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 JONATHAN WILLIAMSON – HYDROGEOLOGY AND GROUNDWATER

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 hydrogeology and groundwater effects arising from 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 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 being addressed by technical advisors for the District Councils.

4. In preparing this report, I have relied on the expert advice from the following technical experts advising the Horizons and GWRC reporting teams:

   (a) James Lambie, Terrestrial Ecology;

   (b) Michaela Stout, Water Allocation; and

   (c) Michael Thompson, Water Allocation.

5. 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

6. My name is Jonathan Lindsay Williamson. I am Principal Hydrogeologist and Managing Director of Williamson Water & Land Advisory ("**WWLA**"). I have held these positions since 2015.

7. My role involves providing specialist technical expertise in hydrogeology, hydrology, and irrigation engineering. I also oversee the management of staff and clients within our consulting firm of currently 21 people.

8. I hold a Bachelor of Science (BSc) in Earth Science (1993), and a Master of Science and Technology first class honours (MSc (Tech)[I]) (1995) in Hydrology and Geology from the University of Waikato. I am a member of the New Zealand Hydrological Society.

9. I have 27 years' specialist technical expertise in hydrogeology, hydrology and irrigation engineering covering a wide spectrum of services including field investigations and testing; data collection and analysis; modelling; engineering design; construction contract management; technical report writing; community and stakeholder consultation; resource consent hearings; and technical working panels.

10. I have provided independent advice across a wide spectrum of client types within New Zealand, including regional councils, district councils, government agencies such as the Ministry of Business, Innovation and Employment; Te Puni Kōkiri (Ministry of Māori Development); Ministry for the Environment; and the Department of Conservation; sector interest groups such as Horticulture New Zealand, water management groups such as Wairarapa Water User Society; agricultural and horticultural businesses; energy companies; mining; and beverage companies.

11. From the year 2000 until 2015 I held various technical and managerial roles in the natural resource management and irrigation sectors within the Auckland office of Sinclair Knight Merz (now Jacobs). From 1995 to 1999 I was based in Sydney undertaking a range of hydrogeological work in the

mining and municipal water supply sectors for a global multidisciplinary engineering consulting firm.

12. I am familiar with the site and surrounding area. I visited the site along with other Horizons and GRWC experts on 24 August 2022.

C. CODE OF CONDUCT

13. 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.

14. In my report, I have addressed the potential hydrogeology and groundwater effects relating to the construction and operation of the Ō2NL Project, including:

    (a) Road cuts that intercept groundwater and potential impacts on wetlands or streams;

    (b) Drawdown from dewatering to install Culvert 4 and Culvert 11;

    (c) Groundwater levels during the winter of 2022;

    (d) Groundwater levels in the soakage sites;

    (e) Groundwater quality impacts from soakage sites;

    (f) Groundwater level and flow impacts from pre-loading and/or compaction during road construction;

    (g) Community groundwater supply bores; and

    (h) Spoil and gravel borrow sites.

15. Statements expressed in this report are made within the scope of my expertise, except where I rely on the technical advice, I have referred to in paragraph 4 of this report.

16. I have all the information necessary to assess the application within the scope of my expertise and am not aware of any gaps in the information or my knowledge.

D. EXECUTIVE SUMMARY

17. The key conclusions of my report include:

(a) In paragraphs 30-37, I discuss cuts below the groundwater table resulting in permanent dewatering in areas adjacent to natural wetlands (e.g. road cuts and gravel borrow areas).[1] The concern is that quantification on the reduction in hillslope seepage rate in comparison to the natural flow to the wetland was not provided. However, I understand from discussions with Dr McConchie that any wetlands within close proximity to dewatering, where potential effects will not be "less than minor', have been treated as lost and included in the offsetting package. This matter is addressed in the s87F report of Mr Lambie for Horizons and GWRC.

(b) I have relied on further information provided by Waka Kotahi which indicates the highway is *"…now essentially 'at grade' and the maximum groundwater levels at key locations has been assumed to be at the ground surface"*.[2] I understand this to mean that the latest road alignment (in the Consent Application Design) has no excavations, and if this is the case I am satisfied that there would be no dewatering effects. If this is the case, then the conditions should be changed to reflect this undertaking by Waka Kotahi. However, if

[1] Noting that dewatering adjacent to a stream is not considered a significant potential effect because the dewatering discharge is returned to the stream within close proximity to the diversion.

[2] Waka Kotahi, 2022a. Ōtaki to north of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991. Letter dated 22 December 2022. Item 64.

excavation below the groundwater table is still proposed to occur in the locations identified in Table 1 (as the original application suggests), then the effects will need to be managed through conditions of consent (RGW1 to RGW3). These conditions largely address issues with cuts below the groundwater table, subject to a better understanding being needed of the monitoring locations in relation to these cut areas and associated wetlands. I also recommend that condition RGW2 is modified to specifically include wetlands.

(c) In paragraphs 38 to 41, I discuss dewatering required to install Culvert 4 and Culvert 11. Waka Kotahi has confirmed that the timing of installation (likely during summer when groundwater is low) means the need for and extent of any dewatering will be either avoided or minimised. Further, I understand any dewatering is also intended only for installation of the culverts and is of short duration. On that basis, I am comfortable with the proposed dewatering measures and consider that the draft conditions of consent relevant to groundwater (RGW1 to RGW3) cover these matters. In particular, RGW1 includes provision for the taking of groundwater for the purpose of dewatering to continue only for the time required to carry out the construction activities and, to occur when groundwater is low. In my opinion, Waka Kotahi should consider providing a more definitive period of time for dewatering based on typical construction time (including weather contingencies) for the scale of culverts within the Ō2NL Project.

