BEFORE THE COMMISSIONER APPOINTED BY THE OTAGO REGIONAL COUNCIL

Consent No: RM20.039

IN THE MATTER	of the Resource Management Act 1991 ("the Act")
APPLICANT	**VARIOUS – COLLECTIVELY REFERRED TO AS PIGBURN WATER USERS GROUP**

BRIEF OF EVIDENCE OF MATT HICKEY
EVIDENCE ON BEHALF OF PIG BURN WATER USERS GROUP

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STATEMENT OF EVIDENCE OF MATT HICKEY

1. My name is Matthew Aaron Hickey.

2. I am an Environmental Scientist and sole Director of Water Resource Management Ltd

3. I hold a Bachelor of Science Double Major, Geography and Ecology (2000), a Post Graduate Diploma of Science in Ecology (2002) and a Master of Science (MSc) in Ecology (2005) all from the University of Otago. My MSc was focused on comparing two methods for obtaining fish population estimates - electric fishing compared to night spotlight counts.

4. Between 2003 and 2006, I was a Water Resource Scientist - Water Quantity within the Resource Science Team at Otago Regional Council (ORC). While at ORC, I authored reports on management flows for the Waianakarua River[1], Trotters Creek[2]2, Taieri River at Tiroiti[3], Waiwera River[4], Luggate Creek[5], Pomahaka River[6] and Manuherikia River[7]. These reports include hydrological analysis, a summary of aquatic ecosystem values, as well as consideration of the flow requirements of fish communities. In support of these documents I also carried out assessments of water surety for the respective plan change assessments.

5. In April 2006 I moved roles at ORC taking up the position of Manager of Resource Science. In this role I was responsible for managing the science program including the delivery of technical information for minimum flow setting across Otago. In this role I oversaw numerous

[1] ORC (2006). Management flows for aquatic ecosystems in the Waianakarua River. Otago Regional Council, Dunedin. 31 p.
[2] ORC (2006). Management flows for aquatic ecosystems in Trotters Creek. Otago Regional Council, Dunedin. 29 p.
[3] ORC, (2006). Management flows for the Taieri River at Tiroiti. Otago Regional Council, Dunedin. 30 p.
[4] ORC, (2006). Management flows for aquatic ecosystems in the Waiwera River. Otago Regional Council, Dunedin. 33 p.
[5] ORC, (2006). Management flows for aquatic ecosystems in Luggate Creek. Otago Regional Council, Dunedin. 31 p.
[6] ORC, (2006). Management flows for aquatic ecosystems in the Pomahaka River. Otago Regional Council, Dunedin. 38 p.
[7] ORC, (2006). Management flows for aquatic ecosystems in the Manuherikia River. Otago Regional Council, Dunedin. 37 p.

technical management flow reports. As Manager of Resource Science I also oversaw numerous hydrological investigations as well as reporting on water quantity issues at a regional level.

6. In 2015 I left ORC and started my own company (Water Resource Management Ltd) providing technical advice on ecological flow setting, hydrology, surety of supply and water sharing. I currently work for 20 water management groups or irrigation companies in both Otago and Canterbury helping them prepare for the transition from deemed permits to Resource Management Act (1991) (RMA) consents post 2021. I also currently work on behalf of several catchment groups either in or about to enter the minimum flow process, providing technical advice and liaising with the council and stakeholders.

7. Over the last 17 years I have made or reviewed over 100 technical recommendations for residual flow conditions to protect the ecological values at individual takes points across Otago; worked on setting environmental flows and allocation limits for a number of Otago's rivers; as well as water quantity policy development for the Regional Plan: Water for Otago (RPW), specifically around managing the transition from deemed permits to RMA consents.

8. As well as working at a regional level I've also worked on national level initiatives. In 2006 I started work on the Sustainable Water Program of Action, specifically the proposed National Environmental Standard on Ecological Flows and Water Levels[8]. As a member of the working group I applied my allocation knowledge to both policy and technical issues in a limit setting context. Further to this I was also a reviewer of the final science report[9] regarding ecological methods prepared by many of the lead scientists in the field in New Zealand.

[8] Ministry for the Environment, 2008. Proposed National Environmental Standard on Ecological Flows and Water Levels. https://www.mfe.govt.nz/publications/fresh-water/draft-guidelines-selection-methods-determine-ecological-flows-and-water-24
[9] Beca. 2008. Draft Guidelines for the Selection of Methods to Determine Ecological Flows and Water Levels. Report prepared by Beca Infrastructure Ltd for MfE. Wellington: Ministry for the Environment.

9. In 2014 I contributed to the freshwater accounting guidance being prepared by the Ministry for the Environment as part of the implementation of the National Policy Statement for Freshwater Management, specifically providing a case study on managing water allocation and reviewing the wider document.[10]

10. I have been given a copy of the Environment Courts code of conduct for expert witnesses. I have reviewed that document and confirm that this evidence has been prepared in accordance with it and that all opinions that I offer in this evidence are within my expertise. I have not omitted to refer to any relevant document or evidence except as expressly stated. I agree to comply with the code and in particular to assist the Commissions in resolving matters that are within my expertise.

Scope of Evidence

11. This brief of evidence addresses the following:

    1. Hydrological regime of the Pig Burn.
    2. A comparison of the Pig Burn hydrological regime to the status quo, natural and what is proposed by the Pig Burn Water Users Group (PBWUG).
    3. The influence of the Pig Burn on the hydrology of the Taieri River at times of low flow.

