NORTHLAND REGIONAL COUNCIL

HEARINGS COMMITTEE AGENDA

APPLICANT:	Aupouri Aquifer Water User Group – 24 Resource consent applications for groundwater takes from the Aupouri Aquifer for horticultural irrigation
APPLICATION NO.:	REQ.596300
HEARING COMMENCEMENT:	9.30 am, Monday, 31 August 2020
VENUE:	Te Ahu Centre, Mathews Avenue, Kaitaia.
COMMITTEE:	David Hill (Chair) Peter Callander

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SUBMISSIONS

Copies of all submissions have been provided to the Hearings Committee under separate cover.

NOTE:

All pre-circulated material, including the agenda and written submissions, is taken as read at the hearing.

NORTHLAND REGIONAL COUNCIL
HEARING PROCEDURES

PRIOR TO THE HEARING

(1) The receipt of this hearing agenda does not preclude the possible resolution of any issues that were unresolved at any pre-hearing meeting before the date of the hearing. Discussions between Council staff, the applicant, and any person who made a submission may still take place, with a view to resolution or clarification of any outstanding issues.

(2) Any outcomes of any pre-hearing meetings will be reported to the Hearings Committee in staff reports.

EVIDENCE

If you intend to, at the hearing, read any additional evidence that expands on your evidence already provided to the Committee with the hearing agenda, please provide at least ten copies for circulation amongst those present at the hearing. It is normal for pre-circulated evidence to be taken as read at the hearing. No new submissions will be accepted at the hearing.

THE HEARING

(1) The Chairperson opens the proceedings by introducing the Committee and asking the parties to introduce themselves and their witnesses. The hearing procedure is to be as informal as possible but must, where appropriate, recognise tikanga Māori.

(2) The Council's officer may be asked by the Chairperson to briefly outline the application, describe the area and provide any other background information considered essential at this stage.

(3) The Council officer's report and recommendation is to be taken as read, but the officer may give additional verbal or written comments arising from earlier responses to the circulated hearing agenda.

(4) Applicants expand on their application material and produce any evidence not pre-circulated, adding any comments on the officer's verbal statements.

(5) Submittors expand on their pre-circulated submissions and produce any evidence not pre-circulated, adding any comments on the previous statements by the applicant or by the Council's officer.

(6) Normally only Committee members may question (through the chair) any of the parties to the application. **Any question** (as opposed to comments) **by any party shall be in writing** and given to the Chairperson for consideration as to whether it shall be put to any party. No cross examination will be allowed.

(7) Prior to the applicant exercising a right of reply, the Council's officer shall answer questions raised in material presented by the applicant and the submittors, and shall state any changes to his or her original recommendation.

(8) The applicant exercises a right of reply, taking the opportunity to cover matters raised by the Council's officer and submittors.

(9) The Chairperson will then either close or adjourn the hearing and then:

- If the hearing is closed, the decision will be notified to the applicant and the submitters within 15 working days or such extended time as may be determined under Section 37 of the Act.
- If the hearing is adjourned the reasons for the adjournment will be given (eg. further information required, the applicant's Right of Reply yet to be given etc) together with the length of time of the adjournment. Note that if the hearing is adjourned after the applicant's right of reply has been exercised, the hearing must be concluded within 10 working days after the right of reply has been exercised. At the end of the adjournment, the hearing will be concluded and the decision will be notified to the applicant and the submitters within 15 working days of the date of conclusion or such extended time as may be determined under Section 37 of the Act.
- The hearing will be recorded for quality assurance purposes only (a sound file copy of the recording may be obtained from the Hearings Administrator).

NORTHLAND REGIONAL COUNCIL STAFF REPORT

APPLICATION NO.:	REQ.596300.01.01	
REPORT BY:	Stephanie Kane Consultant Planner	
SUB APPLICATION NOS.:	**APP.039859.01.01**	Te Aupōuri Commercial Development Limited
	APP.040601.01.01	Waikopu Avocados Limited
	APP.017428.02.01	Henderson Bay Avocados Limited
	APP.040600.01.01	Far North Avocados Limited
	APP.041211.01.01	P McLaughlin
	APP.040121.01.01	N E Evans Trust & W J Evans & J Evans
	APP.040231.01.01	P & G Enterprises (P J & G W Marchant)
	APP.039644.01.01	M P Doody & D M Wedding
	APP.040397.01.01	A Matthews
	APP.040652.01.01	S E & L A Blucher
	APP.040919.01.01	N A Bryan Estate, S G Bryan, C L Bryan, K Y Bryan Valadares & D Bryan (Property No 1)
	APP.040979.01.01	M V Evans (Property No 2)
	APP.040558.01.01	M V Evans (Property No 1)
	APP.040130.01.01	Tuscany Valley Avocados Limited (M Bellette)
	APP.040918.01.01	N A Bryan Estate, S G Bryan, C L Bryan, K Y Bryan Valadares & D Bryan (Property No 2)
	APP.008647.01.06	Avokaha Limited (C/– K Paterson & A Nicholson)
	APP.039628.01.04	KSL Limited (C/– S Shine)
	APP.040361.01.01	Tiri Avocados Limited
	APP.040362.01.01	Valic NZ Limited
	APP.040363.01.01	Wataview Orchards (Green Charteris Family Trust)
	APP.039841.01.02	Mate Yelavich & Co Limited
	APP.040368.01.01	Robert Paul Campbell Trust

APP.040364.01.01	Elbury Holdings Limited (C/– K J & F G King)
APP.020995.01.04	Te Rarawa Farming Limited and Te Make Farms Limited

NATURE OF ACTIVITY: Groundwater abstraction.

LOCATION OF TAKES: Refer to Table 1 of *AAWUG Application – Technical Comments Report* included at Attachment 5

LOCALITY:

DURATION OF CONSENT SOUGHT:

APP.039859.01.01 – 20 years
APP.040231.01.01 – not stated
APP.020995.01.04 – 25 years

All other applications seek consent for a duration of 30 years

RELEVANT STATUTORY PLANNING INSTRUMENTS:

- National Policy Statement for Freshwater Management (NPS)
- New Zealand Coastal Policy Statement (NZCPS)
- Regional Policy Statement for Northland (RPS)
- Proposed Regional Plan for Northland (pRPN)
- Operative Regional Water and Soil Plan for Northland (RSWP)
- Resource Management Act 1991 (RMA)

ACTIVITY CLASSIFICATION: Discretionary activity for groundwater take and use (Rule C.5.1.12 of the pRPN and formerly Rule 25.03.01 of the RWSP).

ATTACHMENTS:

- **Attachment 1** – Proposed draft conditions of consent.
- **Attachment 2** – Proposed draft Groundwater Monitoring and Contingency Plans.
- **Attachment 3** – NRC Section 95 Notification Determination Report.
- **Attachment 4** – Technical Review of Groundwater Assessment.
- **Attachment 5** – AAWUG Application – Technical Comments.
- **Attachment 6** – Relevant objectives and policies.

1. INTRODUCTION

1.1 Overview

1. During the period between February 2018 and August 2019, the Northland Regional Council (NRC) received 24 applications for new groundwater takes from the deep shell bed of the Aupōuri Peninsula to service proposed avocado orchards and horticultural/cropping activities at multiple locations.

2. A numerical groundwater model for the Aupōuri Aquifer was developed by Williamson Water and Land Advisory (WWLA) and completed in October 2018. The model informed a number of the assessments for applications that were lodged after its completion.

3. After reviewing the information provided to support the individual applications, the NRC requested further information from the applicants under Section 92(1) of the RMA in order to adequately assess the effects of the proposed abstraction. An addendum to several of the Assessment of Effects on the Environment (AEE) reports prepared for a number of the applicants[1] was provided by WWLA in April 2019, noting that the Aupōuri Aquifer groundwater model has been used as the basis for effects analyses from the Section 92 response for Te Raite Station (November 2018) onward.

4. Separate responses to the request for further information were provided for two applications. WWLA and WSP Opus provided responses in relation to APP.039589.01.01 – Te Aupōuri Commercial Development Limited (November 2018 and February 2019, respectively), and WWLA provided a response in relation to APP.040364.01.01 – Elbury Holdings Limited (August 2019).

5. A LIDAR survey commissioned by NRC in 2019 resulted in an adjustment of the model to accurately levels of NRC monitoring bores used. The model was then calibrated and re-run in February 2020 to assess groundwater conditions and effects for current pumping demand, pumping demand including all proposed takes, and a naturalised no-pumping scenario. WWLA provided an updated Groundwater Model Development Report and AEE report for all applicants that includes the revised modelling results in February 2020.

6. Lands and Survey Limited was engaged by NRC to review the applications and prepare a report on the proposed takes, in accordance with Section 42A of the RMA. Brydon Hughes of Land Water People was engaged by NRC to provide a technical review of the Aupōuri Aquifer Groundwater Model and relevant technical aspects of the application documentation. This report is informed by conclusions drawn by Mr Hughes, and has been prepared to assist the Commissioners in considering the applications for groundwater abstraction.

1.2 Water Volumes Sought

7. The water volumes sought in the applications for groundwater abstraction are as set out in Table 1 below.

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[1] WWLA is providing technical groundwater services to 23 of the 24 applicants

8. The applications submitted by Waikopu Avocados Limited, Henderson Bay Avocados Limited, Avokaha Limited, KSL Limited, and Te Rarawa Farming Limited and Te Make Farms Limited are for increased volumes from existing consented takes. The volumes listed in Table 1 reflect the increase in volume sought above that already consented for these parties. It is noted than any consents for these parties, if granted, will reflect the total volume of take authorised, including the volumes already consented. Whilst the figures in Table 1 and the assessments provided by WWLA as part of the applications only address the proposed increase above the existing takes, the volume already consented has been considered as part of the existing environment in the modelling and analysis of effects.

9. Following lodgement of the initial application documentation, the application by Te Aupōuri Commercial Development Limited was amended to include revised take volumes from three allocation zones within the Aupōuri Aquifer. Whilst the overall annual volume of water sought remains unchanged, the location and volume of the individual takes sought have been altered to focus most of the irrigation development to the south of the station for efficiency.

Table 1: Groundwater Abstraction Volumes Sought

Application number	Applicant	Daily volume (m^3/day)	Annual volume (m^3/year)	Aquifer sub-area
APP.040601.01.01*	Waikopu Avocados Limited	736	83,360	Waihopo
APP.017428.02.01*	Henderson Bay Avocados	178	19,000	Waihopo
APP.040600.01.01	Far North Avocados Limited	240	32,000	Waihopo
APP.041211.01.01	P McGlaughlin	700	78,400	Waihopo
APP.039859.01.01	Te Aupōuri Commercial Development Limited	10,400	1,170,000	Waihopo/ Houhora/Other
APP.040121.01.01	N E Evans Trust & W J Evans & J Evans	1,675	160,000	Houhora
APP.040231.01.01	P&G Enterprises (P J & G W Marchant)	350	28,000	Houhora
APP.039644.01.01	M P Doody & D M Wedding	2,375	304,000	Houhora
APP.040397.01.01	A Matthews	95	12,000	Houhora
APP.040652.01.01	S E & L A Blucher	720	96,000	Houhora
APP.040919.01.01	N A Bryan Estate, S G Bryan, C L Bryan, K Y Bryan, Valdares and D Bryan (Property 1)	500	80,000	Houhora
APP.040558.01.01	M V Evans (Property 1)	1,675	126,000	Houhora
APP.040979.01.01	M V Evans (Property 2)	350	36,400	Houhora
APP.040130.01.01	Tuscany Valley Avocados Limited	375	36,000	Motutangi
APP.040918.01.01	N A Bryan Estate, S G Bryan, C L Bryan, K Y Bryan, Valadares & D Bryan (Property 2)	1,000	160,000	Motutangi
APP.008647.01.06*	Avokaha Limited	70	4,800	Motutangi
APP.039628.01.02*	KSL Limited	90	3,600	Motutangi
APP.040361.01.01	Tiri Avocados Limited	3,876	581,250	Paparore
APP.040362.01.01	Valic NZ Limited	1,158	173,700	Paparore

Application number	Applicant	Daily volume (m^3/day)	Annual volume (m^3/year)	Aquifer sub-area
APP.040363.01.01	Green Charteris Family Trust	225	33,750	Paparore
APP.039841.01.02	Mate Yelavitch & Co Limited	450	52,000	Other
APP.040386.01.01	Robert Paul Campbell Trust	3,350	360,000	Other
APP.040364.01.01	Elbury Holdings Limited	1,875	200,000	Sweetwater
APP.020995.01.04*	Te Rarawa Farming Limited and Te Make Farms Limited	10,705	776,000	Sweetwater
	Cumulative Total	**43,168**	**4,606,260**	

Note: ** denotes applications seeking an increased volume for existing consented takes*

10. The applications for increased takes lodged by Waikopu Avocados Limited, Henderson Bay Avocados Limited, Avokaha Limited, and Te Rarawa Farming Limited and Te Make Farms Limited have been lodged as new applications for water permits. However, in the event that the applications are granted, any additional allocation will be added to the existing (or replacement) consent, which will reference the total allocation authorised for the Consent Holder, not only the net increase sought and assessed as part of the AAWUG consent applications.

2. SITE DESCRIPTION

2.1 Environmental Setting

11. The Aupōuri Aquifer covers a land area of approximately 75,000 hectares extending along the length of Te Oneroa-a-Tohe/Ninety Mile Beach on the west coast, and from Kōkōta (The Sandspit) to Waimanoni on the east coast. It also includes the low-lying land between Waimanoni and Ahipara.

12. The landform of the Aupōuri Peninsula comprises a relatively thick sequence of sedimentary deposits largely comprising sand, silt and organic materials which have formed as a tombolo (essentially a sand bar accumulated due to wave and current action) connecting outcrops of basement rocks at either end of Te Oneroa-a-Tohe/Ninety Mile Beach.

13. The subsurface geology of the area consists of Pleistocene and Holocene unconsolidated sedimentary materials deposited in beach and dune environments (abandoned shorelines and marine terraces) and associated alluvial, intertidal estuarine, shallow marine, lakebed and wetland environments. These deposits overlie Cretaceous basement rocks of the Mount Camel Terrain, which typically comprises hard grey to dark green/black igneous rocks described in Isaac (1996)[2] as intercalated basalt and basaltic andesite lava, pillow lava, rhyolitic tuff, tuff-breccia, conglomerate, and sedimentary sandstone and mudstone.

[2] Isaac, M.J. (compiler), 1996: *Geology of the Kaitāia area*. Institute of Geological & Nuclear Sciences 1:250 000 geological map 1. 1 sheet + 43 p. Lower Hutt, New Zealand. GNS Science.

14. The unconsolidated sedimentary deposits of the Aupōuri Peninsula host a spatially extensive aquifer system. As described in the AEE, the sedimentary deposits can be broadly classified into two primary hydrostratigraphic units:

- The upper unit comprising 40 to 120 metres of fine-grained sands, interspersed with sporadic iron pan, peat, lignite, silt, gravel and shellbeds. With distance inland from the coast, the sand deposits become progressively older and exhibit a higher degree of compaction and weathering compared to younger foredune sands at the coast. These shallow, fine sand dominated deposits host a low yielding unconfined aquifer.
- In many areas, the lower 5 to 30 metres of the sedimentary sequence (overlying the basement rocks) comprises fine to medium sand containing a high percentage of relatively coarse shell fragments. These deposits are commonly referred to as 'shellbeds' and exhibit significantly higher permeability than the overlying sands so are typically the target for larger scale groundwater development.

15. While there is no well-defined, laterally continuous confining layer that separates the two units, the occurrence of numerous, low-permeability layers within the sand deposits (e.g., iron pan, brown (organic) sand, silt and peat) that vary in depth and thickness, collectively provide a degree of confinement to the shellbed aquifer. As a result, the shellbed is best characterised as a semi-confined aquifer that exhibits varying degrees of hydraulic connection to the overlying sand deposits depending on the local geological setting (e.g. depth and lateral continuity of low permeability layers within the sand deposits at a local scale). The structure of the underlying geology and the degree of interconnection between the two units is important to understand in considering the ways in which taking from one may affect the other.

16. Groundwater underlying the Aupōuri Aquifer is recharged by infiltration of rainfall through the surficial sand deposits. Localised perched water tables (and associated dune lakes and wetlands) occur in areas where infiltration is impeded by the accumulation of fine-grained sediments (typically silt or organic-rich sediments deposited in interdune areas) or the formation of laterally continuous iron-pan. The rate of recharge may also be significantly influenced by overlying landcover, particular plantation forestry which reduces recharge due to canopy interception.

17. The water table is mounded under areas of higher dunes along the central axis of the Aupōuri Peninsula. Groundwater flow is interpreted to occur perpendicular to this flow divide toward the east and western coastlines respectively[3]. The overall hydraulic gradient is determined by the elevation difference between the water table along the axis of the peninsula and sea level along the coastal margin. As a result, areas such as Kaimaumau which extend laterally some distance from the central axis exhibit a low hydraulic gradient toward the eastern coastline.

[3] HydroGeo Solutions, 2000; *Aupōuri Aquifer Sustainable Yield Groundwater Modelling Study*. Report prepared for Northland Regional Council.

18. Current evidence indicates that surface flows, wetlands and dune lake across the inland parts of the peninsula are maintained through discharge from perched water tables rather than by discharge from the regional groundwater system. However, the relationship between the groundwater system and wetland levels and surface discharges in low-lying coastal areas is not particularly well understood, and there may be local-scale nuances that could potentially result in local-scale effects due to changes in the underlying aquifer layers.

19. The Aupōuri Aquifer is divided into ten different sub-areas for the purposes of water quantity management, each of which has its own allocation limit prescribed in the pRPN.

3. SUBMISSIONS

3.1 Introduction

20. The application was notified on a limited basis to all property owners and occupiers in the modelled area of effects. However, only persons who have an existing groundwater or surface water take within the extent of the Aupōuri Aquifer were able to make a valid submission. In making this determination, Council considered the effects on existing bore takes as follows:

Any variation in another person's bore, whether the requirement is to drill deeper to make a fully efficient bore or to lower the pump, incurs cost to that person. This additional cost is considered by council to be at least a minor adverse effect on that person.

In addition, the council's bore log database is neither accurate nor complete, and it is considered likely that there will be existing bores on properties throughout the aquifer that the council has no knowledge of. The effects on the owners of these bores cannot be determined as no details of the bores are known.

The same consideration is given to person who may take water from a surface water feature. While the adverse effects on the actual surface water feature may be no more than minor, there is no information on whether the adverse effect will be less than minor on a person who may take water from the surface water feature.

Council does not have a record of all permitted activity takes from groundwater or surface water, so it has determined that the applications will be limited notified to all property owners and occupiers in the modelled area of effects.[4]

21. Mandated Mana Whenua representatives and marae committees within the area of influence and the Department of Conservation were also notified. The Section 95 limited notification determination is included as Attachment 3 to this report.

[4] NRC Notification Decision Report, dated 29 August (included as Attachment 3 to this report).

22. The potential need for renotification of the application to identified parties has been considered in light of the changes made to the model and revisions to the effects assessments in February 2020. Whilst the updated assessment shows some changes in drawdown levels as a result of the proposed takes, the increases remain within the acceptable limits of available drawdown within bores, and the effects on surface water flows have not changed. It is important to note that the inaccuracies in the historical survey level data affected all groundwater takes within the model area, not just those proposed under these 24 applications. As such, it is reasonable to extrapolate that the predicted drawdown attributable to existing consented takes would have also increased in response to the new data.

23. The scope of the applications remains the same as lodged and provided to those parties identified for limited notification. It is my opinion that neither the magnitude, nature, nor extent of the actual and potential effects of the proposed groundwater takes has changed sufficiently to warrant renotification of identified potentially affected parties.

3.2 Potentially Affected Parties

24. Submissions were received from 113 potentially affected parties, comprising:

- The Department of Conservation;
- Mana Whenua, iwi and hapū representatives and groups:
  - Waiora Marae;
  - Ngāti Kurī Trust Board/Te Manawa o Ngāti Kurī; and
  - Mr Albert Burgoyne – Ngāti Kurī Taumatua Research Unit;
- Far North District Council; and
- 108 general submissions from property owners/occupiers, and water users, including the NZ Fire Service and Ministry of Education.

25. Of the 108 private submissions, six were neutral, two supported the application and 88 opposed the application. The remaining 12 submissions did not specify a position. A summary of the key issues raised in the private submissions is provided in Section 3.2 below.

3.2.1 Department of Conservation

26. The Department of Conservation was considered an affected party to the applications due to its statutory responsibility for land and waterbodies within the modelled area of effects, including dune lakes and the Kaimaumau wetland.

27. A submission was received from the Director-General of Conservation seeking that the applications be declined unless further clarity is provided around the actual or potential effects on significant waterbodies. The Director-General's specific concerns relate to areas of land administered by the Department of Conservation located over the Aupōuri Aquifer, and also land and waterbodies of important conservation value within the same area that are not managed by the Department of Conservation. The submission particularly identifies the Kaimaumau Wetland, Lake Rotokawau, Lake Ngapuka, Lake Ngāti, Lake Rotoroa and the Sweetwater dune lakes, along with High

or Outstanding Natural Character Areas, Outstanding Natural Features and Significant Ecological Areas identified in the Northland Regional Plan.

28. The basis of the Director-General's submission is that the assessment(s) provided do not adequately identify potential effects on the natural character and biodiversity of surface water bodies, and their significant or outstanding values, and therefore do not provide sufficient certainty that the adverse effects of the proposals will be no more than minor. Concern is also expressed about the number of individual takes and their location and proximity to the coast, which do not reflect the recommendations of the Te Hiku Advisory Water Board.

29. The Director-General supports conditions for the proposed water takes similar to those developed through the Environment Court for the consents sought by the Motutangi-Waiharara Water Users Group (MWUGG).

3.2.2 Mana Whenua

30. The Section 95 notification decision report (refer to Attachment 3) noted that the proposed water takes occur in areas covered by Settlement Acts for Te Aupōuri, Te Rarawa, Ngāi Takoto, Ngāti Kahu and Ngāti Kurī, and that multiple statutory acknowledgements exist in the modelled area of effects. These iwi groups were considered to be affected parties.

31. The application documentation was circulated to all iwi/hapū groups with a registered interest in the area where the proposed groundwater applications are located and all marae committee within the modelled area of effects.

32. A submission was received from Waiora Marae opposing the application on the grounds that the proposed abstractions will give rise to significant cultural effects on cultural practices. The submission identifies a lack of consultation, acknowledgement and upholding of Te Mana o te Wai, and the lack of recognition of concerns already raised in relation to water at hui. Waiora Marae seeks an instant moratorium on consents and more discussion surrounding the management of resources, in line with information already provided to Council by Ngāti Kurī.