(d) In paragraphs 42 to 50, I discuss the issue of potentially high groundwater tables east of Levin in areas of proposed stormwater soakage facilities. In particular, I am concerned that prolonged high groundwater tables due to frequent succession of storm events will prevent emptying of the devices and also promote groundwater mounding on adjacent low-lying areas. The application does not provide the necessary detail/information for an informed

assessment to be made of this issue and the related risk to the environment. However, I consider the matter can be resolved through the detailed design process whereby a Stormwater Soakage Device Management Plan is developed for the project, and is required to undergo technical certification at least forty (40) working days prior to the commencement of construction activities by a stormwater engineer and a hydrogeologist.

(e) In paragraphs 51 to 52, I discuss construction effects on groundwater quality and how this can be avoided by ensuring that all runoff from the construction and adjacent areas is appropriately managed.

(f) In paragraphs 53 to 55, I discuss the potential for groundwater mounding on the upgradient side of the Ō2NL Project due to reduction in shallow aquifer permeability from sub-grade consolidation.

(g) In paragraphs 56 to 62, I discuss the potential impact on community groundwater supplies, which in all instances I consider to not be an issue.

(h) In paragraphs 63 to 66**,** I discuss the impacts on groundwater from proposed spoil and borrow areas, and the further information, investigation works and monitoring required to alleviate any unacceptable groundwater effects.

(i) In paragraphs 67 to 81, I discuss the potential for groundwater impacts due to reduction in stream baseflows due to surface water abstractions from streams and rivers. I do not anticipate a take of up to 10% of flow at the point of abstraction would create a measurable downstream impact.

18. With a widespread linear project of this nature, it is impossible to quantify the potential effects with a high degree of precision across the entire area. There will always remain an element of uncertainty and site-specific issues

will arise during construction. In my opinion, the activities that have the greatest potential to cause environmental effects have all been identified and considered by Waka Kotahi, with the exception of dewatering timeframes for culverts and the spoil and borrow areas. The development of management plans by Waka Kotahi, to be certified by the regional councils, coupled with monitoring and reporting requirements, will provide assurance that the effects on groundwater can be appropriately managed during both construction and operation of the Ō2NL Project.

E. SCOPE OF REPORT

19. My report focuses only on issues related to hydrogeology and groundwater. It covers the following topics:

    (a) The potential hydrogeology and groundwater effects arising from the construction and operation of the Ō2NL Project;

    (b) A review of the hydrogeology and groundwater assessment provided by Waka Kotahi, as the Applicant, including specific issues arising from:

        (i) Road cuts that intercept groundwater and potential impacts on wetlands or streams;

        (ii) Drawdown from dewatering to install Culvert 4 and Culvert 11;

        (iii) Abnormally high groundwater levels during the winter of 2022; and

        (iv) Groundwater levels in the soakage sites;

    (c) Proposed conditions; and

    (d) Submissions as they relate to hydrogeology and groundwater.

20. I have also reviewed and relied on the information provided by:

(a) McConchie, J, 2022. Ōtaki To North Of Levin Highway Project: Technical Assessment Groundwater: Hydrogeology & Groundwater. Prepared by Dr Jack McConchie on behalf of Waka Kotahi NZ Transport Agency, 18 October 2022.

(b) Stantec, 2022a. Ōtaki To North Levin Highway. Potential Alignment Cuts Below Groundwater. Reported prepared for SLR Consulting. 30 April 2022.

(c) Stantec, 2022b. Ōtaki To North Levin Highway. Groundwater Investigations Report. Reported prepared for Waka Kotahi. May 2022.

(d) Waka Kotahi, 2022a. Ōtaki to north of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991, dated 22 December 2022 (the "**Section 92 Response**").

(e) Waka Kotahi, 2022b. Ōtaki to north of Levin Highway Project – Volume II - Supporting Information And Assessment Of Effects On The Environment Appendix 5: Proposed Conditions.

F. BACKGROUND – HYDROLOGICAL AND GROUNDWATER OVERVIEW

21. Dr McConchie provides a hydrogeological overview of the Ō2NL Project setting within the application, which I agree with and summarise as follows:

(a) The Ō2NL Project will traverse several coalescing alluvial fans, formed by highly mobile rivers and streams of various sizes. The alluvium deposited by these rivers and streams ranges from coarse gravels to clay; depending on the size of the stream and the relative position to the swiftest flow part of the channel when the sediment was deposited. This complex mosaic of alluvium is further complicated by the mobile nature of the rivers and streams, potential

truncation of some stream channels by strike-slip motion on faults, fluctuating sea level, and changes in sediment supply from the headwaters.

(b) The alluvial sedimentary deposits host a groundwater system that contains both unconfined and confined aquifers.

(c) In general, the groundwater table mimics the topographic surface and ranges in depth from ground surface to greater than 20m below ground level (mBGL).

(d) Springs and some wetlands occur where the water table intersects the ground surface, especially towards the northern and southern ends of the Ō2NL Project.

(e) The deepest groundwater levels generally occur at locations east of Levin (near Tararua Rd).

(f) The highest groundwater levels range from 0.5m to 2mBGL in areas near Queen Street East (east of Levin), east of Manakau Township, and adjacent to Manakau Stream.

(g) Despite the complexity in depositional processes that have occurred over geological time, groundwater behaviours at different depths demonstrate an interconnected system.