12. For clarity to align take location names used in this evidence with those used in the section 42a Report I provide Table 1.

[10] Ministry for the Environment. 2015. A Guide to Freshwater Accounting under the National Policy Statement for Freshwater Management 2014. Wellington: Ministry for the Environment.

Table 1. Take location names used in this evidence compared to the names used in the Section 42a Report.

Take name in this evidence	**Take name in the S42a Report**
Herlihy at the gorge	Greenbank Pastoral Ltd
Weirs	Hamilton Runs Ltd
Herlihy at the ford	Hamilton's Dairy Ltd
Kirkwood South/Combined Take	Sophic Trust/Combined Take
Mulholland	Mulholland
Kirkwood North	Concept Farms

Hydrological analysis

13. There is one continuous flow site on the Pig Burn known as Pig Burn at the Gorge. This site is upstream of the majority of takes from the Pig Burn (Figure 1).

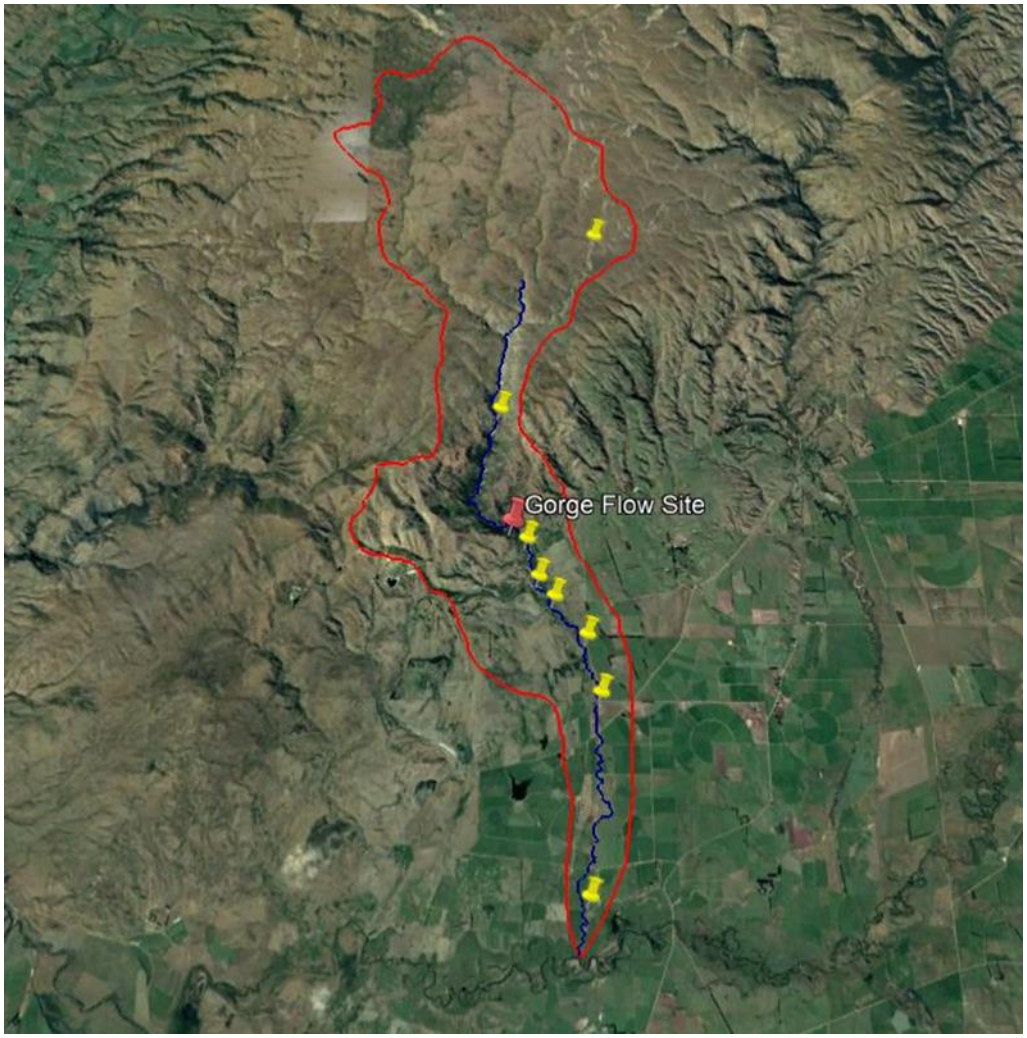


Figure 1. Pig Burn at the Gorge Flow Site (red pin), the Pig Burn Catchment (red outline) and existing water take locations (yellow pins).

14. All takes downstream of the gorge have water meters that record taking.

15. The two takes upstream of the Gorge Flow Site take very little water during summer low flows (<5 l/s combined based on metering) and water that is taken during low flows is for domestic and stock water use (Figure 1).

16. The following flow statistics for the Pig Burn at the Gorge show that summer low flows can be as low as 31 l/s and are often less than 50 l/s in the Pig Burn upstream of the majority of takes with an observed 7-Day MALF of 53 l/s (Table 2).

Table 2. Observed flow statistics based on daily average flows for the Pig Burn at the Gorge during the irrigation season (Oct-April).