33. A submission was received from the Ngāti Kurī Trust Board/Te Manawa o Ngāti Kurī supporting the applications, subject to conditions relating to prioritisation of current and future community access over commercial interests; investment in alternative water sources and storage; demonstration of best practice water use through investment in technology and management; best practice management of discharges; ringfencing and banking of a comparable allocation of groundwater for future commercial development as part of the current consenting process; and activation of the Mana Whakahono a Rohe framework to provide appropriate cultural consideration of the applications.

34. For clarity, it is noted that:

- Te Rarawa, Ngāi Takoto and Te Aupōuri are applicants;
- Treaty claims have been settled in respect of the above three iwi, Ngāti Kurī and Ngātikahu ki Whangaroa, and man whenua status over areas denoted in the relevant Settlement Acts is inferred; and

- The Ngāti Kurī Trust Board/Te Manawa o Ngāti Kurī, who are the mandated authority authorised to act on behalf of Ngāti Kurī, have advised that Mr Burgoyne does not represent Ngāti Kurī. However, Mr Burgoyne does have a bore within the modelled area of effects and is therefore his submission is accepted due to affected persons status being conferred on the basis of his bore.

3.2.3 Mr Albert Burgoyne – Te Taumatua Ngāti Kurī Research Unit

35. A submission was received from Wendy Thomas on behalf of Mr Albert Burgoyne – Te Taumatua Ngāti Kurī Research Unit opposing the applications. Mr Burgoyne's reasons for opposing the applications include that the quantities sought are disproportional to the actual need; the lack of artesian bores makes some of the applications invalid; and that the exclusion of the whole community through the limited notification process.

36. Much of Mr Burgoyne's submission asserts that the applications are "subjudicae" [sic], because some of the applicants have previously applied for consent and/or the applications pertain to matters that are already before a judge/the court. It is inferred that this relates to Mr Burgoyne's appeal to the High Court regarding the MWWUG resource consents for groundwater abstraction[5].

37. In my opinion, the sub judice rule does not apply to these applications. Whilst the submissions were received prior to the final appeals against the MWWUG applications being decided, the AAWUG applications stand alone, and do not influence the decision-making for previous applications, except to the extent that any applications granted form part of the existing and receiving environments within which applications in process must be considered. The appeal against the Environment Court's final decision has since been dismissed in full and therefore no relevant matters remain before the court to consider in relation to the MWWUG applications and/or applicants.

38. In regard to WAI 292 rendering the subject applications sub judice, it is unclear on what basis this statement is made. WAI 292 is an historical claim relating to the Te Kao School site (Te Aupōuri) and Te Kao lands and waterways (Ngāti Kurī) and is included as an historical claim settled under both the Te Aupōuri and Ngāti Kurī Claims Settlement Acts. Regardless of the status of any remaining claims or grievances relating to WAI 292, the Te Kao School site is located outside the modelled area of effects, and the actual and potential adverse effects of the proposed abstractions on land and water are considered irrespective of whether those environments are subject to a Treaty Claim.

39. The High Court judgement dismissing Mr Burgoyne's appeal was delivered on 17 February 2020[6]. In the decision, Davison J notes that Mr Burgoyne raises two point: the first being land ownership, alongside an alleged breach of the Overseas Investment Act 2005; and the second being potential damage to archaeological sites and the Kaimaumau Wetland as a result of the granting of the consent itself[7].

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5 CIV-2019-488-23
6 Decision [2019] NZHC 189
7 At [15]-[17]

40. Davison J notes the following in paragraphs [21] to [23]:

…challenging a resource consent application is not an appropriate legal process for challenging ownership of land. In particular, where the appellant is submitting that land disputes and Waitangi Tribunal claims have not been properly determined, and that land has been transferred from Crown entities to private interests in contravention of s 27B of the State Owned Enterprises Act 1986, those matters are much more appropriately dealt with in the Maori Land Court.

Furthermore, as the respondents submit, the Water Users' ownership of the land is not relevant to a determination of whether a consent should be granted or not.

Nor does Mr Burgoyne's contention that some of the Water Users are overseas entities operating in breach of the Overseas Investments Act 2005 have any bearing on the grant of consents under the Resource Management Act 1991.

41. These same issues have been raised in Mr Burgoyne's submission on the current applications for groundwater abstraction. Given that the decisions issued by both the Environment Court and the High Court have identified these matters as outside the scope of the RMA process and irrelevant to the granting (or not) of a resource consent in relation to a previous, very similar proposal, it can be reasonably maintained that they are also outside the scope of, and irrelevant to, the current applications.

42. As such, it is my recommendation that the Commissioners consider striking out part of Mr Burgoyne's submission, in accordance with Section 41D of the RMA, on the basis that it discloses no reasonable or relevant case and that allowing those parts of the submission to be taken further or used as the basis for appeal would constitute an abuse of the hearing process.

43. Matters relating to legal process and the strategic approach to management of resources—including water—in Northland are outside the scope of this report. As already noted above, the limited notification determination is not revisited in this report, but concerns raised in relation to the process and extent of consultation are addressed in Section 3.3.7.

3.2.4 Far North District Council

44. Far North District Council (FNDC) made a neutral submission on the applications, the main focus of which is "ensuring continued water supply to Kaitāia" in line with FNDC's requirement under the Local Government Act 2002 to provide water in a manner that ensures sufficient capacity to meet demand. FNDC currently provides potable water to approximately 5,000 residents and 250 non-residential users in Kaitāia.

45. At the time the submission was received, FNDC's sole source for potable community supply was a consented take from the Awanui River, with additional consents providing for potential abstraction from Kauri Dam and Ōkahu Stream. The submission notes that these surface water takes will not be subject to potential effects as a result of the proposed abstractions from the Aupōuri Aquifer.

46. FNDC's primary concern rests around potential impacts on its consented groundwater take from an existing production well (PW1) and a yet-to-be-drilled production well (PW2) located in the Sweetwater sub-zone. These wells are located in the general vicinity of 16 bores proposed by two applicants: Te Rarawa Farming Limited and Te Make Farms Limited and Elbury Holdings Limited. Whilst FNDC acknowledges that the applicants' assessments indicate that the predicted cumulative drawdown at PW1 and PW2 is unlikely to result in adverse effects on water supply operations, FNDC's submission seeks that conditions ensuring that there are no adverse effects on FNDC's water supplies are imposed on any consents granted.

47. FNDC also noted the potential impact of the proposed abstractions on the future needs of Te Hiku communities, insofar as the lack of certainty around future allocation availability may render potential additional community supplies unviable. To this effect, FNDC has requested that NRC is mindful of the obligations of both Councils in respect to development capacity for housing and business land under the RMA, and the reliance on security of water supply for both.

3.2.5 General Submissions

48. A summary of the key issues raised in the other submissions received is provided Section 3.3 of this report.

3.2.6 Late Submissions

49. Submissions were received from the following parties after the limited notification period closed on 1 November 2019:

- Russell John McAlees
- Sidney Waitai
- Jared and Kiran Bratton
- Cavey
- Matich
- S Williams
- R Eltringham
- M Day
- W & R Jones
- I E P & D P Kemp
- J White
- Albert Burgoyne – Te Taumatua Ngāti Kuri Research Unit
- Douglas Nathaniel Calhoun
- Elizabeth Losleben Calhoun
- Ngāti Kurī Trust Board/Te Manawa o Ngāti Kurī
- Michele Andra Mitcalfe
- Ngaire Dawn O'Higgins

- M L & D J Shepherd

50. Under Sections 37 and 37A of the RMA, Council may extend a time limit or waive compliance with a time limit specified in the RMA. In deciding whether to waive the time limit and accept late submissions, particular consideration should be given to the interests of the community in achieving adequate assessment of the effects of a proposal. These interests must be balanced with the Council's duty to avoid unreasonable delay.

51. While the Council's 'default' position is that late submissions are generally not accepted, it is my opinion that the late submissions should be accepted in this instance for the following reasons:

- The potential area of effects is large, rural and isolated, and therefore it is not unreasonable that delivery of submissions may be delayed;
- For submissions to be considered valid, submitters needed to provide confirmation of existing groundwater or surface water takes, which may have required additional time and effort;
- There is a great deal of community interest in the proposed water takes, particularly in light of recent decisions/judgements regarding the MWWUG consent applications; and
- With the exception of Mr Burgoyne's submission, the late submissions raise matters generally consistent with those raised in other submissions. Given that part of the rationale behind the scope of the limited notification determination was the absence of information on specific water takes and users, these late submissions may help provide a clearer picture on which potential effects may be assessed.

3.3 Summary of Key Issues

52. The following sections present a summary of the key issues raised by submitters in relation to the proposed groundwater abstractions. The summary includes matters raised repeatedly, those considered relevant to the scope of the applications, and groups matters into general categories, where possible, but is not a complete list of all matters included in submissions.

3.3.1 Allocation of Water

53. **Submissions:** 1, 5, 9, 10, 11, 13, 20, 22, 23, 24, 26, 28, 31, 36, 41, 42, 43, 45, 46, 49, 54, 56, 57, 62, 63, 70, 72, 77, 79, 81, 83, 84, 85, 87, 88, 89, 90, 92, 94, 95, 97, 100, 104, 107, 111, and 113.

- Volume of water is excessive.
- Uncertainty around actual water requirements for activities proposed (avocado orcharding).
- Concerns regarding water banking and intentions of applicants in regard to investment.
- Preclusion of community use of the aquifer water resource due to commercial interest.

- Proposed takes in the Motutangi and Sweetwater subzones will result in near maximum allocation.
- Lack of data and consideration regarding permitted/unconsented groundwater use.

Comments

54. The volume of groundwater sought by the applicants has been determined based on the requirements for irrigation of horticultural and pastoral land, in most cases avocado orchards. The MWWUG consents were issued based on the application of a general formula for calculating the irrigation requirements for Total Orchard Area, and set a maximum annual volume per hectare of canopy area. This methodology was informed by actual historical use at established orchards, took into account soil conditions, and an assumed level of irrigation efficiency. With the exception of Te Aupōuri Commercial Development Limited and Te Rarawa Farming Limited and Te Make Farms Limited, which have applied for water to irrigate pasture and other crops as well as avocados, the applicants have calculated their proposed takes in a manner consistent with that established through the MWWUG process. Mr Hughes has addressed reasonable and efficient use of water in his technical comments report (Attachment 5) and further discussion on this matter is provided in Section 4.2 of this report.

55. Several submitters raised concerns around the intentions of some of the applicants to develop the land for the stated purposes, or whether the actual purpose of the proposed water takes was to increase the value and viability of the subject properties for resale. The purpose and use of the proposed water abstractions have been stipulated in the application documentation presented by the applicants. These applications set out the rationale and justification for the volume of groundwater required, which are balanced alongside the actual and potential effects of the proposals to determine whether enabling the proposed takes meets the sustainable management purpose of the RMA.

56. The consent authority cannot compel a consent holder to enact a consent once it is granted. It can, however, stipulate a lapse period within which the consent must be enacted before it becomes invalid and specify a shorter duration of consent. It is not appropriate for the consent authority to question or doubt the intentions of the applicants to follow through on their development plans; the assessment must assess the application on its merits. Notwithstanding this, the viability of land development depends on a multitude of factors outside the Council's control or influence.

57. In regard to potential preclusion of future use of groundwater from the aquifer for community or domestic purposes, the allocation of water rights on a 'first in, first served' basis is well entrenched in case law[8]. The process of assessing and deciding each application for consent on its own merits and in the order competing applications for the same resource are accepted by Council is accepted practice confirmed by further case law[9].

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[8] *Fleetwing Farms v Marlborough District Council* [1997] 3 NZLR 257
[9] *Aoraki Water Trust v Meridian Energy Limited* [2005] 2 NZLR 268

58. As noted in the staff report for the MWWUG applications[10], it is not the responsibility of the consent authority to determine the efficiency of an application to take and use water relative to other potential uses of that water. Nor must the consent authority consider potential future uses of that water or resource consent applications to use that. The Council must consider, and has done so in relation to this application, the existing and receiving environments, which include potential use under the permitted baseline and all existing resources consents, whether enacted or not. Additionally, neither the operative Water and Soil Plan for Northland nor the proposed Natural Resources Plan stipulate priority order for water allocation in the Aupōuri Aquifer.

59. It is acknowledged that the importance of water and the allocation thereof for purposes that maintain and enhance natural, ecological, cultural and recreational values, and for domestic use and stock watering must be considered prior to allocation for other uses, particularly where water resources are scarce.

60. Concerns raised regarding the overallocation or near full allocation of the Sweetwater and Motutangi subzones are not unfounded, though are perhaps better focused on the Houhora and Sweetwater subzones. Table 2 in Mr Hughes's report (attached at Attachment 5) shows that the cumulative allocation, including all existing consented and proposed groundwater takes, will represent 97.8 percent of the allocation limit within the Houhora subzone[11] and 101.1 percent of the allocation limit within the Sweetwater subzone[12]. However, it is acknowledged that these calculations do not factor in cross-boundary effects where takes are located proximate to subzone boundaries, which results in a more equitable distribution of allocation without fully exhausting any of the allocation limits across the various aquifer subzones. Further discussion regarding the nuances of cross-boundary effects in relation to allocation limits is provided in Section 1 of Mr Hughes's report (Attachment 5) and in Section 4.4 of this report.

61. It is noted that the methodology used by NRC to calculate groundwater allocation limits includes an estimate of takes for stock drinking water and domestic purposes, and also an estimate of water taken for existing dairy shed use. It does not include other takes that can be undertaken as a permitted activity, as records for such are not collected. However, the allocation limits calculated for the Aupōuri Aquifer also consider base flows and annual recharge rates based on numerical modelling, which has enabled an increased level of certainty in the setting of allocation limits for the aquifer, relative to other aquifers in the Northland region. Whilst not specifically calculated, an allowance for permitted activity takes is inherently included in the conservative allocation limits set in the pRPN.

3.3.2 Long-term Impacts on Aquifer

62. **Submissions:** 1, 5, 9, 10, 11, 17, 18, 20, 23, 24, 33, 35, 39, 43, 45, 52, 61, 72, 74, 76, 77, 95, 97, 98, 102, 103, 106, 108, 110, and 111.

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[10] NRC Staff Report REQ-581172, September 2016

[11] Based on the pRPN allocation limit of 3,211,950 m^3/year and a total cumulative allocation of 3,141,654 m^3/year for the Houhora subzone

[12] Based on the pRPN allocation limit of 4,675,000 m^3/year and a total cumulative allocation of 4,727,982 m^3/year for the Sweetwater subzone

- Lack of knowledge around the underlying geology and functioning of the aquifer.
- Potential loss of shallow sand aquifers from lowering the water table.
- Concern regarding overall allocation limits as a percentage of aquifer recharge.
- Allocations are unsustainable in the face of climate change and increasingly dry conditions with low rainfall for recharge.

Comments

63. The updated assessment of effects and the groundwater modelling report provided by WWLA have addressed the geology and both note that there are some uncertainties surrounding the functioning of the aquifer in respect to permeability between the layers and the extent to which "leaking" occurs between the shallow sand aquifer and deep shellbed aquifer. The two scenarios under which the model was run provide an indication of the differences in effects that may occur when these uncertainties are considered. The parameters upon which the model was built mean that the predictions are generally conservative, and I consider that the precautionary principle has been employed appropriately by the applicants' experts in basing their assessments on the 'worst case' presented across both scenarios.

64. The extent of interaction between the two layers within the Aupōuri Aquifer is not fully understood due to the lack of data regarding the underlying geological conditions and the groundwater system itself. However, both the applicants' hydrogeological expert and Mr Hughes have indicated that the likelihood of there being a significant level of connection or leakage between the two is unlikely due to the underlying geology across much of the aquifer.

65. As noted above, the overall allocation limits for the Aupōuri Aquifer and its composite sub-zones are set by NRC using a methodology that considers a range of variables, including historic data, estimated water usage and underlying geological conditions. This report does not assess or evaluate the methodology used to set allocation limits, nor does it challenge the limits set by the Council, which are outside the scope of these applications.

66. Additionally, it is noted that the allocation limits were set based on the recommendations of the Lincoln Agritech report[13], which modelled recharge and likely limitations, constraints and sensitivities within each of the sub-zones. Whether these limits are revised to reflect the updated bore level data is a matter for Council to determine, and is outside the scope of these applications, except where the actual and potential environmental effects of the proposed activities must be considered.

67. Mr Hughes has advised that the potential effects of climate change have not been explicitly incorporated into the modelling of the potential effects of these 24 proposed groundwater takes, due to:

- A lack of available datasets that provide local climate data incorporating climate change effects at a daily resolution, which is necessary to generate a comparable synthetic recharge dataset;

[13] Lincoln Agritech Limited, April 2015, *Aupōuri Aquifer Review Report 1056-1-R1*

- Data from NIWA climate model projections indicating that the potential effect of climate change on rainfall as a major driver of groundwater sustainability will be relatively minor across the Aupōuri Peninsula (<15% seasonally and 0-5% annually). This level of variability is within the range of historical inter-annual rainfall fluctuations observed across the Aupōuri Peninsula, and is likely to be significantly less than other factors influencing historical recharge, particularly land use and land cover changes attributed to harvesting of plantation forestry;
- Some modelling predictions indicating that seasonal and annual rainfall totals may actually increase slightly across the Peninsula, which means that modelling that uses historic rainfall as the basis for recharge rates may include an additional degree of conservatism; and
- Sea level rise is not expected to impact on the sustainability of groundwater abstraction, as studies indicate that fresh groundwater heads will rise along with sea levels, such that groundwater levels are maintained above coastal threshold levels. Effects attributable to sea level rise are likely to be associated with land drainage and saline infiltration into hydraulically connected shallow groundwater resources, which are distinct from those deep confined/semi-confined aquifers present on the Aupōuri Peninsula.

3.3.3 Effect on Existing Bores

68. **Submissions:** 3, 4, 5, 7, 9, 11, 14, 15, 16, 17, 18, 20, 22, 25, 26, 27, 28, 30, 32, 33, 34, 41, 44, 48, 49, 51, 62, 66, 69, 70, 74, 76, 77, 79, 87, 88, 91, 98, 99, 100, 101, 103, 104, 106, 108, 109, 112, and 113.

- Concern for viability/reliability of shallow takes if the water table is lowered.
- Reliance on existing takes for property owners and businesses is jeopardised.
- Exacerbation of effects on bores already seen as a result of large consented takes.
- Reduction in property values as a result of effects on domestic bores.
- Costs associated with requiring deeper bores as a result of drawdown.
- No clarity around who is legally and financially accountable for effects on existing water users.

Comments

69. Existing bores can be adversely affected in the event that subsequent water abstractions result in a temporary or permanent lowering of drawdown of groundwater levels within the aquifer. The manifestation of any effect on an existing bore is dependent on a number of factors, including the depth of the bore and pump, the proximity of the bore to the proposed water take, and the volume of both the existing and proposed takes.

70. For a bore to be most efficient, best practice[14] guides that it is drilled to penetrate the lower levels of the groundwater resource, with the pump located as low as practicable to ensure sufficient available drawdown. This arrangement enables the bore to continue pumping water in the event that groundwater levels decrease (as a result of abstraction or seasonal variation) across the aquifer or locally within the bore itself, as can occur with large takes where pumping volume is high. Bores that are located near the bottom of the aquifer will provide a more reliable supply of water than those with a shallow penetration in the upper extent.

71. Whilst it is primarily a right in relation to property, the principle of non-derogation generally applies to resource consents, in that a consent cannot be granted where it would significantly derogate from an existing consent. Case law,[15] established regarding the extent to which interference or derogation effects should be considered in determining the efficiency of use of a resource has largely focused on circumstances where a resource is fully allocated, e.g. a water allocation limit has been reached and an additional application to take water from the same resource is lodged. However, it is appropriate to consider the case law in the context of how a derogation or interference can be determined to be an effect, and whether this principle can be applied further to permitted activities.

72. In determining what constitutes an effect, the derogation must be substantial and amount to more than an inconvenience or unfavourable change in amenity. It must also create an adverse impact or effect on the specific rights conferred by the previous consent or permit. Existing permits to take water do not grant consent holders exclusive use of a resource, nor do they guarantee reliability of supply for takes from an aquifer that is not fully allocated. The question then is whether an actual or potential adverse effect on consented water takes from inefficient bores as a result of other/another more efficient abstraction can be considered a substantial derogation or influence on the ability of existing consent holders to exercise their permits to their fullest extents.

73. A number of submitters raised the lack of clarity around who can/will be held legally responsible in the event that their water supplies are adversely affected as a result of the proposed takes. The actual and potential adverse effects on the environment—including impacts on existing water users and the aquifer overall—have been considered in the assessment of these proposals. The information and assessments provided by the applicants have been subject to independent review and proposed conditions of consent developed to in the first instance avoid, and then remedy and mitigate potential adverse effects.

74. The Council can only take enforcement action where the actions of the consent holder(s) breach the conditions of any consents issued or contravene the provisions of the RMA in respect of use of natural and physical resources. The proposed conditions of consent include extensive monitoring requirements that must be complied with, lest the applicants lose their ability to abstract water as authorised under any granted consent.

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[14] As suggested in Policy 10.5(1) in the Regional Water and Soil Plan for Northland

[15] *Hampton v Canterbury Regional Council (Environment Canterbury)* [2015] NZCA 509

75. An assessment of the potential adverse effects on other groundwater users is provided at Section 4.6 of this report, which includes discussion of potential well interference within the policy context of the RWSP.

3.3.4 Water Quality and Contamination

76. **Submissions:** 22, 41, 44, 45, 49, 56, 57, 61, 63, 77, 83, 86, 102, 111, and 112.

- Leaching of pesticides and fertiliser residue from orchard sprays into groundwater.
- Contamination of roof surfaces from spray drift.
- Impact of horticultural runoff on the natural environment.
- Nitrate contamination as a result of excessive use of the groundwater resource.
- Breaking of the pan will allow quicker leaching of contaminants from chemically grown crops and foods.

Comments

77. The applications that this report addresses seek consent under Section 14 of the RMA to take and use groundwater from the Aupōuri Aquifer. They do not seek consent for discharges to air, water or land, nor the use of chemical or hazardous substances. As such, this report is limited to assessing the actual and potential effects of groundwater abstraction, not the use of or potential outcomes relating to the use of the water sought. Whilst it is accepted that the use and potential adverse effects associated with fertiliser and chemical applications are valid environmental concerns, they are not effects attributable to the abstraction of groundwater and thus cannot be addressed through reporting on these applications. Management of land use and discharges must be addressed separately through other district and regional council processes.