22. On a project of linear nature over a significant length, where the proposed infrastructure intersects many varying and complex geological terrains, it is not always possible (or realistic) to investigate and quantify every aspect of the project site. Instead, exploratory investigation work is undertaken in various phases, to firstly inform the general hydrogeological understanding of the project, and secondly, to inform knowledge of the site-specific conditions in areas of greatest potential impact. Indeed, Dr McConchie's report refers to residual uncertainty around potential effects on groundwater

that will be reduced as further investigations are undertaken, additional data collected, and the design of the Ō2NL Project refined.[3]

23. I agree with Dr McConchie that residual uncertainty can be managed through a Groundwater Management Plan, coupled with a certification process of the final design.[4]

24. A key design principle of the project is that there will be only minor changes to the water balance of the areas surrounding the road. Dr McConchie places emphasis on the highway having negligible effect on the water balance of the area by effectively capturing any rainfall that would have infiltrated to groundwater within the road footprint, which will be diverted to ground soakage devices.[5] Dr McConchie describes the diversion process, which involves open swales, and storage and attenuation of run-off provided by the stormwater management devices. I agree with Dr McConchie that from an overall water balance perspective the proposed design will achieve hydrological neutrality in the main.

25. Potential effects on the groundwater system including temporary construction effects are described in the Assessment of Environmental Effects ("**AEE**") and in the technical reports I have referred to above. In my opinion, the technical reports, supplemented by information provided as part of the Section 92 Response, consider all the relevant potential effects of the proposed activities. However, there are aspects of the AEE which are constrained by the lack of detailed information. My approach to assessing this application involves focussing on the issues of greatest potential impact or uncertainty (outlined below), the proposed conditions, and any site-specific issues raised by submitters.

[3] At paragraphs 20, 33(f), 91, 141, 142, 178, 234-237, 281.
[4] At paragraph 234-237.
[5] At paragraphs 145-147.

26. In this case, the areas of greatest potential hydrogeological impact that I will address in my evidence relate to:

(a) Excavations that intersect and proceed below the groundwater table resulting in permanent dewatering in areas adjacent to natural wetlands (e.g. road cuts and gravel borrow areas);[6]

(b) Infrastructure that requires temporary dewatering to install (e.g. culverts, stormwater risers or soakage devices);

(c) Construction effects on groundwater quality;

(d) Areas that are subject to stormwater disposal via ground soakage, where there are naturally high groundwater tables;

(e) Relationship between surface water and groundwater quality, given the shallow nature of the groundwater in parts of the area;

(f) Spoil and borrow sites;

(g) Taking of surface water in streams with potential groundwater-surface water interaction; and

(h) Security of water quality in groundwater supplies for community and domestic purposes.

27. I note that I have had the ability to discuss the above issues with Waka Kotahi and their experts when they sought feedback prior to lodgement of the applications.

28. I discuss the key conclusions of the AEE and technical reports in relation to these effects, and my views on these, below.

[6] Noting that dewatering adjacent to a stream is not considered a significant potential effect because the dewatering discharge is returned to the stream within close proximity to the diversion.

G. REVIEW OF APPLICATION

29. The methodology adopted for assessment of groundwater effects is partially constrained by lack of the final highway design. However, Dr McConchie has provided a level assessment that is appropriate for the conceptual level understanding of the scale of works. As indicated above, residual uncertainty will prevail for a range of reasons even when the final design is produced, and therefore it is important to identify i) the key areas of uncertainty, ii) they key areas of potentially significant effects, and iii) the management responses to mitigating these effects.

Excavation Below the Groundwater Table

30. The general approach to managing groundwater effects from excavation below the groundwater table is outlined in Dr McConchie's technical assessment, which states:[7]

> Using the 'maximum likely groundwater level', it has been possible to design the Ō2NL Project to generally avoid, and where this has not been possible minimise, any direct interaction with the groundwater system. This has been achieved by constructing the highway at grade and above the maximum height of the water table, wherever practical. The few small areas where avoiding any potential interaction with groundwater has not been possible have been described and discussed previously.

31. Early versions of Dr McConchie's technical assessment and the Stantec (2022a) report indicated that the vertical alignment of the road would intersect groundwater adjacent to wetlands at six locations, as summarised in Table 3. One such location, using Site A as an example, is provided in Figure 1.

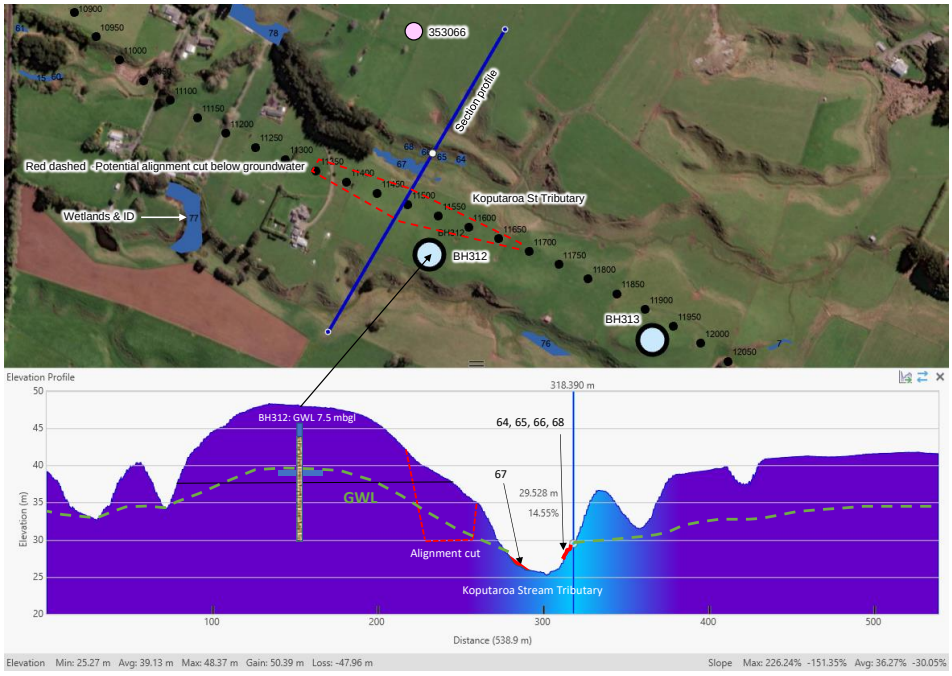
[7] At paragraph 149.

