IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by Waka Kotahi NZ Transport Agency (Waka Kotahi) to Manawatū-Whanganui Regional Council and Greater Wellington Regional Council for resource consents to enable the construction, operation and maintenance of new state highway, shared use path and associated infrastructure, between Taylors Road (to the north of Ōtaki) and Stage Highway 1 north of Levin.

SECTION 87F REPORT OF MICHAEL THOMPSON – WATER TAKE AND ALLOCATION

MANAWATŪ-WHANGANUI REGIONAL COUNCIL AND GREATER WELLINGTON REGIONAL COUNCIL

28 APRIL 2023

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A. OUTLINE OF REPORT

1. This report, required by section 87F of the Resource Management Act 1991 ("**RMA**"), addresses surface water takes (allocation) proposed as part of the activities the subject of resource consent applications lodged with the Manawatū-Whanganui Regional Council ("**Horizons**") and Greater Wellington Regional Council ("**GWRC**") for the Ōtaki to North of Levin Highway Project (the "**Ō2NL Project**").

2. The resource consents applied for, by Waka Kotahi NZ Transport Agency ("**Waka Kotahi**"), are required to authorise the construction, operation and maintenance of a new state highway, shared use path and associated infrastructure, between Taylors Road (to the north of Ōtaki) and State Highway 1 north of Levin.

3. In addition, Waka Kotahi separately lodged Notices of Requirement ("**NoRs**") relating to the Ō2NL Project with Horowhenua District Council and Kāpiti Coast District Council (the "**District Councils**"), respectively. Matters relating to the NoRs are outside the scope of this report and will be addressed by the District Councils.

4. This report specifically addresses the proposed water take from the Waitohu Stream within the GWRC region. Ms Michaela Stout addresses surface water takes from water bodies in the Horizons region in her section 87F report for Horizons and GWRC. Ms Stout and I have conferred in preparing our reports.

5. In preparing this report, I have reviewed technical reports relevant to the proposed take that were submitted by Waka Kotahi in November 2022 in the Assessment of Environmental Effects ("**AEE**") accompanying the consent applications, as well as a subsequent memorandum from Dr Jack McConchie dated January 2023 ("**McConchie (2023)**").[1] Both of these sources of information are described in more detail in Section E – Scope of Report.

[1] A copy of the memorandum was formally provided to Horizons and GWRC under cover of letter dated 21 March 2023.

6. While this report is pursuant to section 87F of the RMA, I have in accordance with section 42A(1A) and (1B) attempted to minimise the repetition of information included in the application and where I have considered it appropriate, adopt that information.

B. QUALIFICATIONS / EXPERIENCE

7. My name is Michael Andrew Thompson. I am a Senior Scientist - Hydrology at GWRC. I have been in that position since 2011.

8. I work in the Hydrology Team within the Environmental Science Department and Environmental Management Group of GWRC. The Hydrology Team is primarily responsible for the collection, analyses and reporting of hydrological data, including groundwater aquifer levels, river levels and flows, wetland and lake levels and water abstraction rates. My role at GWRC primarily involves undertaking hydrological and water resource assessments and investigations in support of GWRC allocation policy as well as providing expert technical advice on water take consents.

9. I hold a Bachelor of Science and Master of Science and Technology degrees from Waikato University, majoring in hydrology. I am a member of the New Zealand Hydrological Society.

10. I have 22 years of employment experience in hydrology and water resource assessment. This includes 14 years with two regional councils (including GWRC), three years with a private consultancy in the UK and six years at the Ministry for the Environment.

11. I am familiar with the site and surrounding area. While I was unable to visit the site along with other Horizons and GWRC experts, I have recently (summer 2022/23) visited several stream locations in the direct vicinity, and downstream of, the proposed point of take.

C. CODE OF CONDUCT

12. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. I confirm that I have stated the reasons for my opinions I express

in this report, and considered all the material facts that I am aware of that might alter or detract from those opinions.

13. Statements expressed in this report are made within the scope of my expertise, except where I rely on the technical advice from other experts I have referred to within this report.[2]

14. I have the information necessary to assess the application within the scope of my expertise and am not aware of any significant gaps in the information or my knowledge. Nevertheless, I note that determining the impacts of water takes on stream ecosystems is an inherently imprecise science (due to the complexity of the relationship between flow and ecosystem health). My opinions and conclusions are therefore based on professional judgement about likely levels of risk.

D. EXECUTIVE SUMMARY

15. Waka Kotahi have applied to take water directly from the Waitohu Stream for construction purposes during the Ō2NL Project. The application is to take water at a maximum rate of up to a maximum of 50 litres per second (L/sec) (provided it does not exceed 10 per cent of stream flow at any time) and a maximum volume of 2,160 cubic metres per day (m^3/d).

16. GWRC allocates water according to instantaneous rate rather than daily volume. The core allocation limit for the Waitohu Stream is 45 L/sec, and 7.5 L/sec is currently allocated. This leaves a maximum of 37.5 L/sec available to be allocated. Therefore, the amount sought by Waka Kotahi appears to exceed the core allocation amount available by 12.5 L/sec. However, it may be that the 50 L/sec maximum rate is intended by Waka Kotahi to also apply when supplementary allocation is being used.

17. The median flow value calculated by Waka Kotahi (540 L/sec) is higher than the value listed in Table 2 of Schedule U of the Proposed Natural Resources Plan for the Wellington Region ("**PNRP**") (450 L/sec). However, Table 2 also states that the first band of supplementary allocation occurring above median should occur in the flow range 510 to

[2] See paragraphs 5 and 24.

790 L/sec. Whether 450 L/sec or 510 L/sec is the most appropriate threshold to use depends on what system Waka Kotahi wish to utilise to access supplementary allocation; i.e. a graduated abstraction system (as per Note 4 in Schedule U) could use a median flow of 450 L/sec whereas a band system of progressively higher maximum band rates (as per the Band 1, 2 and 3 method in Table 2 of Schedule U) should use 510 L/sec as the supplementary take threshold.

18. To avoid doubt, I have recommended that Waka Kotahi separate the rates and volumes sought into those under core allocation policies and those under supplementary policies. In addition, Waka Kotahi should specify whether they intend to operate with a graduated abstraction system for supplementary allocation or opt for progressively higher static allocation amounts of the band system. Together, this additional detail would help ensure that the abstraction is managed on a day to day basis in accordance with the appropriate limits and compliance thresholds.

19. The proposed rates and volumes of abstraction from the Waitohu Stream otherwise generally comply with minimum flows, supplementary flows and allocation limits that are specified for this catchment in the PNRP. In broad terms, I agree with Waka Kotahi that the instream effects of the take are anticipated by the PNRP limits and are likely to be no more than minor. The take will incrementally modify, but most likely not fundamentally change, the natural flow regime or the current morphology.

20. However, there are some aspects of the proposal that I consider need further attention. These matters relate to both the level of effect at some flows and the operational management of the abstraction. In particular, I note:

    (a) I am primarily concerned about effects immediately downstream of the point of take that flows at, or just above, minimum flow. This is because there are natural stream flow losses to groundwater that have not, in my view, been adequately accounted for in the Waka Kotahi proposed abstraction regime. It is likely, at times, that the take under its proposed management regime will equate to more than 10 per cent of natural stream

flow; potentially equating to up to 15 to 20 per cent of stream flow at the point of take at flows just above minimum, and 20 to 50 per cent downstream of that. Given this potential level of flow alteration (which equates to a relatively high risk for ecosystem health), I question whether the conclusions from Waka Kotahi of "extremely small effect" and "less than minor" are fully justified during periods of low flow (but unrestricted) take.

(b) Given the imprecise and uncertain nature of the relationship between abstraction and ecosystem impact and the need to be precautionary, I consider these risks should be dealt with by adjusting the proposed take management regime at low flows, rather than by undertaking further investigation or analysis. I recommend a new consent condition that requires the take to be reduced by 50 per cent (of the maximum core allocation rate sought) when flow at the GWRC management gauge (Waitohu Stream at WSI) is between 140 and 185 L/sec. This condition would also satisfy the PNRP requirement for abstractions to reduce as the minimum flow is approached.

(c) I also recommend, by way of a new consent condition, that the flow rate measured at the WSI gauge is adjusted to account for flow loss to groundwater between that site and the point of abstraction. It is this adjusted flow that should be used to determine allocable rates and volumes on any given day. I have suggested an equation for this adjustment based on my understanding of the relationship between the two sites. I do not consider that any similar adjustment is needed to determine allocable rates and volumes above the supplementary flow threshold as the losses to groundwater are unlikely to be significant at these higher flows.

