As the ORC assessment was completed before mine, I am unsure how they had more up to date data that what was available in their Hilltop database when download on the 20 August 2020.

3.8 I am confident in the calculated estimates of low flows for the Amisfield Burn but suggest there is still some uncertainty about low flows for the Amisfield Burn depending on the assessment method used to estimate low flows.

3.9 This uncertainty could be due to record length[3] which is important because there may be large between-year differences in calculated annual hydrological indices. When

[1] SHINY is a model developed by NIWA and a tool utilized by the Otago Regional Council for modelling flow statistics in catchments where little hydrological information is available, as well as other relevant ecological variables (Booker & Whitehead, 2017).

[2] s42A reports for applications RM20.003 – Rockburn Wines Ltd; RM20.005 – Pisa Holdings Ltd; and RM20.007 – Smallburn Ltd.

[3] Brooker (2015). Hydrological indices for national environmental reporting. NIWA report CHC2015-015.

MALF is calculated from a relatively short record, as it has in this situation, the value can be strongly affected by the inclusion of one particularly low or high flow year.

3.10 I completed an additional assessment using an equal ratio method of Amisfield Burn flow to the gauged flow (January 2019) on the Park Burn and calculated 7day-MALF as 28.6 l/s for the Park Burn upstream of the highest point of take. This is in line with the SHINY and MfE estimate for the Park Burn (Table 1). Both the calculated estimate by equal ratio method and the SHINY and MfE model estimates are inconsistent with the estimated 7day-MALF calculated by the ORC (Table 1).

3.11 SHINY and MfE model estimates of MALF for Breakneck Creek are consistent. The assessment using equal ratio of Amisfield Burn flow to the gauged flow on Breakneck Creek calculated 7day-MALF as 15.0 l/s. This is consistent with estimated low flows from SHINY and MfE models, and therefore these models are likely appropriate for use in describing the hydrology of Breakneck Creek.

Table 1: Hydrological 7-Day MALF for Amisfield Burn and Park Burn, and origin of the source of the 7-Day MALF.

Site	7-Day MALF	Source
Amisfield Burn (immediately U/S permit 96321)	47.8 l/s [4]	Calculated 7Day-MALF from approx. five complete seasons of ORC flow recording. Data record for Amisfield Burn as provided by ORC for period 30 October 2013 – 14 June 2020.
	57.2 l/s	ORC calculation of 7Day-MALF[5] Note a variety of other 7day-MALFs have been reported[6].
	13.6 l/s	NIWA SHINY model for reach where water is abstracted.
Breakneck Creek (immediately U/S permit 96320)	15.1 l/s	NIWA SHINY model for reach where water is abstracted.
	19 l/s	ORC's interpretation of MfE river flow modelling[7].
	15.0 l/s	Equal ratio method[8].
Park Burn (immediately U/S permits RM15.007 & 94394)	29.9 l/s	NIWA SHINY model for reach where water is abstracted.
	34 l/s	ORC's interpretation of MfE river flow modelling[7].
	81l/s	Calculated by ORC using ratio of Amisfield Burn flow[9].
	26.1 l/s	Equal ratio method[5].

[4] 7Day-MALF was completed for period 2013-2018 as included in original application was 65 l/s. Additional data for 2018/2019 and 2019/2020 season gives 7Day-MALF of 52.3 l/s. For complete years only, 2014-2019.

[5] Reported in Appendix 1 of Ciaran Campbell for RM20.007.

[6] 69 l/s reported in paragraph 10 of Ciaran Campbell evidence for RM20.005. 68 l/s reported in Table 1 of Ciaran Campbell evidence for RM20.003. 65 l/s reported on pg. 18 of s42A report for RM20.007 and pg. 16 s42A report for RM20.005.

[7] Ministry for the Environment online data portal. River Flow spatial data layer. See Booker (2015) Hydrological indices for national environmental reporting. NIWA Report CHC2015-015.

[8] The equivalent ratio of recorded flow at the Amisfield Burn monitoring site to determine likely mean flow and 7day-MALF for neighbouring catchments.

[9] Table 1 of Ciaran Campbell evidence for RM20.003.

Flow losses – General Comments

3.1 The extent of losses below the highest permit on the Amisfield Burn (permit 95789) and the Park Burn (permit RM15.007.01 and 94394) has been identified by the applicants' and confirmed by the ORC[10].

3.12 Flow gaugings have been carried out by the applicants to try and determine the flow losses between the highest intake on the Amisfield Burn and the Park Burn and the confluence with the Clutha River/Mata-Au. The assessment was completed in January 2019 across two days (15 & 16 January) and intentionally targeted a period when flow losses were likely to be most extreme during summer. The assessment was completed under flow conditions typical of the spring transition into summer, with all abstraction points turned off. This targeted conditions when ambient groundwater levels were expected to be fully charged.