- **Table 1. Location of road cuts that intercept groundwater[8]**

Location	Site & Chainage
1	Site A (CH 11,350 – 11,650).
2	Site B (CH 20,450 – 20,800).
3	Site C (CH 26,600 – 27,250).
4	Site D (CH 28,950 – 29,200).
5	Site E (CH 31,750 – 31,850).
6	Site F (CH 33,400 – 33,600).

- **Figure 1. Example of road alignment cutting through groundwater table.**

Section 3.1. Site A (CH 11,350 – 11,650).



32. I am concerned that the quantification on the reduction in hillslope seepage rate in comparison to the natural flow to the wetland was not provided in Dr McConchie's technical assessment or the Stantec (2022a) report. Therefore, in my view, critical information required for an ecologist to make an assessment on the ecological effects to the wetland of reduced seepage is not available.

8 Dr McConchie, Table G.7.

33. However, I understand from Dr McConchie with reference to groundwater effects on wetlands, the following:[9]

> …effects that cannot be considered 'less than minor', then it has been assumed that the wetland will be lost. Its loss is compensated for within the offset package. Note that this is an extremely conservative assumption since in most cases, while the wetland might be impacted, it will not be lost.

34. This issue is discussed further in the report of Mr Lambie for Horizons and GWRC.

35. While neither Dr McConchie's evidence or the Stantec (2022a) report have been updated to address the above matter, the Section 92 Response, stated:[10]

> The highway is now essentially 'at grade' and the maximum groundwater levels at key locations has been assumed to be at the ground surface. This assumption is considered to be conservative and negates the need for additional Eigen modelling.

36. I took this to mean that the latest road alignment (as per the Consent Application Design) has no excavations. If this is the case, then I am satisfied that there will be no groundwater dewatering effects. I suggest a condition is imposed ensuring no excavations below the groundwater table occur, given its avoidance of effects. However, if excavation is to still occur in the locations identified in Table 3 or in other locations, monitoring of the cut areas and associated wetlands will be required. The draft conditions of consent relevant to groundwater (RGW1 to RGW3) should address excavation below the groundwater table, subject to my view that the Council certification process is the appropriate mechanism for ensuring the appropriateness of the monitoring locations in relation to these cut areas.

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9 Email dated 21 March 2023.

10 Waka Kotahi, 2022a. Ōtaki to North of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991, dated 22 December 2022 (the "Section 92 Response") at paragraph 64, page 24.

37. Furthermore, I recommend condition RGW2 be modified to ensure that there is no adverse change to wetlands from the construction activities authorised by the resource consents, and/or if this cannot be achieved, offset/compensated for within the offset package.

Infrastructure that Requires Temporary Dewatering

38. On review of the application I questioned the dewatering required to install Culvert 4 and Culvert 11, which are adjacent to identified wetlands EWG5 and EWG4. The predicted drawdown at these wetlands was specified in Technical Assessment G, Appendix H of Appendix G.1 at 0.8 m and 0.5 m, respectively.

39. The Section 92 Response included the following:[11]

> …since the culverts will likely be installed during summer, when seasonal groundwater levels are low, the need for and extent of any dewatering will be either avoided or minimised. Any dewatering will also be only for installation of the culverts and therefore will be of short duration.

40. Dr McConchie states in his technical assessment that:[12]

> Any dewatering will be of short duration, likely no more than a maximum of 1-2 months, and be of limited extent.

41. I am comfortable with this response and consider that the draft conditions of consent relevant to groundwater (RGW1 to RGW3) largely address this matter. In particular, RGW1 provides for the taking of groundwater for the purpose of dewatering only for the minimum time required to carry out the construction activities and, where practicable, for it to occur when groundwater is low. I recommend that this timeframe be limited to no more than 2 months per installation in condition RGW1 a) iii). I also recommend

[11] Waka Kotahi, 2022a. Ōtaki to North of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991, dated 22 December 2022 (the "Section 92 Response") at paragraph 62, page 23.

[12] At paragraph 231.

that condition RGW3 a) ii) be amended to ensure the groundwater sampling and reporting frequency is appropriate to the scale, intensity and duration of the works programme.