78. Nitrate contamination of groundwater is usually attributable to land use and human activities, such as agricultural and horticultural farming, application of fertilisers, and sewage and industrial waste disposal, rather than the abstraction of groundwater. As stated above, this report addresses the applications to take and use groundwater, not the land use activities proposed by the applicants. However, it is acknowledged that the abstraction of water for the purposes of orchard irrigation is a potential determinant for the consequent application of chemical fertilisers, and thus the determination of these applications could feasibly lead to the application of chemical fertilisers at orchard sites.

79. Groundwater quality data is available on the Land and Water Aotearoa (LAWA)[16] for seven sites[17] across the Aupōuri Peninsula. Sampling indicates that the 5-year median for nitrate nitrogen levels across each of the seven sites is less than 0.1 mg/L, which is well below the maximum acceptable limit of 11.3 mg/L stipulated in the Drinking-water Standards for New Zealand.

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[16] Land and Water Aotearoa, www.lawalorg.nz

[17] Aupōuri GW at 1 Kaka Street (Ahipara NGMP site); Aupōuri GW at Far North Road (Awanui Farms); Aupōuri GW at end of West Coast Road; Aupōuri GW at 419 Paparore Road (FN Farms NGMP site); Aupōuri GW at Kaimaumau Road (NRC shallow bore); Aupōuri GW at 87 Hukatere Road new bore (NGMP site); and Aupōuri GW at 4036 Far North Road (fish club).

3.3.5 Ecological Impacts

80. **Submissions:** 4, 22, 33, 34, 44, 45, 49, 61, 75, 81, 83, 84, 85, 86, 93, 102, 111, and 112.

- Impacts on Kaimaumau wetland
- Reduced availability of water for flora and fauna as a result of flow reduction caused by drawdown
- Impact on dune lakes and biodiversity

Comments

81. The Kaimaumau-Motutangi Wetland is recognised as a nationally significant ecosystem for maintaining and enhancing indigenous biodiversity.[18] The wetland is administered by the Department of Conservation and is recognised as an area of conservation value by both DoC and NRC. The wetland is located primarily within the boundaries of the Motutangi and Waiparera sub-zones of the Aupōuri Aquifer, but also extends north across the boundary of the Houhora sub-zone.

82. A number of submitters, including the Director-General of Conservation, have raised concerns about the potential effects on wetland water levels and recharge as a result of groundwater abstraction from the underlying aquifer, and the potential consequent effects on biodiversity and the outstanding and significant natural and ecological values of the wetland.

83. Data collected through the monitoring of the MWWUG consents, along with other environmental monitoring, has been analysed to inform the assessment of these applications, particularly in relation to Kaimaumau Wetland. The potential ecological effects on the wetland, watercourses and dune lakes as a result of the proposed abstractions are addressed in Section 4.12 of this report.

3.3.6 Saline Intrusion

84. **Submissions:** 1, 2, 3, 4, 22, 25, 27, 35, 39, 41, 42, 44, 45, 46, 49, 51, 52, 57, 61, 68, 70, 72, 76, 81, 91, 97, 101, 102, 103, 112, and 113.

- Potential effects of saline intrusion into the aquifer.
- Incorrect classification of potential effect as minimal – likelihood may be low, but the impact is potentially significant.
- Lack of understanding regarding the saline/freshwater interface for the Aupōuri Aquifer.

[18] Boffa Miskell, *Kaimaumau-Motutangi Wetland Mapping: Methods, Wetland and Vegetation Descriptions and* Constraints, dated 21 June 2018.

Comments

85. The intrusion of saline water into an aquifer as a result of changes to the hydraulic gradient or freshwater head can result in irreversible effects on groundwater takes from an aquifer. The geology and landform of the Aupōuri Peninsula and the proximity of a number of the Aupōuri Aquifer sub-zones to the coast put the groundwater resource at risk of potential saline intrusion in some locations.

86. The potential for saline intrusion is likely to be the most significant consideration in understanding the sustainability of allocation of groundwater from within the Aupōuri Aquifer. Mr Hughes has provided a detailed discussion regarding aquifer salinity in Section 5 of his report (Attachment 5), which considers the potential effects as a result of the proposed abstractions. A summary assessment of the potential risks and effects of saline intrusion is included in Section 4.7 of this report.

3.3.7 Lack of Consultation/Public Notification

87. **Submissions:** 11, 13, 20, 23, 43, 45, 52, 56, 57, 61, 62, 68, 77, 86, 105, 107, and 109.

- Community as a whole not consulted regarding use of the groundwater resource.
- Lack of strategic planning of water allocation across the whole Peninsula.
- Limited notification considered inappropriate – should have been publicly notified.

Comments

88. The RPS for Northland was recently adopted and provides the strategy for water allocation within the Region. Confirmation that the pRPN is fully operative is imminent. The development of the RPS and the pRPN followed the prescribed Schedule 1 processes, and the pRPN included public participation.

89. Strategic matters that extend beyond the scope of the process and matters at hand – being the 24 applications to take and use groundwater – are not able to be addressed in this forum, nor is it appropriate that the applicants be prejudiced by larger discussions that are better addressed through regional planning and policy development mechanisms.

90. The consenting authority is required under Section 194 of the RMA to consider relevant statutory and non-statutory matters in the assessment of applications for consent, and an assessment to this effect is provided at Section 7 of this report.

91. Whilst it is acknowledged that several parties feel aggrieved by the perceived exclusivity of the limited notification process, the reasons for the limited notification determination are clearly outlined in the report included as Attachment 3. It is outside the scope of this report to revisit the decision made by NRC under Section 95 of the RMA.

3.3.8 Inadequacy of Assessment and Monitoring

92. **Submissions:** 2, 5, 8, 20, 31, 35, 39, 42, 47, 48, 57, 61, 62, 68, 70, 71, 72, 75, 79, 90, 91, 93, 95, 97, 102, 103, 104, 108, and 113.

- Reliance on predictions in the absence of actual data regarding functioning of and effects on the aquifer.
- Lack of trust regarding applicants' compliance with monitoring and management regimes.
- Not enough data has yet been collected from the Motutangi-Waiharara consents to understand potential effects.

Comments

93. There is a degree of uncertainty inherent in modelling and predicting effects on groundwater due to the nature of the resource and the variables that influence it. The model represents the best available data that exists for the Aupōuri Aquifer. The monitoring regime imposed by the MWWUG conditions of consent will assist in providing data relating to the aquifer and the effects of large water takes from it.

94. The MWWUG consents were granted by the Environment Court after a lengthy process, and the monitoring and adaptive management regime included in the consent conditions has been the subject of much scrutiny and deliberation amongst technical experts. As such, the monitoring and adaptive management regime included in the MWWUG consents is determined to be an appropriate starting point for the consideration of that required for these applications.

95. At the time of writing, approximately 12 months' worth of monitoring data has been collected in relation to the MWWUG consents. This data has been processed and analysed to inform the assessment of potential effects generated by these 24 proposed abstractions, and will be used to help determine the appropriateness of trigger levels and the efficacy of the monitoring imposed on previous consents, as well as providing indications on whether a review of the MWWUG consent conditions is required. Conclusions drawn from the analysis of this data undertaken by Mr Hughes (refer to report included as Attachment 5) are discussed in Section 4 of this report.

3.3.9 Cultural Considerations

96. **Submissions:** 12, 107, and 110.

- Not consistent with Te Mana o te Wai and Mana Whakahono a Rohe.
- Need to respect urupā and wai tapu areas.
- Adherence to Treaty of Waitangi principles.
- Lack of proper consultation with iwi.

Comments

97. Mana Whakahono ā Rohe: Iwi participation arrangements (MWR) is a tool introduced under the Resource Legislation Amendment Act 2017 to "provide a mechanism for iwi authorities and local authorities to discuss, agree, and record ways in which tangata whenua may, through their iwi authorities, participate in resource management and decision-making" under the RMA, and "to assist local authorities with their statutory duties under the RMA".[19] A MWR may also specify how a local authority is to consult or notify an iwi authority on resource consent matters, where the Act provides for consultation or notification and the circumstances in which an iwi authority may be given limited notification as an affected party.[20]

98. Whilst Te Hiku iwi have yet to establish any formal MWR arrangement(s) with NRC, the MWR provisions provide recognition of the need to actively incorporate Māori into freshwater management under the RMA to meet the obligations of consent authorities under both the RMA and te Tiriti ō Waitangi/the Treaty of Waitangi.

99. As noted in the Section 95 notification determination, NRC identified hapū and marae komiti as affected parties for limited notification on the basis of potential cultural impacts that Council is unable to determine. Three submissions were received from iwi/hapū organisations.

100. Information received from Ms Letica on behalf of the applicants regarding the assessment of the potential cultural impacts of the proposed takes has indicated that the primary determination of effects is likely to lie with those iwi who are also applicants for several of the proposed takes. Whilst it is assumed that these groups have internal iwi support as Mana Whenua and that their proposals have considered the actual and potential cultural impacts of the proposed abstraction on taonga, cultural values and relationships, as well as te Mana o te Wai, it is acknowledged that consensus across hapū is not always achieved in iwi level decision-making.

101. The specific nature of concerns raised regarding urupā and wai tapu sites is unclear. However, effects that may result in reduction of baseflows in surface water bodies or land settlement as a result of groundwater drawdown are addressed in later sections of this report.

102. All consent authorities are required to take into account the principles of te Tiriti o Waitangi/the Treaty of Waitangi under Part 2 of the RMA. An assessment of the proposals in relation to the relevant statutory provisions is included in Section 7 of this report.

3.3.10 Procedural and Judicial Matters

103. **Submissions:** 5, 9, 11, 41, 44, 56, 62, 75, 84, 85, 99, 106, and 107.

- Contrary to Council's obligations under the NPS to maintain or improve water quality.
- No consideration of Houhora Community Plan and water needs.

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[19] Resource Management Act 1991, Subpart 2 – Mana Whakahono a Rohe: Iwi participation arrangements, ss

[20] Resource Management Act 1991, Subpart 1 – Mana Whakahono a Rohe: Iwi participation arrangements, s58R(4)

- Thirty (30) year consent duration is too long.

Comments

104. Under Policy A1 of the NPS, councils must implement the NPS in their policies or plans by the end of 2025, unless a programme for implementation is provided to justify extension out to 2030. Whilst the water quantity objectives of the NPS have been largely incorporated into NRC's regional planning framework through the recently operative RPS and pRPN[21], a staged implementation programme to incorporate the remaining policies—including water quality policies—into the regional plan has been developed. Council's programme identifies the notification of a plan change to implement the remaining freshwater policies to occur around 2021, and that the implementation of the NPS into the Northland planning framework will be completed in 2025. In the meantime, the transitional Policy A4 is incorporated into the plan and provides direction for the Council in considering water quality effects of discharge applications.

105. It is acknowledged that the Pukenui-Houhora Community Development Plan includes use and conservation of the aquifer under the Transport and Infrastructure matters. As a non-statutory document relevant to the applications, the Pukenui-Houhora Community Development Plan is considered in Section 7.7 of this report.

106. The majority of the applications seek a consent duration of 30 years, with the exception of the application for a new take by Te Aupōuri Commercial Development Limited and the application for increased allocation volume by Te Rarawa Farming Limited and Te Make Farms Limited, which seek consent durations of 20 years and 25 years, respectively. Duration of consents is considered further in Section 8.2 of this report.

3.3.11 Other Issues

107. **Submissions:** 3, 5, 4, 10, 17, 18, 20, 23, 25, 27, 29, 33, 41, 47, 51, 52, 62, 90, 91, 93, 102, and 105.

- Perception that the applications are a 'quick moneymaking scheme' to increase property values for sale, rather than to develop the land.
- Potential for increased fire risk as a result of less water availability.
- No consideration of the needs (accommodation etc) of pickers required to work in orchards.
- Distrust of large commercial operators and perceived corporate bias.

108. A number of submissions received articulated views against large commercial entities, corporate operations and overseas investors, and doubts about the integrity and ethics of the applicants. It is outside the scope of this report to cast doubt on the intentions of the applicants or to call into question the integrity of the applications. The applications must be taken at face value.

[21] Appeals version – June 2020

109. The possibility for increased fire risk may relate to the possibility that groundwater drawdown may affect the security of supply in existing bores and/or surface water takes. The assessment undertaken by WWLA indicates that appreciable drawdown is only likely to affect a relatively small number of existing bores, and that the modelled effects are primarily a result of pumping from those bores themselves. More information on the risk would assist an understanding of the actual effect

110. Whilst the activity status of the applications is discretionary, the consequent effects of allowing the takes can be assessed insofar as they are relevant and reasonable in the context of the activity for which consent is sought. Accommodation and other such needs of a potential future workforce are not directly related to the applications to take groundwater for irrigation, nor are they within the scope of this RMA process.

4. ASSESSMENT AND ANALYSIS

4.1 Adequacy of Assessment

111. The assessment of hydrological effects is based on predictive simulations using a numerical groundwater flow model. The model utilised has been specifically developed to understand the potential impacts of groundwater abstractions from the Aupōuri Aquifer. The model scenarios include:

- Scenario 1 – a base case scenario – which applies naturalised conditions with no groundwater abstraction;
- Scenario 2 – a proposed extraction scenario – which includes all current groundwater consents and pending take applications; and
- Scenario 3 – a proposed extraction scenario that provides a sensitivity analysis – which includes all current groundwater consents and pending take applications and assumes reduced connectivity between the shallow sand aquifer and the deep shell aquifer.

112. As noted earlier in this report, the model was updated to include revised survey level data after inaccuracies were found in the existing historical data held by NRC. Whilst the initial individual assessments were undertaken using the original modelling data, the updated AEE report provided by WWLA in February 2020 considers the effects of the combined proposed water takes cumulatively alongside existing and consented groundwater takes within the model area.

113. The conceptualisation and development of the Aupōuri Aquifer Groundwater Model are documented in the Factual Technical Report provided by WWLA in March 2019, and the subsequently updated report dated February 2020. It is noted that the model was used to simulate predicted effects for the suite of groundwater take applications submitted by the MWWUG in 2016, and was subject to scrutiny, verification and reviews in response to technical review comments made during the processing of the MWWUG applications.

114. Additionally, the use of two different scenarios to simulate and predict effects from the proposed water takes presents a conservative approach to the assessment of effects. It is noted that NRC has used the greater potential effects predicted under Scenario 3 to provide an envelope for notification, and I concur that the inclusion of the predictions from two different scenarios [22]presents a sufficient level of confidence and a cautious foundation to support decision making.

115. NRC engaged Brydon Hughes of Land Water People to review the documentation lodged with the applications. Mr Hughes initially provided technical review reports for several of the applications, including an addendum to his technical review of the Te Aupōuri application following the receipt of responses to further information requests issued by NRC.

116. Mr Hughes also reviewed the updated AEE report provided by WWLA in February 2020, subsequent to the revision of the model in response to additional data gathered by NRC. As the revised AEE report reflects the most up to date data and modelling results and also considers the applications cumulatively, its review by Mr Hughes supersedes the initial reviews of previous information undertaken, and is relied on for the purposes of this report. The analyses and conclusions drawn by Mr Hughes are contained in the two reports attached to this report at Attachment 4 and Attachment 5.

117. I accept the conclusions drawn by Mr Hughes in his technical review, in relation to both the adequacy of the assessment and the actual and potential effects of the proposed groundwater abstractions, as discussed further in the following sections.

118. Whilst the effects assessment could reasonably be described as conservative, there remains a level of residual uncertainty regarding the extent, magnitude and/or timing of effects due to the unique and complex geological and hydrogeological environment of the Aupōuri Peninsula. I consider that these uncertainties can be addressed through appropriate conditions of consent, as discussed further in Section 6 of this report.

4.2 Reasonable and Efficient Use of Water

119. Whether the proposed takes constitute reasonable and efficient use of water must be considered in light of the purpose for which the water is sought and the justification for the volume required. The proposed volumes and rates of groundwater abstraction outlined in the updated AEE have been calculated using the irrigation module of Soil Moisture Water Balance Model to determine optimal irrigation application for avocado orchards in the Aupōuri Peninsula area. The parameters used in the model include[23]:

- maximum soil moisture content;
- the amount of water physically accessible within the rootzone of the plants;
- allowable and maximum deficits for soil moisture;
- maximum daily irrigation depth;

[22] It is acknowledged that Scenario 3 is not calibrated

[23] As specified in the *Aupōuri Aquifer Groundwater Model Factual Technical Report – Modelling*, WWLA, 5 February 2020.

- duration of peak application;
- daily rainfall threshold; and
- irrigation season length.

120. The AAGM was calibrated using a historical actual groundwater use estimate developed using the Soil Moisture Water Balance Model Irrigation Module. Due to the unavailability of a complete dataset for the entire AAGM area, a conservative estimate of groundwater use was generated. A comparison of simulated demand with measured demand showed that measured demand amounted to approximately 30% of simulated demand, which indicates that the simulated demand is highly conservative and leans towards an over-estimate of the actual water required for irrigation. However, it is noted that the measured demand used as a comparator reflects an orchard that is not fully developed, so actual requirements will vary based on the stage of development.

121. The majority of the applications have calculated volumes sought using a general formula of 25 m^3 per hectare of total orchard area per day for maximum daily volume, and a maximum annual volume of 400 mm/annum across the canopy area. These methodologies are broadly consistent with those recommended by Council in the MWWUG Hearing.

122. I accept the analyses and assessment provided by Mr Hughes at Section 2 of his report (Attachment 5) and agree that the rates and volumes are generally consistent with those determined to represent reasonable and efficient use of water through the MWWUG decisions. I also agree with Mr Hughes's recommendation that the maximum seasonal volume sought by Avokaha Limited should be reduced to align with the other applications for avocado orchard irrigation.

123. I accept Mr Hughes's assessment in relation to the rates and volumes sought by Te Aupōuri Commercial Development Limited and Te Rarawa Farming Limited and Te Make Farms Limited, and accept that the takes are consistent with what constitutes reasonable and efficient use when the irrigation requirements for pasture are taken into account.

124. In order to ensure that the proposed takes are efficient, it is recommended that conditions requiring efficient construction and screening of bores and the preparation of an Irrigation Scheduling Plan be included in any consents granted.

4.3 Groundwater Drawdown

125. The primary concern in regard to groundwater abstraction are the effects associated with groundwater drawdown. When water is abstracted from an aquifer, depending on the volume and rate of take and the aquifer recharge rate, it can result in a decrease in groundwater levels, both within the aquifer and specifically within groundwater bores.

126. Cumulative drawdown effects[24] on the aquifer have been considered in two ways:

- Through the comparison of Scenarios 2 and 3 against the base case naturalised scenario where no pumping occurs. This provides a picture of how predicted drawdown attributable to all takes—being existing consented takes and proposed takes—affects groundwater levels within the Aupōuri Aquifer.
- Through a comparison of the predicted drawdown attributable to the combined takes proposed in the 24 applications against the existing environment.

127. These analyses provide both a picture of the potential overall effects of groundwater pumping on the aquifer, and the isolated potential effects of the 24 applications for takes in comparison to the existing environment, as defined under the RMA.

128. The predicted cumulative drawdown identified within existing bores/wells under Scenarios 2 and 3 includes drawdown attributable to the pumping at each bore, i.e. the decrease in water level within the bore as a result of its use. As such, the entire cumulative drawdown effect is not necessarily wholly attributable to pumping associated with the 24 proposed takes.

129. It is important to note that neither an increase in the amount/percentage of groundwater allocated nor an increase in groundwater drawdown within an aquifer (or aquifer sub-area) constitute an effect, particularly where an allocation limit is not exceeded. The effects that must be considered are the consequences of the increase in water take, both for each take on its own and cumulatively as a contributor to the overall effects of groundwater abstraction on the aquifer and the wider environment. Specific effects that may arise as a result of an increase in groundwater abstraction and/or subsequent drawdown of groundwater levels include impacts on surface water flows, effects on neighbouring bores (well interference) and water takes, potential risk of saline intrusion, and land subsidence. These effects are considered further in subsequent section of this report.

4.4 Effects on Aquifer Sustainability

130. The analysis of effects on groundwater levels undertaken by WWLA used the end of the 2010 irrigation season (30 April 2010) as this represents the end of the driest period within historical record and the greatest seasonal demand for irrigation. Results for both Scenarios 2 and 3, relative to a base case naturalised scenario, show maximum cumulative drawdown results in the deep shell aquifer of up to approximately 14.4 metres and 19.4 metres, respectively. These effects are located at the currently consented FNDC-2 take location.

131. The WWLA report presents an assessment of the effects of the proposed groundwater takes relative to the receiving environment, which includes all existing consented groundwater takes within the model area. The analysis showed that the maximum predicted drawdown within the deep aquifer was 3.9 metres under Scenario 2 and 6.3 metres under Scenario 3.

[24] In the context of these 24 applications, "cumulative drawdown effects" refers to the predicted combined drawdown effects when all consented and proposed takes are fully exercised.

132. The threshold for significant drawdown is typically 0.6 metres[25]. Figures 9 and 10 in the WWLA AEE (2020) indicate predicted drawdown contours in the deep shell aquifer under both scenarios, respectively. The majority of the model area sits outside the 0.6 metres drawdown contour for Scenario 2. A greater proportion of the model area is within the 0.6 metres predicted drawdown contour for Scenario 3.

133. Whilst the analysis shows that some areas within the model are predicted to experience significant drawdown effects (i.e. 0.6 metres or more) relative to the base case/naturalised scenario, the WWLA AEE (2020) notes that the drawdown within the deep shell aquifer as a result of the proposed groundwater takes (i.e. relative to the receiving environment) remains within the limits of available drawdown for production bores.

134. In the shallow sand aquifer, the maximum predicted drawdown attributable to the proposed groundwater takes (relative to the receiving environment) was 1.3 metres under Scenario 2. Scenario 3 showed no predicted drawdown in the shallow sand aquifer due to the lack of hydraulic connection between the upper and lower units. The part of the model area where the predicted drawdown is likely to be significant (i.e. ≥0.6m) is within the Houhora sub-area in the vicinity of Te Raite Station.

135. Regardless of the available drawdown limits, the analysis shows that the proposed abstractions will give rise to significant drawdown (i.e. ≥0.6 metres) within the deep shell aquifer across parts of the model area under both scenarios. This predicted drawdown must be considered within the context of the allocation limits prescribed in the pRPN, which set the threshold for sustainable abstraction from the aquifer.

136. The combined water take volumes sought in the 24 applications submitted by the Aupōuri Aquifer Water Users Group within each of the aquifer sub-areas is shown below in **Table 2**, along with the cumulative allocations and percentage of allocation exhausted/used within each sub-area.