Season	Minimum (l/s)	Median (l/s)	Mean (l/s)	7-day ALF (l/s)
2010/11	69	316	355	76
2014/15	34	133	260	35
2016/17	66	242	350	74
2017/18	31	170	304	33
2018/19	42	244	412	46
2019/20	50	208	315	60
AVG	48	217	332	53

17. The flows presented in Table 2 are observed flows but because the two takes upstream are either very small or during times of low flows taking very little the natural 7-day MALF for the period of record will only be marginally higher than 53 l/s.

18. For the data period that we have confidence in both flow and water metering statistics for the Gorge Flow Site are provided in Table 3. They highlight that the upstream takes particularly the shared take have the most effect on higher-than-average flows.

Table 3. Observed and Natural Daily Average flows for the Pig Burn at the Gorge Flow Site (5th Oct 2016 – 9th May 2018).

	Observed Flow at the Gorge (l/s)	Natural Flow at the Gorge (l/s)
Minimum	30	32
Median	281	289
Mean	403	415
Maximum	3,332	3,402

19. Anecdotal observations by members of the Pig Burn Water Users Group (PBWUG) have been that the Pig Burn dries up naturally in at least two reaches[11].

20. In May 2018 the PBWUG produced a report highlighting the monitoring the group had done of flow observations throughout the Pig Burn. In addition to this ORC have carried out a number of longitudinal gaugings.

21. After completion of the Pig Burn AEE the ORC completed a further set of longitudinal gaugings and after being made aware of this by the hydrology review completed by PDP Ltd I assessed these also. The additional gaugings are shown in Table 4.

Table 4. Additional Gaugings by ORC on the 21st January 2020

Site	**Flow (l/s)**
Gorge	99
Hamilton's Ford below Herlihy Take	6
D/S Mulholland Take	27
Patearoa - Waipiata Rd	0
Kirkwood Ford	4
O'Neil Rd Bridge	35
D/S Kirkwood Nth Take	16

22. The gaugings indicate at 27 l/s loss in the 500m reach from the Mulholland take to the Patearoa-Waipiata Rd Bridge. The Kirkwood Ford is more than 600m below the Patearoa–Waipiata Rd Bridge. Flows at the Kirkwood Ford were measured at 4 l/s.

23. Three days prior to the gaugings outlined in Table 4 aerial imagery is available for the Pig Burn (Figure 2).

[11] Refer to the evidence of Mr Gavan Herlihy

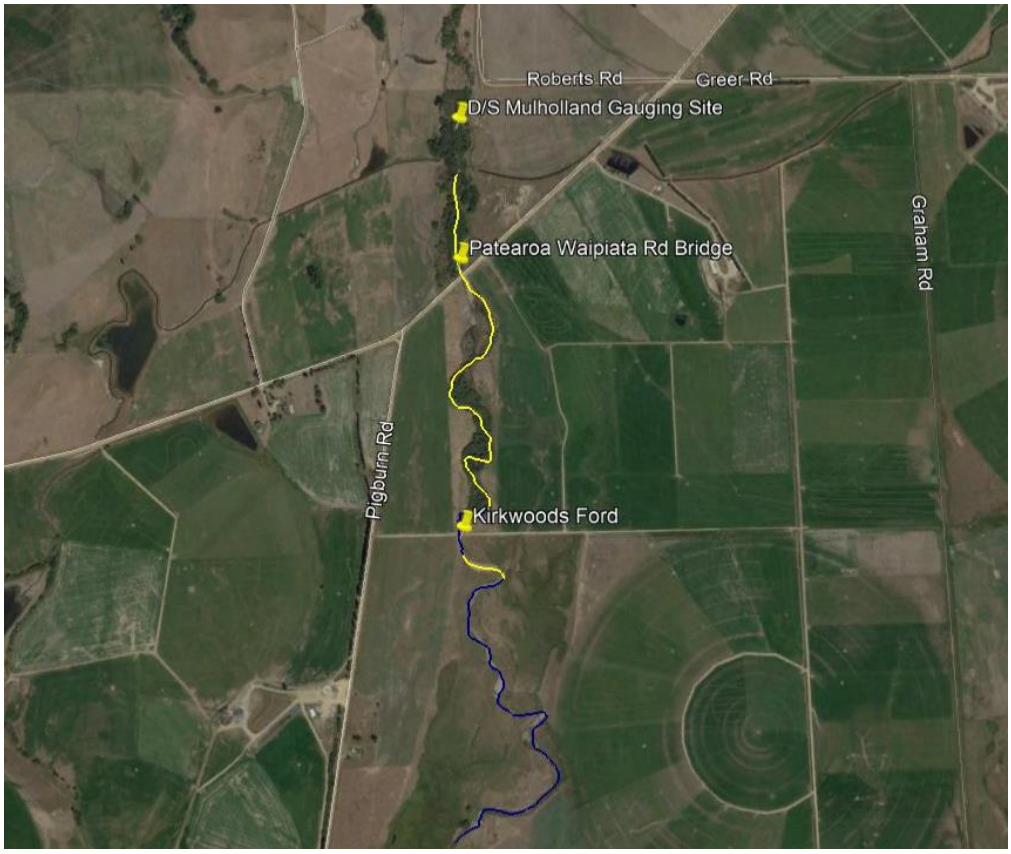


Figure 2. Aerial photograph of the lower losing reach on the 18th of January 2020, three days prior to the gaugings in Table 4. The flow pattern above matches the gauged flow pattern on the 21st of January 2020. Dry reaches are in yellow and wetted reaches are shown in blue.