Stormwater Disposal via Ground Soakage

42. A key aspect for successful performance of a stormwater soakage to ground device is sub-surface conditions having capacity to take groundwater during periods of high groundwater levels. This issue became particularly relevant during the winter of 2022, which was one of the wettest on record and numerous groundwater related flooding in the Manawatū region occurred (e.g. Queen Stream East, Levin and Waitarere Rise).[13]

43. As a result, Waka Kotahi was requested to conduct additional Eigen modelling for each of the soakage sites including climate data through the 2022 winter to confirm the groundwater "headroom".[14] The Section 92 Response advised:[15]

> The concept design stormwater treatment devices have the capacity to store the entire volume of runoff and 'intrude' only a short distance below the existing ground level. Therefore, even if groundwater levels rise to the ground surface (being the most extreme scenario) the device will retain/contain all the runoff until conditions allow it to drain naturally.

44. I am not fully satisfied that this addresses my concerns. I remain concerned with multiple events occurring in quick succession such as what occurred during the Auckland floods of 27 January, 14 February (Cyclone Gabrielle) and 24 February. If groundwater levels remain high, ground conditions may not allow the soakage facilities to drain naturally between events.

[13] Prolonged pooling of water above the ground surface due to high groundwater tables.
[14] The Eigen Model is a site specific (local scale) groundwater level analytical model developed by the Waka Kotahi's consultants.
[15] Waka Kotahi, 2022a. Ōtaki to North of Levin Highway Project – Response to request for additional information pursuant to section 92 of the Resource Management Act 1991, dated 22 December 2022 (the "Section 92 Response") at paragraph 63, page 24.

45. This is recognised within the Waka Kotahi 'Stormwater Treatment Standard for State Highway Infrastructure' dated May 2010 (section 5.4.2.1), which provides that "*Having a high groundwater table can preclude the use of a number of practices*". Infiltration or soakage to groundwater is a key practice out of the identified practices that should not be undertaken in high groundwater table areas so as to avoid groundwater related flooding of adjacent properties.

46. In my opinion, the effects of groundwater mounding and consequent flooding of adjacent properties outside the designation area has not been considered adequately. However, I consider this can be managed through appropriate design and consent conditions.

47. With regard to design, the design needs to balance loading rates, with infiltration capacity, depth to groundwater, the hydraulic conductivity of the shallow aquifer and lateral distance to the nearest downgradient discharge point (surface water receptor). The design report should include reporting on these parameters from field testing / investigation, and the appropriateness for meeting the design intent should be certified by Council. These requirements should be explicitly addressed through a condition, including certification.

48. With regard to consent conditions, I suggest a new clause b) under the proposed condition RWS1:

> b) Stormwater management devices that involve soakage to ground, must be located in areas and operated in a manner that will not cause, or exacerbate, flooding outside of the designation during the typical wet weather conditions and in extreme events such as the 1% AEP design rainfall (increased to allow for the effects of climate change).

49. Proposed condition RSW2 requires as-built plans for all stormwater management devices to be provided to the Regional Councils and Project Iwi Partners within twelve months of the Ō2NL Project being open for public use. However, this provides no opportunity for the issue of high groundwater

table and groundwater mounding to be satisfactorily addressed with Horizons, GWRC and Project Iwi Partners during the design process. Hence, I suggest an additional condition:

> b) v. natural groundwater level in meters below ground level, where soakage to ground is practiced.

50. I recommend that a Stormwater Soakage Device Management Plan is also developed for the Ō2NL Project, and is required to undergo technical certification at least forty (40) working days prior to the commencement of construction activities by a stormwater engineer and a hydrogeologist. As a minimum any Stormwater Soakage Device Management Plan would need to include the following matters:

(a) Design Report including description of all devices, a map of their locations, and key groundwater parameters for soakage devices, such as:

(i) Design loading rate (m^3/s);

(ii) Depth to groundwater (m);

(iii) Soil infiltration rate (mm/hr); and

(iv) Shallow aquifer hydraulic conductivity (m/s).

(b) Monitoring Plan, designed to confirm that groundwater mounding and consequent flooding of properties outside the designation area during operation of the consent is not occurring.

Construction Effects on Groundwater Quality

51. Dr McConchie indicates that groundwater contamination effects will be avoided by ensuring that all runoff from the construction and adjacent areas:[16]

[16] At paragraph 227.

(a) is diverted away from any excavations;

(b) will be treated by a comprehensive system of erosion and sediment control measures outlined in the Construction and Environmental Monitoring Plan ("**CEMP**"); and

(c) will have sediment and any pathogens removed as it passes through the soil and unsaturated zone.

52. I agree with Dr McConchie that any residual risk of groundwater contamination from bulk earthworks on existing groundwater users, groundwater dependent ecosystems, lakes and streams will need to be verified as less than minor through the Project's ongoing groundwater monitoring programme and Groundwater Monitoring Plan.[17]

Subsurface Consolidation Impacts on Groundwater

53. Subsurface consolidation due to highway construction loading can lead to a rise in groundwater levels on the upgradient side of a highway where the highway is aligned perpendicular to the predominant groundwater flow direction. This can occur due to consolidation of compressible soils, which in turn reduce the permeability or hydraulic conductivity of the shallow aquifer sediments resulting in groundwater to rise.

54. I discussed the potential issue with Dr McConchie and he indicated that this was not considered a risk on the Ō2NL Project because of the nature of the geological materials being uncompressible sands and gravels, as opposed to peat, and highly plastic clays.

55. I am satisfied with this explanation, and subject to not encountering these materials within the sub-grade, I do not envisage groundwater rising due to consolidation to be an issue on the Ō2NL Project. However, if compressible soils were encountered and the highway loading rates suggested consolidation could occur, mitigation would be in the form of permeable

[17] At paragraph 234-237.

under drains to facilitate groundwater migration from the upgradient to downgradient side of the highway.