3.13 Losing or gaining reaches were defined in the hydrological assessments carried out in January 2019 using the assumption that surface water flow interacts with the hyporheic zone (sub-surface zone below the riverbed within alluvial gravels). This is due to factors such as topography, geology, and geomorphology that control the movement of water between the river as surface water and shallow groundwater in the hyporheic zone.

3.14 It has been acknowledged for some time by the applicants' and the ORC that many creeks along the Pisa Range are ephemeral[11]. This knowledge informed the assessment of the Amisfield Burn and Park Burn given the likelihood of similar behaviour due to

[10] s42A reports for RM20.003 & RM20.007. Evidence of Ciaran Campbell appended to each s42A report.

[11] Ephemeral here refers to a term used to describe waterways that only flow for short periods of time, usually after significant rainfall events. Intermittent is used to describe stream reaches that cease to flow for periods of the year because the stream bed is periodically above the water table. Sources: Waikato Regional Plan (2010) & Environment Guide New Zealand – Freshwater.

topographic, geological, and hydrological similarities between the catchments along the Pisa Range.

3.15 Similar naturally intermittent behaviour of Central Otago waterways was acknowledged in the recent hearing decision for Long Gully Stream[12], where the stream has naturally intermittent flows and is therefore naturally dry for periods of time.

3.16 It is likely that for a period over summer that there is permanently no connection between the Amisfield Burn and the Park Burn to the Clutha River/Mata-Au naturally, likely December/January to April/May based on my observations and anecdotal evidence provided by the applicants'.

3.17 When assessing the hydrological benefit or requirement of a residual flow, it is common to compare the maximum rate of take to the 7day-MALF to emphasise the amount of water allocated (which is based on maximum amounts). In my opinion this is an overly simplistic assessment method for determining the effects of an allocation on low flows and any requirement for a residual flow. This does not consider the natural flow variability of the system and potential for flow losses that naturally occur or the effects of these things. This is further expanded on in the following sections that address the Amisfield Burn and Park Burn more specifically.

3.18 A groundwater technical review completed by Pattle Delamore Partners Limited was appended to each s42A report and is applicable to both the Amisfield Burn and Park Burn that are underlain by the proposed Pisa Groundwater Management Zone. These reports reinforce the groundwater connection of the Amisfield Burn and Park Burn to the underlying Pisa Groundwater Management Zone. In my opinion, it is more than likely that the flow losses that occur naturally in these waterways are connected to the

[12] Decision Report Long Gully Race Society. 23 July 2020. Paragraph 064.

shallow sub-surface water of this groundwater management zone, and as such contribute to the wider aquifer that maintains connection with the Clutha River/Mata-Au and wider catchment.

Flow Losses & Residual Flows – Amisfield Burn

3.19 Figure 1 (taken from the application) provides an overview of the flow gaugings completed at various sites on the Amisfield Burn and a single gauging on Breakneck Creek.

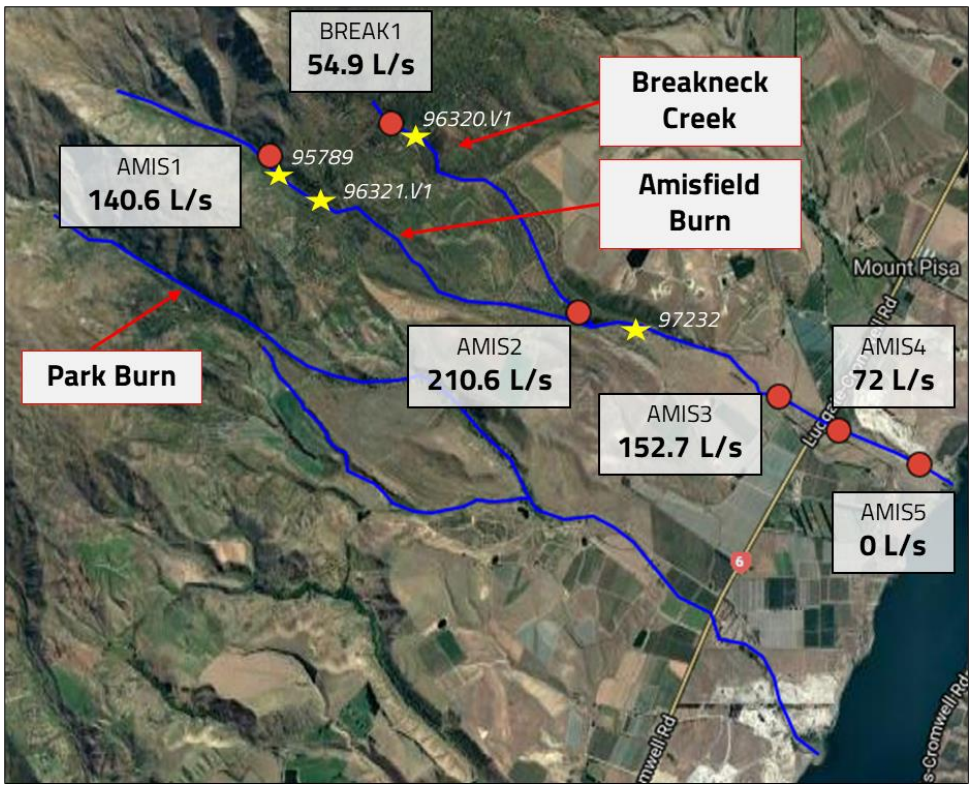

Figure 1: Flow gauging results (red dots) as measured 15 January 2019. All points of take were closed so that there was no take. No flow measured at the confluence with the Clutha River/Mata-Au River.