21. The proposed conditions of consent are not, in my view, sufficient for Waka Kotahi to adequately demonstrate compliance of the take with the PNRP. In collaboration with Ms Stout, I have suggested several amendments and/or new conditions that I consider will address current deficiencies (as well as the matters raised in the preceding paragraphs). These have been summarised at paragraphs 85-91 of my report.

22. Drawing conclusions about whether the peak and average rates and volumes sought by Waka Kotahi represent an efficient allocation of water is outside the scope of my report and I recognise that the PNRP offers no specific criteria with which to assess this type of water use. However, it remains unclear whether the amounts sought are justified once other potential sources of construction water have been acquired (i.e. as a "top up"). To ensure that no more water is allocated than is necessary, I recommend Waka Kotahi should either:

    (a) be more specific about how much water is likely to be acquired from bores, and reduce the volume they are seeking to take from surface water accordingly, or

    (b) reduce the volume of surface water allocation by the same amount acquired once this latter figure has been established.

E. SCOPE OF REPORT

23. My report focuses only on issues related to the proposed take of surface water from the Waitohu Stream in the Wellington region. It covers the following:

    (a) The size of the take in relation to available core and supplementary allocation;

    (b) The level of natural flow alteration in downstream reaches that could be expected from such a take, and the risk of related adverse impacts;

    (c) Whether the proposed regime for managing the water take is reasonable; and

    (d) Appraisal of, and comment on, submissions.

24. In preparing this report, I have reviewed the following information supplied by Waka Kotahi in relation to water take and allocation matters:

    (a) Waka Kotahi (November 2022). Ōtaki to north of Levin Highway Project: Volume II Notices of Requirement for a Designation and Application for Resource Consents: Supporting Information and

Assessment of Effects on the Environment. The following sections in particular:

(i) Section 19.4 (Take, use and diversion of water), and in particular, sub-section 19.4.3 and Table 19.3;

(ii) Design and Construction Report (Section 4.7.6.8 and Appendix 4.7);

(iii) Technical Assessment K: Freshwater Ecology (Dr Alex James)

(iv) Accommodation Works Sheet 18, and;

(v) Appendix 5 Proposed conditions (including refinements submitted on 23 March 2023);

(b) Waka Kotahi (December 2022). Ōtaki to north of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991 (the "**Section 92 Response**").

(c) McConchie J (2023). Effect of proposed abstraction of construction water from Waitohu Stream. Memorandum prepared for GWRC by SLR.[3]

25. The McConchie (2023) memorandum was provided in response to my review of the AEE and a request for further information.[4] It focuses specifically on the Waitohu Stream flow regime downstream of the proposed point of take.

26. Where I have relied on information other than the Waka Kotahi information mentioned above, it is referenced in the body of my report, including Section M.

27. I consider the following matters to be outside the scope of my report:

[3] O2NL Reference 720.30017.00000 O2NL Waitohu Abstraction FINAL.docx.
[4] Request for further information pursuant to section 92 of the Resource Management Act 1991, dated 9 December 2022.

(a) Presence of, and potential impacts of the water take on, wetlands;

(b) Impact of the proposed take on cultural values;

(c) Any groundwater or surface hydrological impacts of the wider highway construction activities that are unrelated to the proposed abstraction of water from the Waitohu Stream (e.g. stream diversion for culvert installation);

(d) The use of the water once in storage;

(e) Any matters relating to the discharge of used or unused water; and

(f) Any impacts on community drinking water supplies.

F. BACKGROUND

28. The Waitohu Stream drains a relatively small catchment in the foothills east of Otaki (**Figure 1**). It has a shallow channel profile and predominantly gravel and cobble bed in the upper and middle reaches with riffle-run-pool sequences typical of these hard bottom streams. It transitions to softer bottom, finer grain material with deeper incised channel in the lower reaches as it traverses sand dune country before discharging to sea. Due to the relatively short, steep nature of the upper catchment, flows in this stream tend to respond rapidly to rainfall events and recede relatively quickly. There is significant surface-groundwater exchange in the middle reaches (between SH1 and the Mangapouri Stream confluence).

29. Waka Kotahi have applied to take water directly from the Waitohu Stream as a restricted discretionary activity for construction purposes during the Ō2NL Project.

30. The application is to take water at a maximum rate of up to 10 per cent of stream flow up to a maximum of 50 litres per second (L/sec) and a maximum volume of 2,160 cubic metres per day (m^3/d).[5]

31. The exact location and configuration of the point of take is to be confirmed but it is indicatively proposed just upstream of the current SH1 alignment (Figure 3).

32. The application is to pump water from the stream during normal daytime work hours (i.e. over a 12 hour period) and divert to a storage pond – the location is indicatively shown in **Figure 2**.

33. I understand the consent term sought by Waka Kotahi is 10 years. This aligns with the typical maximum term of water take consents currently granted by GWRC (also 10 years).

G. WAITOHU STREAM AND THE PNRP: MINIMUM FLOW, ALLOCATION LIMITS AND EFFICIENT ALLOCATION

34. The main rule in the PNRP governing the take and use of water in the Kapiti Coast Whaitua is K.R1. This rule sets the minimum flow and allocation limits as well as lists matters of discretion.

35. The minimum flow for the Waitohu Stream is 140 L/sec, measured at the GWRC continuous flow gauge site 'Water Supply Intake,[6] ("**WSI**"). This is the flow at which consented direct surface water takes from the stream must cease and highly connected groundwater takes must reduce by 50 per cent. Additionally, Policy P119 of the PNRP requires takes to reduce as minimum flows are approached.

36. The minimum flow was established in the 1990s, and adopted in the Wellington Regional Freshwater Plan (WRC 1999) on the basis of statistical analyses of the fairly limited flow record available at the time.

37. There are now almost 30 years of good quality low flow records available for the Waitohu Stream at the WSI site. This data suggests that the

[5] See Table 19-3 and Appendix 5 in Waka Kotahi AEE Vol II (2022) and Figure 1 in this report.
[6] For clarity, this is the location of the historical public water supply intake that was operated by Kapiti Coast District Council but is now de-commissioned.

natural mean annual low flow ("**MALF**") of the Waitohu Stream at this site is 150 L/sec. The minimum flow therefore equates to slightly more than 90 per cent of the natural MALF.

38. While this stream has not been subject to a comprehensive instream values and minimum flow investigation, a minimum flow of 90 per cent of MALF is generally regarded by leading New Zealand freshwater ecology experts as ecologically precautionary.[7]

39. The **core allocation** limit in the Waitohu Stream catchment is 45 L/sec. Core allocation refers to the rate/amount of water that can be abstracted by consent above the minimum flow. For surface water, core allocation is specified as an instantaneous rate and for groundwater as either a weekly average rate or an annual rate (depending on level of connection to the surface). As of February 2023, 7.5 L/sec has been allocated by resource consent and 37.5 L/sec of core allocation remains available.

40. The core allocation for this catchment was originally set at 57 L/sec in the Regional Freshwater Plan (WRC 1999) but in the past 10 years has been reduced to 45 L/sec in the PNRP. This reduction occurred on the basis of recalculating core allocation as a proportion of MALF at the bottom of the catchment and setting an upper limit equating to 30 per cent of MALF, a method more aligned with recommendations in the proposed National Environmental Standard for Ecological Flows and Water Levels (MfE 2008). More recent re-calculations by GWRC suggest the core allocation limit probably equates to around 20-25 per cent of MALF (i.e. more precautionary than the PNRP suggests).

41. In general terms, the combination of the minimum flow and core allocation limit in the PNRP is considered to be appropriate for managing the overall environmental impact of water takes in the catchment. However, in the Waitohu Stream catchment there is significant flow loss and then regain in the reaches between the foothills and the coastal margin, particularly during severe summer dry spells. This indicates that additional care should be taken when allocating new water, even within the PNRP limits, to ensure that the distribution and magnitude of

[7] See, for example, Beca 2008, Hayes et al 2018.

individual takes is not placing undue stress on any parts of the stream that might be more vulnerable. I note that discretion is available through application of Rule K.R1 to address this issue.[8]

42. Rule K.R1 (c) allows for **supplementary allocation** at flows above median. This means that, in addition to core allocation, further water is available above median flows, providing certain conditions are met. In this case, where the Waitohu Stream is listed in Table 2 of Schedule U in the PNRP, the amount of supplementary allocation available equates to a maximum of 10 per cent of the total flow in the river at the point of abstraction, providing the frequency of flushing flows in the stream is not changed. Flushing flows are defined in the PNRP as those of three times the median flow and higher. Schedule U also sets out a method by which bands of allocation can be calculated above median flow, however, it also allows for flexibility to depart from this method if the consent holder has the ability to operate a graduated abstraction system.[9]

43. The intention of the supplementary allocation policy is primarily to enable some additional water abstraction when the stream is not under flow stress, and it is typically of most benefit to water users where storage is available to them. Maximum supplementary allocation allowances from streams (such as the Waitohu) are much smaller than from larger rivers, in proportion with the comparative risk posed to instream values in these contrasting environments.