Table 2: Combined water take volumes sought from Aupōuri Aquifer sub-areas

Aquifer sub-area	pRPN allocation limit (m^3/year)	Proposed AAWUG allocation (m^3/year)	Cumulative allocation (m^3/year)	% pRPN allocation limit
Aupōuri-Waihopo	1,278,200	322,760	511,450	**40.0**
Aupōuri-Houhora	3,211,950	1,717,400	3,141,654	**97.8**
Aupōuri-Motutangi	1,604,400	205,200	1,164,042	**72.6**
Aupōuri-Paparore	3,787,500	788,700	1,999,952	**52.8**
Aupōuri-Sweetwater	4,675,000	521,000	4,727,982	**101.1**
Aupōuri-Ahipara	922,500	455,000	572,532	**62.1**
Aupōuri-other	N/A. Allocation limit is 15% of annual average recharge.	587,000	678,918	-

[25] Significant drawdown (i.e. 0.6m or more) does not necessarily correlate to a significant effect.

137. The above table shows that the proposed takes will exceed the allocation limits specified in the pRPN within the Sweetwater subzone, and reach near-full allocation in the Houhora subzone. Under this volumetric methodology for calculating allocation in relation to limits, those takes within the Sweetwater sub-area would be considered a Non-Complying activity under Rule C.5.1.14 of the pRPN[26].

138. However, in his technical review, Mr Hughes notes that the use of volumetric allocation limits and the drawing of "arbitrary sub-divisions of a laterally continuous aquifer system" do not consider potential cross-boundary effects from takes proximate to subzone boundaries, nor that the primary factor influencing the overall sustainability of a coastal aquifer system such as the Aupōuri Aquifer is likely to be the potential for saline intrusion.

139. Mr Hughes presents an alternative calculation of the proposed allocations in each sub-area based on a methodology recently developed by NRC to account for cross-boundary effects, rather than solely on geographic location. A summary provided in Table 3 of Mr Hughes's technical comments report (Attachment 5) shows that allocations are more evenly distributed and remain within the pRPN sub-area allocation limits when cross-boundary effects are taken into account. Under this methodology, all of the proposed AAWUG takes would be discretionary activities under Rule C.5.1.12 of the pRPN, and I have assessed the applications on this basis.

140. I accept the assertion made by Mr Hughes that the volume of water that may be sustainably abstracted from a coastal groundwater system such as the Aupōuri Aquifer is dependent on the location of the take. However, the heterogeneity within the underlying geology and groundwater system and the uncertainty regarding how potential effects may occur at and beyond the interfaces between sub-areas means that a precautionary approach is necessary. Staged implementation, adaptive management and appropriate monitoring are recommended as part of a proposed GMCP to ensure that the effects are measured and assessed under a balance of both volumetric abstraction limits and in relation to cross-boundary effects.

141. Taking into account the calculated recharge rates and cross-boundary effects, I consider that the overall effects on the sustainability of the aquifer will be less than minor, as the assessments by WWLA and Mr Hughes demonstrate that there is sufficient capacity within the allocation limits of each aquifer sub-area to enable the proposed takes.

[26] Taking and use of water that would cause an allocation limit for an aquifer to be exceeded.

4.5 Effects on Surface Water

142. The potential effects on aquifer drainage to farm drains and wetlands have been assessed by WWLA. The analysis shows a reduction of 4.3% in the mean annual low flow between the base case naturalised scenario (no groundwater pumping) and Scenario 2 (including all consented existing and proposed groundwater takes). This reduction is well within the relevant allowable impact threshold for small rivers as stated in the pRPN[27], and includes ephemeral watercourses within the model area. It is noted that this reduction is a conservative estimate due to the exaggeration of shallow and surface effects present in the model as a result of hard pans being excluded from the model.

143. Subsequent to the submission of the updated AEE (WWLA, 2020), an analysis of wetland water levels was undertaken by WWLA for the MWWUG. The *Kaimaumau Wetland Modelling Report: Assessment of Wetland Water Level Behaviour* (WWLA, 2020A) was produced in support of applications to change consent conditions under Section 127 of the RMA submitted by three existing MWWUG consent holders: Honeytree Farms Limited, Largus Avocados Limited Partnership, and Mapua Avocados Limited. The report detailed the development of a water balance model for the Kaimaumau Wetland that simulated relative water levels and fluctuations across the extent of the wetland.

144. The wetland water balance model showed that fluctuations are dominated by rainfall and evaporation, with rainfall representing 100% of the inputs to the wetland and evaporation representing approximately 78% of losses from the wetland. The model showed that the remainder of water losses are attributable to shallow seepage to drains (approximately 14%) and overland flow (approximately 9%).

145. The wetland water balance model was also used to simulate effects of existing and proposed groundwater abstraction on water levels within the wetland. The outcome of the simulations predicted a maximum additional impact of approximately 0.064 mm reduction in water levels, which is described in the report as "barely noticeable over natural seasonal oscillation… particularly when placed into context of evaporation", which averages approximately 2.6 mm reduction in water levels. This assessment thus suggests that there is little interaction between the underlying aquifers and the wetland, and that any impact on water levels within the wetland that is directly attributable to existing or proposed groundwater takes is less than minor.

146. Mr Hughes's technical review report (Attachment 4) considers it reasonable to conclude that the cumulative effects of the proposed takes on surface water bodies, including wetlands, dune lakes and stream, will be less than minor, given the limited potential for hydraulic connectivity between surface water features and the shallow sand aquifer. He notes that the potential effect is further reduced by the limited drawdown predicted to occur within the shallow sand aquifer as a result of the proposed abstraction.

[27] 80 percent of the seven-day mean annual low flow, as specified in *Table 24: Minimum flows for rivers*, Policy H.4.1

147. However, Mr Hughes does note that there is potentially additional complexity within the relationships between groundwater, wetland levels and surface discharge in low-lying coastal areas, including around the Kaimaumau Wetland. In his technical comments report (Attachment 5), Mr Hughes used groundwater and wetland water level monitoring data from the MWWUG consents along with DoC monitoring data to "validate predicted effects and characterise the degree and nature of hydraulic connection between the Aupōuri Aquifer systems and the Kaimaumau Wetland". In summary, this data indicates:

…there are no clear indications of any substantial hydraulic connection between the Kaimaumau Wetland and the underlying Aupōuri Aquifer based on data from the MWWUG monitoring sites. Wetland water levels appear to function as a (relatively) linear storage that responds to rainfall events independently of the underlying groundwater system (which is also influenced by the same rainfall events)…

[The model] appears to confirm that interconnection between the wetland underlying groundwater system are limited, with inflows derived from exclusively from rainfall and discharge primarily occurring via evapotranspiration, with smaller outputs via surface drains and overland flow.

148. In regard to dune lakes, Mr Hughes states that the porosity and permeability of the sands on the Aupōuri Peninsula is high, and therefore the dune lakes present within the modelled area of effects are likely to be perched as a result of underlying iron-pan layers, peat or the accumulation of fine-grained sediments impeding infiltration. As a result, there is limited interaction with the aquifer units and the lakes are unlikely to be affected by the proposed groundwater abstractions.

149. Potential adverse effects on the natural and ecological values of surface water bodies are discussed further in Section 4.12 of this report.

4.6 Effects on Existing/Other Groundwater Users

150. Predicted drawdown at all 410 NRC registered bores within 2 km of the proposed take locations is provided under both Scenario 2 and Scenario 3 conditions in Appendix B of the WWLA AEE (2020). Under Scenario 2, the maximum predicted drawdown within the deep aquifer is 14.23 metres at an existing monitoring bore. Predicted drawdown is less than 2 metres for most registered bores. Under Scenario 3, the maximum predicted drawdown is 19.53 metres at the same monitoring bore, with drawdown at most bores likely to be less than 5 metres.

151. Modelling shows the average predicted drawdown within the deep shell aquifer for NRC registered bores to be 1.3 metres under Scenario 2 and 3.38 metres under Scenario 3. The cumulative drawdown effects in the shallow sand aquifer are generally less than 1 metre across the model area, with the exception of some areas within the Sweetwater zone, where the maximum drawdown is up to around 2 metres.

152. Mr Hughes's report notes that, based on the assessment provided by WWLA, calculated drawdown at existing bores in the deep shellbed aquifer will equate to between five and eight percent of the available drawdown, assuming a minimum of 60 metres of available drawdown. His conclusion is that a drawdown of this magnitude is unlikely to result in adverse effects on the reliability of supply for existing takes within the shellbed aquifer.

153. Whilst Mr Hughes acknowledges that bores screened within the shallow sand aquifer have considerably less available drawdown than those in the shellbed aquifer, the calculated drawdown within the shallow sand aquifer is also considerably less, and the extent of any potential well interference is also unlikely to affect existing takes from the shallow sand aquifer in terms of reliability or yield.

154. The WWLA AEE (2020) notes that the available drawdown for shellbed aquifers is typically 60-100 metres, and the explanation for Policy 10.5(1) of the RWSP for Northland promotes efficient bore takes as:

…when a bore fully penetrates the water bearing layer and takes water from the base of the aquifer. The water level in a bore, which is only partially penetrating an aquifer or is drawing from the top of the aquifer, may be drawn below the bottom of that bore as a result of water being taken (at a sustainable rate) from another deeper bore. The user of the shallow bore has not lost his or her use of the groundwater resource. Rather, the method of extraction is no longer effective.

It would be wasteful management of the groundwater resource, should shallow water supply bores restrict the use of an available resource…

This policy promotes efficient management of the available groundwater resource. It recognises that some groundwater reduction must occur if the resource is to be used, but it does not necessarily mean that use of the resource is lost. Any reduction should be a short-term effect, which is remedied through recharge of the aquifer.

The policy also promotes the avoidance of adverse effects on surface water, which may result from taking groundwater.

155. However, the assumption that all consented bores are sufficiently efficient in terms of depth and pump depth to absorb the potential drawdown is difficult to corroborate, particularly in relation to permitted activity groundwater takes. In his technical assessment, Mr Hughes notes that partial penetration is a major consideration for assessment of well interference effects, and has suggested that a combination of the RWSP definition and the wording suggested by the Environment Court in the MWWUG decision[28] would strike an appropriate balance between take efficiency and reliability of supply for assessing and monitoring well interference effects.

[28] ENV-2018-AKL-126, Decision No. [2019] NZEnvC 137

156. I agree with Mr Hughes's suggestion and consider that the proposed conditions address potential effects on existing bore takes in a manner that also promotes efficient allocation and use of the available groundwater resource. Based on the information provided by WWLA and Mr Hughes, I consider the potential adverse effects of the proposed takes on existing/other groundwater users to be generally less than minor.

157. The exception to the above assertion is in relation to the consented FNDC abstraction at Sweetwater. Mr Hughes notes that modelled cumulative drawdown at the FNDC #2 production bore is calculated to represent 20-27 percent of the available drawdown within that bore. Whilst much of the predicted drawdown at this bore appears to be attributable to pumping from within the bore itself, the concentration of a significant volume of existing and proposed abstraction around the Sweetwater area presents a risk of increased effects in this location. As such, I consider the potential adverse effects of the proposed takes on the FNDC bore to be minor.

4.7 Saline Intrusion

158. Groundwater naturally seeps towards the coast due to a hydraulic gradient formed by recharge to the aquifer in inland areas, naturally transitioning from fresh to brackish to saline with increasing distance offshore. The interface where groundwater and seawater mix tends to occur close to or offshore of the coastal margin in shallow unconfined aquifers but can be more variable in terms of geometry and depth within deeper aquifers, though the saline concentrations in groundwater typically increase with depth.

159. Saline intrusion occurs when saline water moves inland and displaces the freshwater within an aquifer. Groundwater abstraction can cause this to occur through a reduction in the head of freshwater in an aquifer that can either allow saline water to move upwards through the aquifer or allow the saline interface to migrate further inland. These processes are referred to as up-coning and lateral migration, respectively, and can result in saline contamination of groundwater resources, rendering affected water takes effectively unusable.

160. Given the proximity of the Aupōuri Aquifer to the coast and the underlying geometry, the potential for saline intrusion presents a potentially significant risk to the sustainability of the groundwater supply, particularly in those sub-zones where the saline interface is near to the coastal margin and the freshwater heads do not sit significantly above sea level. The most likely mechanism for saline intrusion to occur within the subject area is through lateral migration, due to the underlying geology of the Aupōuri Peninsula.

161. The Ghyben-Herzberg relation, which uses the relationship between the relative densities of freshwater and seawater to estimate the likely depth of the saline interface at any point based on the known head of freshwater in an aquifer, has been utilised by WWLA in the AEE (WWLA, 2020) to estimate the groundwater head required to maintain the saline interface below the interpolated base of the shellbed aquifer (the "Required Head"). The results of the modelling of groundwater levels for Scenarios 1 and 2 are then compared with the estimates to assess the relative potential for saline intrusion around the coastal margin.

162. The results of the WWLA assessment indicate that groundwater levels are at or below the Required Head under naturalised conditions (Scenario 1) in locations along a significant section of the eastern coastline north of Kaimaumau, except around Pukenui, and around the mouth of the Awanui River. The most significant shortfall in heads predicted by the model occurs around Houhora Heads and towards the southern end of East Beach. In comparison with the modelled results of Scenario 2 (cumulative abstraction), the additional reduction in groundwater levels attributable to pumping is minor — typically less than 0.1 metre — where naturalised groundwater levels are below the Required Head.

163. Around the Sweetwater area, where the modelled drawdown effects are greatest, groundwater levels remain above the Required Head, except or a short section of coastline west of Lake Heather, where results indicate that cumulative abstraction will reduce groundwater levels below the Required Head. Modelled groundwater levels are below the Required Head along Te-Oneroa-a-Tōhē/Ninety Mile Beach, but remain essentially unaffected by groundwater abstraction.

164. In his technical review of the application, Mr Hughes notes that the application of the Ghyben-Hyzberg relation is not the only methodology available for assessing the risk of saline intrusion. However, given the limited data available, Mr Hughes is of the opinion that using an alternative methodology would not likely provide any further certainty than the generalised assessment and identification of risk areas enabled through the application of the Ghyben-Herzberg relation, without validation through physical monitoring.

165. Mr Hughes notes that the assessment provided by WWLA does not specifically consider the potential for up-coning of brackish water in the context of the Aupōuri Aquifer, but focuses on lateral migration as the primary risk due to the low permeability of the basement rocks beneath the deep shellbed aquifer. Whilst Mr Hughes acknowledges that it is difficult to reliably assess the potential for up-coning to affect groundwater quality in response to proposed abstraction, it is not unreasonable to assume that the volume of any brackish water drawn up from the basement rock will be small in relation to the volume of freshwater flowing laterally through the shellbed aquifer. As such, any consequent effect on overall water quality can be construed as likely to be very limited.

166. Additionally, any saltwater intrusion as a result of up-coning would typically manifest locally around individual take locations. Mr Hughes has recommended monitoring of electrical conductivity is included as a requirement for all proposed production bores to identify localised variations that may not otherwise be identified in sentinel monitoring bores.

167. Section 3 of the RMA outlines the meaning of the term ‘effect’, which specifically includes “any potential effect of low probability which has a high potential impact.” Whilst the probability of saltwater intrusion into the Aupōuri Aquifer may be low, the potential impact on groundwater users and the environment is high. In his report, Mr Hughes describes the assessment of potential saline intrusion provided by WWLA as more a “means to identify areas where there is an elevated ‘risk’ of seawater intrusion to occur”, rather than an assessment of the potential effects generated by the proposed takes. I agree with this interpretation and Mr Hughes’s recommendation that detailed requirements for monitoring of salinity indicators

around the coastal margin are included in a GMCP to manage the risk of potential saline intrusion effects appropriately.

4.8 Other Water Quality Effects

168. A number of submitters have raised concerns about potential groundwater quality effects as a result of consequent land use activities that would be enabled by the groundwater takes, there is a limit to how far the Regional Council's discretion to consider a matter neither material to nor necessarily predetermined by the activity applied for, extends. For clarity, these consents (if granted) do not provide authorisation for the application of fertiliser or chemicals, or consequent discharges, beyond that provided for as a permitted activity under the relevant District and Regional Plan provisions, or as authorised through separate consents.

169. The matter of fertiliser and chemical use and subsequent leaching and nutrient loss to groundwater as a result of orcharding activities was raised during the consideration of the MWWUG applications. In the initial decision on the MWWUG applications[29], the Commissioners noted that the use of pesticide sprays "are not matters directly engaged by the present applications for water abstraction", that they had "no present jurisdiction to consider those putative effects", and any resource consent required for such activities (presumed to be application or discharge of fertiliser and/or chemical sprays) that required resource consent would be subject to a separate process. Despite these views, it is noted that the final confirmed conditions and the GMCP for the MWWUG applications do not specifically require monitoring of any water quality parameters beyond those identified as indicators of salinity.

170. Objective D.4.17 of the pRPN requires the inclusion of a condition on water permits that requires "the use of a backflow prevention system to prevent the backflow of contaminants to surface water or ground water from irrigation systems used to apply animal effluent, agrichemical or nutrients." Whilst this stipulation was not explicitly included in the MWWUG consents as a condition, it is presumed to be a matter covered in the Irrigation Scheduling Plan(s) required under the conditions of consent relating to water use efficiency. Further discussion regarding proposed draft conditions of consent is provided in subsequent sections of this report.

4.9 Land Subsidence

171. Land subsidence in sedimentary aquifers can occur when fine-grained sediments are dewatered and compressed under the weight of overlying geological materials. This compression can also lead to changes in the porosity and permeability of the materials present within the aquifer.

172. Mr Hughes has considered the assessment of effects in relation to land subsidence provided by WWLA in the combined AEE (WWLA, 2020) and considers it reasonable. He acknowledges that maximum drawdown will occur within the deep shellbed aquifer, which is not prone to compaction, and that the risk of compaction and consequent subsidence lies mainly within the shallow sand aquifer, which the modelling predictions indicates minimal drawdown.

[29] Decision on application no. REQ.581172, dated 1 June 2018, paragraph 48

173. Where subsidence is predicted to occur, it is primarily located around and associated with existing large-scale abstractions on the Sweetwater Farms property. The calculated subsidence impact of the proposed abstractions at all proposed pumping locations is less than 0.1 metre, which Mr Hughes considers to be relatively minor, sub-regional in nature, and unlikely to result in differential settlement or adverse effects within the rural environment.

174. I agree with Mr Hughes's assessment, and accept that the predicted subsidence effects will be less than minor.

4.10 Social, Economic and Community Effects

175. The Far North is an area of socioeconomic deprivation.[30] The applications state that the ability to utilise establish and grow horticulture in the Far North will benefit the local and regional economy financially and socially in providing a sustainable source of income and employment for local people. In particular, the development and utilisation of Māori-owned land will have benefits for iwi and hapū by providing a means to access the potential of underdeveloped land.

176. Whilst the extent of the economic and employment benefits of the proposals has not been quantified, I accept that the proposed scale of horticulture development will positively impact the local economy.

177. Several submitters have raised concerns that the proposals will impact on the ability to realise community aspirations around water reticulation, allocation and use. The status of any potential reticulated water supply for the Pukenui/Houhora community is unclear, however, it is acknowledged that the FNDC-2 water take was granted for municipal supply. Nevertheless, the FNDC-2 take has already been consented, and thus the take from that bore—be it enacted and used to supply a reticulated scheme or not—has been considered in the modelling as part of the existing environment. The volumes sought by the applicants do not result in the full allocation from the Aupōuri Aquifer or its subzones being exhausted, and as such, there remains allocation available for future applications to be considered by Council.

4.11 Cultural and Archaeological Heritage Effects

178. The original applications and combined AEE (WWLA, 2020) are relatively silent on potential cultural and archaeological effects associated with the proposed groundwater takes, with the exception of the Te Rarawa Farming Limited and Te Make Farms Limited application. It is acknowledged that several of the applicants (including the abovementioned) are iwi/hapū enterprises, and the Te Rarawa/Te Make application states that:

The proposal has been developed in consideration of the relationship of Mana Whenua with their taonga: the Aupōuri Aquifer and the wider Environment.

From the perspectives of the applicants, the effects of the take and use of groundwater as proposed on tangata whenua and their taonga are considered to be beneficial.

[30] New Zealand Index of Deprivation 2018 (NZDep2018), Environmental Health Indicators New Zealand (EHINZ)

179. The remainder of the applications rely on the assumption that metaphysical effects will be commensurate to the physical effects of the proposals—less than minor in the case of the applications—and that because three of the applicants are iwi the taking of water is not an activity iwi are averse to. These assumptions, along with reliance on the internal Council procedures for circulating resource consent applications, have been used as the basis on which consultation with representative Māori bodies was deemed unnecessary by the applicants.

180. Whilst I accept the validity of the position that the absence of any more than minor biophysical effects (as can be roughly extrapolated from the applicants' assessments) makes cultural impacts unlikely, I also recognise the relationship of Māori with the natural environment, taonga and ancestral/cultural traditions and beliefs is a matter of national importance that must be recognised and provides for under Section 6 of the Act. As it stands, I find the assessment of the potential cultural effects of the proposals contained in most of the applications to be inadequate.

181. Through personal communication with Ms Letica of WWLA, I have sought further clarity on the applicants' consideration of cultural impacts. Ms Letica has advised that conversations with a number of cultural advisors indicated that the appropriate parties to determine cultural effects were those three Mana Whenua iwi groups that are applicants. Ms Letica's conclusion was that those iwi, as applicants, are cognisant of the potential cultural effects and impacts of the proposed groundwater takes, have considered tikanga and kaitiakitanga in their approach to developing their lands and using groundwater to do so, and that any determination of cultural impacts is theirs to make.

182. I acknowledge the Mana Whenua status of these groups, however, I also consider it important that potential cultural impacts on parties beyond just those three identified applicants are taken into account. The Section 95 notification determination report notes that "council cannot make a decision that the adverse effects on [marae komiti], and the people they represent, are less than minor" and thus the limited notification decision included marae komiti within the modelled area of effects as affected persons. As per NRC's established protocols, resource consent applications within specific rohe are circulated to relevant iwi and hapū authorities, marae komiti.

183. I note the small number of submissions from Mana Whenua representatives and acknowledge those received from Waiora Marae and Ngāti Kurī Taumatua Research Unit (noting this body does not have a mandate to speak for Ngāti Kurī iwi authority) as an indication that some potential for adverse effects on cultural values exists.

184. The basis of the submission received from Waiora Marae is around the concept of te Mana o te Wai, as enshrined in the National Policy Statement for Freshwater Management. The perceived lack of consideration of te Mana o te Wai and MWR mechanisms—both concepts integral to Māori resource management and important foundations for co-management and kaitiakitanga—is a criticism of the notification and consultation process followed for the applications. It is outside the scope of this report to relitigate the notification decision or comment on relationship and consultation matters regarding the broader management of water in Te Hiku.