3.20 The differential gaugings in the middle reach of the Amisfield Burn show gains between the highest intake (95789) and downstream of the confluence with Breakneck Creek

(Figure 1 - AMIS2) of approximately 70 l/s. Accounting for flows from Breakneck Creek, an additional 15.1 l/s is gained from the upper reaches (Reach 1 – Figure 1 AMIS1 to AMIS 2).

3.21 The differential gaugings in the lower reaches show loss of 57.1 l/s between the Breakneck Creek confluence and State Highway 6 (Reach 2 – Figure 1 AMIS2 to AMIS3), with further flow losses across the lowest reaches; 79.7 l/s Reach 3 (Figure 1 AMIS3 to AMIS4) and 72 l/s across Reach 4 (Figure 1 AMIS4 to AMIS5). The total loss is 210.6 l/s between AMIS2 and AMIS5 (just above the Clutha River/Mata-Au confluence) and is higher than the natural (calculated by equal ratio method)[13] 7-Day MALF for the confluence of Breakneck Creek and the Amisfield Burn of 57.6 l/s and demonstrates that the lower reach of the Amisfield Burn is naturally intermittent.[14]

3.22 The longitudinal gaugings indicate that the intakes are situated in flow neutral reaches on schist geology, upstream of where flow losses are expected to occur. There is then a transition to a significant losing reach for the length of river downstream from the confluence with Breakneck Creek and the Clutha River/Mata-Au confluence due to the alluvium and loess geology of the middle and lower reaches.

3.23 This geology of the river channel and alluvial bed morphology promotes flow interaction with the sub-surface zone and losses through the loose alluvial gravels to shallow groundwater.

[13] I have calculated the 7day-MALF for the site downstream of the confluence between Breakneck Creek and the Amisfield Burn using an equal ratio method to the upstream flows to estimate the natural 7day-MALF.

[14] Intermittent is used to describe stream reaches that cease to flow for periods of the year because the stream bed is periodically above the water table, and therefore only flow at certain times of the year. Sources: Waikato Regional Plan (2010) & Environment Guide New Zealand – Freshwater.

3.24 The flow loss that occur across reaches 2, 3 and 4 suggest that there is an acceleration of flow losses per metre along the total drying reach of the Amisfield Burn. The loss rates are summarised in Figure 2. The total drying reach is 2.7 km; the most extreme losses are observed in the lowest reaches (Figure 2).

3.25 The average water loss rate is approximately 0.11 l/s per meter over the 2.7km drying reach. This drying reach is approximately where the transition is from hard schist lithology to alluvium and loess where flow losses are expected to occur[15].

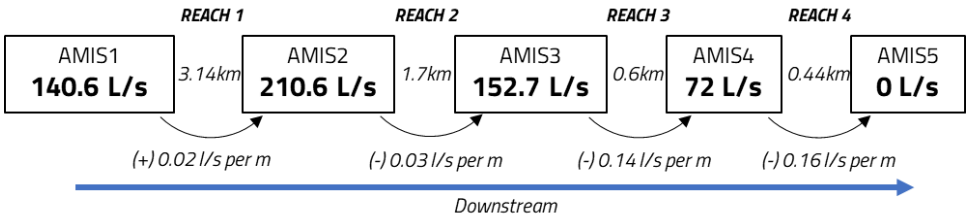

Figure 2: Rates of flow gain or loss along Amisfield Burn. (-) denotes flow loss and (+) denotes flow gain. Results of hydrological survey 15 January 2019.

3.26 In my opinion during peak summer conditions it is likely that flow losses of up to 210 l/s occur over the 2.7km drying reach downstream from the confluence of Breakneck Creek and the Amisfield Burn, so that if a connection is to be maintained to the Clutha River/Mata-Au more than 210 l/s would need to be passing the Breakneck Creek Amisfield Burn confluence.

3.27 An assessment of ORC's temperature records for the Amisfield Burn provide further evidence of naturally drying behaviour and describe the general conditions under which the river is dry in the reach below the State Highway where the temperature logger is located. This assessment concluded that the channel drying occurs primarily in late

[15] Refer to Figure 13 of the Technical Report appended to the original application.

summer and early autumn, and coincides with the period of low upstream flows, low rainfall, and high air temperatures. This also coincides with a general trend of decreasing abstraction at this time of year.