44. Again, the matters of discretion attached to Rule K.R1 allow for some additional site-specific scrutiny of local depletion effects to ensure that any supplementary allocation granted within the PNRP limit is acceptable.

45. In addition to the policies and rules governing minimum flow and allocation limits, the PNRP also requires reasonable and efficient use of water. Objective O43 of the PNRP requires that "*efficient allocation and efficient use of water is improved and maximised through time…*", while Policy P125 requires the application of "*reasonable and efficient use*

[8] Rule K.R1, matter for discretion 5 (relating to the local effects on a downstream river reach).
[9] Schedule U, note 4.

criteria identified in Schedule P" as well as industry guidelines. Schedule P is focused primarily on irrigation and water supply uses and, in respect of "other" uses, states the following:

> An assessment of reasonable and efficient use must accompany a resource consent application for any other use of water. The amount of water applied for should be calculated in accordance with good management practices for efficient use of water in relation to that use or by demonstrating that water is not being wasted, such as by means of a water use audit by an independent party to identify any wastage and any opportunities for re-use or conservation.

H. REVIEW OF THE APPLICATION

Rates and volumes sought

46. The rates and volumes of abstraction from the Waitohu Stream that are sought by Waka Kotahi generally comply with minimum flows and allocation limits that are specified for this catchment in the PNRP. However, there are some matters requiring clarification.

47. As noted above, the maximum instantaneous rate applied for by Waka Kotahi is 50 L/sec. The core allocation limit for the Waitohu Stream is 45 L/sec and 7.5 L/sec is currently allocated. This leaves a maximum of 37.5 L/sec available to be allocated. Therefore, the amount sought exceeds the core allocation amount available by 12.5 L/sec.

48. Waka Kotahi have correctly used the 37.5 L/sec instantaneous rate figure to arrive at their daily volume calculations but have then sought a higher instantaneous rate (50 L/sec) on the basis of pumping the full daily volume in less than 24 hours.

49. However, it is not clear whether the proposed 50 L/sec maximum rate is intended to include both core allocation and supplementary allocation. If it does, then the maximum rate could comply with the allocation policies once flows are above median.

50. Because Waka Kotahi have proposed that its maximum instantaneous rate will also not exceed 10 per cent of flow in the stream, it may be that

revising the cap down from 50 L/sec to a maximum of 37.5 L/sec when taking water below flows of median is inconsequential for them most of the time. That is, the 10 per cent cap will likely constrain the take to below 37.5 L/sec for a large majority of the time when the stream is flowing at less than median anyway.

51. I also note that GWRC core and supplementary surface water allocation policies are based on instantaneous rates (L/sec) whereas Horizons' are based on daily volumes. It may be that Waka Kotahi have not accounted for this difference in proposing a Waitohu Stream maximum take rate (50 L/sec) that is higher than the available rate.

52. The median flow value calculated by Waka Kotahi (540 L/sec) is also higher than the value listed in Table 2 of Schedule U of the PNRP (450 L/sec). However, Table 2 states that the first band of supplementary allocation occurring above median should occur in the flow range 510 to 790 L/sec. Whether 450 L/sec or 510 L/sec is the most appropriate threshold to use depends on what system Waka Kotahi wish to use to access supplementary allocation; i.e. a graduated abstraction system (as per Note 4 in Schedule U) could use a median flow of 450 L/sec, whereas a band system of progressively higher maximum band rates (as per the Band 1, 2 and 3 method in Table 2 of Schedule U) should use 510 L/sec as the supplementary take threshold.

53. Waka Kotahi have not included any analysis in their AEE to demonstrate how the proposed take will comply with the policy to maintain flushing flow frequency. I expect that in a flashy stream like the Waitohu, supplementary abstraction will most likely only be practically viable on the receding limb of fresh flows when the stream has fallen enough for sediment load to fall to manageable levels but flow is still higher than the median flow trigger. Given this likely operational constraint, combined with the 10 per cent abstraction cap, I do not expect any significant change in the frequency of flushing flows would occur under the proposed regime. Therefore, I do not consider any further analysis is needed by Waka Kotahi, or that the flushing flow part of the PNRP policy needs any specific consent conditions to demonstrate compliance, however, this view is contingent upon Waka Kotahi confirming that my interpretation of how supplementary abstraction will occur is accurate.

54. To avoid doubt, I recommend that Waka Kotahi separate the rates and volumes into those sought under core allocation policies and those sought under supplementary policies. Waka Kotahi should also specify whether they intend to operate with a graduated abstraction system for supplementary allocation or opt for the progressively higher static allocation amounts of the band system. Together, this additional detail would help ensure that the abstraction is managed on a day to day basis in accordance with the appropriate limits and compliance thresholds.

55. Waka Kotahi have made no mention of Policy P119 that requires takes to reduce as the minimum flow is approached. I comment on this below.

56. With regard to total water requirements and use, Waka Kotahi have stated that peak daily water demand will be 3,900 m^3/day, and the average daily demand across all sites will be 2,350 m^3/day. The total core allocation sought across all GWRC and Horizons abstraction points is equivalent to 5,491 m^3/day. Additional water is sought via the supplementary allocation. No cap or limit on the supplementary allocation over and above '10% of the mean daily flow on the preceding day' has been proposed. Therefore, the amount of water sought under the core allocation across all sites exceeds both the peak and average daily demand, and the supplementary allocation is additional to this.

57. Waka Kotahi explain they have sought an allocation over and above the average and peak daily demand for, primarily, the following reasons:

    (a) Security of supply during times of minimum flow restriction: Waka Kotahi have explained that peak water demand is most likely to occur during summer and autumn. This is the same time of year that abstraction is most likely to be limited by minimum flow restrictions which require abstractions to cease, or by low flows which prevent the full volume of water being abstracted. Waka Kotahi have indicated that they will build water storage structures to store water harvested at higher flows, and to supply water during times when demand exceeds the ability to take water under the core allocation.

(b) Recognising that not all abstractions will be used at once: Waka Kotahi have explained that they wish to avoid transporting water between catchments. Assuming the road will be built in stages, it is unlikely that all abstraction points will be used at the same time.

58. However, Waka Kotahi have also indicated that if they acquire land with productive bores, that water from those bores will be used to support the construction of the road. In their Section 92 response to a query from Ms Stout about this issue, Waka Kotahi further explained that:

> At this stage the location and volume of any bores that have the potential to be used to support construction activities is unknown. That said, resource consent is sought for a maximum amount of water to support construction sourced from a hierarchy of sources. Abstraction from rivers and streams will only be used to 'top up' the available water to meet the actual demand. This will assure optimal efficiency of water use and minimise abstraction from rivers and streams.

59. Commenting on whether the peak and average rates and volumes sought by Waka Kotahi represent an efficient allocation of water is outside the scope of my report and I recognise that the PNRP offers no specific criteria with which to assess this type of water use. However, it remains unclear whether the amounts sought are justified (i.e. as a “top up”) once other potential sources of construction water have been acquired. To ensure that no more water is allocated than necessary, Waka Kotahi should either:

(a) be more specific about how much water is likely to be acquired from bores, and reduce the volume they are seeking to take from surface water accordingly; or

(b) reduce the volume of surface water allocation by the same amount acquired once this latter figure has been established.

Assessment of effects

60. As far as I am aware, no new catchment and site-specific hydrological data were collected in the process of assembling the application. Nor

were any ecological data collected for the specific purpose of informing the water take assessment. Rather, the application (including the Section 92 Response) has leaned heavily on a re-analysis of available hydrological data.

61. Waka Kotahi has also adopted two primary positions to conclude effects will be less than minor. Firstly, that the amount of water sought is within the allocation limits set by GWRC and, secondly, that in constraining the take to no more than 10 per cent of stream flow (above minimum flow), it will barely be measurable beyond standard error margins or, therefore, detectable as a flow loss. I comment on each of these below.

Effects at low flows

62. As I noted in paragraphs 44 and 45, I consider the existing allocation and minimum flow limits in the Waitohu Stream catchment to be generally appropriate for managing the cumulative adverse effects of all takes. However, I do not consider that this translates into an automatic assumption that any individual take complying with those limits will have a less than minor effect. This is because the Waitohu Stream has a highly variable natural flow regime at low flows. There are substantial losses to groundwater in the middle reaches of the coastal plain, such that the location of a proposed take in these reaches could reasonably be expected, in my view, to exacerbate instream stress conditions disproportionately more than a take in the foothills or at the bottom of the catchment.