24. Although the imagery shows the same flow pattern as those gauged three days later, we don't know the exact flows on the day. However, the imagery does indicate a significant dry reach from the Mulholland Take to below the Kirkwood Ford (Figure 2).

25. The point where permanent flows begin again below Kirkwood Ford in Figure 2 is the same location identified by Dr Olsen in his Figure 8 of his evidence in chief on the 18th of March 2020.

26. Dr Olsen's drone footage shows despite flow at the Patearoa-Waipiata Bridge on the 18th of March 2020 the Pig Burn was dry both above and below the Kirkwood Ford[12].

27. In my view the gauging in Table 4 and the distance of dry creek bed between the Mulholland take and the Kirkwood Ford in Figure 2

[12] Refer to Dr Olsen's Figures 1 to 8 in his evidence in chief.

indicates a flow well above 30 l/s is required below the Mulholland take point to guarantee connection through to O'Neil Road.

28. For example, if we conservatively[13] assume flows receded from 27 l/s at the Mulholland intake to 0 l/s at the Patearoa – Waipiata Rd Bridge some 500m downstream as gauged by ORC on the 21st of January 2020 (Table 4) then that equates to a loss of 5.4 l/s per 100m. Thus a 10 l/s residual flow is expected to cease ~185m below the Mulholland intake and a 20 l/s residual flow would cease ~370m past the Mulholland intake.

29. With a 20 l/s residual flow there would still be ~1.9 Km of dry riverbed to the point where flows return based on Figure 2 above and Figure 7 in Dr Olsen's evidence.

30. Based on the available longitudinal gaugings, PBWUG observations and water metering data I attempted to make estimates of gains and losses along the length of the Pig Burn from the Gorge Flow Site to the Taieri Confluence. A summary of the gains and losses I have used in the longitudinal modelling later in this evidence with an explanation is provided in Table 5.

Table 5. Description of the different hydrological reaches of the Pig Burn.

Reach description	Estimated flow gain or loss	Rationale for gains and losses
Upper Neutral Reach from the Pig Burn Gorge upstream	Neutral reach, no significant groundwater gains or losses.	The upper Pig Burn is in a confined gorge and the landholders are unaware of any obvious gaining or losing sections.
Upper losing reach Gorge down to 300m upstream of the Hamilton Rd Ford	90 l/s loss.	Observed dry below Weirs Take on the 04/01/2017. In-flows were 160 l/s and total take was 79 l/s. Flow required to maintain surface connection was therefore greater than 81 l/s.
Upper gaining reach from Hamilton Rd Ford to Kirkwood's South Take.	Assume all water lost (excluding water taken) in the upper losing reach returns in this section.	The difference between flow recorded at the gorge and the combined abstraction from Herlihy at the Gorge and Weirs take.

[13] I say conservatively because if there was zero flow at the bridge then it is likely flows ceased upstream meaning that losses would be higher than I've used.

Mid neutral reach from Kirkwood's South Take to Patearoa Waipiata Bridge	Neutral reach, no significant gains or losses.	Doesn't appear to lose or gain water compared to the other losing and gaining reaches.
Lower losing reach from below Mulholland take to 500 upstream of O'Neil Rd Bridge.	at least 40 l/s loss and possibly > 50 l/s.	Based on ORC flow gaugings showing a 27 l/s loss between Mulholland Take and the Patearoa-Waipiata Bridge (Table 4 above). Observed dry 600m below the Patearoa-Waipiata Rd Bridge on the 04/01/2017 and the 18/01/2017[14]. Based on inflows at the Gorge Flow Site and recorded takes there was 23 -29 l/s expected to be passing the Mulholland Take on these days respectively. Flow required to maintain surface connection was therefore greater than 30 l/s.
Lower Gaining reach 500m upstream Of O'Neil Rd Bridge to Kirkwood's North take	Gaining reach with a range of 5 – 35 l/s.	Observed that the Pig Burn was Dry upstream of the Kirkwood North Take on the 04/01/2017 but the take was getting 34 l/s. No flow was observed below the take. Therefore, the gain was 34 l/s. Gains vary greatly in this reach depending on time of the season.
Lower neutral Reach from Kirkwood's North Take to Taieri Confluence	Small gain observed near the confluence. A small 2 l/s gain is modelled.	Observations suggest a small gain below the Kirkwood North Take towards the confluence.

PBWUG Proposal

31. The hydrological information indicates that there is significant variation in flows naturally downstream of the Gorge Flow Site due to losses and gains from groundwater. It is likely that ecologically the gaining reaches are of the highest value for fish and invertebrates.

32. Both the Herlihy Gorge Take and the Weir Take are naturally curtailed during times of low flow due to the losing reach going dry. It is proposed that these two takes remain as they are due to their natural constraints.

[14] Pig Burn Report on the monitoring of the flows and abstractions in the Pig Burn by the Pig burn Water Users Group during the last three seasons, namely 2015/16, 2016/17, 2017/18. Provided by the Pig Burn Water Users Group.

33. Currently the gaining reach in the Pig Burn between the Hamilton Runs Ford and the Patearoa-Waipiata Rd Bridge is changed from perennial to intermittent due to abstraction by the three takes within it. It is proposed that while flows are high the Herlihy Ford Take should operate as normal while leaving a residual flow of 70 l/s past their intake.