185. However, given the importance of Te Mana o Te Wai within the water management framework outlined in the NPS and the importance of water in tea o Māori, it is important that Māori are given the tools and opportunity to exercise their kaitiakitanga. For this reason, I have included a clause in the proposed draft GMCPs requiring the provision of annual monitoring reports to mandated iwi, hapū and marae representatives so that they are able to use the information to inform their own cultural resource management practices and relationships.

186. In the absence of targeted consultation with Mana Whenua and specific cultural values assessments or cultural impact assessments, I expect that the submissions from these parties will assist the Commissioners to make a determination on the significance of the adverse cultural effects and how the proposals recognise and provide for the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga, as required under Section 6 of the RMA.

187. I have not been made aware of any archaeological sites, features or potential effects relevant to the specific nature and/or locations of the proposed groundwater abstraction activities. Beyond the potential effects of subsidence on heritage sites and buildings, which have been addressed above, I do not consider it necessary to address potential effects on archaeological or heritage values as a result of the proposed takes.

4.12 Ecological and Natural Character Effects

188. In general, the assessments of effects provided by the Applicants are largely silent on matters pertaining to ecological and natural character effects. Presumably, this is due to the modelling predictions and assessments concluding that the effects on surface water bodies will be less than minor.

189. Both the assessment provided by WWLA and Mr Hughes's technical review and assessment conclude that there is unlikely to be adverse effects on surface water bodies as a result of groundwater drawdown attributable to the proposed abstractions. Based on the predicted absence of effects on water levels, I do not consider it likely that the ecological and natural character values of surface water bodies—including those significant and outstanding values—will be affected.

190. The proposals do not give rise to any associated effects or activities that will have consequent effects on ecology and/or natural character values.

4.13 Climate Change Consideration

191. The Aupōuri Aquifer Review report prepared by Lincoln Agritech Limited[31] formed the basis for the determination of allocation limits for the Aupōuri Aquifer and its sub-zones. The report acknowledged that the climate models projected a drier future climate for Northland, and that overall, the predictions indicate a net reduction in recharge across the aquifer. It is noted that the allocation limits prescribed in the pRPN include allowances for the effects of climate change.

[31] Lincoln Agritech Limited, April 2015, *Aupōuri Aquifer Review Report 1056-1-R1*

192. Additionally, the simulations run in the AAGM used historic climate records, which include several periods of drought over the past 58 years, and the simulation used to evaluate potential cumulative drawdown effects used maximum abstraction rates and volumes sought and the 2009/10 irrigation period, which represents drought conditions. Mr Hughes's review of the model considers the assumed climatic stresses to be appropriate.

193. It is recommended that a programme of monitoring both groundwater levels and salinity indicators for the duration of any consents that may be granted be included in a Groundwater Monitoring and Contingency Plan (GMCP) to ensure that potential effects of the proposed takes can be understood in the context of any long-term climatic trends.

5. ALTERNATIVES

194. Under Schedule 4, clause 6(1)(a) of the RMA, an AEE should include "if it is likely that the activity will result in any significant adverse effects on the environment, a description of any possible alternative locations or methods for undertaking the activity". Consideration of alternatives is therefore only required where there are likely to be significant adverse effects. Credible evidence of any significant adverse effect or potential effect on the environment arising from the proposals must exist for the consideration of alternatives to be relevant.

195. Through analysis of the proposal, I have not identified any credible significant adverse effect on the environment. Nor have any of the submissions received provided credible evidence of any significant adverse effect or potential effect on the environment arising from the proposal. A full assessment of alternatives is therefore not strictly required under Schedule 4.

196. The assessment criteria in the RWSP and pRPN do require consideration of the adequacy of the assessment of any alternative water sources considered, or other water management strategies and the reasons for the proposed system.

197. The AEE does not comment on options for using alternative water sources for irrigation. Northland has recently experienced a severe drought and FNDC recently implemented Level 3 water restrictions and placed a ban on the use of Council water supply schemes at Kaitāia, including for all irrigation and sprinkler use over the period 16 February 2020 to 12 June 2020[32]. Work is currently in progress to bring the FNDC bore at Sweetwater online so that the municipal supply, which is currently drawn from the Awanui River, is bolstered. The recent drought has highlighted that the potential use of surface water as an alternative source for irrigation is not reliable. Additionally, the fact that sufficient allocation remains within the Aupōuri Aquifer to supply the requested volumes highlights the preference for, and reliability of, utilising groundwater for water supply in the region.

[32] All water restrictions in Kaitāia were lifted on 17 July 2020.

198. I agree with WWLA and Mr Hughes that the effects of the proposed groundwater take are likely to be no more than minor. The volumes sought will be within the proposed allocation limits for the relevant Aupōuri Aquifer sub-aquifer zones, when cross-boundary effects are taken into account. As such, I consider it appropriate that groundwater is utilised as the primary water source for irrigation of the proposed avocado orchards and horticulture/cropping areas.

199. I recommend that appropriate monitoring conditions are proposed to ensure the effects are no more than minor, as assessed for these applications. Proposed management and mitigation measures are discussed in Section 6 of this report.

6. MANAGEMENT AND MITIGATION MEASURES

6.1 Precautionary Principle and Adaptive Management

200. The assessment and analysis undertaken in this report in order to make a recommendation on the subject applications is based on the most current information available on the extent, function, and interaction of the Aupōuri Aquifer and its composite sub-zones, and an up-to-date and relevant groundwater model developed by the Applicants that uses the most accurate data available to form credible predictions. However, given the nature of groundwater resources, and particularly the limited understanding of what is a particularly complex and variable groundwater system, there remains a degree of uncertainty inherent in the assessment and predictions.

201. The Applicants have proposed an adaptive management regime that stages the rate of abstraction for each take to enable monitoring, reporting and analysis to be undertaken. This staged approach addresses the inherent uncertainty regarding potential effects associated with the proposed takes by enabling effects to be identified to be identified and addressed as they arise, and trigger levels to be reviewed and/or remedial actions taken.

202. The frameworks for proposed draft conditions included at Attachment 1 include specification of the volumes to be abstracted at each stage. WWLA has provided preferred staging allocations for the two of the applications, outlined in **Table 3** below. The preferred staging allocations for the remainder of the applications had not been received at the time of writing. As such, the proposed draft conditions and GMCPs are incomplete and cannot be finalised. However, I consider the frameworks included in Attachments 1 and 2 to provide an appropriate mechanism through which the potential risks and effects can be addressed, once the necessary detail is incorporated.

Table 3: Preferred Staging Allocations

Application number	Applicant	Stage 1 maximum annual volume (m^3)	Stage 2 maximum annual volume (m^3)	Stage 3 maximum annual volume (m^3)	Stage 4 maximum annual volume (m^3)
APP.040364.01.01	Elbury Holdings Limited	50,000	100,000	150,000	200,000
APP.020995.01.04*	Te Rarawa Farming Limited and Te Make Farms Limited	2,317,000	2,317,000	3,093,000	3,093,000

Note: ** denotes applications seeking an increased volume for existing consented takes. The Stage 1 take for these applications comprises the existing consented take volumes.*

6.2 Sub-regional Management Approach

203. Pre-hearing engagement between the Applicants and Council has indicated a preference for potential effects to be managed at a more regional level, given the geographical spread of the proposed takes. I consider this appropriate, and thus propose that the applications be collated into three separate and distinct groupings:

- The Northern group – applications 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 and 13, located approximately between Ngataki and Houhora Heads;
- The Middle group – applications 11, 14, 15, 16, 17, 18, 19, 20, 21 and 22, located approximately between Houhora Heads and Paparore; and
- The South-western group – applications 23 and 24, located around Sweetwater and Ahipara.

204. The rationale for the proposed split is to acknowledge that the allocation limits in the pRPN are set separately for each of the sub-zones that comprise the Aupōuri Aquifer, and to provide a more relevant and equitable approach to monitoring, identifying and managing potential effects attributed to the proposed takes. Additionally, the proposed split acknowledges and provides for the unique environment of the Kaimaumau Wetland in proposing specific management measures for those takes in areas proximate to it and its surrounding coastal environment, and enables the specific statutory requirements of the NPS and the NZCPS to be addressed appropriately within each group.

205. A separate draft condition set and separate draft GMCP have been prepared for each of the three groups. The draft conditions and draft GMCPs for the Northern and South-western groups are based on the MWWUG conditions and GMCP, but do not contain provisions specifically relevant to the Kaimaumau Wetland.

206. It is proposed that the Middle group of takes be absorbed into the MWWUG GMCP to consolidate the management and monitoring of large groundwater takes for irrigation within that wider area proximate to the Kaimaumau Wetland. The same trigger levels and adaptive management regime would apply to all existing MWWUG and new AAWUG takes identified within that GMCP. There is scope within the existing GMCP to enable amendments and the inclusion of additional takes, and this could feasibly be achieved as part of the revision of the GMCP through the Staged Implementation and Monitoring Programme Review process currently being initiated by NRC in

respect to three of the MWWUG consents, or through a separate revision and amendment process initiated by NRC.

207. The complexity in absorbing additional takes into the existing MWWUG framework lies in ensuring that the grant/addition of new takes does not result in any impediments to the rights of existing consent holders to exercise their permits in accordance with the conditions of consent or reduce the reliability of supply for those consent holders. The first in, first served approach means that, where multiple consents are granted in respect of the same resource, the rights of existing consent holders take precedence over the rights of those subsequently granted consent. This prioritisation becomes difficult to practically accommodate in the mitigation approach taken by the MWWUG consents and GMCP, where the exceedance of T2 trigger levels requires a reduction or potential cessation of take.

208. In an attempt to address this, a banded approach to mitigation has been proposed, which gives priority to existing MWWUG consent holders by requiring earlier mitigating action (reduction or cessation of take) for those new takes added to the GMCP, in the event that trigger levels are exceeded. Whilst this presents a risk for new applicants in the Middle group in terms of reliability of supply, it provides a fairer approach to identifying and managing potential adverse effects associated with groundwater drawdown and saline intrusion. Council remains open to working with the Applicants, submitters and existing consent holders to explore options and approaches for managing water takes in the MWWUG and Middle group area.

209. The sub-regional approach proposed is intended to provide a more equitable approach to monitoring and mitigation, in that the costs of monitoring and the potential consequences of trigger level exceedances are shared amongst those takes that require or contribute to them.

6.3 Monitoring

210. Policy D.4.23 of the pRPN sets out requirements for conditions for water permits.

Water permits must include conditions that:

- *clearly define the take amount in instantaneous take rates and total volumes, including by reference to the temporal aspects of the take and use, and*
- *require that the water take is metered and information on rates and total volume of the take is provided electronically to the regional council, and*
- *for water permits for takes equal to or greater than 10 litres per second, require the water meter to be telemetered to the regional council, and*
- *clearly define when any restrictions and cessation of the water take must occur to ensure compliance with freshwater water quantity limits set in this plan, and*
- *require the use of a backflow prevention system to prevent the backflow of contaminants to surface water or ground water from irrigation systems used to apply animal effluent, agrichemical or nutrients, and*
- *specify when and under what circumstances the permit will be reviewed pursuant to Section 128(1) of the RMA, including by way of a common review date with other water permits in a catchment.*

211. A set of recommended monitoring conditions are proposed to enable council's obligations in granting any water permits to be fulfilled. Similarly to the approach taken for the MWWUG, the conditions include a GMCP that sets out the monitoring requirements – both for production bores and sentinel bores – and specifies the processes for setting trigger levels and/or progressing to subsequent stages of allocation.

212. Mr Hughes's technical review has utilised the existing available MWWUG consent monitoring data along with the relevant data from NRC and DoC data sources to consider the potential monitoring requirements for the proposed groundwater takes. His suggestions include the provision of a number of new telemetered sentinel bores that, along with identified existing monitoring bores and the proposed production bores, shall be used to monitor the following:

- Groundwater levels;
- Volume and rate of water extraction;
- Salinity indicators; and
- Water quality parameters, where appropriate.

213. Mr Hughes has indicated a requirement for two new sentinel bores as part of the monitoring suite for the South-western group takes within the Sweetwater and Ahipara sub-aquifers. The approximate locations for these sentinel bores are along the coast adjacent to the proposed takes within the Ahipara sub-aquifer, and between the coast and the Sweetwater Farm, FNDC and Elbury Holdings take locations.

214. Mr Hughes recommends that these sentinel bores continuously monitor groundwater levels and electrical conductivity in both the deep shell and shallow sand aquifers, and that they are telemetered. These locations have been selected to provide a relevant and indicative picture of potential effects, particularly in relation to potential saline intrusion risks. Further details regarding the locations and parameters for these monitoring bores and additional monitoring required, including for production bores, are included in the relevant proposed draft GMCP in Attachment 2.

215. In addition to these two additional sentinel bores, Mr Hughes recommends that the existing NRC shellbed piezometer at Lake Heather is telemetered to monitor groundwater levels. This site is generally central to the bulk of the proposed takes (Sweetwater Farm, FNDC and Elbury Holdings) and can be used to monitor and manage cumulative well interference effects.

216. For the Northern group, two new sentinel bores are proposed along the coastal margin, seaward of areas where abstraction is concentrated. These bores will provide the primary reference sites for monitoring and management of potential saline intrusion effects. Mr Hughes recommends that these bores continuously monitor groundwater levels and electrical conductivity in both the deep shell and shallow sand aquifers, and that they are telemetered.

217. Additional monitoring of groundwater levels is also proposed at selected locations inland of Pukenui and in the Waihopo area, either at suitably located existing bores or new piezometers, to enable monitoring and management of localised and cumulative drawdown effects. An additional location for monitoring of salinity indicators in the Waihopo area is also proposed. Further details regarding the locations and parameters for these monitoring bores and additional monitoring required, including for production bores, are included in the relevant proposed draft GMCP in Attachment 2.

218. For the Middle group, one new sentinel bore is proposed near the coast at Heath Road, north of Paparore, to enable targeted monitoring of potential effects within the Paparore sub-aquifer area. Mr Hughes recommends that this bore continuously monitors groundwater levels and electrical conductivity in both the deep shell and shallow sand aquifers, and that it is telemetered.

219. Further details regarding the locations and parameters for this monitoring bore and additional monitoring required, including for production bores, are included in the relevant proposed draft GMCP in Attachment 2.

220. In the event that these consents are granted, the installation of new sentinel bores and associated monitoring equipment should be undertaken by the Consent Holders, and the costs of doing so should be borne by the Consent Holders. This will allow the Applicants to manage the procurement of contractors to install the bores and equipment. Provided the bores and monitoring equipment are installed to a high specification, the data collected will be reliable and fit for purpose. Separate consents required from NRC for the installation of the sentinel bores can be applied for at a later date. These consents are controlled activities under the pPRP.

221. NRC will manage the maintenance of the monitoring equipment and collection of monitoring data and recoup the costs of doing so from the Consent Holders. To allow efficient data collection, real time monitoring and quality assessment of data, it is recommended that any data which is required to be collected continuously is telemetered directly to NRC. It is acknowledged that there is an initial cost associated with installing telemetry; however, over the term of a consent it is expected to be no greater than relying on manual collection and processing of the data. The benefits of having real time data are significant to NRC, the Applicants and the public, especially given the sensitivity of the resource and the reliance of the proposed adaptive management regime on monitoring data

7. STATUTORY ASSESSMENT

7.1 Planning Framework

222. The relevant planning documents are listed in **Table 4** below.

Table 4: Relevant Statutory and Non-statutory Planning Documents

Planning Document	Description/Purpose
Statutory documents considered under Section 104(1)(b) of the RMA	
National Policy Statement for Freshwater Management 2014 (updated August 2017)	The NPS directs regional councils, in consultation with the communities they serve, to set objectives for the state of freshwater bodies within their regions, to identify freshwater units, and to set limits on resource use to meet these objectives. Relevant key requirements of the NPS in the context of these 24 applications include: ▪ Consider and recognise te Mana o te Wai in freshwater management; ▪ Safeguard the life-supporting capacity of freshwater, ecosystem processes and indigenous species; ▪ Protect the significant values of wetlands and outstanding freshwater bodies; ▪ Follow the national objectives framework in identifying tangata whenua and community values for freshwater and use a specified set of attributes to set objectives; ▪ Set limits on resource use and allocation to meet limits over time, through determination of an appropriate method to meet objectives; ▪ Take an integrated approach to managing land use, freshwater and coastal water; and ▪ Involve iwi and hapū in decision-making for, and management of, freshwater. The NPS generally focuses on the development of freshwater management objectives and policies within the regional planning framework. However, guidance is also provided on in the form of transitional provisions for assessing proposals prior to the full incorporation of the NPS requirements into the regional plan. NRC's programme for implementing the NPS extends to 2025; however, the majority of initiatives relating to water quantity have been implemented, including the setting of allocation limits for the Aupōuri Aquifer.
New Zealand Coastal Policy Statement	The NZCPS guides regional authorities in their management of the coastal environment. The NZCPS is relevant to the proposed groundwater abstractions insofar as they may potentially impact on the ecological and natural character values of the coastal environment, particularly around the coastal margins of the Kaimaumau Wetland.
Regional Policy Statement for Northland	The RPS was made operative in May 2016, with the exception of specific provisions relating to the use of genetic engineering and release of genetically modified organisms into the environment.

Planning Document	Description/Purpose
	The objectives, policies and methods of the RPS underpin those within the regional plan to set the direction for achieving integrated management of Northland's natural and physical resources.
Proposed Regional Plan for Northland	The pRPN was notified in September 2017, prior to the lodgement of any of these 24 applications for groundwater take from the Aupōuri Aquifer. The current version of the pRPN—the Appeals Version—was released in June 2020, and all provisions not subject to appeal are currently operative. Rule C.5.1.12 – *Other water takes – discretionary activity*, pursuant to which the 24 applicants are seeking consent is not subject to appeal, and is thus considered operative, and supersedes the relevant rule in the RWSP. Policy H.4.4, which sets the allocations limits for aquifers, is not subject to appeal, and is thus considered operative and superseded the relevant policy in the RWSP.
Regional Water and Soil Plan for Northland	The operative RWSP sets out the objectives, policies and rules for the management of groundwater. The RWSP is in the process of being replaced by the pRPN as the remaining appeals are resolved. However, given that a number of the applications were lodged at a time when the RWSP rules took precedence over the pRPN rules, it is relevant to consider the planning framework at the time of lodgement.
Non-Statutory documents considered under Section 104(1)(c) of the RMA	
Pukenui-Houhora Community Development Plan	The Pukenui-Houhora Community Development Plan was developed by the local community in collaboration with FNDC in 2007. The plan sets out community values and aspirations, including in relation to groundwater management and economic development.
Ngā Tai e Rua o Te Aupōuri, Environmental Management Plan	Iwi Environmental Management Plans have been prepared by Te Aupōuri, Ngāi Takoto and Ngā Marae o Ahipara following the culmination of Treaty Settlements as a means through which Mana Whenua can guide and exercise kaitiakitanga.
Te Iwi o Ngāi Takoto Environmental Plan	
Ahipara Takiwā Management Plan	

223. Also of specific relevance to applications for groundwater take are the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010. These regulations detail requirements for holders of water permits in relation to record keeping and continuous measurement of water taken under a water permit. The regulations specify the content and format of records and the accuracy of metering. Proposed draft conditions have been recommended in accordance with the regulations, in the event that consent for the proposed takes is granted.

7.2 National Policy Statement for Freshwater Management

224. The relevant provisions (refer to Attachment 6) of the NPS address mana whenua issues and introduce the concept of te Mana o te Wai, maintenance and improvement of freshwater quality, efficient water allocation and sustainable freshwater quantity management, and integration of freshwater and land management and ecosystems.

225. In terms of quality, quantity and integrated management, I consider that the proposals are generally consistent with the relevant provisions and overall direction of the NPS. The allocation limits for the Aupōuri Aquifer sub-areas have been set in accordance with recognised and accepted processes, and the proposed takes do not exhaust the sub-area limits when cross-boundary effects are considered. The analyses undertaken by WWLA and Mr Hughes indicate that the proposed abstractions, if granted, can be sustained within the existing allocation limits of the Aupōuri Aquifer[33] and its sub-areas, and that the takes are unlikely to adversely affect surface water bodies within the Aupōuri Peninsula.

226. The proposed adaptive management regime seeks to integrate the management of the takes at a sub-regional level to enable the broader and cumulative effects of groundwater abstraction from the aquifer to be monitored and understood. The precautionary nature of the proposed conditions and GMCP is appropriate for enabling communities to provide for their wellbeing while promoting efficient use of the groundwater resource and safeguarding the life-supporting capacity of freshwater ecosystems.

227. With respect to te Mana o te Wai and tangata whenua involvement, NRC sought feedback from relevant iwi, hapū and marae komiti through the limited notification process, as well as through the established consent notification protocol NRC has with Mana Whenua partners. The concerns raised through those processes are outlined in Section 3.2.2, and a preliminary assessment of potential cultural effects associated with the proposed takes is provided in Section 4.11 of this report.

228. The NPS notes that tangata whenua involvement in freshwater management is key to giving effect to te Tiriti o Waitangi/the Treaty of Waitangi. The principles of Te Tiriti are generally recognised as: partnership; active protection; and participation. The proposed abstractions—particularly those for which Mana Whenua groups are applicants—provide for active protection of natural resources and Māori interests in that they will facilitate the growth and development of economic and employment opportunities within the Far North in a manner that will avoid, remedy and mitigate effects to safeguard the sustainability of the Aupōuri Aquifer.

[33] Utilising NRC's calculation methodology to take into account cross-boundary effects

229. Whilst the scope of these 24 applications does not allow for criticisms of broader water and resource management processes within Te Hiku to be addressed, there are opportunities available for council and the Applicants to engage with Māori in meaningful ways to understand what te Mana o te Wai means in the context of the Far North, and to actively meet the principles of partnership and participation. The proposed draft GMCPs include a requirement to provide monitoring reports to mandated iwi, hapū and marae representatives to initiate ongoing discussions regarding the management of groundwater in Te Hiku.

7.3 New Zealand Coastal Policy Statement

230. The relevant provisions (refer to Attachment 6) of the NZCPS seek to safeguard the and sustain the coastal environment and its ecosystems, take account of the principles of the Treaty of Waitangi and recognise the role of tangata whenua as kaitiaki, and enable people and communities to provide for their wellbeing. The NZCPS also requires the adoption of a precautionary approach where effects of activities are uncertain and provides for integrated and coordinated management of activities within the coastal environment. Most importantly, the NZCPS requires that significant adverse effects on indigenous biodiversity, natural character, and natural features and landscapes within the coastal environment.