63. The GWRC minimum flow and allocation limits do not automatically safeguard all potential scenarios or configurations of takes in the catchment, hence the inclusion of local depletion effects as a matter for discretion in the GWRC rule framework. The question is whether the proposed take, located near SH1 at the upstream boundary of the stream reaches in which most flow loss occurs, will cause more flow alteration (and related impact) than is anticipated by the catchment limits.

64. The original AEE (November 2022) did not recognise the pattern of flow loss to groundwater in the Waitohu Stream and assumed either neutral

or gaining conditions in a downstream direction. However, additional information provided by McConchie (2023) explores this pattern further, making use of GWRC concurrent flow gauging data (see Figure 4 – reproduced from McConchie 2023).

65. McConchie (2023) draws a number of conclusions:

(a) That while the available data is sparse in some areas and the pattern of flow loss/gain is variable between seasons, it appears that when flows are above 100 L/sec at the WSI gauge site, there is likely to be flow continuity through the reaches that are prone to bed drying.[10] I agree with this.

(b) That when flow at WSI is at the PNRP minimum flow (140 L/sec), flow at the 'Golf Club' site would be around 60 to 70 L/sec, and the maximum proposed rate of take of 14 L/sec at SH1 would equate to around 20 to 23 per cent of the Golf Club flow, suggesting only "extremely small" effects. However, I am of the view that the calculated flow depletion is likely to be an underestimate. I have compared flow between WSI and the Golf Club site in Figure 5 and the spread of results suggests that at a WSI flow of 140 L/sec, flow at the Golf Club could plausibly range between about 40 and 70 L/sec and the maximum rate of take at SH1 (14 L/sec) as a proportion of this would therefore more likely be in the range of 20 to 40 per cent.

(c) That flow between the WSI gauge and the proposed point of abstraction at SH1 is "essentially constant" and, therefore, flow rate at WSI provides an appropriate indication of flow rate at SH1. I agree that there is a reliable and predictable relationship between these two sites and, broadly speaking, equivalence of flow. However, when I plot one against the other (**Figure 6**) it appears to me that the average pattern is actually one of flow loss of around 30 L/sec in the low to mid flow range, equating to about 10 to 20 per cent, and exceeding the standard error margins associated with flow measurement (being ±8 per cent).

[10] This excludes data from the gauging run in 1995. I have confirmed the zero data point for the site 'Below Ngatotora Ditch' that McConchie (2023) refers to is erroneous.

Of particular note in Figure 6 is that at flows of around 140 to 150 L/sec at WSI (i.e. just around minimum flow), flow at SH1 has ranged between 80 and 120 L/sec, quite substantially lower than upstream.

66. To summarise, the additional information in McConchie (2023) satisfies me that the proposed take is unlikely to be operating at times when the 2-3km reach downstream is experiencing bed drying or maximum stress conditions. Even with the uncertainty in the downstream flow conditions there would appear to be sufficient buffer in the minimum flow setting at WSI gauge to ensure flow is sustained through the lower reaches and that bed drying between SH1 and the Golf Club only results from prolonged natural dry spells.

67. However, I consider the potential scale of reduction in flows downstream of the point of take is likely to be greater than characterised (due to compounding flow losses). Further, it is likely, at times, that the take under its proposed management regime will equate to more than 10 per cent of natural stream flow; potentially equating to up to 15 to 20 per cent of stream flow at the point of take for flows just above minimum, and 20 to 50 per cent downstream of that.

68. I have a particular concern about the level of abstraction at, and around, minimum flow (in the range 130 to 160 L/sec at WSI). From the relatively sparse data available this appears to me to be the flow range across which the stream transitions quite rapidly from good, sustained flow throughout to a more variable and uncertain flow regime, probably with accelerating bed losses in downstream reaches.

69. Noting my concerns above, I question whether the conclusions from Waka Kotahi of “extremely small effect” and “less than minor” are fully justified, particularly during periods of low flow but unrestricted take.

70. I am not aware of any specific advice from the Waka Kotahi project ecologist (Dr Alex James) that relates to how the flow dependent values of the Waitohu Stream may be affected by the proposed take (beyond that captured in, for example, section 51.4.2.5 of the AEE). The application and S92 responses are fairly generic in this regard,

maintaining that attributes such as habitat, sediment load, periphyton biomass, thermal regime and dissolved oxygen would not typically be sensitive to changes in flow of less than 10 per cent (and with a cease take in operation). While I am not an ecologist, experience in other flow setting projects (e.g. working with hydraulic habitat survey data and interpreting dissolved oxygen model outputs) suggests this is likely to be a reasonable conclusion. However, if those flow changes are, at times, substantially more than 10 per cent, I am not certain the conclusions reached by Waka Kotahi still stand (in the absence of site-specific data to support them).

71. Following a school of thought held by many leading freshwater ecologists in New Zealand and abroad,[11] the potential degree of flow alteration from this take, as currently proposed, could be considered at times to create a risk of more than minor structural and functional changes to the ecosystem. 'Structure' in this context could refer to flow-related habitat, species composition and abundance of instream communities.

72. With regard to specific ecological values and attributes of the Waitohu Stream that may be relevant to the assessment of effects from this proposal, I note the following:

    (a) The stream is generally regarded as being in poor condition and health in its lowest reaches (indicatively, downstream of the Mangapouri Stream confluence). Routine State of the Environment monitoring shows consistently high nutrient levels, *E.coli* and turbidity and macroinvertebrate scores that are indicative of moderate levels of pollution and nutrient enrichment.[12]

    (b) Monitoring does not occur in the upper and middle reaches of the stream, but sporadic measurements in the past[13] suggest these reaches, including the stretch between SH1 and the Mangapouri Golf Club, are in better health than downstream,

[11] For example, BECA (2008), Hayes et al (2018) and Richter et al (2012).
[12] See LAWA scorecard at link: Land, Air, Water Aotearoa (LAWA) -.
[13] Robertson (2000).

with lower nutrients and well oxygenated water. However, water temperatures have been seen to spike over 20°C in these reaches when stable low flows coincide with hot days (higher than sites sampled elsewhere in the catchment).

(c) The GWRC regional plan identifies the Waitohu Stream as one that has significant biodiversity values and provides significant indigenous fish habitat.[14] This includes habitat for indigenous threatened/at-risk species throughout the catchment as well as habitat for several migratory species. Inanga spawning habitat is identified in the tidal reaches of the stream.

(d) While fish are not routinely monitored in the Waitohu catchment, the following indigenous species have been recorded (and are identified in the PNRP):[15] *banded kokopu, black flounder,* brown mudfish, *common bully, common smelt, giant kokopu, inanga, koaro,* ***lamprey****, longfin eel, redfin bully, shortfin eel,* ***shortjaw kokopu****, torrentfish and upland bully.*

(e) Inanga fishery health has been identified recently (e.g. Royal 2021) as a particular topic of interest in the Waitohu catchment. Efforts have focused on improving the spawning habitat in the tidal reaches of the stream although the middle reaches of the stream in the vicinity of the proposed take have also been identified as important for adult inanga feeding and as a migration pathway for recruitment and spawning.

(f) While brown and rainbow trout have been observed in the past, the Waitohu Stream is not identified in the regional plan (Schedule I) as having important trout fishery or spawning waters.

73. In my experience, reductions of up to 10 per cent in stream flow are unlikely to adversely affect the specific values and attributes listed above in a more than minor way. However, it seems plausible at least that flow-

[14] Schedule F (https://pnrp.gw.govt.nz/assets/Uploads/Chapter-12-Schedules-Appeal-version-2023.pdf).
[15] Migratory species are indicated in italics and the conservation status of "At Risk" and "Nationally Vulnerable" species are underlined and in bold, respectively.

related habitat space, particularly for the species that prefer faster water (e.g. torrentfish) may be impacted in a more than minor way in the immediate downstream reaches should flow alteration substantially exceed 10 per cent.

74. That said, beyond the theoretical risks and my opinion on effects as expressed above, I am unable to comment on this point with high confidence. This is due to a lack of catchment specific flow-habitat relationship data and the variability and uncertainty in the low flow regime (particularly where other losses to groundwater are also occurring). Nevertheless, the combination of relatively high indigenous fish values and low stream base flow creates a relatively high risk setting and suggests a precautionary approach to taking water is warranted. With this in mind, I have recommended amendments to the proposed abstraction regime in Section I.

Effects at flows above median

75. Waka Kotahi have not stated a proposed maximum instantaneous rate of abstraction when stream flow is above median in L/sec terms, but have constrained it to 10 per cent.

76. I anticipate that operational conditions on the ground such as sediment content of the stream at higher flows and maximum capacity of the pump will place further limits around the size of the available take in practice.