34. It is proposed that the Kirkwood South and Mulholland takes combine at a new point between their existing take locations. Further to this it is envisaged once flows fall to 70 l/s at the Hamilton Runs Ford that the Herlihy Take also abstracts from the new combined take location. Water from the combined take will be shared between the three users. It is expected that there will be a residual flow of at least 10 l/s below the combined take at all times.

35. The most downstream take on the Pig Burn, Kirkwood North will remain in place with a residual flow of 10 l/s.

36. Figure 3 below attempts to show the proposed change in take points and when they would operate in the Pig Burn compared to the existing take setup.

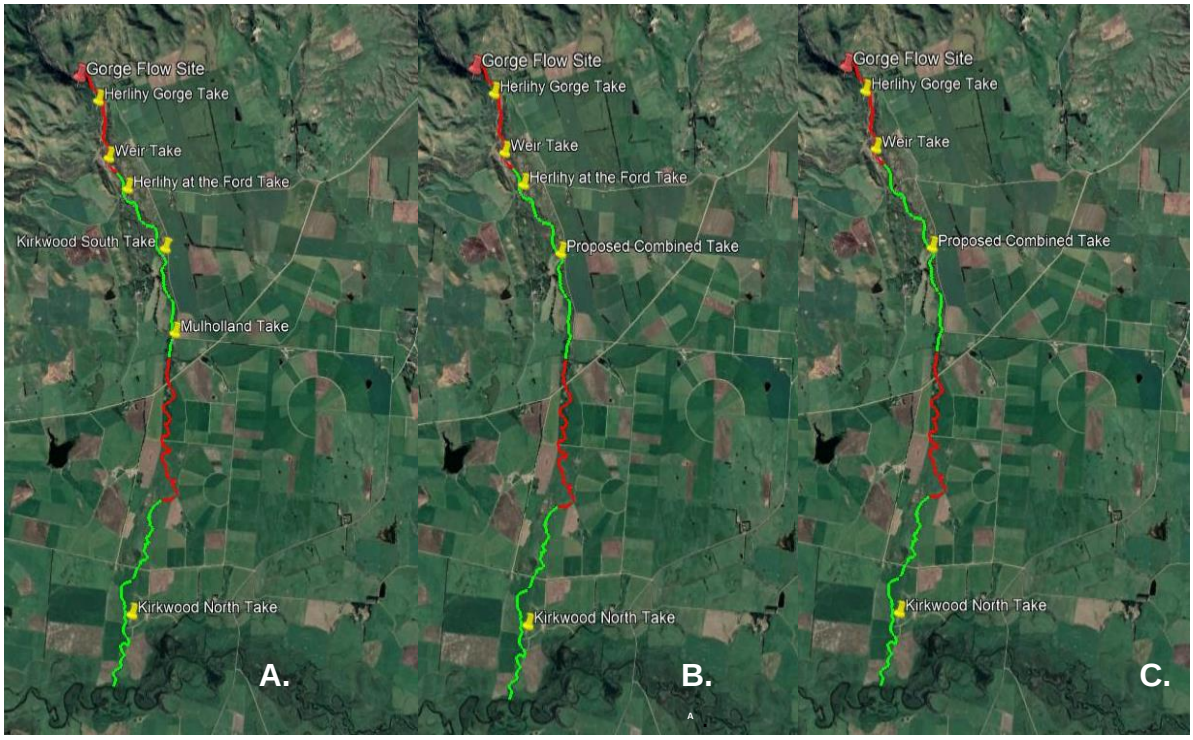


Figure 3. A. Existing Take locations (operates at all flows) compared to proposed take locations during B. higher flows (>70 l/s at the Hamilton Runs Ford) and C. low flows (<70 l/s at the Hamilton Runs Ford). Losing reaches (red) and gaining/neutral reaches (green) are shown.

37. Figure 4 provides a comparison of longitudinal flows at the 7-day MALF at the Gorge Flow Site of 53 l/s comparing the natural flow regime, observed flow regime and that proposed by the consent application. The gains and losses are based off those in Table 5 and the rates of take used are taken from the metering data when the inflow at the Gorge Flow Site was occurring.