3.28 A 50:50 flow sharing residual flow condition has been recommended by the ORC for the replacement permits for 96320 & 96321 (Smallburn Ltd) and 95789 (Pisa Holdings Ltd) in relation to Breakneck Creek (96320) and the Amisfield Burn (96321, 95789).[16] The 50:50 flow sharing requires that at least '50% of the natural flow in the waterway is left in the waterway', this is also a recommendation made by Aukaha[17] in relation to RM20.005 only. This implies that during summer when natural low flows are most extreme, 50% of the natural 7Day-MALF should always be the remaining flow in a waterway, but also implies year-round maintenance of 50% of flows, regardless of whether flows are high or low.

3.29 In my opinion, and as explained further in paragraphs below, the natural hydrology downstream of the confluence of Breakneck Creek and the Amisfield Burn would not be significantly enhanced through this form of flow sharing. Ecological values relating to the residual flows at the points of take are addressed by Mr Allibone[18].

3.30 Based on my evidence in Figure 1 and 2, if 50% of the natural flow is to remain in the waterways at all times, over summer when natural flow losses occur, a minimum 23.9 l/s would be required to be left in the Amisfield Burn below the highest take point (permit 95789). This, less any water taken at the downstream point of take (permit 96321.V1), plus the possible flow gain and inputs from Breakneck Creek (and accounting for the 96320 abstraction on Breakneck Creek) is substantially less than the estimated

[16] Draft consents: RM20.005.01 & RM20.007.01 & RM20.007.01

[17] Paragraph 6.2 of Aukaha's submission on RM20.005.

[18] Paragraph 37 – 39 of Dr Allibone's Evidence.

flow loss (loss of up to 210 l/s) between the Breakneck Creek and Amisfield Burn confluence and the Clutha River/Mata-Au that is approximately 2.7km downstream. Therefore, during low flows, this 50% of natural flow residual flow in my opinion will more than likely be lost in the lower reaches even after inputs from Breakneck Creek and surrounding hillslopes.

3.31 As flow losses occur below the Breakneck Creek confluence, the 50% of natural flow residual recommended by ORC for Breakneck Creek (permit 96320) is also unlikely to achieve flow connectivity beyond the current dry reaches downstream on the Amisfield Burn.

3.32 Therefore, when assessing the system entirely and considering the wider contributing factors of the overall hydrology, the use of a residual flow and 50:50 flow regime will only provide for the maintenance of the hydrological regime in the upper reaches where flow losses do not occur.

3.33 Technically, Pisa Holdings Ltd could maintain a residual flow of 50% of the flow measured at the upstream flow monitoring site. In practice, however, this would be very difficult. Furthermore, the form of monitoring recommended by ORC to ensure compliance is unnecessarily complicated for a take point that is not easily accessible on a day-to-day basis. I propose that a visual residual flow be maintained downstream to the 96321.V1 point of take, as this is a more suitable method for monitoring flows below the point of take. This is the simplest approach to ensuring a connective flow below the point of take is maintained and promotes collaborative water use between users.

3.34 Smallburn Ltd cannot easily maintain a residual flow of 50% of available flow as there is no upstream meter associated to Breakneck Creek, and as there is one meter that

operates for both the Breakneck Creek permit and the Amisfield Burn permit it would be difficult to monitor the 96321.V1 rate of take by subtracting the difference from the upstream Amisfield Burn flow monitoring site and rate taken by Pisa Holdings Ltd. Therefore, a numerical residual flow is not suitable on Breakneck Creek or the Amisfield Burn replacement permits. I propose that a visual residual flow could be maintained below the 96320.V1 Breakneck Creek and 96321.V1 Amisfield Burn take points.

Flow Losses & Residual Flows – Park Burn

3.35 Figure 3 (taken from the application) provides an overview of the flow gaugings completed at various sites on the Park Burn.