77. While no comprehensive concurrent flow gauging data at median flow or higher are available (such as shown in Figure 4 for lower flows), I expect the pattern of streamflow above median is one of neutral to gaining in a downstream direction. Flows of this magnitude are generally associated with either winter base flows when the groundwater table is higher or on the recession of fresh flows throughout the year; in both situations, losses to groundwater will be proportionately much less than during summer low flows. Thus, I do not have the same concern (as expressed for the core allocation component) about the potential for the 10 per cent cap to be inadvertently and significantly exceeded in

downstream reaches (due to groundwater losses) at these higher flows.[16]

78. Waka Kotahi have not explicitly recognised clause K.R1 c (i) regarding preservation of flushing flow frequency when taking supplementary allocation. Given the planning and likely operational constraints to the take mentioned above, I do not expect that abstractions above median will be sufficiently large and prolonged to effect flushing flow frequency (defined as the annual frequency of flows exceeding three times median flow). However, for the avoidance of doubt Waka Kotahi should confirm how they anticipate the abstraction being operated when a flushing flow is occurring.

Cumulative effects

79. There is currently only one other consented water take that is considered to be primarily sourcing water from the Waitohu Stream; this is held by the Otaki Golf Club in the lower part of the catchment. Under this consent, water is drawn from a groundwater bore near the stream at a weekly average rate of 7.5 L/sec.

80. The only other potential water takes I am aware of are those which may occur under RMA and PNRP rules for unconsented and permitted use (e.g., for stock water and minor garden irrigation, etc). Individually, such takes can occur at rates of up to 2.5 L/sec but only for short periods at this rate (around an hour) until a daily volume of 20 m^3/day is reached. Typically, they would operate at much lower instant rates.

81. No measurement data is available on the total rates and volumes of unconsented and permitted water abstracted in the Waitohu catchment as these types of takes do not need to be registered with GWRC or metered. However, desktop modelling commissioned by GWRC (Beca 2013) estimated use at around 4-5 L/sec.

82. Given the relatively low current consented use, likely low unconsented use rates and distribution of existing takes through the catchment, I do not have significant additional concerns about the increase in cumulative

[16] Although noting my reservations in Section I about how the take will be operated in practice when flows are potentially changing rapidly through the day.

effect associated with the proposed Waka Kotahi take (i.e. beyond those concerns already stated previously).

Summary

83. On balance, I consider the AEE contains some broadly reasonable conclusions. In large part, I agree that the effects of the take are anticipated by the GWRC allocation and minimum flow limits and are likely to be no more than minor. The take will incrementally modify, but most likely not fundamentally change, the natural flow regime or the current morphology (including the riffle-run-pool sequences).

84. I am concerned about effects immediately downstream of the point of take at flows at or just above minimum flow. Given the imprecise and uncertain nature of the relationship between abstraction and ecosystem impact and the need to be precautionary, I consider this should be dealt with by adjusting the take management regime at these flows (from that proposed) rather than by undertaking further investigation or analysis. I address recommendations to manage this below.

I. MANAGEMENT OF THE ABSTRACTION

85. The draft conditions of Appendix 5 of the AEE[17] including the refinements submitted on 21 March 2023 – offer some information about how Waka Kotahi intend to manage this abstraction. However, there is insufficient detail to ensure consent conditions have the necessary specificity.

86. My understanding is that the take will be manually set once a day at a rate not exceeding 50 L/sec or 10 per cent of "the mean daily flow in the water body on the preceding day measured at the flow gauge" and will be operated for up to 12 hours, generally coinciding with business hours or until the daily volume cap of 2160 m^3 is reached.

87. At flows of 140 L/sec or below at the GWRC gauge site WSI, the take will cease and at flows of more than 540 L/sec (median) at the WSI site,

[17] See Figure 2 of this report.

the instantaneous and daily volume caps can be exceeded (i.e. as supplementary allocation becomes available).

88. The following comments draw on earlier parts of my report in making some suggestions for management of the take.

(a) I agree that the minimum flow of 140 L/sec at WSI is an appropriate trigger to use for cease take at SH1. Typically, in the Wellington region, the mean daily flow from the 24 hours prior is used to determine whether a minimum has been breached and water users are required to check the GWRC website for these compliance flow alerts. I suggest the same process is followed for this take.

(b) While I consider the WSI continuous gauge site is also generally suitable for determining the daily abstraction rate at SH1, I am of the view that the loss of flow between the two sites (discussed in paragraph 65(c)) should be taken into account. This could be done by applying the regression equation in my Figure 6 to the WSI record and generating a 'virtual' site record for SH1.

(c) I consider the maximum instantaneous rate should be reduced from 50 L/sec to no more than 37.5 L/sec when core allocation is being taken (i.e. at WSI flows between 140 and 540 L/sec).

(d) I have noted that P119 in the PNRP requires abstraction to reduce as minimum flows are approached. I consider that application of this policy could help mitigate the risk to immediate downstream reaches discussed earlier, particularly in paragraphs 73 and 74. While no 'stepdown' flow threshold is listed in Schedule Q of the PNRP for the Waitohu Stream, this schedule is not intended to be exhaustive. Where waterways are not listed in Schedule Q, a stepdown flow has typically been calculated by adding the core allocation (in this case, 45 L/sec) to the minimum flow (140 L/sec). This gives a stepdown flow of 185 L/sec at WSI, below which abstraction should reduce by half (again, a 50 per cent reduction is not prescribed in the PNRP but has been the commonly applied figure). In practice, this would

mean that at flows between 140 and 185 L/sec, five per cent of the streamflow at SH1 could be taken, rather than 10 per cent.

(e) **Figure 7** illustrates how an adjusted take management regime might address some of my concerns and compares rates and volumes to those proposed.

(f) I appreciate that, when combined with applying a slightly lower virtual flow record at SH1, this stepdown reduction will constrain availability in some periods relative to the current Waka Kotahi proposals. On the other hand, it will, in my view, reduce some of the risks associated with heightened uncertainty of effects around minimum flows in a meaningful way. For example, at flows of between 140 and 185 L/sec at WSI, the estimated proportional depletion of flows downstream would reduce from 20 to 40 per cent under current proposals to between 10 and 20 per cent.

(g) With regard to the daily adjustment of the abstraction rate, I assume Waka Kotahi will be operating a variable rate pump capable of incremental adjustments between about 5 and 50+ L/sec. I note that proposed condition RWT1(h) makes reference to submitting daily volume metering data only. I am of the view that instant rate abstraction (15 minute) data will also be required to ensure compliance.

89. Finally, I note that, typically, the Waitohu Stream naturally recedes (as measured at WSI) during dry spells at a rate that ranges between about 5 and 15 L/sec per day. This is fairly modest and suggests to me that a relatively simple and pragmatic approach can be taken to setting the daily abstraction rate (i.e. it would not necessarily need to use the most up to date streamflow data but could be based on the previous day's readings, albeit adjusted for flow loss at SH1). That is, I agree with Waka Kotahi that mean daily flow from the preceding day can be used.

90. At flows above median, however, changes are more rapid. For example, flow will typically recede after a fresh at a rate of between 50 and 150 L/sec per day. This means that more care needs to be taken in setting

the supplementary allocation abstraction rate in order to not exceed the 10 per cent criteria. In my view, setting the abstraction rate at these higher flows needs to be done using real time data from the WSI site and potentially adjusted more than once within normal working day hours (especially if maximum abstraction rates are being sought on that day).

91. Based on my conclusions regarding management of the abstraction (and generally), I have recommended amendments (in collaboration with Ms Stout) to the proposed water take consent conditions, including several new conditions. In summary:

(a) Correcting the maximum core allocation as an instantaneous rate from 50 L/sec to 37.7 L/sec (Table RWT-1);

(b) Correcting the median flow value from 540 L/sec to 450 L/sec (Table RWT-2), albeit with a caveat that the actual flow threshold to be used to trigger supplementary allocation may be 510 L/sec depending on the system of abstraction selected by Waka Kotahi;

(c) Adding a new Table RWT-3 to be clear about the flow management site and the adjustment factor needed to account for stream flow losses between the management site and the abstraction point when calculating core allocation abstraction rates;

(d) Adding a new Table RWT-4 and associated text adjustments to be clear about the flow management site and flow record (four-hour averaging) used to manage the supplementary allocation (note – this table assumes Waka Kotahi intend to operate to a graduated system of take; this needs to be confirmed);

(e) Adding a new Table RWT-5 to set out the cease take flows;

(f) Adding a new Table RWT-6 to set out a stepdown flow (185 L/sec) and maximum core allocation amount below this flow (18 L/sec) in order to address concerns about abstraction rates at

low flows (and also comply with PNRP Policy P119, which requires abstraction reductions as minimum flow is approached);

(g) Addition of further detail to RWT1 to specify minimum water meter installation and reporting requirements, including the need to measure and report instantaneous rate water meter data (i.e., 15 minute) as well as daily volumes.