231. Whilst the proposed takes occur outside of the coastal environment, the values of the coastal environment are pertinent in relation to the Kaimaumau Wetland—part of which is recognised as an outstanding natural landscape—and the dune lakes present within the modelled area of effects. Additionally, the Kaimaumau Wetland is a recognised area for indigenous biodiversity. The potential effects of the proposed abstractions on the values of surface water bodies, including wetlands, have been considered in Section 0 and 4.12 of this report. The assessment concludes that the adverse effects of the proposed abstractions will be less than minor, as the data currently available indicates that the surface water bodies are perched, and there is little to no hydraulic connectivity and/or interaction with the underlying aquifer units. As such, the proposed groundwater takes are unlikely to affect the natural character, landscape and ecological values preserved and protected under the NZCPS and Sections 6(a), (b) and (c) of the RMA.

232. The proposed adaptive management regime recognises the uncertainty inherent in the modelling of predicted effects. The staging of takes, continual monitoring of groundwater levels and salinity indicators, and the setting of trigger levels provide an appropriate response to measuring and mitigating potential effects if and when they arise.

233. An assessment of the proposals in relation to Treaty principles and tangata whenua involvement is provided in Section 0 of this report.

7.4 Regional Policy Statement for Northland

234. The relevant provisions (refer to Attachment 6) of the RPS relate to integrated catchment management, region-wide water quality improvement and the protection of drinking water sources, maintenance of ecological flows and water levels, and enabling economic wellbeing through efficient use and allocation of resources.

235. The proposals are considered to be generally consistent with the relevant provisions of the RPS, in that they will be managed in an integrated manner to avoid adverse effects and meet water quality and quantity objectives for the Aupōuri Peninsula.

236. Several of the proposed takes at Sweetwater Station are in proximity to FNDC's consented groundwater take for the community supply scheme serving Kaitāia. The modelling predictions indicate that the existing FNDC bore is likely to experience significant drawdown effects when all existing consented and proposed takes are factored in[34]. However, it is assumed that the other FNDC production bore will be constructed efficiently with sufficient available drawdown to enable it to remain operational and efficient in the face of increased take within the nearby area.

237. The proposed take sought by Te Rarawa Farming Limited and Te Make Farms Limited is an increase to the existing take authorised under the existing water permit (AUT.020995.01.03) held by Landcorp Farming Limited and Te Runanga O Te Rarawa [35], which is being replaced as part of Application APP.020995.01.04. As part of the total take volume sought in the application relates to the replacement of an existing take that pre-dates the granting of the FNDC consent at Sweetwater, the replacement of the consented volume essentially takes precedence under the first come, first served allocation system. There is no national policy instrument that specifies a hierarchy for take and use of groundwater, although the need to protect water quality for registered drinking water supplies is recognised in the *National Environmental Standard for Sources of Human Drinking Water*. Discussions with FNDC in relation to how the consented community supply take for Kaitāia can be protected are ongoing.

238. The assessment of whether the proposed abstractions constitute efficient and reasonable use of the groundwater resource provided in Section 4.2 of this report concludes that the proposed takes are reasonable and will provide for the sustainable development of land for horticulture. Conditions requiring efficient construction and screening of bores and the preparation of an Irrigation Scheduling Plan are included in the proposed draft conditions at Attachment 1.

7.5 Proposed Regional Plan for Northland

239. The relevant provisions (refer to Attachment 6) of the pRPN relate to the management of freshwater quantity and quality in a manner that safeguards the life-supporting capacity and ecosystem processes of freshwater systems, avoids adverse effects associated with land subsidence and saline intrusion, and maintains the reliability of groundwater as a resource for consumptive and non-consumptive uses. Objectives for enabling economic wellbeing through the management of natural and physical resources, as well as involving tangata whenua in decision-making processes are also relevant to the proposals.

[34] The majority of the impact is attributable to pumping at the existing bore itself.

[35] At the time of lodgement, an application for transfer of ownership of consent AUT.020995.01.03 to Te Rarawa Farming Limited and Te Make Farms Limited.

240. The finite characteristics of the groundwater resource of the Aupōuri Aquifer have been considered in the assessment provided in Section 4 of this report, particularly the sustainability of abstraction from the aquifer in relation to both overall aquifer storage and recharge, and effects on other groundwater users. The assessment concludes that the proposed takes, if granted, can be exercised in a manner that does not compromise the sustainability of the aquifer, and that the adverse effects on other groundwater takes will be less than minor. The proposed adaptive management regime will provide a framework within which groundwater levels and salinity indicators can be monitored and takes reduced or ceased in the event that trigger levels are exceeded, so that the sustainability of abstraction and the overall groundwater system are maintained.

7.6 Regional Water and Soil Plan for Northland

241. The relevant provisions (refer to Attachment 6) of the RWSP include those relating to recognition of and provision for Māori and their culture and traditions, water quality management, groundwater management, and integrated catchment management. The objectives and policies have largely been superseded by those made operative in the pRPN but relate largely to the same matters and seek to implement a similar policy direction to that within the pRPN.

242. The assessment provided in the above sections can be applied in the context of those objectives and policies of the RWSP that are considered relevant to the proposals. With the exception of the water allocation limits now specified in the pRPN and additional specificity provided in relation to water quantity targets and outcomes[36], the two plans are considered to be generally consistent in the overall approach to freshwater management in Northland.

7.7 Pukenui-Houhora Community Development Plan

243. Objective 3.2 of the Pukenui/Houhora Community Development Plan (Appendix 1) seeks that:

…aquifers will be conserved by minimising commercial exploitation; and the potential for contamination of shell aquifers in particular will be avoided. Deep aquifers will continue to be closely monitored for falling levels and quality. Long term planning will take into account the probable need for a reticulated water supply.

244. These matters have been addressed in the response to submissions (Section 3 of this report), particularly in relation to commercial uses of water and potential future reticulation, and the assessment of effects in Section 4, which addresses contamination and drawdown of groundwater. Section 6 of this report provides details of monitoring and mitigation. The proposals do not preclude the aspirations of the Pukenui/Houhora Community Development Plan, and the proposed management measures address those matters integral to the maintenance and sustainability of the groundwater resource.

[36] The RWSP includes transitional policies inserted into the RWSP to give effect to the NPS prior to the implementation of relevant requirements. The pRPN includes a number of specific and bespoke objectives and policies that give effect to the NPS.

7.8 Iwi Environmental Management Plans

245. Three Iwi Environmental Management Plans (IEMPs) are relevant to the applications, being:

- Ngā Tai e Rua o Te Aupōuri, Environmental Management Plan
- Te Iwi o Ngāi Takoto Environmental Plan
- Ahipara Takiwā Management Plan

246. These plans have been prepared by mandated iwi, hapū and marae representatives following the settlement of respective Treaty claims. These plans set directions for the exercise of kaitiakitanga across Treaty settlement areas and the wider environment within each group's respective rohe, in accordance with cultural values, protocols and traditions.

247. The Applicants are currently undertaking assessments of the proposals against the provisions of the IEMPs. It is anticipated that these assessments will be available by the time the hearing is convened, and a proper analysis of their adequacy and the consistency of the proposals with the objectives and policies can be made.

7.9 Value of Investment

248. Section 101(2A) of the RMA requires the consent authority to have regard to the value of the investment of the existing consent holder in relation to any application affected by Section 124 of the RMA. The application lodged by Te Rarawa Farming Limited and Te Make Farms Limited seeks to replace the existing consent (AUT.020995.01.03) held by Landcorp Farming Limited and Te Rūnanga o Te Rarawa, which expires on 30 November 2021.

249. Application APP.020995.01.04 seeks to replace the existing consent and increase the volume of groundwater taken for irrigation of orchard/cropping areas and pasture. Substantial investment has been made into the development of irrigation infrastructure at Sweetwater Farm in recent years, including time and costs invested in obtaining and altering consents to draw groundwater for irrigation. The future development of Sweetwater Farm is guided by a masterplan and includes broadening horticultural activities to increase the productive use of the Farm in a suitable manner.

7.10 Part 2 Assessment

250. In the context of these 24 applications, where the objectives and policies of the relevant statutory documents were prepared having regard to Part 2 of the RMA, they capture all relevant planning considerations and contain a coherent set of policies designed to achieve clear environmental outcomes. They also provide a clear framework for assessing all relevant potential effects. As such, a separate assessment of the proposals against the relevant matters of Part 2 of the RMA is considered unnecessary and unlikely to add to the evaluative exercise.

8. CONCLUSIONS AND RECOMMENDATION

8.1 Summary

251. The assessment provided in Section 4 of this report concludes that the proposed groundwater abstractions will not adversely affect the ability of the immediate and wider Far North communities to provide for their future needs and wellbeing. The proposed abstractions will not prevent future applications for groundwater (provided that there remains available allocation within the aquifer), nor will they impinge on the rights of existing consent holders and water users currently operating lawfully.

252. Cumulative drawdown predictions and validation of these through the analysis of existing data indicate that there is little interaction between surface water bodies—including Kaimaumau Wetland and dune lakes within the modelled area of effects—and the shallow sand and deep shellbed layers of the Aupōuri Aquifer. As a consequence, effects on the integrity, and natural, ecological and landscape values of surface water bodies are determined to be unlikely.

253. The analysis undertaken in preceding sections regarding the effects on the Aupōuri Aquifer and its composite sub-zones, existing users, communities and the environment concludes that the proposed water takes can occur in a manner that will not compromise the overall sustainability of groundwater resources within the Aupōuri Peninsula, will maintain the life-supporting capacity of the environment, and will meet the reasonably foreseeable needs of future generations. The proposals are broadly consistent with the relevant objectives and policies of the relevant statutory documents, along with the provisions of relevant non-statutory documents.

254. Granting these applications will enable the development of land through establishment and growth of horticultural operations, primarily avocado orchards, which will in turn provide for the social and economic wellbeing of the applicants and wider Far North community through creation of jobs and economic stimulus.

255. The proposed draft conditions and GMCPs include staged increases in allocation over time, continuous monitoring of groundwater level and salinity indicators, and requirements for consent holders to reduce or cease abstraction should adverse effects greater than those anticipated and assessed through the resource consent process. These suggestions are made in light of the inherent uncertainty in modelling groundwater effects to enable adverse effects on the environment to be avoided, remedied or mitigated to support the sustainable allocation of water from the Aupōuri Aquifer.

256. Overall, based on the assessment provided in this report, and in consideration of the proposed draft conditions and GMCPs, I consider that the proposals will represent sustainable management of natural and physical resources, and recommend that consents are granted, subject to acceptable conditions.

8.2 Proposed Draft Conditions

257. Initial frameworks for the GMCPs and proposed draft conditions for each of the three groups were developed from the MWWUG consents and GMCP and were circulated to NRC and Ms Letica on 2 July 2020 and 4 July 2020. These framework documents were also provided to Mr Hughes on 13 July 2020. All parties were requested to provide comments and changes on the drafts to enable some degree of agreement to be reached on the details prior to the pre-circulation of evidence. Mr Hughes provided feedback on and amendments to the proposed draft GMCPs for all three groups, and these have also been reviewed and commented on by Stuart Savill, Consents Manager for the NRC. The proposed draft GMCPs included in Attachment 2 have incorporated these changes and comments.

258. Mr Savill has reviewed the conditions and provided comments and amendments, which have been incorporated into the frameworks for proposed draft conditions included in Attachment 1. Ms Letica provided initial feedback that the prioritisation of the two separate 'bands' of consents as proposed was not supported.

259. The proposed draft conditions and GMCPs (as included in Attachments 1 and 2 respectively) provide a framework which is expected to be supplemented and completed through the Applicants' evidence, particularly specific information on the proposed locations, volumes, rates, staging and monitoring and mitigation requirements for each application, to complete the draft conditions for each permit (if granted).

260. The assessment of these 24 proposed groundwater takes has been undertaken on the basis that these details can be incorporated into the frameworks in a manner that will provide for adequate monitoring and appropriate management of abstractions to avoid, remedy and mitigate adverse effects. It is my opinion that the proposed draft conditions provide an appropriate framework which, when populated with the specific data regarding staging, rates and locations of takes, will result in identified actual and potential adverse effects being appropriately mitigated.

8.3 Term of Consent

261. Policy D.2.12[37] of the pRPN and Section 37.5 RWSP state matters that council must have regard to, including (but not limited to):

- The sustainability of the resource affected by the proposed activity;
- Security of tenure for investment (with a general approach of the larger the investment, the longer the consent duration);
- Alignment of expiry dates with other resource consents for the same activity in the surrounding area;
- Certainty of effects (the less certainty, the shorter duration of consent) and the extent of knowledge of the effects and environment;

[37] Subject to appeals ENV-2019-AKJL

- In relation to consent renewals and/or additional volumes sought, past compliance with consent conditions and voluntary adoption of good management practice methods to minimise environmental effects

262. The durations of consent sought by the applicants are 20 years (APP.039859.01.01), 25 years (APP.020995.01.04) and 30 years (all other applications[38]). The uncertainty inherent in the modelling requires that a precautionary approach is taken in determining the duration for which large volume water permits are granted.

263. The recommended duration of consent for these consents, if granted, is 13 years. The existing MWWUG consents expire in November 2033. In the interests of maintaining a consistent approach to groundwater allocation and management for the Aupōuri Aquifer and enabling a comprehensive review of all consents to be undertaken at an identifiable point in the future, it is recommended that the expiry dates for these 24 applications align with the MWWUG consents.

264. This term is considered an appropriate timeframe to enable the orchards to reach maturity and determine whether changes to irrigation requirements are necessary. The term also provides sufficient financial security of investment as the orchards can be developed fully within the consent duration.

265. Considering this timeframe in light of the proposed staging of allocations outlined in the adaptive management approach within the GMCP, this timeframe would essentially allow for the full allocation (Stage 4) to be taken from the aquifer for up to approximately eight years, after Stages 1-3 have been completed. Monitoring data collected over this period would provide a more complete picture of the groundwater system and enable further understanding of effects and sustainability of groundwater allocation within the Aupōuri Aquifer.

266. It is noted that the adaptive management regime suggested in the frameworks for proposed draft conditions and GCMPs (refer to Attachment 1 and Attachment 2) and the review provisions contained in Section 128 of the RMA provide scope for review of and changes to the consents prior to the expiry dates, if required.

267. A proposed draft condition requiring the surrender of existing consent(s) prior to exercising the new consents is recommended for consents granted to those parties seeking consent to increase and/or replace existing consents, being:

- Waikopu Avocados Limited (APP.040601.01.01);
- Henderson Bay Avocados Limited (APP.017428.02.01);
- Avokaha Limited (APP.008647.01.06);
- KSL Limited (APP.039628.01.04); and
- Te Rarawa Farming Limited and Te Make Farms Limited (APP.020995.01.04)

268. It is recommended that the applications for consent are granted, subject to conditions consistent with those proposed draft conditions included in Attachment 1.

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[38] The duration of consent sought by P & G Enterprises (PJ & GW Marchant) in application APP.040231.01.01 is not stated. For assessment purposes, this application has been grouped with those seeking a 30 year duration of consent.

8.4 Recommendation

269. It is recommended that the applications for consent are granted, subject to conditions consistent with the frameworks for proposed draft conditions included in Attachment 1, including GMCPs consistent with the proposed draft GMCPs included in Attachment 2.

ATTACHMENT 1

ATTACHMENT 1A Proposed Draft Conditions – Northern Group

This framework comprises proposed draft conditions applicable to the following applications:

APP.017428.02.01	Henderson Bay Avocados
APP.040600.01.01	Far North Avocados Ltd
APP.041211.01.01	P McGlaughlin
APP.039859.01.01	Te Aupōuri Commercial Development Ltd
APP.040121.01.01	NE Evans Trust & WJ Evans & J Evans
APP.040231.01.01	P&G Enterprises (PJ & GW Marchant)
APP.040652.01.01	SE & LA Blucher
APP.039644.01.01	MP Doody & DM Wedding
APP.040397.01.01	A. Matthews
APP.040558.01.01	MV Evans (Property 1)
APP.040979.01.01	MV Evans (Property 2)

Note: *Pursuant to Section 116 of the Resource Management Act 1991, the date of commencement of this consent is* ***XX XX 20XX****.*

[CONSENT HOLDER]

AUT.XX **To take and use groundwater from the Aupōuri Waihopo, Houhora and Other sub-aquifer management units for the purposes of horticultural irrigation purposes.**

LOCATION

Address of Site

[Insert address reference]

Legal Description of Site

Site of take: [Insert legal descriptions]

Sites of use: [Insert legal descriptions]

Map Reference (New Zealand Transverse Mercator Projection)

[Bore 1:XXE XXN]

[Bore 2:XXE XXN]

Note: An error accuracy of +/- 50 metres applies to these map references.

CONSENT DURATION

This consent is granted for a period expiring on **30 November 2033.**

CONDITIONS OF AUT.XX

1 The consent holder shall pay all charges relating to the recovery of cost for the administration, monitoring and supervision of this consent fixed by Council under Section 36 of the Resource Management Act 1991.

2 The exercise of this consent is bound by the Master Consent conditions **attached** as Appendix A. The Master Consent uses an alternate numbering system '1MC, 2MC, 3MC…'.

3 Subject to compliance with the conditions of this consent, the activity authorised by this consent shall be carried out in accordance with the application and documents submitted as part of the application, including the following documents:

(a) Assessment of Environmental Effects prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Take Consent Applications, Assessment of Environmental Effects – Aupōuri Aquifer Water User Group. WWLA0184: Rev. 2*, dated 27 February 2020;

(b) Model Report prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Model, Factual Technical Report – Modelling – Aupōuri Aquifer Water User Group. WWLA0184: 3*, dated 5 February 2020.

For the avoidance of doubt, where information contained in the application documents is contrary to the conditions of this consent and those in the Master Consent (Appendix A), or where the information contained in the application documents is internally inconsistent, the conditions of this consent and the Master Consent shall prevail.

4 This consent operates under an adaptive management regime. The detail of that adaptive management regime is set out in the Groundwater Monitoring and Contingency Plan for the Waihopo and Northern Houhora Sub-areas of the Aupōuri Aquifer Management Unit, **Dated: [July 2020] ("GMCP")**. The primary purpose of the GMCP is to set out the procedures by which the abstraction will be monitored and managed to ensure compliance with Condition 1MC. For the purpose of this consent, the GMCP is the most recent version of the GMCP which may be changed under Condition 8MC. In the event that any of the provisions of the GMCP conflict with the requirements of these conditions of consent, these conditions of consent shall prevail.

5 The consent shall be exercised in a staged manner as follows:

(a) Stage 1, which shall be a minimum period of 12 months after consent is first exercised and must include abstraction for a full irrigation season;

(b) Stage 2, which shall be for the minimum period of two consecutive irrigation seasons;

(c) Stage 3, which shall be for the minimum period of two consecutive irrigation seasons;

(d) Stage 4 which shall be from the irrigation season immediately following written approval to progress from Stage 3 until the expiry of the consent, unless Conditions 9-13 apply.

6 The combined daily volume of water taken across all bores shall not exceed the following:

(a) [XX] cubic metres in any 24 consecutive hours unless Conditions 9(b), 11 or 13 of this consent apply; and

(b) That required to replace soil moisture depleted by evapotranspiration over the irrigated area.

7 The annual volume of water taken from Bore [xx] for each stage shall not exceed the following, unless Conditions 9-13 apply:

(a) Stage 1: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(b) Stage 2: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(c) Stage 3: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(d) Stage 4: [XX] cubic metres between 1 July in a year and 30 June in the following year.

8 Progress to the next stage shall only occur where written approval is given by the Council's Compliance Manager; and

(a) This written approval will only be given if the council is satisfied that the Staged Implementation and Monitoring Review prepared in accordance with the GMCP confirms that the groundwater abstraction complies with Condition 1MC; and

(b) A decision on whether written approval will be given or not will not be made until the Council has consulted with the Consent Holder and the Department of Conservation over the Staged Implementation and Monitoring Review; and

(c) Notwithstanding Condition 8(b), written approval to progress from Stage 1 to Stage 2 will not be considered unless all the monitoring trigger levels required by the GMCP have been set; and

(d) A report detailing the reasons for the Council's decision in regard to progressing to the next stage, including the identification and discussion of any matters raised during the consultation described in Condition 8(b), will be provided to the Consent Holder and the Department of Conservation.

Breaching of Trigger Levels

9 In the event of a Trigger Level 2 (TL2) in the GMCP being exceeded, the following actions and requirements shall be initiated;

(a) The Council will advise the Consent Holder in writing that a TL2 has been reached;

(b) Upon receipt of this notice, the Consent Holder shall immediately reduce their daily abstraction to 50% of the current average daily quantity, as advised by the Council in the notice. The current average daily quantity will be calculated using the previous months water use records required by Condition 19. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only;

(c) As required by the GMCP, the Council will commission a Groundwater Trigger Exceedance Report to assess why the trigger level has been breached, identify the pumping bores in the area of effect and review all of the available data collected in the affected area(s).

10 Once Condition 9(b) has been complied with, the Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council's approval of an alternative reduction value will only be given if it is satisfied that a TL2 exceedance that is attributable to this consent will not occur. The applicable alternative reduction value is the value that is contained in the recommendations made in the Groundwater Trigger Exceedance Report required to be prepared by Condition 9(c).

11 If the TL2 trigger levels are still exceeded after 21 days, then the Consent Holder shall reduce their daily abstraction to 25% of the current average daily quantity calculated for Condition 9(b). The Council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

12 Once Condition 11 has been complied with, the Consent Holder shall also comply with the recommendations contained in the revised and updated Groundwater Trigger Exceedance Report commissioned by the Council which will be prepared for the purpose of specifying a programme of actions to achieve compliance with Condition 1MC.

13 If the TL2 trigger levels continue to be exceeded after the implementation of the remedial measures required under Conditions 9-12, the Council may require the Consent Holder to suspend the exercise of this consent, or continue their daily abstraction at a specified rate, until such time as the Council issues written notice that the Consent may be exercised again in accordance with the requirements of the revised and updated Groundwater Trigger Exceedance Report.

Notification of Irrigation

14 The Consent Holder shall advise the Council's assigned Monitoring Officer in writing when irrigation is to commence for the first time each season, at least five working days beforehand.

Metering and Abstraction Reporting

15 Prior to the first exercise of this consent, a meter shall be installed to measure the volume of water taken, in cubic metres, from each production bore. Each meter shall:

(a) Be able to provide data in a form suitable for electronic storage;

(b) Be sealed and as tamper-proof as practicable;

(c) Be installed at the location from which the water is taken; and

(d) Have an accuracy of +/-5%.

The Consent Holder shall, at all times, provide safe and easy access to each meter installed for Council to undertake visual inspections and record water take measurements.