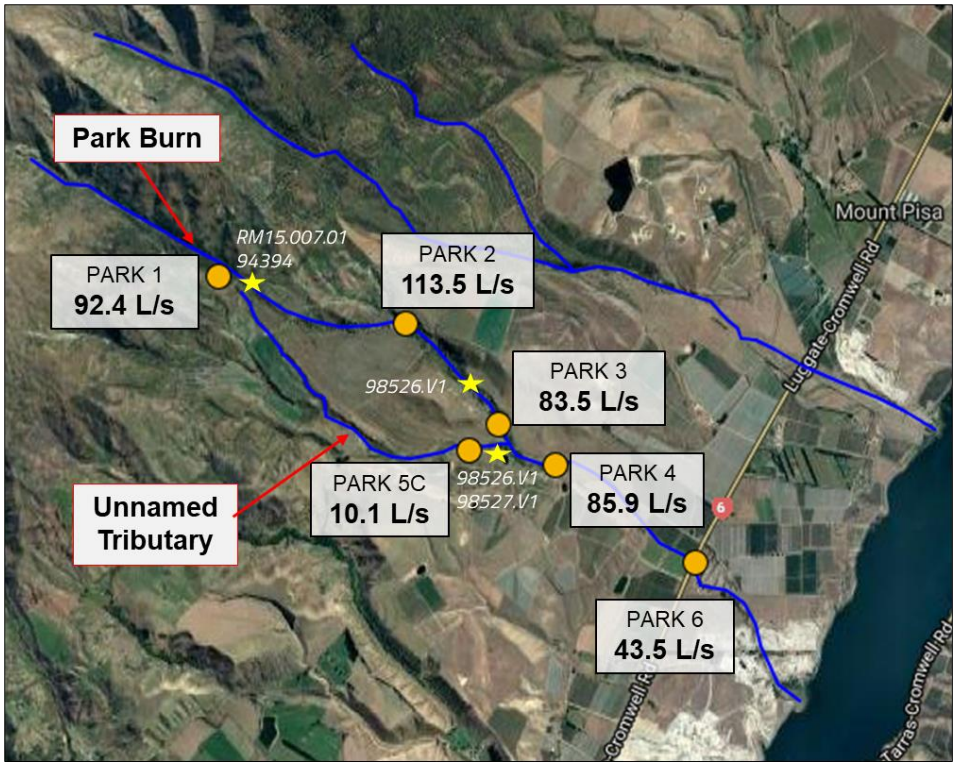

Figure 3: Flow gauging results (orange dots) as measured 16 January 2019. All points of take were closed so that there was no take.

3.36 The differential gaugings in the middle reach of the Park Burn show a flow gain (21.1 l/s) between the highest intake (RM15.007.01 and 94394) (Figure 3 - PARK 1) and 1.6km downstream, above the confluence with an unnamed Park Burn tributary (Figure 3 - PARK2).

3.37 The differential gaugings in the middle and lower reaches of the Park Burn showed the following:

- loss of 30 l/s between the confluence with the unnamed tributary and a point upstream from permit 98526.V1 (Reach 2 – Figure 3 PARK2 to PARK3);
- A small gain (2.4 l/s) occurs downstream of where the unnamed tributary meets the Park Burn (Reach 3 – Figure 3 PARK3 to PARK4).
- There is a further flow loss across the lowest reach towards the State Highway of 42.4 l/s (Reach 4 – Figure 3 PARK4 to PARK5).

3.38 The total loss observed during the 16 January assessment was 115.9 l/s. This is higher than any of the estimated natural 7-Day MALF statistics for the natural hydrology of the Park Burn upstream of the highest take point, including the higher estimate of 89 l/s included in Table 1, this indicates that the Park Burn is naturally intermittent.[19]

3.39 The longitudinal gaugings indicate that the highest intake (RM15.007.01/94394) is situated above the point where flow losses are likely neutral due to being located on schist geology. There is then a transition to a significant losing reach for the length of

[19]Intermittent is used to describe stream reaches that cease to flow for periods of the year because the stream bed is periodically above the water table, and therefore only flow at certain times of the year. Sources: Waikato Regional Plan (2010) & Environment Guide New Zealand – Freshwater.

river downstream from the confluence with the unnamed Park Burn tributary and the State Highway due to the alluvium and loess geology of the middle and lower reaches.

3.40 This geology of the river channel and alluvial bed morphology promotes flow interaction with the sub-surface zone and losses through the loose alluvial gravels to shallow groundwater.

3.41 The flow loss that occurs across reaches 2, 3 and 4 suggest that there is an acceleration of flow losses per metre along the total drying reach of the Amisfield Burn. The loss rates are summarised in Figure 4. The total drying reach is 2.7 km, the most extreme losses are observed in the lowest reaches (Figure 4).

3.42 The average water loss rate is approximately 0.02 l/s per meter over the 5.1km drying reach. This drying reach is approximately where the transition is from hard schist lithology to alluvium and loses, where flow losses are expected to occur[20].

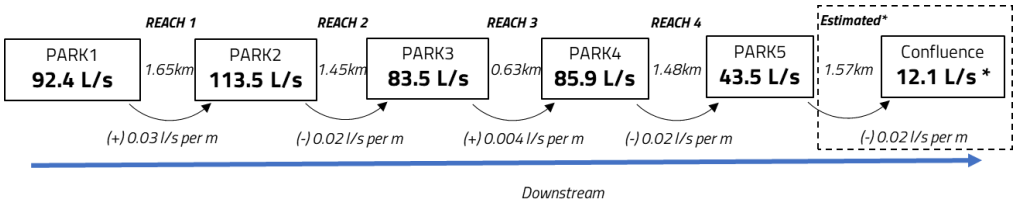

Figure 4: Rates of flow gain or loss along Park Burn. (-) denotes flow loss and (+) denotes flow gain. Results of hydrological survey 15 January 2019. Dashed box indicates flow assumed by upstream flow loss rate.