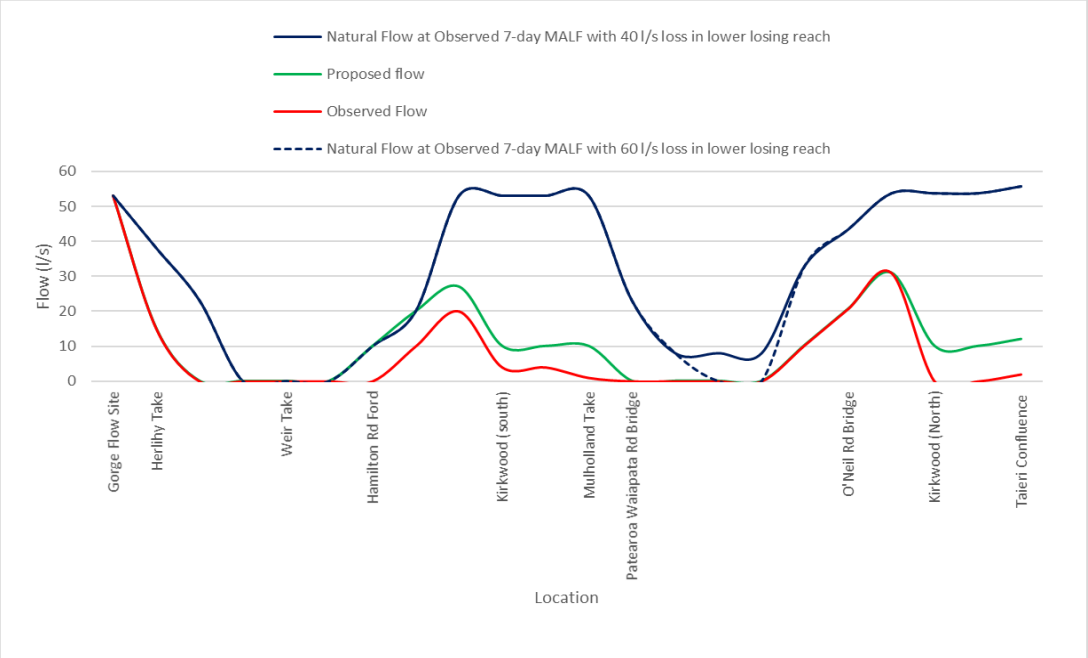


Figure 4. Longitudinal flows in the Pig Burn with 53 l/s (MALF) at the Gorge Flow Site comparing the natural flow regime, the existing or observed flow regime and the regime expected under the consent proposal. The natural flow regime profile has losses of 40 to 60 l/s shown given the variation in losses in this reach.

38. Figure 5 provides a comparison of longitudinal flows at the daily minimum flow at the Gorge Flow Site of 31 l/s comparing the natural flow regime, observed flow regime and that proposed by the consent application. Again the gains and losses are based off those in Table 5 and the rates of take used are taken from the metering data when the inflow at the Gorge Flow Site was occurring.

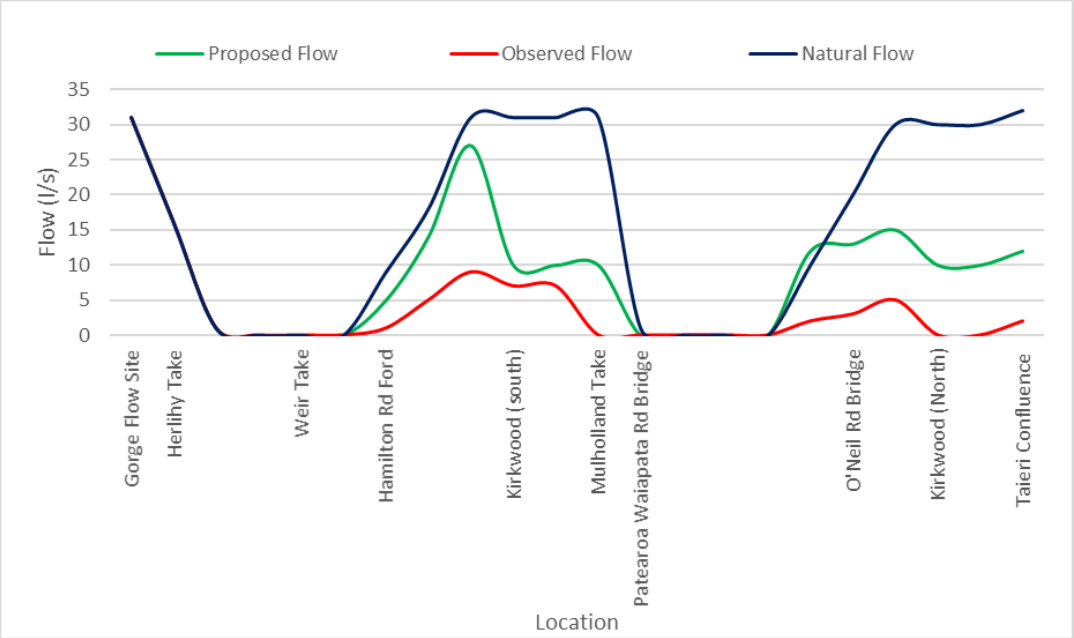


Figure 5. Longitudinal flows in the Pig Burn with a flow of 31 l/s (min daily average flow) at the Gorge Flow Site comparing the natural flow regime, the existing or observed flow regime and the regime expected under the consent proposal. The observed flow regime is based on measured flows and takes on the 17th of January 2018.

39. Figure 4 and Figure 5 shows the significant influence of natural losses and gains in the Pig Burn downstream of the Gorge Flow Site.

40. It is likely that the gains and losses along with the effects of abstraction in the reach from Hamilton Ford to the Patearoa-Waipiata Bridge led Dr Allibone to advise that the habitat model developed in this reach is unreliable at the applicants pre-hearing meeting on the 30th of July 2020[15].

41. Figure 6 to Figure 8 and Table 6 to Table 8 below provide some further comparisons of the expected longitudinal flow regime with different inflows and the Herlihy Ford take off as there is not at least 70 l/s below it.

[15] Para. 9 of Section 3.1 of the Pre Hearing Meeting minutes.