16 The Consent Holder shall verify that the meter required by Condition 15 is accurate. This verification shall be undertaken prior to 30 June:

(a) Following the first taking of water from each production bore in accordance with this consent; and

(b) At least once in every five years thereafter.

Each verification shall be undertaken by a person, who in the opinion of the Council's Compliance Manager, is suitably qualified. Written verification of the accuracy shall be provided to the council's assigned Monitoring Officer no later than 31 July following the date of each verification.

17 The Consent Holder shall keep a record of the daily volume of water taken from each production bore in cubic metres, including all nil abstractions, using the readings from the meter required by Condition 15.

18 If the instantaneous rate of taking is equal to or greater than 10 litres per second, then the water meter required by Condition 15 shall be telemetered to the Northland Regional Council.

19 A copy of the records required to be kept by Condition 17 shall be forwarded to the Council's assigned Monitoring Officer:

(a) On a monthly basis, by the seventh of the following month, if the water meter is not telemetered to the Northland Regional Council; or

(b) Annually by the 31 July, for the previous period 1 July to the 30 June, if the water meter is telemetered to the Northland Regional Council.

In addition, a copy of these records shall be forwarded immediately to the Council's assigned Monitoring Officer on written request. The records shall be in an electronic format that has been agreed to by the council.

Advice Note: *If no water is taken during any calendar month then the Consent Holder is still required to notify the council's Monitoring Manager in writing of the nil abstraction. Water use record sheets in an electronic format are available from the council's website at www.nrc.govt.nz/wur.*

Water Use Efficiency

20 The Consent Holder shall prepare an Irrigation Scheduling Plan (ISP) that outlines how irrigation decisions will be made. The purpose of the ISP is to set out how the irrigation will be undertaken to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop. The ISP shall be prepared by a suitably qualified and experienced person and submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP. The ISP shall, as a minimum, address:

- Water balance and crop water requirements;
- Subsurface drainage; and
- Overall irrigation strategy.

For each irrigation area, the ISP should include:

(a) A description of how water requirements for each irrigation cycle are calculated;

(b) Method(s) for assessing current soil moisture levels;

(c) Method(s) for assessing potential evapotranspiration (PET) and rainfall to date;

(d) Soil moisture target to be maintained in each zone by irrigation;

(e) How measured data will be used to assess irrigation requirements over the next irrigation cycle; and

(f) A description of proposed method(s) for remaining within consent limits at each borehole or group of boreholes.

21 The Consent Holder shall not exercise this consent until the ISP required by Condition 20 has been certified by the Council's Compliance Manager.

22 The ISP certified in accordance with Condition 21 shall be implemented prior to the first irrigation season, unless a later date has been approved in writing by the Council's Compliance Manager.

23 The Consent Holder shall, within six months of the first exercise of this consent, undertake an audit of the irrigation system and of the certified ISP. The audit shall be undertaken by a suitably qualified and experienced person. The irrigation system audit shall be prepared in accordance with Irrigation New Zealand's "Irrigation Evaluation Code of Practice" (dated 12 April 2010), and shall include recommendations on any improvements that should be made to the system to increase water efficiencies or any amendments to the ISP. The results of the audit and its recommendations shall be submitted in writing to the Council's assigned Monitoring Officer within one month of the audit being undertaken. Any recommended amendments to the ISP shall be submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP before they take effect. A follow-up audit shall occur at five yearly intervals throughout the term of this consent with the intent of confirming an irrigation efficiency of at least 80 percent.

24 The Consent Holder shall, within three months of notification in writing by the Council's Compliance Manager, implement any recommendations of the audit referred to in Condition 23.

25 The reticulation system and its component parts shall be maintained in good working order to minimise leakage and wastage of water.

26 The rate at which water is applied to the irrigated area shall not result in ponding of irrigated water within any irrigated area, or runoff from either surface or subsurface drainage to a water body, as a result of the exercise of this consent.

Advice Note: *The ISP seeks to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop.*

Review Condition

27 The Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions annually during the month of September for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or

(b) To insert trigger level thresholds established in accordance with the GMCP as conditions of consent.

(c) To review the allocation of the resource.

The Consent Holder shall meet all reasonable costs of any such review.

Lapsing Condition

28 This consent shall lapse five years after the date that the consent commences in accordance with section 116(1) of the Resource Management Act 1991, unless the consent has been given effect to before this date.

APPENDIX A – MASTER CONSENT CONDITIONS

General

1MC. The consented activity must not, individually or cumulatively, result in:

(a) saltwater intrusion into the Aupōuri aquifer; or

(b) adverse effects on the hydrological functioning of dune lakes and natural wetlands; or

(c) adverse effects on the significant indigenous vegetation and habitats in dune lakes and natural wetlands; or

(d) lowering of the groundwater levels in the Aupōuri aquifer such that existing efficient bore takes operating as a permitted activity or in accordance with resource consent conditions cannot access groundwater of the quantity authorised.

Prior to the Exercise of Consent

2MC. Prior to the exercise of this consent, new bores required to be installed for the purposes of monitoring the baseline effects in accordance with the GMCP shall be constructed and all required equipment installed by a suitably qualified person(s).

3MC. Where the GMCP requires that the frequency of monitoring for a parameter is continuous, then the monitoring equipment shall be installed as follows:

(a) for groundwater level recording, to the requirements of the National Environmental Monitoring Standards;

(b) for conductivity sensors they must be able to record "Specific Conductance" (corrected to 25 deg C), have available software for field calibration, and be able to record across the whole expected conductivity range for the water body measured;

(c) Sensors must be installed in a secure manner to ensure stationarity over time;

(d) Instantaneous reading recorded every 5 minutes;

(e) Recording to NZ Standard Time (NZST);

(f) Water Level readings compensated for barometric pressure prior to transmission;

(g) Telemetered to Northland Regional Council with a minimum of hourly transmission of data; and

(h) Reference points levelled to One Tree Point datum and NZVD

4MC. Prior to the exercise of this consent, the Consent Holder shall provide to the Council's assigned monitoring officer the installation details from the suitably qualified person of all monitoring equipment that has been installed in accordance with Condition 3MC. This information will be used by the Council's Compliance Manager to determine compliance with Conditions 2MC and 3MC.

5MC. Prior to the exercise of this consent, a suitable approach to detecting and responding to saline intrusion effects during Stage 1 (Year 1) shall be prepared. The Council's Compliance Manager shall certify that the approach to detecting and responding to saline intrusion will give effect to Condition 1MC. The certified information shall be inserted into the GMCP through the process set out in Condition 8MC prior to the exercise of this consent.

Monitoring and Contingency Measures

6MC. This consent shall be exercised and monitored in accordance with the most recent revision of the GMCP.

7MC. The Consent Holder shall, at all times, provide safe and easy access to the production bore wellhead(s) for the purpose of undertaking monitoring on the bore(s), as set out in the GMCP.

8MC. Excluding the Staged Implementation and Monitoring Programme Review process, the GMCP may be amended at any time by the following process:

(a) Subject to Condition 8MC(d), the Council may amend the GMCP by providing notice in writing to the Consent Holder that the GMCP has been amended and providing a copy of the amended GMCP to the Consent Holder.

(b) Subject to Condition 8MC(d), the Consent Holder may submit a request for an amendment by giving written notice to the Council of the proposed amendment along with any supporting technical documents.

(c) Prior to making any decision to amend the GMCP or not, the Council will seek input on any proposed amendment from the Consent Holder and from the Director-General of Conservation.

(d) The Council will not approve any amendment to the GMCP unless the technical assessment of the proposed change clearly indicates that the change will not result in a breach of Condition 1MC.

ATTACHMENT 1B Proposed Draft Conditions – South-western Group

This framework comprises proposed draft conditions applicable to the following applications:

APP.040364.01.01	Elbury Holdings Ltd
APP.020995.01.04	Te Rarawa Farming Ltd and Te Make Farms Ltd

Note: *Pursuant to Section 116 of the Resource Management Act 1991, the date of commencement of this consent is* ***XX XX 20XX****.*

[CONSENT HOLDER]

AUT.XX **To take and use groundwater from the Aupōuri-Sweetwater and Ahipara sub-aquifer management units for the purposes of horticultural irrigation purposes.**

LOCATION

Address of Site

[Insert address reference]

Legal Description of Site

Site of take: [Insert legal descriptions]

Sites of use: [Insert legal descriptions]

Map Reference (New Zealand Transverse Mercator Projection)

Bore 1: XXE XXN

Bore 2: XXE XXN

Note: An error accuracy of +/- 50 metres applies to these map references.

CONSENT DURATION

This consent is granted for a period expiring on **30 November 2033.**

CONDITIONS OF AUT.XX

1 The consent holder shall pay all charges relating to the recovery of cost for the administration, monitoring and supervision of this consent fixed by Council under Section 36 of the Resource Management Act 1991.

2 The exercise of this consent is bound by the Master Consent conditions **attached** as Appendix A. The Master Consent uses an alternate numbering system '1MC, 2MC, 3MC…'.

3 Subject to compliance with the conditions of this consent, the activity authorised by this consent shall be carried out in accordance with the application and documents submitted as part of the application, including the following documents:

(a) Assessment of Environmental Effects prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Take Consent Applications, Assessment of Environmental Effects – Aupōuri Aquifer Water User Group. WWLA0184: Rev. 2*, dated 27 February 2020;

(b) Model Report prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Model, Factual Technical Report – Modelling – Aupōuri Aquifer Water User Group. WWLA0184: 3*, dated 5 February 2020.

For the avoidance of doubt, where information contained in the application documents is contrary to the conditions of this consent and those in the Master Consent (Appendix A), or where the information contained in the application documents is internally inconsistent, the conditions of this consent and the Master Consent shall prevail.

4 This consent operates under an adaptive management regime. The detail of that adaptive management regime is set out in the Groundwater Monitoring and Contingency Plan for the Sweetwater and Ahipara Sub-areas of the Aupōuri Aquifer Management Unit, Dated: [**July 2020**] **("GMCP")**. The primary purpose of the GMCP is to set out the procedures by which the abstraction will be monitored and managed to ensure compliance with Condition 1MC. For the purpose of this consent, the GMCP is the most recent version of the GMCP which may be changed under Condition 8MC. In the event that any of the provisions of the GMCP conflict with the requirements of these conditions of consent, these conditions of consent shall prevail.

5 The consent shall be exercised in a staged manner as follows:

(a) Stage 1, which shall be a minimum period of 12 months after consent is first exercised and must include abstraction for a full irrigation season;

(b) Stage 2, which shall be for the minimum period of two consecutive irrigation seasons;

(c) Stage 3, which shall be for the minimum period of two consecutive irrigation seasons;

(d) Stage 4 which shall be from the irrigation season immediately following written approval to progress from Stage 3 until the expiry of the consent, unless Conditions 9-13 apply.

6 The combined daily volume of water taken across all bores shall not exceed the following:

(a) [XX] cubic metres in any 24 consecutive hours unless Conditions 9(b), 11 or 13 of this consent apply; and

(b) That required to replace soil moisture depleted by evapotranspiration over the irrigated area.

7 The annual volume of water taken from Bore [xx] for each stage shall not exceed the following unless Conditions 9-13 apply:

(a) Stage 1: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(b) Stage 2: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(c) Stage 3: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(d) Stage 4: [XX] cubic metres between 1 July in a year and 30 June in the following year.

8 Progress to the next stage shall only occur where written approval is given by the Council's Compliance Manager; and

(a) This written approval will only be given if the council is satisfied that the Staged Implementation and Monitoring Review prepared in accordance with the GMCP confirms that the groundwater abstraction complies with Condition 1MC; and

(b) A decision on whether written approval will be given or not will not be made until the Council has consulted with the Consent Holder and the Department of Conservation over the Staged Implementation and Monitoring Review; and

(c) Notwithstanding Condition 8(b), written approval to progress from Stage 1 to Stage 2 will not be considered unless all the monitoring trigger levels required by the GMCP have been set; and

(d) A report detailing the reasons for the Council's decision in regard to progressing to the next stage, including the identification and discussion of any matters raised during the consultation described in Condition 8(b), will be provided to the Consent Holder and the Department of Conservation.

Breaching of Trigger Levels

9 In the event of a Trigger Level 2 (TL2) in the GMCP being exceeded, the following actions and requirements shall be initiated;

(a) The Council will advise the Consent Holder in writing that a TL2 has been reached;

(b) Upon receipt of this notice, the Consent Holder shall immediately reduce their daily abstraction to 50% of the current average daily quantity, as advised by the Council in the notice. The current average daily quantity will be calculated using the previous months water use records required by Condition 19. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only;

(c) As required by the GMCP, the Council will commission a Groundwater Trigger Exceedance Report to assess why the trigger level has been breached, identify the pumping bores in the area of effect and review all of the available data collected in the affected area(s).

10 Once Condition 9(b) has been complied with, the Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council's approval of an alternative reduction value will only be given if it is satisfied that a TL2 exceedance that is attributable to this consent will not occur. The applicable alternative reduction value is the value that is contained in the recommendations made in the Groundwater Trigger Exceedance Report required to be prepared by Condition 9(c).

11 If the TL2 trigger levels are still exceeded after 21 days, then the Consent Holder shall reduce their daily abstraction to 25% of the current average daily quantity calculated for Condition 9(b). The Council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

12 Once Condition 12 has been complied with, the Consent Holder shall also comply with the recommendations contained in the revised and updated Groundwater Trigger Exceedance Report commissioned by the Council which will be prepared for the purpose of specifying a programme of actions to achieve compliance with Condition 1MC.

13 If the TL2 trigger levels continue to be exceeded after the implementation of the remedial measures required under Conditions 9-12, the Council may require the Consent Holder to suspend the exercise of this consent, or continue their daily abstraction at a specified rate, until such time as the Council issues written notice that the Consent may be exercised again in accordance with the requirements of the revised and updated Groundwater Trigger Exceedance Report.

Notification of Irrigation

14 The Consent Holder shall advise the Council's assigned Monitoring Officer in writing when irrigation is to commence for the first time each season, at least five working days beforehand.

Metering and Abstraction Reporting

15 Prior to the first exercise of this consent, a meter shall be installed to measure the volume of water taken, in cubic metres, from each production bore. Each meter shall:

(a) Be able to provide data in a form suitable for electronic storage;

(b) Be sealed and as tamper-proof as practicable;

(c) Be installed at the location from which the water is taken; and

(d) Have an accuracy of +/-5%.

The Consent Holder shall, at all times, provide safe and easy access to each meter installed for Council to undertake visual inspections and record water take measurements.

16 The Consent Holder shall verify that the meter required by Condition 15 is accurate. This verification shall be undertaken prior to June 30:

(a) Following the first taking of water from each production bore in accordance with this consent; and

(b) At least once in every five years thereafter.

Each verification shall be undertaken by a person, who in the opinion of the Council's Compliance Manager, is suitably qualified. Written verification of the accuracy shall be provided to the council's assigned Monitoring Officer no later than 31 July following the date of each verification.

17 The Consent Holder shall keep a record of the daily volume of water taken from each production bore in cubic metres, including all nil abstractions, using the readings from the meter required by Condition 15.

18 If the instantaneous rate of taking is equal to or greater than 10 litres per second, then the water meter required by Condition 15 shall be telemetered to the Northland Regional Council.

19 A copy of the records required to be kept by Condition 17 shall be forwarded to the Council's assigned Monitoring Officer:

(a) On a monthly basis, by the seventh of the following month, if the water meter is not telemetered to the Northland Regional Council; or

(b) Annually by the 31 July, for the previous period 1 July to the 30 June, if the water meter is telemetered to the Northland Regional Council.

In addition, a copy of these records shall be forwarded immediately to the Council's assigned Monitoring Officer on written request. The records shall be in an electronic format that has been agreed to by the council.

Advice Note: *If no water is taken during any calendar month then the Consent Holder is still required to notify the council's Monitoring Manager in writing of the nil abstraction. Water use record sheets in an electronic format are available from the council's website at www.nrc.govt.nz/wur.*

Water Use Efficiency

20 The Consent Holder shall prepare an Irrigation Scheduling Plan (ISP) that outlines how irrigation decisions will be made. The purpose of the ISP is to set out how the irrigation will be undertaken to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop. The ISP shall be prepared by a suitably qualified and experienced person and submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP. The ISP shall, as a minimum, address:

- Water balance and crop water requirements;
- Subsurface drainage; and
- Overall irrigation strategy.

For each irrigation area, the ISP should include:

(a) A description of how water requirements for each irrigation cycle are calculated;

(b) Method(s) for assessing current soil moisture levels;

(c) Method(s) for assessing potential evapotranspiration (PET) and rainfall to date;

(d) Soil moisture target to be maintained in each zone by irrigation;

(e) How measured data will be used to assess irrigation requirements over the next irrigation cycle; and

(f) A description of proposed method(s) for remaining within consent limits at each borehole or group of boreholes.

21 The Consent Holder shall not exercise this consent until the ISP required by Condition 20 has been certified by the Council's Compliance Manager.

22 The ISP certified in accordance with Condition 21 shall be implemented prior to the first irrigation season, unless a later date has been approved in writing by the Council's Compliance Manager.

23 The Consent Holder shall, within six months of the first exercise of this consent, undertake an audit of the irrigation system and of the certified ISP. The audit shall be undertaken by a suitably qualified and experienced person. The irrigation system audit shall be prepared in accordance with Irrigation New Zealand's "Irrigation Evaluation Code of Practice" (dated 12 April 2010), and shall include recommendations on any improvements that should be made to the system to increase water efficiencies or any amendments to the ISP. The results of the audit and its recommendations shall be submitted in writing to the Council's assigned Monitoring Officer within one month of the audit being undertaken. Any recommended amendments to the ISP shall be submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP before they take effect. A follow-up audit shall occur at five yearly intervals throughout the term of this consent with the intent of confirming an irrigation efficiency of at least 80 percent.

24 The Consent Holder shall, within three months of notification in writing by the Council's Compliance Manager, implement any recommendations of the audit referred to in Condition 23.

25 The reticulation system and its component parts shall be maintained in good working order to minimise leakage and wastage of water.

26 The rate at which water is applied to the irrigated area shall not result in ponding of irrigated water within any irrigated area, or runoff from either surface or subsurface drainage to a water body, as a result of the exercise of this consent.

Advice Note: *The ISP seeks to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop.*

Review Condition

27 The Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions annually during the month of September for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or

(b) To insert trigger level thresholds established in accordance with the GMCP as conditions of consent.

(c) To review the allocation of the resource.

The Consent Holder shall meet all reasonable costs of any such review.

Lapsing Condition

28 This consent shall lapse five years after the date that the consent commences in accordance with section 116(1) of the Resource Management Act 1991, unless the consent has been given effect to before this date.

APPENDIX A – MASTER CONSENT CONDITIONS

General

1MC. The consented activity must not, individually or cumulatively, result in:

(a) saltwater intrusion into the Aupōuri aquifer; or

(b) adverse effects on the hydrological functioning of dune lakes and natural wetlands; or

(c) adverse effects on the significant indigenous vegetation and habitats in dune lakes and natural wetlands; or

(d) lowering of the groundwater levels in the Aupōuri aquifer such that existing efficient bore takes operating as a permitted activity or in accordance with resource consent conditions cannot access groundwater of the quantity authorised.

Prior to the Exercise of Consent

2MC. Prior to the exercise of this consent, new bores required to be installed for the purposes of monitoring the baseline effects in accordance with the GMCP shall be constructed and all required equipment installed by a suitably qualified person(s).

3MC. Where the GMCP requires that the frequency of monitoring for a parameter is continuous, then the monitoring equipment shall be installed as follows:

(a) for groundwater level recording, to the requirements of the National Environmental Monitoring Standards;

(b) for conductivity sensors they must be able to record "Specific Conductance" (corrected to 25 deg C), have available software for field calibration, and be able to record across the whole expected conductivity range for the water body measured;

(c) Sensors must be installed in a secure manner to ensure stationarity over time;

(d) Instantaneous reading recorded every 5 minutes;

(e) Recording to NZ Standard Time (NZST);

(f) Water Level readings compensated for barometric pressure prior to transmission;

(g) Telemetered to Northland Regional Council with a minimum of hourly transmission of data; and

(h) Reference points levelled to One Tree Point datum and NZVD

4MC. Prior to the exercise of this consent, the Consent Holder shall provide to the Council's assigned monitoring officer the installation details from the suitably qualified person of all monitoring equipment that has been installed in accordance with Condition 3MC. This information will be used by the Council's Compliance Manager to determine compliance with Conditions 2MC and 3MC.

5MC. Prior to the exercise of this consent, a suitable approach to detecting and responding to saline intrusion effects during Stage 1 (Year 1) shall be prepared. The Council's Compliance Manager shall certify that the approach to detecting and responding to saline intrusion will give effect to Condition 1MC. The certified information shall be inserted into the GMCP through the process set out in Condition 8MC prior to the exercise of this consent.

Monitoring and Contingency Measures

6MC. This consent shall be exercised and monitored in accordance with the most recent revision of the GMCP.

7MC. The Consent Holder shall, at all times, provide safe and easy access to the production bore wellhead(s) for the purpose of undertaking monitoring on the bore(s), as set out in the GMCP.

8MC. Excluding the Staged Implementation and Monitoring Programme Review process, the GMCP may be amended at any time by the following process:

(a) Subject to Condition 8MC(d), the Council may amend the GMCP by providing notice in writing to the Consent Holder that the GMCP has been amended and providing a copy of the amended GMCP to the Consent Holder.

(b) Subject to Condition 8MC(d), the Consent Holder may submit a request for an amendment by giving written notice to the Council of the proposed amendment along with any supporting technical documents.

(c) Prior to making any decision to amend the GMCP or not, the Council will seek input on any proposed amendment from the Consent Holder and from the Director-General of Conservation.

(d) The Council will not approve any amendment to the GMCP unless the technical assessment of the proposed change clearly indicates that the change will not result in a breach of Condition 1MC.

ATTACHMENT 1C Proposed Draft Conditions – Middle Group

This framework comprises proposed draft conditions applicable to the following applications:

APP.040919.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valdares and D Bryan (Property 1)
APP.040130.01.01	Tuscany Valley Avocados Ltd
APP.040918.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valadares & D Bryan (Property 2)
APP.008647.01.06	Avokaha Ltd
APP.039628.01.02	KSL Ltd
APP.040361.01.01	Tiri Avocados Ltd
APP.040362.01.01	Valic NZ Ltd
APP.040363.01.01	Green Charteris Family Trust
APP.039841.01.02	Mate Yelavitch & Co Ltd
APP.040386.01.01	Robert Paul Campbell Trust

AUT.XX **To take and use groundwater from the Aupōuri Paparore, Waiparera, Motutangi, and Houhora sub-aquifer management units for the purposes of horticultural irrigation purposes.**

LOCATION

Address of Site

[Insert address reference]

Legal Description of Site

Site of take: [Insert legal descriptions]

Sites of use: [Insert legal descriptions]

Map Reference (New Zealand Transverse Mercator Projection)

Bore 1: XXE XXN

Bore 2: XXE XXN

Note: An error accuracy of +/- 50 metres applies to these map references.