3.43 During the survey it was not possible to access the lowest reach of the Park Burn where the confluence with the Clutha River/Mata-Au is located below the Park Burn Quarry. Assuming the loss rate is equivalent to that of the upstream reach, the remaining 43.5 l/s would be reduced to an estimated 12.1 l/s at the Clutha River/Mata-Au confluence

[20] Refer to Figure 11 of the Technical Report appended to the original application.

assuming a loss rate of 0.02 l/s per m. This estimate is approximate only, and on the conservative side. As shown in Figure 2 it is also plausible there is an acceleration of flow loss like that observed in the Amisfield Burn It is therefore highly possible that all flow was lost over the lowest reach due to Quarrying activities, and/or an accelerated loss rate.

3.44 In my opinion during peak summer conditions it is more than likely that flow losses of up to 113 l/s can occur over the 5.1km drying reach downstream from confluence of the unnamed Park Burn tributary and the Park Burn, so that if a minimum connection is to be maintained to the Clutha River/Mata-Au more than 113 l/s would need to be passing the unnamed tributary confluence.

3.45 An assessment of ORC's temperature records for the Amisfield Burn (neighbouring catchment and catchment subject to this evidence) provides further evidence of naturally drying behaviour as described in paragraph 3.27 above.

3.46 In my opinion, and as explained further in paragraphs below, the natural hydrology of the Park Barn would not be significantly enhanced through use of more than the ORC recommended visual residual flow on the Park Burn associated to replacement permit RM20.007.01 (currently RM15.007.01 & 94394). Ecological values relating to the residual flows at the points of take for both RM15.007.01/94394 (Smallburn Ltd) and 98526 (Rockburn Wines Ltd) are addressed by Mr Allibone[21].

3.47 A visual residual flow is more achievable from a compliance perspective and will largely achieve the same thing as a numeric residual flow with perhaps a better hydrological

[21] Paragraph 37 - 39 of Dr Allibone's Evidence.

outcome. Therefore, I agree with ORC's residual proposal on Smallburn's Park Burn take (permits RM15.007.01 & 94394).

3.48 When assessing the Park Burn system entirely and considering the wider contributing factors of the overall hydrology, to use anything more than the status quo residual flow that applies to Smallburn's Park Burn take is not required. Furthermore, any residual flow recommended for below 98526 is likely to be lost due to natural flow loses that occur below this point of take.

Residual Flows – Summary and General Comments

3.49 The flow loses assessment has identified flow loses greater than the estimates of 7day-MALF for these catchments (regales of which 7day-MALF estimate from Table 1 is applied), and therefore when flows are low naturally there is likely to be extended periods of dryness in the lowest reaches of the Amisfield Burn and Park Burn.

3.50 Therefore, residual flows below the highest points of take purely serve the purpose of maintaining the hydrological regime in the flow neutral reaches of the Amisfield Burn and Park Burn.

3.51 In summary I recommend the following:

3.51.1 I recommend a visual residual flow below 96320.V1 as opposed to a numeric 50% of natural flow as this cannot reliably be monitored.

3.51.2 I recommend a visual residual flow below permit RM20.005.01 to the intake location of RM20.007.01 site 2 (Amisfield Burn). Whilst I acknowledge there is the upstream flow site in which compliance of a 50% of available flow

residual flow could be determined, in practice this will be incredibly difficult on a day-to-day operational basis.

3.51.3 I recommend a visual residual flow below 96321.V1 as opposed to a numeric 50% of available flow condition as this cannot reliably be monitored.

3.51.4 I agree with ORC's recommendation for a visual residual flow below permit RM15.007.01.

3.51.5 In line with ORC recommendations, I recommend that no residual flow be required below permit 98526.V1 as any residual flow here will be lost at a rate of 0.02 l/s.

3.52 Historical water use that is discussed below has not been used to propose replacement allocation, and rather proposed volumes are based on efficiency of use. Therefore, by nature of the improved water use approach towards efficiency, this will provide for and maintain the natural hydrology of the upper reaches of each waterway and maintain the hydrological regime between the points of take and the Clutha River/Mata-Au that is naturally intermittent.

3.53 The proposed residuals and collaborative approach to water management in the catchments will maintain the natural hydrological functions of the watercourses to the extent practicable.

Historic Water Use – Allocation Rates and Volumes

3.54 I have reviewed the historical water use data for each application as some time has passed since the applications were lodged and there is a further season of abstraction data available which formed part of the ORC's assessment.

3.55 Historical water use data is summarised below under separate sub-headings for each application. General comments are provided below.