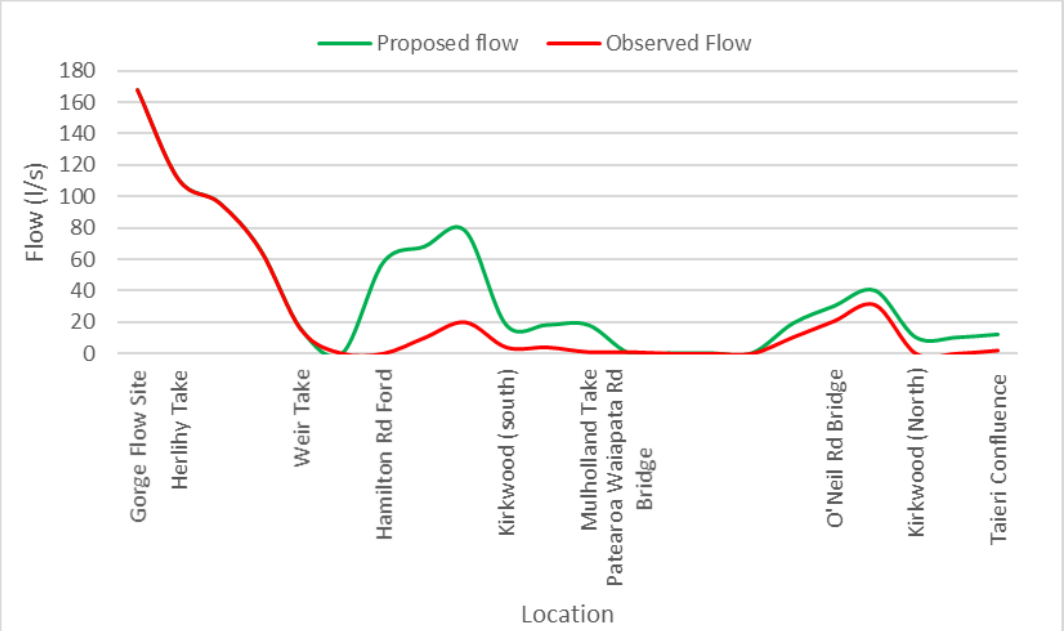


Figure 6. Herlihy Ford Take is off as flows are less than 70 l/s below it. Combined take is operating with the 3 users sharing. Inflow at the Gorge is 168 l/s.

Table 6. rates of take used in Figure 6.

Take location	Observed flow rates of take (l/s)	Proposed flow rates of take (l/s)
Herlihy at the gorge	42	42
Weirs	36	36
Herlihy at the ford	58	0
Kirkwood South/Combined Take	16	60
Mulholland	3	0
Kirkwood North	31	30

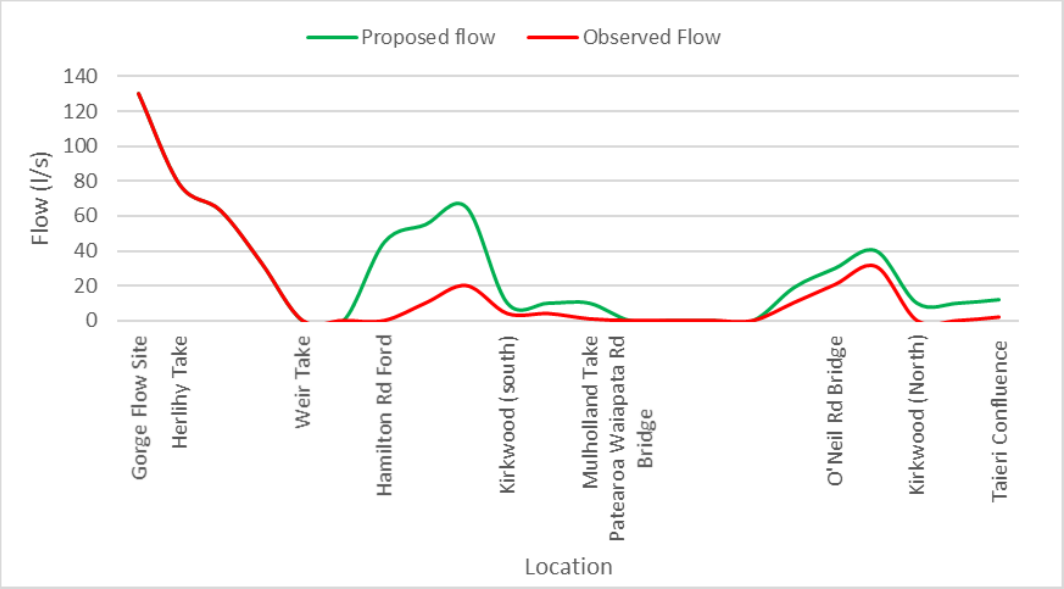


Figure 7. Herlihy Ford Take is off as flows are less than 70 l/s below it. Combined take is operating with the 3 users sharing. Inflow at the Gorge is 130 l/s.

Table 7. Rates of take used in Figure 7.