Community Groundwater Supply Bores

56. Dr McConchie has identified community groundwater supply bores that have some potential to be affected by the Ō2NL Project in his technical assessment.[18] These bores were identified on the basis that they are either located within the road designation or have recharge capture zones that cross or are close to the designation.[19] Table 3 summarises the key hydrogeological information of these bore schemes.

- **Table 2. Summary of community groundwater supply bore schemes.**

Region	Scheme	No. Bores	Bore Depths	Screen Depths	Aquifer Hydraulic Conductivity	Aquifer Type	Bore Distance from Designation
GWRC	Rangiuru Road, Otaki	1	35	23 – 35	8×10^{-3} m/s Extremely high	Unconfined to Semi-Confined	~3,500m
GWRC	Tasman Road, Otaki	2	35	20 - 27	9.33×10^{-3} m/s Extremely high	Unconfined to Semi-Confined	~3,900m
HRC	Glenmorgan Water Supply Scheme	1	unknown	unknown	unknown	Unknown	<100m
HRC	Tatum Park Holiday Conference Centre	2	unknown	Unknown	unknown	unknown	~700m

57. The capture zone for the Rangiuru Road bore does not intersect with the Ō2NL Project and I agree with Dr McConchie that this bore will not be affected by the Ō2NL Project.

[18] At paragraphs 84 and 85.
[19] Capture zones are the total source area on the ground surface where water may potentially travel from the land surface to a groundwater bore.

58. The capture zone for the Tasman Road bores passes through the southern end of the Project designation. However, as indicated in Table 3, the distance downstream to the bores is approximately 3,500m. Protection zone maps, presented in Toews (2017),[20] indicate that the time required for water to travel through the aquifer from the Ō2NL Project designation to the bore is between 2 and 5 years. In addition, Toews (2017) states that "*Groundwater flow to the Otaki bores is relatively slow, taking more than 1-year for groundwater to travel from the water table to reach the well screens.*"

59. Given the significant distance downstream, the long travel times, and the highly permeable nature of the aquifer, which means flushing rates will be high, I do not anticipate any water quantity or quality impact of the Ō2NL Project on these bores, subject to the Ō2NL Project maintaining groundwater throughflow perpendicular to the Ō2NL Project alignment.

60. The qualifier in the previous paragraph was addressed in paragraphs 5355-55 above and I am comfortable that the groundwater throughflow beneath the project footprint will be maintained on the basis of Dr McConchie's advice. However, this should be reinforced through a consent condition requiring mitigation if compressible soils were encountered and the highway loading rates suggested consolidation could occur during construction.

61. The Glenmorgan Water Supply Scheme resides within the designation of the Ō2NL Project. This water supply will need replacement if it is going to continue to be required. It is not clear whether it will be required going forward, and this should be confirmed by Waka Kotahi.

62. The Ō2NL Project passes through the inferred groundwater capture zone of two bores from the Tatum Park Holiday Conference Centre, which are both located approximately 700m west (downgradient) of the Ō2NL Project. Given the distance and the nature of the Ō2NL Project, which is designed

[20] Toews, M.W., 2017. Groundwater protection zones for community drinking water supply wells in the Wellington Region. GNS Science Consultancy Report 2017/190. November 2017.

for hydrological neutrality and has suitable stormwater management to protect surface and groundwater water quality, I do not consider the holiday park is likely be affected by the Ō2NL Project.

Spoil and Gravel Borrow Sites

63. The Ō2NL Project has shortlisted four sites as potential quarries for gravel and spoil disposal. The information provided on these sites is at a conceptual level and it is therefore impossible to be overly definitive about potential groundwater and other effects.

64. However, it is fair to say that the selection criteria used in the shortlisting process sought to minimise potential environmental and cultural effects.[21]

65. Of all aspect of the Ō2NL Project I have reviewed, this aspect is considered to have the greatest uncertainty, simply because of the lack of design detail available at the time I reviewed the documents. Dr McConchie acknowledges this uncertainty:[22]

> It is recommended that, prior to the finalisation of design, construction, and rehabilitation plans, piezometers be installed in the immediate vicinity of the proposed borrow pit. This would allow the depth to groundwater and seasonal groundwater dynamics to be defined more accurately. The resulting bore logs would also allow the characteristics of the material beneath the site to be assessed more accurately.
>
> This information would also be critical to the design and effectiveness of any rehabilitation of the site, particularly if the desire is to create a 'legacy' by constructing a wetland and associated habitat.

66. To address this uncertainty, further information should be provided as to these sites, and their effects, and/or at the very least, I recommend a

[21] At paragraph 239.
[22] At paragraph 257-258.

detailed Council certification process is required with respect to the design detail and proposed monitoring of these sites.

Groundwater-Surface Water Interaction Related to Surface Water Takes

67. Waka Kotahi are proposing several surface water takes in the GWRC and Horizons regions to support construction of the Ō2NL Project, with the total abstraction across the sites not exceeding 3,950 m^3/day, with an average of 2,160 m^3/day[23] (Table 3). I have considered the potential for groundwater impacts due to the reduction in stream baseflows only. Ms Stout (Horizons) and Mr Thompson (GWRC) consider the effects of the water takes, and Mr Brown (Horizons and GWRC) addresses ecological matters.

68. The key premise of the proposed surface water take regimes is as follows:

    (a) all takes cease at the river's minimum flow level; and

    (b) the maximum rate of take is 10% of the flow (above the minimum).