3.56 It is unclear what final method has been used in ORC's water use analysis as the commentary refers to Method 10.4.A of the Regional Plan: Water for Otago. This is the method proposed as part of ORC's Plan Change 7 to the Regional Plan. This method has received considerable scrutiny. The Schedule 10A.4 methodology of Plan Change 7 is an overly simplified approach and misunderstands irrigation practice. The method is fundamentally different to the process carried out under the Regional Water Plan for determining allocation based on historical maximums, where Plan Change 7 uses data grooming prior to calculating the average of the maximum recorded in each season for rate, daily, and monthly allocations, and the average only for annual allocation. Using the average is an over simplistic attempt to reduce on-paper allocation, whereas use of efficiency calculations is better placed to accurately determine water needs compared to historical maximums to guide decisions on historic use versus efficiency.

3.57 Further analysis included within the ORC's report of water use records to determine allocation presented in each s42A report is simply a statistical method using medians and percentiles that reduces proposed maximum rates of take. Essentially, the highest rate of take values are filtered from historic water take data using percentiles for reasons that are ambiguous and not explicitly justified. The statistical analysis does not reflect water use or demand moving forward. These methods used were agreed to not be appropriate in a joint witness statement[22] (JWS) signed following a recent water

[22] Joint witness statement agreeing on a methodology to calculate maximum rates of take for the Last Chance Irrigation Company hearing in June 2020. Signed by Ms. Alex King (ORC Senior Consents Officer), Mr Sean Leslie (Senior Resource Management Analyst) and Mr Matt Hickey (WRM Ltd).

permit hearing in June 2020. I agree with the position reached in the joint witness statement.

3.58 How often a maximum rate is taken will largely be driven by the reliability of supply coupled with the infrastructure. Higher rates of take to counter water availability is common in particularly dry parts of Otago and where storage is available, as is the case for Rockburn Wines Ltd, Pisa Holdings Ltd, and Smallburn Ltd.

3.59 To determine the historical water use I assessed the water take records to determine maximum instantaneous rates of take, and monthly and seasonal maximums. I have used the method outlined in the JWS.

Historical Water Use RM20.003 – Rockburn Wines Ltd

3.60 The historical maximums for permit 98526 calculated by ORC[23] are less than the historic maximum calculated by me. I acknowledge ORC have capped monthly and seasonal historical use at the consented rate of 28 l/s with the equivalent monthly and seasonal volumes that would have reflected taking 28 l/s. In principle this is inconsistent with the approach to calculate historical maximums based on actual use rate. Rockburn Wines Ltd has noted this higher water take rate of maximum 112 l/s was abstracted on the basis of joint abstraction under 98526 and 98527. However, the proposed monthly and seasonal volumes are less than the actual historic use. I therefore recommend that going forward the proposed rate of take is 28 l/s as proposed, and what has been authorised on permit 98526.V1, and monthly and seasonal volumes are determined by efficiency of use calculations.

[23] Section 7.7.1 of Ms Linday's s42A report.

3.61 I disagree with the use of the PC7 method used in ORC's water use assessment as this restricts historical maximums to the period 1 July 2012 to 30 June 2017. Refer to paragraph 3.56.

3.62 Whilst the monthly and seasonal volumes proposed by Rockburn Wines Ltd are less than the actual historic use calculated here, the recommended volume by ORC is based on ORCs interpretation of historic use (see paragraph 3.60) and is less than the proposed volume that reflects efficiency of use. It is therefore appropriate for replacement allocation to be based on the volume proposed by Rockburn Wines Ltd and not ORCs interpretation of historic use that is inconsistent with the assessment of the actual full historic record.

Table 2: Historic water use for Rockburn Wines Limited (RBL) with proposed and ORC recommended volumes.

Historical Maximum	Rate l/s	Monthly vol. m^3/month	Seasonal vol. m^3/year
RBL Calc - 98526.V1 & 97133 @ 112 l/s	122.9	95,771	621,442
ORC Calc - 98526.V1 & 97133 @ 112 l/s and capped monthly and seasonal to 28 l/s	112	51,300	230,000
Proposed - RBL	28	73,000	237,933
Recommended - ORC	28	73,000	229,602

Historical Water Use RM20.005 – Pisa Holdings Ltd

3.63 The historical maximums calculated by ORC are roughly correct for 95789. I however disagree with the use of the PC7 method as included in ORC's water use assessment as this restricts historical maximums to the period 1 July 2012 to 30 June 2017. Refer to paragraph 3.56.

Table 3: Historic water use for Pisa Holdings Limited (PHL) with proposed and ORC recommended volumes.

Historical Maximum	Rate l/s	Monthly vol. m^3/month	Seasonal vol. m^3/year
PHL Calc – permit 95789	169.5	234,924	1,808,577
ORC Calc – permit 95789	109	229,000	1,829,500
Proposed - PHL	120	223756	1,145,347
Recommended - ORC	120	241,858	981,940

3.64 Historical use as calculated here demonstrates use above that proposed by Pisa Holdings Ltd and therefore the proposed volume can be used as the replacement allocation as this is based on efficiency of use for irrigation and can be demonstrated as being used historically.