Take location	Observed flow rates of take (l/s)	Proposed flow rates of take (l/s)
Herlihy at the gorge	37	37
Weirs	28	28
Herlihy at the ford	65	0
Kirkwood South/Combined Take	16	60
Mulholland	3	0
Kirkwood North	31	30

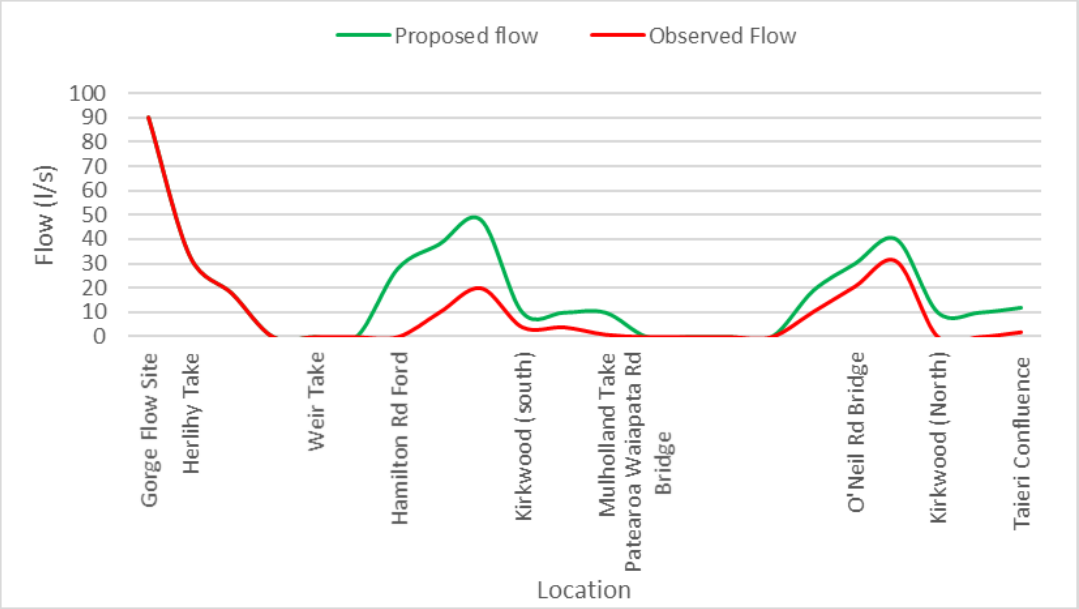


Figure 8. Herlihy Ford Take is off as flows are less than 70 l/s below it. Combined take is operating with the 3 users sharing. Inflow at the Gorge is 90 l/s.

Table 8. Rates of take used in Figure 8.

Take location	Observed flow rates of take (l/s)	Proposed flow rates of take (l/s)
Herlihy at the gorge	42	42
Weirs	0	0
Herlihy at the ford	48	0
Kirkwood South/Combined Take	16	38
Mulholland	3	0
Kirkwood North	31	30

Pig Burn's influence on the Taieri mainstem during low flows

42. The Pig Burn is a relatively small tributary of the Taieri with a 7-dy MALF of 53 l/s.

43. Taieri River at Waipiata has a minimum flow of 1.0 m^3/s in Schedule 2A of the Regional Plan Water (RPW). Few takes above Waipiata (from the mainstem or tributaries) have a minimum flow condition on their existing consent. Although the mainstem water users between Paerau Weir and Waipiata roster voluntarily to maintain the minimum flow at Waipiata.

44. The most significant water user with the greatest influence on flows in the Taieri at Waipiata is the Maniototo Irrigation Company (MIC). Low flows in the Taieri mainstem are most influenced by MIC and their existing consents which are in place until 2034.

45. MIC must maintain flows of at least 0.850 m^3/s at the Paerau Weir. They also have a consent condition that they must maintain 1.0 m^3/s at Paerau Weir if Waipiata falls below 1.0 m^3/s if the water level in the Logan Burn Dam is above 923.75m above sea level (the old dam crest level). Once the water level in the dam falls below 923.75m above sea level then MIC have no regulatory obligation to uphold flows at Waipiata.

46. However, during dry periods MIC releases more water past Paerau to ensure the Waipiata minimum flow of 1.0 m^3/s is maintained while the mainstem users also voluntarily roster to maintain the Waipiata minimum flow. This has been occurring for at least the last 5 years.

47. As it stands the minimum flow for the Taieri at Waipiata in the RPW is maintained by MIC. Granting consents for the Pig Burn water users does not prevent the Taieri River minimum flow at Waipiata from being achieved.

Summary

48. The Pig Burn is a relatively small tributary of the Taieri with a 7-day MALF of 53 l/s.

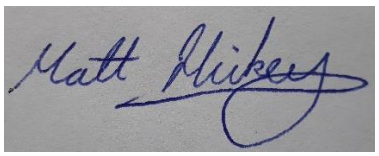
49. The hydrology of the Pig Burn is relatively complicated with two naturally intermittent reaches and two perennial gaining reaches downstream of the Gorge Flow Site.

50. Gains and losses are variable and appear to be heavily influenced by ambient groundwater levels.

51. The length of the dry reaches and the duration of drying in the losing reaches is extended by taking. Under the status quo taking regime the perennial reaches also become intermittent.

52. Under the PBWUG proposal the perennial reaches will be continuous, more closely reflecting the natural hydrology than the status quo. The length of the dry reach and the duration of drying in the lower losing reaches is likely to be reduced under the PBWUG proposal compared to the status quo.

53. At times of natural low flow flows at Waipiata in the Taieri mainstem are overwhelmingly influenced by the operation of MIC and releases past Paerau Weir. MIC must maintain flows of at least 0.850 m^3/s at Paerau and if flows fall to less than 1.0 m^3/s at Waipiata they voluntarily discharge more than 0.850 m^3/s past Paerau until Waipiata is above 1.0 m^3/s. The MIC consent expires in 2034.



Matt Hickey

27 August 2021