J. SUBMISSIONS

92. I have read all submissions. Very few mention the proposed water takes, either directly or indirectly, or raise specific concerns about the abstraction of construction water. Those that do are the focus of my comments in the following paragraphs.

93. The submission from the New Zealand Fish Game Council ("**Fish and Game**") is the most extensive in terms of references to the effects of the water takes (among other project activities).

94. At a high level, Fish and Game oppose the application until further clarification is provided to address their concerns, in particular relating to consent conditions. The submission is not specific about particular catchments, sites or locations of interest but raises general concerns about the following matters:

(a) Potential impacts of taking water on sports fish, game birds and their habitat, including trout and trout spawning and migration passage;

(b) Potential impact on stream structure and integrity (including maintenance of riffle/run/pool sequences);

(c) Lack of conditions to ensure health and abundance of fish and habitat;

95. Fish and Game advocate in their submission for an improvement in ecosystem health (as measured by Macroinvertebrate Community Index and fish counts) and maintenance and improvement of habitat quality and extent for trout and native fish. However, they also accept in principle some detrimental ecosystem effects may occur during the

construction phase and anticipate a recovery period. Their view is that, if improvements cannot be achieved then, as a minimum, stream structure (i.e. runs/riffles/pools) and integrity should be maintained through the construction period.

96. With regard to water takes, my view (as expressed earlier) is that the proposed regime will not alter the flow regime to the extent that the existing structure and integrity of the stream will be compromised.

97. However, as I have also stated, I consider that the proposed maximum rates of take in the lowest (but unrestricted) flow conditions have the potential to create more than minor ecosystem health risks in some downstream reaches. While I note that the Waitohu Stream catchment is not identified in the PNRP as having particular value for trout or trout spawning, these species are known to be present in the catchment, as are native fish with similar flow demands to trout (e.g. torrentfish).

98. Overall, I consider that the suggestions outlined in this report for the abstraction rates to be trimmed at the lowest flows are consistent with the relief sought by Fish and Game (to ensure risks to ecosystem health and habitat quality are appropriately managed). I note Fish and Game seek conditions relating to monitoring of trout but I have assumed that this is intended to apply more in the catchments to the north (in Horizons jurisdiction) where trout values may be higher.

99. Fish and Game also state that the proposed highway development project creates "*no additional drain on municipal supply*" and that "*water takes are only to be used during construction phase, not in any future maintenance*". With respect to the first comment, I am unaware of any intention from Waka Kotahi for construction water to be reticulated directly from a town or community supply (although this matter lies outside the scope of my report). With respect to the second comment, I agree that the proposed takes should only be used for the construction phase. I understand this phase is likely to have a duration of around five years and, in principle, see some merit conditioning the duration of consent accordingly. However, I also understand from an operational point of view that a standard 10 year term allows for some flexibility and contingency around start and end dates of the construction phase. With

this in mind, I would favour a condition that requires Waka Kotahi to demonstrate that construction is occurring, and that water is being used for the intended purpose.

100. Several submissions are from mana whenua. These include a collective submission from ten hapū of Ngāti Raukawa ki te Tonga (although submitted separately by each hapū), one from Rangitāne o Manawatū and one from Muaūpoko Tribal Authority. All are generally supportive of the Waka Kotahi application. However, Rangitāne o Manawatu have some concern that the Cultural Impact Assessments ("**CIA**") and AEE developed primarily with Ngāti Raukawa are not reflective of their narrative, while the hapū of Ngāti Raukawa do not consider that the consent conditions adequately provide for their cultural values, relationships with their ancestral lands, water, waahi tapu, and other taonga, for their kaitiakitanga responsibilities, and their mana.

101. I am not aware of specific matters or concerns raised about, the Waitohu Stream and proposed water take from my review of Section 40 of the Waka Kotahi AEE Volume II (Cultural effects). However, it is beyond the bounds of my expertise or knowledge to assess cultural effects. In very general terms, I think many of my earlier comments about the risk of adverse instream effects, and my additional recommendations to manage those risks, are broadly relevant also to some of the values expressed by iwi and hapū; such as maintaining flow continuity and fish passage for taonga species and maintaining stream conditions that support mahinga kai.

102. Various submissions, including one from Merie Cannon and Trevor Guy in the GWRC region, oppose the Waka Kotahi application due to concerns about adverse impacts from construction on their existing bore water. Such impacts, as well as potential impacts to groundwater related to other construction activities (e.g. earthworks and dewatering) are matters contemplated in the Section 87F report of Mr Williamson.

Michael Thompson

28 April 2023

K. FIGURES

Figure 1. Catchment boundary and location of key monitoring and abstraction points.

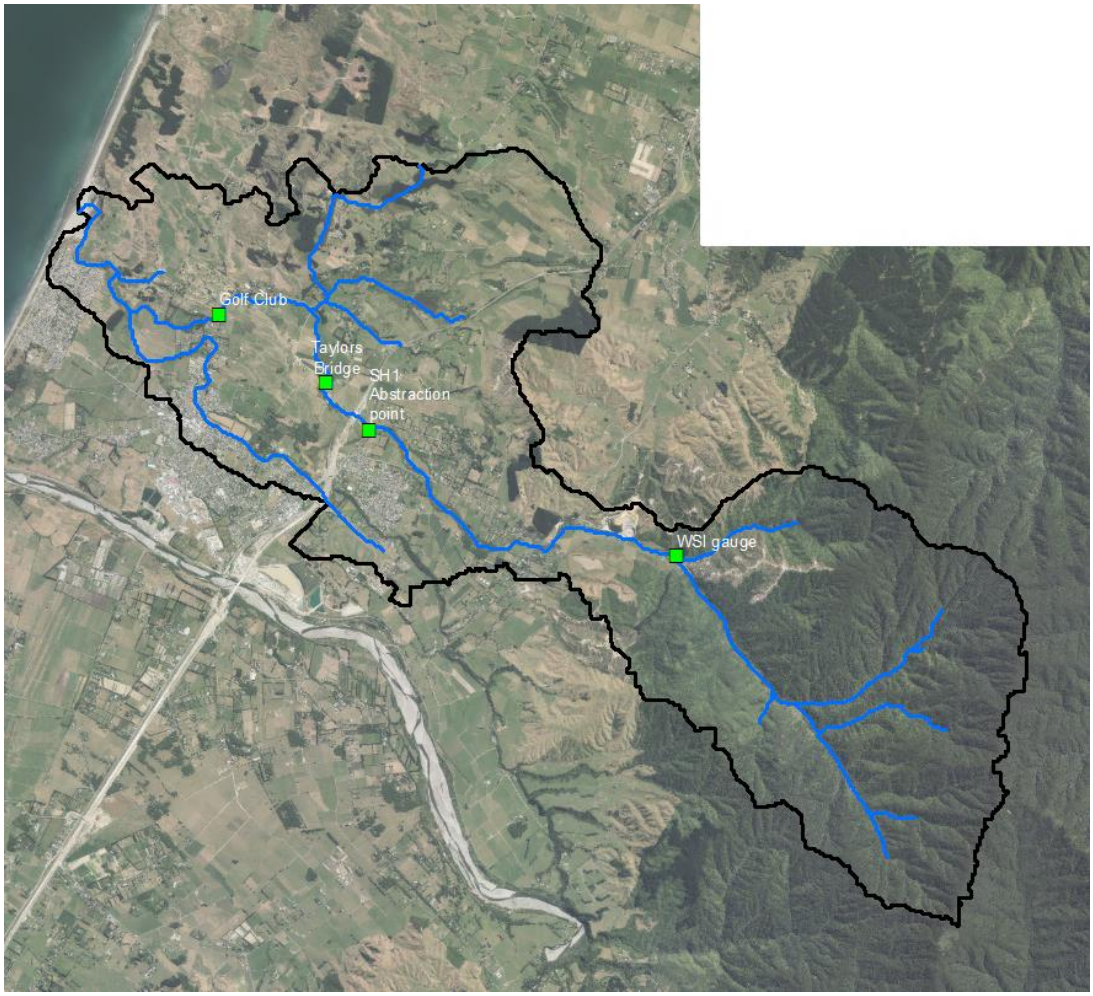

Figure 2. Proposed rates and volumes of water takes and associated take management conditions

Source: Waka Kotahi (2022) – Appendix 5: Draft conditions including refinements (in red) submitted in March 2023

Surface Water

RWT1

Surface water abstraction

a) The ~~taking~~ abstraction of surface water ~~for~~ to support construction activities must not exceed the maximum ~~abstraction~~ volumes or ~~maximum abstraction~~ rates in Table RWT-1:

Table RWT-1 Maximum Abstraction Volume and Rate

Water body	Maximum abstraction volume	Maximum abstraction rate
	m^3/day	L/s
Koputaroa Stream	231	6
Ohau River	~~409~~ 0	70
Waikawa Stream	2,998	70
Manakau and Waiauti Stream	102	6
Waitohu	2,160	50

b) The maximum abstraction volumes specified in table RWT-1 can be exceeded when ~~water~~ flow in the water body is ~~volumes are~~ above the median flows specified in Table RWT-2.