Historical Water Use RM20.007 – Smallburn Ltd

3.65 I agree with the historic rates calculated for the Amisfield Burn Permit. As the ORC have recommended rates of take in line with those proposed by Smallburn Ltd.

3.66 I disagree with the ORC calculated historic rates for the Park Burn permits as there is a significant difference between the rate calculated here in my assessment and the ORC historic rates. This recommended 92.3 l/s rate is calculated using the PC7 method and is inconsistent with the signed JWS, see paragraph 3.57. This has restricted historical maximum rate to the period 1 July 2012 to 30 June 2017. Refer to paragraph 3.56.

3.67 I agree with the historical volume maximums calculated by ORC for all four permits (Table 4).

3.68 I disagree with the recommended volumes. The recommended allocation from ORC has excluded data applicable to the 2019/2020 season by use of a PC7 method, but also is

acknowledged in the s42A where it is stated[24] that the water use in the latest season is not considered representative of the last five years, and was excluded. This is inconsistent with Policy 6.4.2 of the Regional Plan: Water for Otago where direction is given to assess historical use over the past 5 years or more. The 2019/2020 season data included in the assessment is complete, and therefore should be included in the assessment for allocation.

Table 4: Historic water use for Smallburn Limited (SBL) with proposed and ORC recommended volumes.

Historical Maximum	Rate l/s	Monthly vol. m^3/month	Seasonal vol. m^3/year
SBL Calc - Permit 96320 & 96321	107	199,566	1,261,085
SBL Calc - Permits RM15.007 & 94394	242	419,388	1,879,199
Combined		**618,954**	**3,140,283**
ORC Calc – Permit 96320 & 96321	115	200,000	1,269,900
ORC Calc - Permits RM15.007 & 94394	92.3	419,000	1,875,180
Combined		**619,000**	**3,145,080**
SBL Proposed - Permit 96320 & 96321	97.3		
SBL Proposed - Permits RM15.007 & 94394	120		
SBL Proposed Combined	217.3	**492,127**	**2,319,363**
ORC Recommended - Permit 96320 & 96321	97.3		
ORC Recommended - Permits RM15.007 & 94394	92.3		
ORC Recommended Combined	189.3	**546,184**	**2,640,354**

3.69 Historical use as calculated here demonstrates use above what is proposed by Smallburn Ltd. This is because when the application was lodged, the 2019/2020 season data was not complete and not considered. The ORC has recommended more than that

[24] Pg. 36 of Ms Lindsay's s42A report for RM20.007.

proposed by Smallburn Ltd (as the application was lodged prior to completion of the 2018/19 and 2019/20 seasons and was capped at a lower historic rate than my calculations now show), but less than the historical maximum calculated by ORC. The ORC recommended volume can be used as the replacement allocation as this is based on efficiency of use for irrigation and can be demonstrated as being used historically when accounting for the 2019/2020 season.

Conclusion

3.70 The Amisfield Burn and Park Burn are naturally intermittent, with the lower reaches of both waterways expected to dry annually on average.

3.71 I have made recommendations regarding residual flows that considers the hydrology of the systems and the practicalities of compliance monitoring. Where appropriate, a visual residual flow is a meaningful way to ensure connectivity across the upper reaches of the both the Amisfield Burn and Park Burn. I have highlighted that the 50% residual flows recommended by ORC in the upper reaches provide only for the hydrological regime in the flow neutral reaches and will not provide further hydrological value in the lower reaches where flow loses far exceed natural upstream low flows. In consideration of this, and the difficulty in adhering to conditions of this nature, I have instead recommended visual residual flows below the RM20.005 and RM20.007 take points.

3.72 I disagree with the use of the PC7 method as included in ORC's water use assessment for each of the applicants' as this restricts average historical maximum use to the period 1 July 2012 to 30 June 2017. Despite recommended historical maximums largely being reflective of the actual use that concurs with my assessment, the use of the statistical approaches within the water use assessments and use of the PC7 method creates confusion.

3.73 In all cases I consider it is appropriate for the maximum historical rate of take to be retained as this allows opportunistic taking of water when flows are high. This water can be stored for use when flows have diminished. The proposed volume controls prevent these maximum rates of take being exercised for sustained periods.

3.74 For Rockburn Wines Ltd the proposed and recommended volumes are less than historic use. I agree with the recommended volumes that are in-line with the proposal and represent efficient use for the intended purpose.

3.75 For Pisa Holdings Ltd, the proposed volume is less than historic use, and reflects efficient use for the irrigation of cherries and vineyards. In my opinion the allocation sought by the applicant is appropriate.

3.76 For Smallburn Ltd, the ORC recommended volume can be used as the replacement allocation as this is based on efficiency of use for irrigation and can be demonstrated as being used historically.

Christina Bright

Hydrologist – Landpro Limited

27 August 2020

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