69. This approach is consistent with the default provisions for water allocation in both the GWRC Proposed Natural Resources Plan and the Horizons One Plan.

- **Table 3. Summary of proposed surface water takes.**

Take Name	Region	Location		Rate of Take (L/s)		Minimum Flow (L/s)
		Easting	Northing	> Median Flow Take	Low Flow Take (Core Allocation)	
Waitohu Stream	GWRC			-	14 to 50 (Up to 10% of the flow)	140

[23] McConchie, J., 2023. Memorandum entitled "Effect of proposed abstraction of construction water from Waitohu Stream". 26 January 2023 Ref: 720.30017.00000 O2NL Waitohu Abstraction FINAL.docx.

Take Name	Region	Location		Rate of Take (L/s)		Minimum Flow (L/s)
		Easting	Northing	> Median Flow Take	Low Flow Take (Core Allocation)	
Ohau River	HRC	Site 1: 1788423 Site 2: 1788517	Site 1: 5491924 Site 2: 5491934	Maximum rate of 10% of mean daily flow.	-	4,150
Waikawa River	HRC	Site 1: 1788423 Site 2: 1788517	Site 1: 5491924 Site 2: 5491934	Maximum rate of 10% of mean daily flow, or 70 L/s (whichever is less).	2,998 m^3/day	220
Manaukau and Waiauti Streams	HRC	Waiauti: 1786592 Manakau: 1786722	Waiauti: 5488680 Manakau: 5488791	Maximum combined rate of 10% of mean daily flow, up to a maximum of 6 L/s, and the rate of take from each point is at most 5% of the actual flow measured at the Manakau SH1 Flow recorder.	(Up to a max. of 102 m^3/day combined)	40
Koputaroa Stream	HRC	1796997	5501473	Maximum rate of 10% of mean daily flow, up to a maximum of 6 L/s (whichever is less).	1.3 to 2.67 (Up to a max. of 231 m^3/day)	13

Waitohu Stream Take

70. *Low Flow Take (Core Allocation):* Waka Kotahi is proposing to take water when flow is above the minimum flow cut-off of 140 L/s, up to a maximum of 10% of the flow. Mr Thompson addresses the water take in detail in his section 87F report. I understand from Mr Thompson's report that flow in the river ceases downstream of the proposed take point due to losses to shallow groundwater during times when flow at the upstream gauging site is less

than 100 L/s.[24] Waka Kotahi is therefore not proposing to take any water during the times when the stream naturally goes dry, or close to it.

71. *>Median Flow Take:* Waka Kotahi is proposing to take up to 10% of the flow during periods of above median flow. In my opinion, a take of this proportion of river flow during moderate to high flow periods, is unlikely to change the flow dynamics in the river downstream. This is because:

    (a) It is only a small proportion of the flow in the river; and

    (b) Measurement error (8%) would mean it would be difficult to detect any change during exercising of the take.

Ōhau River Take

72. *Low Flow Take (Core Allocation):* Waka Kotahi is not proposing to take when flow in the river is below the median flow. This is due to there being no core allocation available and is pragmatic given the river flow downstream of the take location reduces severely due to losses to groundwater during low flow periods.

73. *>Median Flow Take:* Waka Kotahi is proposing to take up to 10% of the flow during periods of above median flow. A water take of this nature is unlikely to change the flow dynamics in the river downstream, because of the same reasons stated in paragraph 71 and 74. Further, during periods of above-median flow, the Ōhau River typically gains flow with distance downstream from the proposed take.[25]

74. It is not surprising that flow gains occur downstream during essentially normal to wet conditions (as opposed to losing during dry conditions). This is because groundwater levels in the shallow aquifer will be recharged (normal to high) and therefore there is not a strong hydraulic gradient between the riverbed and the shallow aquifer with which to drive the flow of

[24] At paragraph 64(a).

[25] On average 114% of the flow recorded at the Rogomatane flow recorder (upstream gauge) is recorded concurrently at the Haines Ford (downstream gauge), with a range from 97% to 128%.

river water into the aquifer i.e. the path of least resistance is for the water in the river to continue flowing downstream.

Waikawa River Take

75. *Low Flow Take (Core Allocation):* Waka Kotahi is proposing to take up to 10% of the minimum flow cut-off and a maximum of 70 L/s, whichever is less. The Waikawa Stream is known to lose a considerable proportion of its stream flow to groundwater in the reaches below SH1, particularly during periods of low flow. However, a take of up to 10% of the flow in the river, particularly one as big as the Waikawa, is unlikely to be measurable.

76. >*Median Flow Take:* Waka Kotahi have applied to take the supplementary allocation at a rate of up to 10% of the mean daily flow on the preceding day when flow in the Waikawa Stream [measured at the Waikawa at North Manakau Road flow recorder] is above median. For the same reasons as outlined in paragraph 71 and 74, I have no concerns with any groundwater effects at this level of take.

Manakau & Waiauti River Take

77. Waka Kotahi is proposing to abstract up to a maximum of 102 m^3/day from either the Manakau OR Waiauti Stream (both tributaries of the Manakau River) as the designation for the Ō2NL Project passes through both catchments. 102 m^3/day relates to a constant flow rate of only 1.2 L/s, but the maximum instantaneous rate of 6 L/s is being sought, which implies that the daily volume would be supplied in 4.75 hours of pumping. As with the other takes, both the core allocation and above median flow takes are proposed to be capped at 10% of the flow in the river, or the daily volume south, whichever is the lesser amount.