Table RWT-2 Median Flows

Water body	Median flows m^3/sec
Koputaroa Stream	0.059
Ohau River	4.15
Waikawa Stream	0.95
Manakau and Waiauti Stream	0.14
Waitohu	0.54

c) The ~~taking~~ abstraction of surface water set out in clause (a) must occur at the locations shown on the Accommodation Works Plans included in the '*Notices of Requirement for a Designation and Application for Resource Consents*' dated 1 November 2022 '*Volume III Drawings and Plans*'.

d) The ~~taking~~ abstraction of surface water must occur at a rate of not more than ten (10) percent of the mean daily flow in the water body on the preceding day ~~stream discharge on any particular day~~ measured at the flow gauge ~~metres~~ required by clause (e).

e) The ~~taking~~ abstraction of surface water must cease when:

i. except as provided by clause (e)(II), a Regional Plan minimum flow level is reached;

ii. ~~, except that~~ for the Koputaroa Stream, the minimum flow, calculated using the same method as the Regional Plan, at Tavistock Road is reached. ~~water abstraction must cease when the Manawatū River is below 12,240L/s.~~

f) In addition to the requirements of clauses (a), (b) and (e), the abstraction of surface water from the Koputaroa Stream must be proportionate to the catchment area upstream of the abstraction point relative to the catchment area upstream of the flow recorder at Tavistock Road at any time flow is between the minimum and median flows set out in Table RWT-2.

g~~f~~) For each water take, a flow ~~metre~~ meter must be installed and maintained and must:

i. be located on the abstraction line;

ii. have a pulse counter output traceably calibrated to plus or minus (+/-) five (5) percent or better; and

iii. be capable of providing daily water use as well as pulse counter data.

h~~g~~) A record of the daily water volumes abstracted and rates of water abstracted must be maintained and provided to the Regional Council and Project Iwi Partners on request.

Figure 3. Indicative locations of the proposed abstraction reach in the Waitohu Stream and storage pond.

Source: Clipped from 'Accommodation Works Sheet 18' of the Waka Kotahi AEE

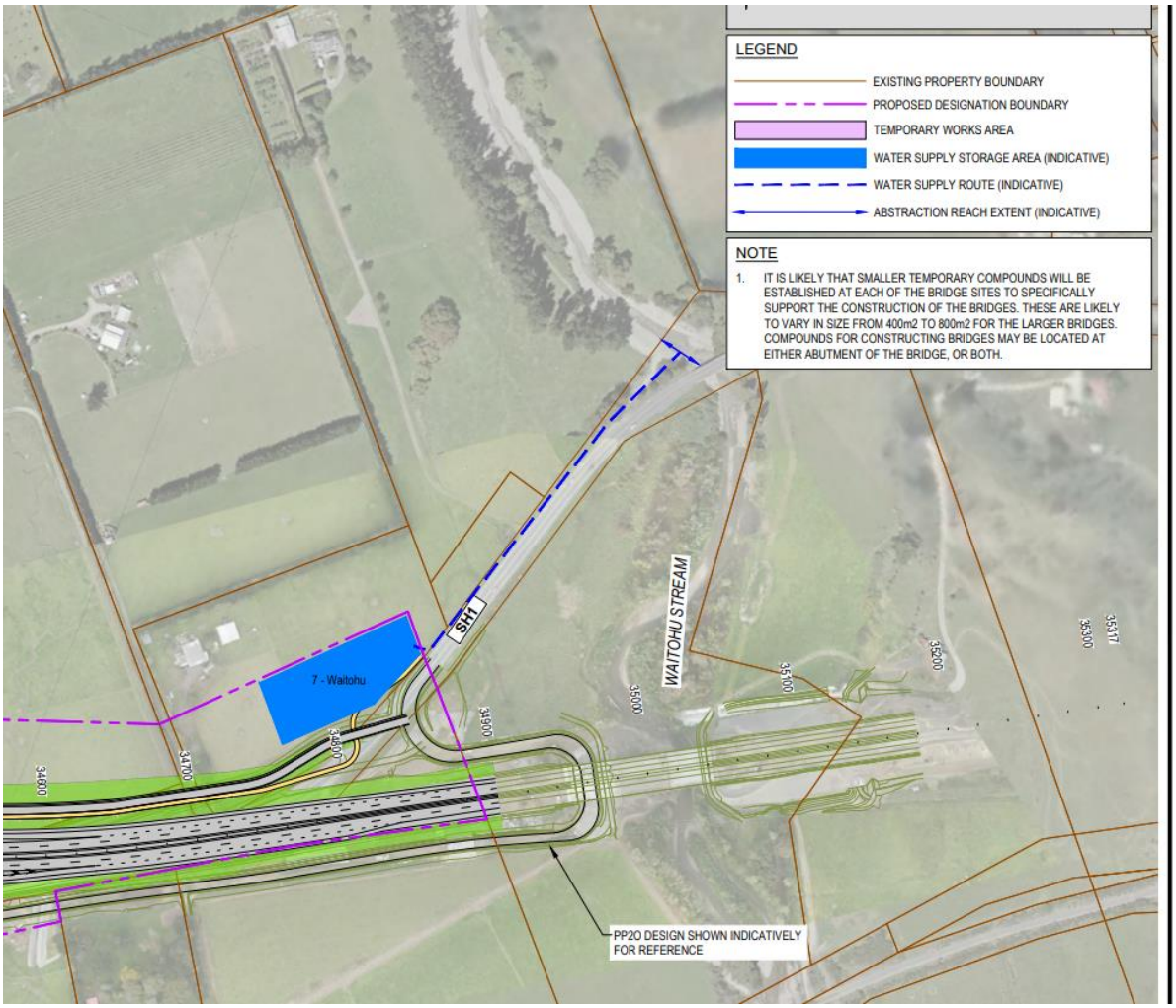

Figure 4. Waitohu Stream concurrent flow gaugings

Source: McConchie (2023) compiled from GWRC gauging data

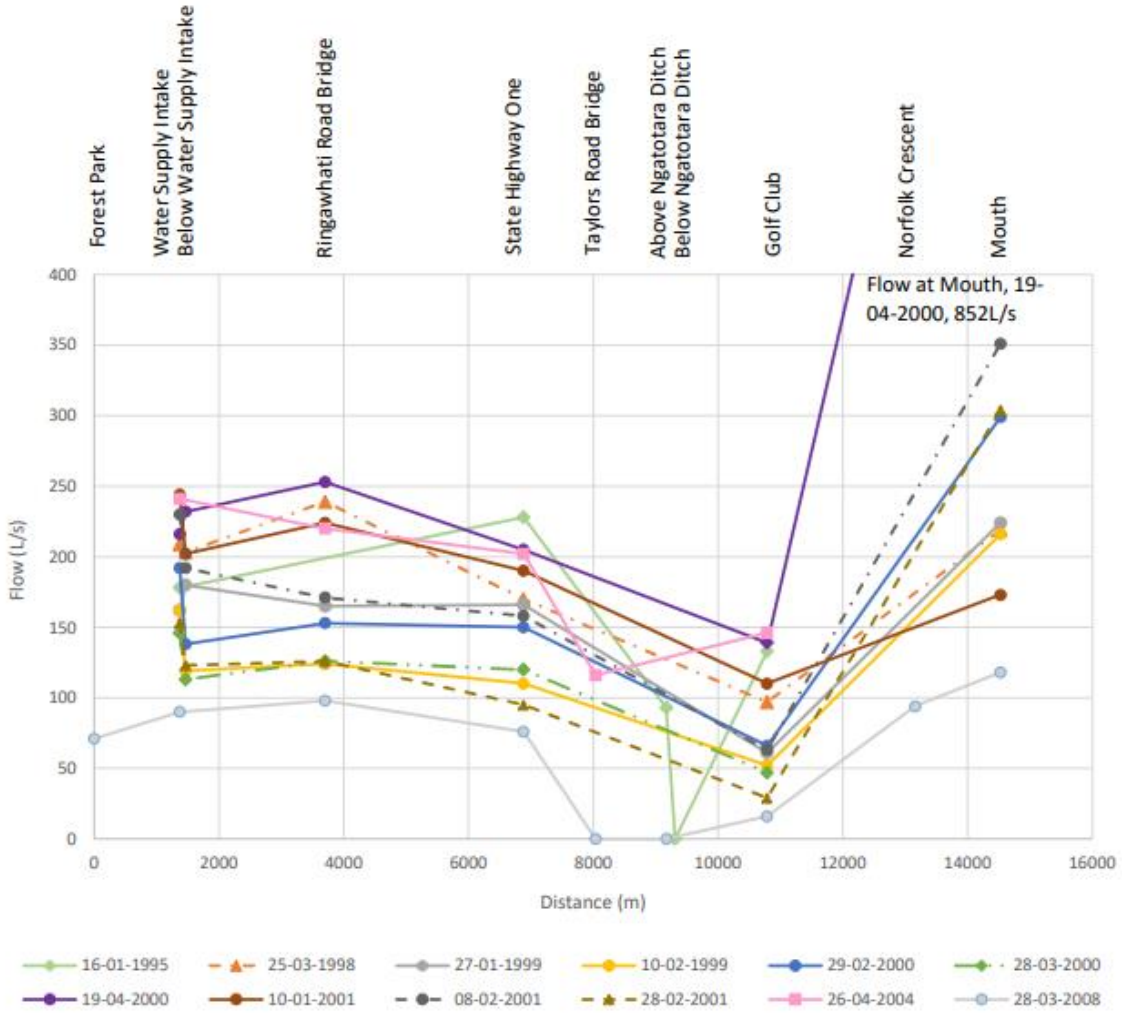

Figure 5. Regression of flow between WSI (continuous gauge site) and Golf Club (spot gaugings). Spread of results about the linear regression are shown by the dashed black lines and vertical dashed blue line shows the minimum flow (140 L/sec) threshold at WSI.

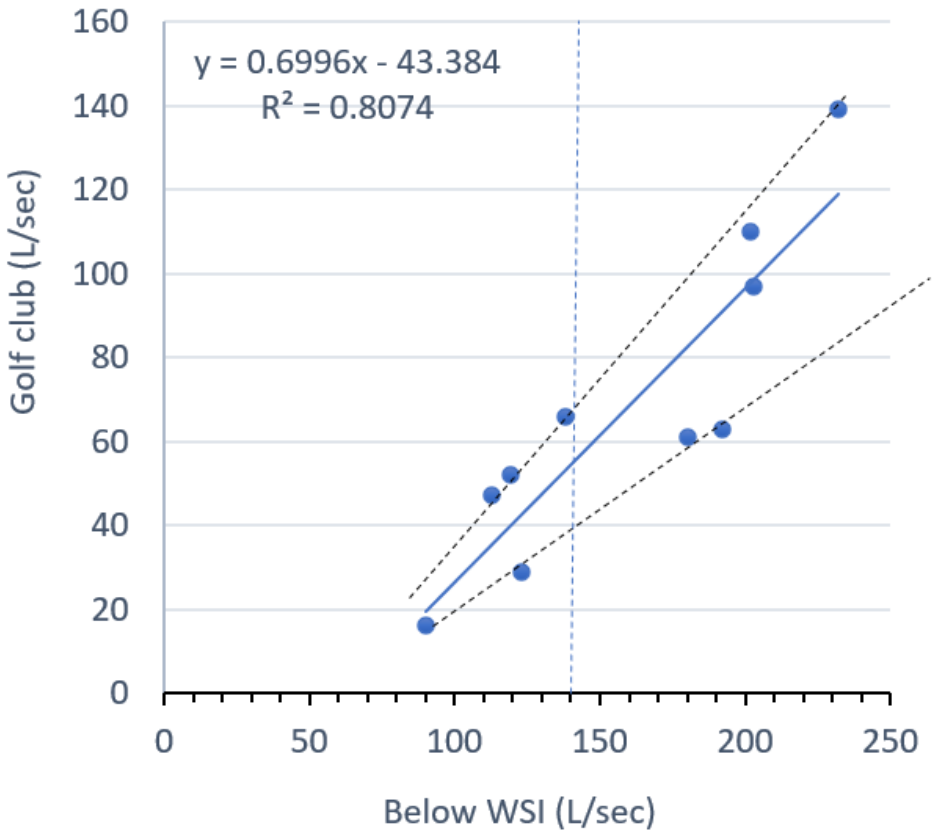

Figure 6. Correlation of Waitohu Stream spot flow gaugings from SH1 (horizontal axis) with concurrent upstream measurements at the WSI gauge station (vertical axis). Regression of the data shown as the black dashed line. Line of equivalence (matching flow between the two sites) is shown in red and minimum flow (140 L/sec) at WSI shown in green.

Source: GWRC Hilltop archive.

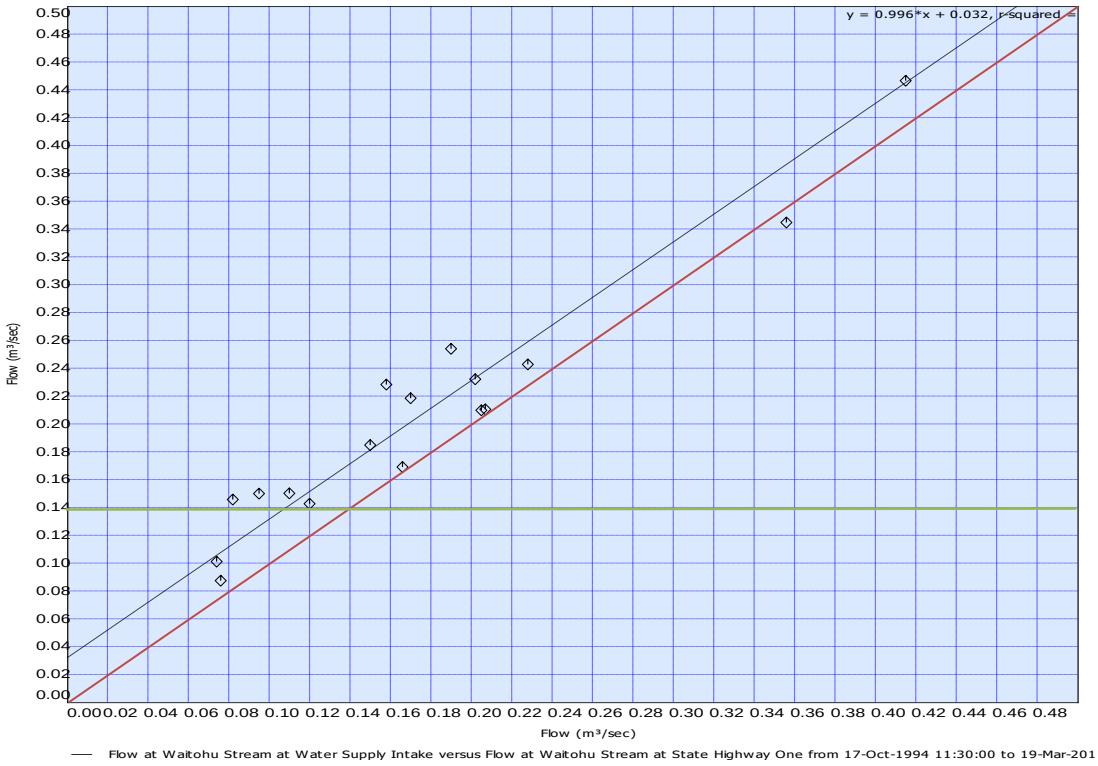

Figure 7. Recommended alternative management regime (rates and volumes table) to account for flow loss between gauge site (WSI) and abstraction point (SH1), lower instantaneous rate cap than proposed (37.5 L/sec compared with 50 L/sec) and adoption of a stepdown. Rates and volumes proposed by Waka Kotahi are shown in square brackets.

Flow at GWRC gauge site "WSI" (L/sec)	**Corresponding flow at SH1 abstraction point (L/sec)[1]**	**Allocation available**	**Maximum instantaneous abstraction rate (L/sec)[2]**	**Maximum daily volume (m^3)**	**Comment**
140 or below	110 or below	None	0 [same]	0 [same]	Cease take below minimum
141 to 185	111 to 150	Core allocation	6–7 [14–18]	2,160 [same]	Stepdown in operation Instant take = 5% of stream flow
186 to 540	151 to 510		16–37 [18–50]	2,160 [same]	Instant take = 10% of SH1 flow up to cap of 37.5 L/sec
450 **or** 510 and above[3]	420 **or** 480 above[3]	Core + Supplementary	51+	2,160?	Supplementary + core allocation Instant take = 10% of SH1 flow, no cap

[1] Based on regression equation in Figure 6

[2] Actual abstraction rate on any given day scaled within this range (to 10% of flow)

[3] Actual threshold to be determined after Waka Kotahi specify which system of supplementary allocation they intend to operate with (graduated or banded)

L. REFERENCES

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7. Royal C (2021). *Inanga Abundance Monitoring Report for the Waitohu Stream Mahi Waiora Project.* Report produced by Waiora Solutions for the Greater Wellington Regional Council, June 2021.