78. Given the similar geomorphological settings of the Manukau and Waitauti Streams to the Waikawa and Ōhau, I expect there to be similar responses

in the Manukau and Waitautio Streams and accordingly the take should be managed in a similar manner. A report by PDP[26] report indicates:[27]

> ...the effects of the Ōhau River and other streams such as the Waikawa and Manakau are evident in the shapes of the [groundwater] contours, which is a result of the seepage from, and groundwater discharge to, those surface waterways.

I infer this to mean losses during low flow periods and slight gains during higher flow periods.

79. Similar to the other alpine sourced river, I do not consider the downgradient effects on groundwater will be measurable as a result of this take.

Koputaroa Stream Take

80. This Koputaroa Stream is quite different to the others in that it is a foothills stream rather than derived from deep within the ranges themselves, and the stream alignment has formed as a result of geological folding within a syncline. Given the stream resides in a syncline, it is likely the stream gains groundwater along its reach due to higher ground on the valley sides. I would therefore expect this to be a more conventional stream than the rivers debouching from the ranges onto alluvial gravel fans and losing water thereafter. However, I have not seen any gauging data to support this conceptual understanding.

81. Nevertheless, the proposed take is still only a small proportion (a maximum of 10%) of flow and like the other rivers, I do not anticipate any measurable impact on downgradient groundwater resources.

H. SUBMISSIONS

Submission 8: Wendy McAlister and Dion Miles

[26] Pattle Delamore Partners, 2021. Lake Horowhenua Groundwater Model. Consultancy report prepared for Horizons Regional Council.

[27] At page 35.

82. Ms McAlister and Mr Miles oppose all resource consents and NORs sought by Waka Kotahi. Of relevance to this review, Ms McAlister has concerns about effects on their bore water.

83. Their property is located immediately adjacent to one of the main off-ramp interchanges and they have a bore registered in the Council bore database. The bore is presumably being used for water for domestic purposes[28] because there is no permit to take groundwater.

84. My understanding is that the bore is shallow and installed within a high permeability sand and gravel aquifer, which would make it highly susceptible to any surficial influences including machinery vibration induced changes in groundwater quality related to mobilisation of iron and clay colloids in the aquifer.

85. In this regard, the potential effects of the Ō2NL Project on this submitter are considered construction related only and temporary, because operation of the new highway is unlikely to alter the groundwater quantity or quality of groundwater in the long term. However, although temporary, during construction the risk of effects on the bore is considered high.

86. Given the high construction risk (temporary), I recommend that Waka Kotahi as a minimum undertake the following:

    (a) Verify the existence, structural integrity and functionality of the bore; and

    (b) If verified as operational and fit for the current purpose, supplement the property owner's groundwater supply until such time as the construction ceases and any construction effects have passed.

Submission 56: Merie Cannon and Trevor Guy

87. Ms. Cannon and Mr. Guy are concerned about adverse effects on the water bore on their property due to the Ō2NL Project's construction. My

[28] Under s14(3)(b), RMA.

understanding is that their property is located on the eastern upgradient side of the Ō2NL Project.

88. I am not certain where the relevant bore is exactly located, but given the property's close proximity to the Ō2NL Project, I recommend Waka Kotahi undertakes the verification work outlined above in response to submission 8.

Submission 71: Sarah Hodge

89. Ms Hodge has concerns that there will be impacts on their bore, which they rely upon for their commercial plant nursery.

90. The Project alignment is approximately 300m to the east of the property and according to Dr McConchie is at grade in this location. The implication of this is that no dewatering of groundwater is required, and stormwater management will only enhance groundwater quantities. On this basis, I do not anticipate any groundwater quality effects to be realised given the stormwater controls proposed as part of the Ō2NL Project.

Submission 75: Chris Corke

91. Mr Corke's submission indicates he 'generally agrees' with the application but has concerns about effects on their bore.

92. In my opinion, Mr Corke's bore would not be affected by the Ō2NL Project. The alignment is at least 650m to the northeast of his property near the northern end of the Ō2NL Project area, and in this location groundwater is flowing away from the bore because a local groundwater divide resides between Mr Corke's bore and the Ō2NL Project.

I. CONDITIONS

93. I have made a number of recommendations in the body of this report for consent conditions. These relate to excavation below the groundwater table; groundwater dewatering; stormwater disposal; design and

certification of spoil and gravel borrow sites; and management of effects on neighbouring bores.

J. DISCUSSION AND CONCLUSION

94. The assessment of hydrogeology and groundwater effects is conceptually sound and supported with field investigations and testing. In some instances it would have been preferable to have more site-specific data. However, I understand property access has been a major constraint for Waka Kotahi and in the end the data set provided was appropriate for a high level effects assessment. Without more specific data, however, conditions have been recommended to ensure further scrutiny at the design stage.

95. The key hydrogeological principal that has been adhered to in the design is maintaining the water balance or hydrological neutrality, which I consider will be achieved given the design has been tailored to suit the ground and groundwater conditions. Key features of this approach are maintaining the highways vertical alignment at grade to avoid dewatering, and stormwater management via a system of swales, retention and soakage ponds. The latter will maintain groundwater quantity and quality if constructed in appropriate locations.

96. In my opinion, if the Ō2NL Project proceeds in general accordance with the design and management plans, along with the strengthened conditions, the Ō2NL Project should result in hydrogeological neutrality with respect to groundwater quantity and quality.

Jonathan Williamson

28 April 2023