CONSENT DURATION

This consent is granted for a period expiring on **30 November 2033.**

CONDITIONS OF AUT.XX

1 The consent holder shall pay all charges relating to the recovery of cost for the administration, monitoring and supervision of this consent fixed by Council under Section 36 of the Resource Management Act 1991.

2 The exercise of this consent is bound by the Master Consent conditions **attached** as Appendix A. The Master Consent uses an alternate numbering system '1MC, 2MC, 3MC…'.

3 Subject to compliance with the conditions of this consent, the activity authorised by this consent shall be carried out in accordance with the application and documents submitted as part of the application, including the following documents:

(a) Assessment of Environmental Effects prepared by Williamson Water Advisory Ltd: *Irrigation Water Supply, Groundwater Take Consent Application – Motutangi Waiharara Water User Group. WWA0026: Final – Rev. 4*, dated 30 August 2017;

(b) Model Report prepared by Williamson Water Advisory Ltd: *Motutangi-Waiharara Groundwater Model, Factual Technical Report – Modelling. Motutangi-Waiharara Water User Group. WWA0026: Final – Rev. 9*, dated 31 August 2017.

(c) Technical Peer Review Letter Report prepared by LWP Ltd: *Water Permit Application – Motutangi – Waiharara Water User Group (MWWUG), Aupōuri Peninsula*, dated 19 September 2017.

(d) Assessment of Environmental Effects prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Take Consent Applications, Assessment of Environmental Effects – Aupōuri Aquifer Water User Group. WWLA0184: Rev. 2*, dated 27 February 2020;

(e) Model Report prepared by Williamson Water & Land Advisory Ltd: *Aupōuri Aquifer Groundwater Model, Factual Technical Report – Modelling – Aupōuri Aquifer Water User Group. WWLA0184: 3*, dated 5 February 2020.

For the avoidance of doubt, where information contained in the application documents is contrary to the conditions of this consent and those in the Master Consent (Appendix A), or where the information contained in the application documents is internally inconsistent, the conditions of this consent and the Master Consent shall prevail.

4 This consent operates under an adaptive management regime. The detail of that adaptive management regime is set out in the Groundwater Monitoring and Contingency Plan for the Paparore, Waiparera, Motutangi and Houhora Sub-areas of the Aupōuri Aquifer Management Unit, **Dated: [July 2020] ("GMCP")**. The primary purpose of the GMCP is to set out the procedures by which the abstraction will be monitored and managed to ensure compliance with Condition 1MC. For the purpose of this consent, the GMCP is the most recent version of the GMCP which may be changed under Condition 8MC. In the event that any of the provisions of the GMCP conflict with the requirements of these conditions of consent, these conditions of consent shall prevail.

5 The consent shall be exercised in a staged manner as follows:

(a) Stage 1, which shall a minimum period of 12 months, which must include abstraction for a full irrigation season after the consent is first exercised;

(b) Stage 2, which shall be for the minimum period of two consecutive irrigation seasons;

(c) Stage 3, which shall be for the minimum period of two consecutive irrigation seasons;

(d) Stage 4 which shall be from the irrigation season immediately following written approval to progress from Stage 3 until the expiry of the consent, unless Conditions 9-13 apply.

6 The combined daily volume of water taken across all bores shall not exceed the following:

(a) [XX] cubic metres in any 24 consecutive hours unless Conditions 9(b), 11 or 13 of this consent apply; and

(b) That required to replace soil moisture depleted by evapotranspiration over the irrigated area.

7 The annual volume of water taken from Bore [xx] for each stage shall not exceed the following unless Conditions 9-13 apply:

(a) Stage 1: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(b) Stage 2: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(c) Stage 3: [XX] cubic metres between 1 July in a year and 30 June in the following year;

(d) Stage 4: [XX] cubic metres between 1 July in a year and 30 June in the following year.

8 Progress to the next stage shall only occur where written approval is given by the Council's Compliance Manager; and

(a) This written approval will only be given if the council is satisfied that the Staged Implementation and Monitoring Review prepared in accordance with the GMCP confirms that the groundwater abstraction complies with Condition 1MC; and

(b) A decision on whether written approval will be given or not will not be made until the Council has consulted with the Consent Holder and the Department of Conservation over the Staged Implementation and Monitoring Review; and

(c) Notwithstanding Condition 8(b), written approval to progress from Stage 1 to Stage 2 will not be considered unless all the monitoring trigger levels required by the GMCP have been set; and

(d) A report detailing the reasons for the Council's decision in regard to progressing to the next stage, including the identification and discussion of any matters raised during the consultation described in Condition 8(b), will be provided to the Consent Holder and the Department of Conservation.

Breaching of Trigger Levels

9 In the event of a Trigger Level 2 (TL2) in the GMCP being exceeded, the following actions and requirements shall be initiated;

(a) The Council will advise the Consent Holder in writing that a TL2 has been reached;

(b) Upon receipt of this notice, the Consent Holder shall immediately reduce their daily abstraction to 50% of the current average daily quantity, as advised by the Council in the notice. The current average daily quantity will be calculated using the previous months water use records required by Condition 19. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only;

(c) As required by the GMCP, the Council will commission a Groundwater Trigger Exceedance Report to assess why the trigger level has been breached, identify the pumping bores in the area of effect and review all of the available data collected in the affected area(s).

10 Once Condition 9(b) has been complied with, the Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council's approval of an alternative reduction value will only be given if it is satisfied that a TL2 exceedance that is attributable to this consent will not occur. The applicable alternative reduction value is the value that is contained in the recommendations made in the Groundwater Trigger Exceedance Report required to be prepared by Condition 9(c). Approval for an alternative reduction will be given to Priority A Consent Holders first, as identified in the GMCP.

11 If the TL2 trigger levels are still exceeded after 21 days, then the Consent Holder shall reduce their daily abstraction to 25% of the current average daily quantity calculated for Condition 9(b). The Council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

12 Once Condition 11 has been complied with, the Consent Holder shall also comply with the recommendations contained in the revised and updated Groundwater Trigger Exceedance Report commissioned by the Council which will be prepared for the purpose of specifying a programme of actions to achieve compliance with Condition 1MC.

13 If the TL2 trigger levels continue to be exceeded after the implementation of the remedial measures required under Conditions 9-12, the Council may require the Consent Holder to suspend the exercise of this consent, or continue their daily abstraction at a specified rate, until such time as the Council issues written notice that the Consent may be exercised again in accordance with the requirements of the revised and updated Groundwater Trigger Exceedance Report. Any increase in abstraction will be provided to Priority A Consent Holders first, as identified in the GMCP.

Notification of Irrigation

14 The Consent Holder shall advise the Council's assigned Monitoring Officer in writing when irrigation is to commence for the first time each season, at least five working days beforehand.

Metering and Abstraction Reporting

15 Prior to the first exercise of this consent, a meter shall be installed to measure the volume of water taken, in cubic metres, from each production bore. Each meter shall:

(a) Be able to provide data in a form suitable for electronic storage;

(b) Be sealed and as tamper-proof as practicable;

(c) Be installed at the location from which the water is taken; and

(d) Have an accuracy of +/-5%.

The Consent Holder shall, at all times, provide safe and easy access to each meter installed for Council to undertake visual inspections and record water take measurements.

16 The Consent Holder shall verify that the meter required by Condition 15 is accurate. This verification shall be undertaken prior to 30 June:

(a) Following the first taking of water from each production bore in accordance with this consent; and

(b) At least once in every five years thereafter.

Each verification shall be undertaken by a person, who in the opinion of the Council's Compliance Manager, is suitably qualified. Written verification of the accuracy shall be provided to the council's assigned Monitoring Officer no later than 31 July following the date of each verification.

17 The Consent Holder shall keep a record of the daily volume of water taken from each production bore in cubic metres, including all nil abstractions, using the readings from the meter required by Condition 15.

18 If the instantaneous rate of taking is equal to or greater than 10 litres per second, then the water meter required by Condition 15 shall be telemetered to the Northland Regional Council.

19 A copy of the records required to be kept by Condition 17 shall be forwarded to the Council's assigned Monitoring Officer:

(a) On a monthly basis, by the seventh of the following month, if the water meter is not telemetered to the Northland Regional Council; or

(b) Annually by the 31 July, for the previous period 1 July to the 30 June, if the water meter is telemetered to the Northland Regional Council.

In addition, a copy of these records shall be forwarded immediately to the Council's assigned Monitoring Officer on written request. The records shall be in an electronic format that has been agreed to by the council.

Advice Note: *If no water is taken during any calendar month then the Consent Holder is still required to notify the council's Monitoring Manager in writing of the nil abstraction. Water use record sheets in an electronic format are available from the council's website at www.nrc.govt.nz/wur.*

Water Use Efficiency

20 The Consent Holder shall prepare an Irrigation Scheduling Plan (ISP) that outlines how irrigation decisions will be made. The purpose of the ISP is to set out how the irrigation will be undertaken to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop. The ISP shall be prepared by a suitably qualified and experienced person and submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP. The ISP shall, as a minimum, address:

- Water balance and crop water requirements;
- Subsurface drainage; and
- Overall irrigation strategy.

For each irrigation area, the ISP should include:

(a) A description of how water requirements for each irrigation cycle are calculated;

(b) Method(s) for assessing current soil moisture levels;

(c) Method(s) for assessing potential evapotranspiration (PET) and rainfall to date;

(d) Soil moisture target to be maintained in each zone by irrigation;

(e) How measured data will be used to assess irrigation requirements over the next irrigation cycle; and

(f) A description of proposed method(s) for remaining within consent limits at each borehole or group of boreholes.

21 The Consent Holder shall not exercise this consent until the ISP required by Condition 20 has been certified by the Council's Compliance Manager.

22 The ISP certified in accordance with Condition 21 shall be implemented prior to the first irrigation season, unless a later date has been approved in writing by the Council's Compliance Manager.

23 The Consent Holder shall, within six months of the first exercise of this consent, undertake an audit of the irrigation system and of the certified ISP. The audit shall be undertaken by a suitably qualified and experienced person. The irrigation system audit shall be prepared in accordance with Irrigation New Zealand's "Irrigation Evaluation Code of Practice" (dated 12 April 2010), and shall include recommendations on any improvements that should be made to the system to increase water efficiencies or any amendments to the ISP. The results of the audit and its recommendations shall be submitted in writing to the Council's assigned Monitoring Officer within one month of the audit being undertaken. Any recommended amendments to the ISP shall be submitted to the Council's Compliance Manager for written certification that it will achieve the purpose of the ISP before they take effect. A follow-up audit shall occur at five yearly intervals throughout the term of this consent with the intent of confirming an irrigation efficiency of at least 80 percent.

24 The Consent Holder shall, within three months of notification in writing by the Council's Compliance Manager, implement any recommendations of the audit referred to in Condition 23.

25 The reticulation system and its component parts shall be maintained in good working order to minimise leakage and wastage of water.

26 The rate at which water is applied to the irrigated area shall not result in ponding of irrigated water within any irrigated area, or runoff from either surface or subsurface drainage to a water body, as a result of the exercise of this consent.

Advice Note: *The ISP seeks to ensure that at least 80 percent of the annual volume of water applied to the irrigable area is retained in the soil in the root zone of the crop, compared to the average gross depth of water applied to the crop.*

Review Condition

27 The Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions annually during the month of September for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or

(b) To insert trigger level thresholds established in accordance with the GMCP as conditions of consent.

(c) To review the allocation of the resource.

The Consent Holder shall meet all reasonable costs of any such review.

Lapsing Condition

28 This consent shall lapse five years after the date that the consent commences in accordance with section 116(1) of the Resource Management Act 1991, unless the consent has been given effect to before this date.

APPENDIX A –MASTER CONSENT CONDITIONS

General

1MC. The consented activity must not, individually or cumulatively, result in:

(a) saltwater intrusion into the Aupōuri aquifer; or

(b) adverse effects on the hydrological functioning of the Kaimaumau-Motutangi wetland; or

(c) adverse effects on the significant indigenous vegetation and significant habitats of indigenous fauna in terrestrial and freshwater environments of the Kaimaumau-Motutangi wetland; or

(d) lowering of the groundwater levels in the Aupōuri aquifer such that existing efficient bore takes within the aquifer cannot access groundwater.

Prior to the Exercise of Consent

2MC. Prior to the exercise of this consent, new bores required to be installed for the purposes of monitoring the baseline effects in accordance with the GMCP shall be constructed and all required equipment installed by a suitably qualified person(s).

3MC. Where the GMCP requires that the frequency of monitoring for a parameter is continuous, then the monitoring equipment shall be installed as follows:

(a) for groundwater level recording, to the requirements of the National Environmental Monitoring Standards;

(b) for conductivity sensors they must be able to record “Specific Conductance” (corrected to 25 deg C), have available software for field calibration, and be able to record across the whole expected conductivity range for the water body measured;

(c) Sensors must be installed in a secure manner to ensure stationarity over time;

(d) Instantaneous reading recorded every 5 minutes;

(e) Recording to NZ Standard Time (NZST);

(f) Water Level readings compensated for barometric pressure prior to transmission;

(g) Telemetered to Northland Regional Council with a minimum of hourly transmission of data; and

(h) Reference points levelled to One Tree Point datum and NZVD

4MC. Prior to the exercise of this consent, the Consent Holder shall provide to the Council’s assigned monitoring officer the installation details from the suitably qualified person of all monitoring equipment that has been installed in accordance with Condition 3MC. This information will be used by the Council’s Compliance Manager to determine compliance with Conditions 2MC and 3MC.

5MC. Prior to the exercise of this consent, a suitable approach to detecting and responding to saline intrusion effects during Stage 1 (Year 1) shall be prepared. The Council’s Compliance Manager shall certify that the approach to detecting and responding to saline intrusion will give effect to Condition 1MC. The certified information shall be inserted into the GMCP through the process set out in Condition 8MC prior to the exercise of this consent.

Monitoring and Contingency Measures

6MC. This consent shall be exercised and monitored in accordance with the GMCP.

7MC. The Consent Holder shall, at all times, provide safe and easy access to the production bore wellhead(s) for the purpose of undertaking monitoring on the bore(s), as set out in the GMCP.

8MC. Excluding the Staged Implementation and Monitoring Review process, the GMCP may be amended at any time by the following process:

(a) Subject to Condition 8MC(d), the Council may amend the GMCP by providing notice in writing to the Consent Holder that the GMCP has been amended and providing a copy of the amended GMCP to the Consent Holder.

(b) Subject to Condition 8MC(d), the Consent Holder may submit a request for an amendment by giving written notice to the Council of the proposed amendment along with any supporting technical documents.

(c) Prior to making any decision to amend the GMCP or not, the Council will seek input on any proposed amendment from the Consent Holder and from the Director-General of Conservation.

(d) The Council will not approve any amendment to the GMCP unless the technical assessment of the proposed change clearly indicates that the change will not result in a breach of Condition 1MC.

ATTACHMENT 2

NOTIFICATION DECISION REPORT

APPLICATION DETAILS

Applicant: **Multiple applications for new, and S127 increases for existing, groundwater takes as shown in Table 1 below.**

Application Number: **See Table 1 below.**

Description of Activity: **Groundwater take applications from the Aupouri aquifer for irrigation of avocado orchards and mixed horticultural crops.**

Table 1. Details of all applicants

Note: Applications denoted with an asterisk are S127 change to existing consent. All others are new

Applicant Name	Application number
Te Aupouri Commercial Development Ltd	APP.039859.01.01
Waikopu Avocados Ltd	APP.040601.01.01
Henderson Bay Avocados Ltd	APP.017428.02.01
Far north Avocados Ltd	APP.040600.01.01
P McLaughlin	APP.041211.01.01
NE Evans Trust & WJ Evans & J Evans	APP.040121.01.01
P&G Enterprises (PJ & GW Marchant)	APP.040231.01.01
MP Doody & DM Wedding	APP.039644.01.01
A Matthews	APP.040397.01.01
SE & LA Blucher	APP.040652.01.01
NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan	APP.040919.01.01
MV Evans	APP.040979.01.01
MV Evans	APP.040558.01.01
Tuscany Valley Avocados Ltd	APP.040130.01.01
NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan	APP.040918.01.01
Avokaha Ltd	APP.008647.01.06
KSL Ltd	APP.039628.01.04
Tiri Avocados Ltd.	APP.040361.01.01
Valic NZ Ltd	APP.040362.01.01
Green Charteris Family Trust (Wataview Orchards)	APP.040363.01.01
Mate Yelavich & Co Ltd	APP.039841.01.02
Robert Paul Campbell Trust	APP.040386.01.01
Elbury Holdings Ltd	APP.040364.01.01
Te Rarawa Farming Ltd and Te Make Farms Ltd	APP.020995.01.04

STEP 1 Request for Public Notification

Has the applicant requested public notification?

☑ No ➔ Go to **Step 2**.

☐ Yes ➔ Go to **Step 21**. Tick the **Publicly Notified** box as the application must be publicly notified as required by section 95A(2) of the Resource Management Act (RMA).

STEP 2 Has the Applicant Refused a section 92 Request

☑ No ➔ Go to **Step 3**.

☐ Yes ➔ Go to **Step 21**. Tick the **Publicly Notified** box as the application must be publicly notified as required by section 95A(2) of the RMA.

STEP 3 National Environmental Standard (NES)

Is there a NES that precludes public notification of each activity?

☑ No ➔ Go to **Step 4**.

☐ Yes ➔ Name of NES: **INSERT NAME**. Go to **Step 9 – Special Circumstances**.

STEP 4 Plan Provisions Regarding Public Notification

Is there a rule or provision in a Regional Plan that precludes public notification of this type of application?

☑ No ➔ Go to **Step 5**.

☐ Yes ➔ Rule **INSERT RULE**. Go to **Step 9 – Special Circumstances**.

STEP 5 Classification of Activity

Are all the resource consents either:

(a) *"controlled"* activities; or

(b) *"restricted discretionary"* or *"discretionary"* activities for a residential activity only?

Note: Residential activity is defined in section 95A(6) and relates to consents that are for the use of one or more dwelling houses solely for residential purposes and can include residential subdivisions.

☑ No ➔ Go to **Step 6**.

☐ Yes ➔ Go to **Step 9 – Special Circumstances**.

STEP 6 National Environmental Standard (NES)

Is there a NES that precludes public notification of each activity?

☑ No ➔ Go to **Step 7**.

☐ Yes ➔ Name of NES: **INSERT NAME**. Go to **Step 21**. Tick the **Publicly Notified** box as the application must be publicly notified as required by section 95A(7) of the RMA.

STEP 7 Plan Provisions Regarding Public Notification

Is there a rule or provision in a Regional Plan that requires this type of application to be publicly notified?

☑ No ➔ Go to **Step 8**.

☐ Yes ➔ Rule **INSERT RULE**. Go to **Step 21**. Tick the **Publicly Notified** box as the application must be publicly notified as required by section 95A(7) of the RMA.

STEP 8 Adverse Effects

What do the potential effects of the activity relate to? *(tick as many as appropriate)*

☑ Downstream flows	☐ Air quality
☑ Aquifer levels	☑ Human health
☐ Flooding	☑ Natural character
☐ Scouring	☐ Archaeological/historic sites
☑ Water quality	☐ Public/recreational access
☑ Cultural	☐ Navigation
☑ Ecological	☑ Structural security
☑ Habitat/wildlife	☐ Other Subsidence

Is it considered that the activity will have, or is likely to have, adverse effects on the environment that are more than minor?

Note: The requirements of section 95D of the RMA shall be taken into account when determining whether the adverse effects of any activity will be more than minor.

☑ No ➔ State reasons below, then go to **Step 9**.

☐ Yes ➔ State reasons below. Go to **Step 21**. Tick the **Publicly Notified** box as the application must be publicly notified as required by section 95A(7) of the RMA.

Reasons:

Effects on the deep and shallow aquifers

All applicants lodged separate applications with Council. A combined assessment of the cumulative groundwater drawdown effect from all the consents, relative to a 'no take' naturalised scenario, was however provided to council by Williamson Water & Land Advisory (WWLA) as part of an additional information request. This cumulative assessment was undertaken using a numerical model developed by WWLA, which encompassed 9 subsections of the Aupouri Aquifer from Ngataki to Ahipara. The application documents and cumulative effects assessment has been independently peer reviewed for council by LWP Ltd (LWP).

The groundwater model was run over a 58-year timeframe using historical climate data from 1960 to 2018. Pumping associated with all existing and proposed abstraction was applied to the model over this period (i.e. to simulate proposed pumping over the historical record). Cumulative groundwater drawdown maps for a worst-case scenario of a 1 in 50 year return period drought were provided for the following scenarios and aquifer characteristics:

- Scenario 1: naturalised no take scenario;
- Scenario 2: all existing and proposed takes assuming aquifer hydraulic properties that result in modelled water levels exhibiting the best match to actual measured groundwater levels; and

- Scenario 3: all existing and proposed takes assuming aquifer hydraulic properties that result in lower connectivity between the shallow sand and deep shell bed aquifers.

This model is based on relatively conservative assumptions, using known aquifer characteristics derived from pumping tests from a variety of locations. It is recognised that the model is limited in its ability to include hard pans and other low permeability layers (such as peat and silt beds) that are likely to occur intermittently throughout this area, which limit the hydraulic linkage between the deep and shallow aquifers. Therefore, while calibrated to water levels at a sub-regional scale, Scenario 2 is considered to potentially over-estimate the effect of pumping on the shallow aquifer and under-estimate effects on the deep aquifer. For this reason, Scenario 3 was developed to provide the worst-case scenario for a less leaky system which would mimic the conditions where hardpans are present at a local scale.

The model was unable to vary between Scenarios 2 and 3 within the same model run, so Scenario 3 was required to be applied to the whole aquifer, even though this is not the actual case in reality. While providing a worst-case assessment of local drawdown, maps of drawdown calculated using Scenario 3 are considered over estimates of the likely drawdown in the deep aquifer across the wider aquifer (because low permeability layers are intermittent and limited in spatial extent).

It is therefore important to note that the Scenario 2 drawdown map was produced using a calibrated version of the model and is therefore the most representative of the potential adverse effects that may occur on a regional scale. The purpose of Scenario 3 is to show the possible drawdown where there may be a localised anomaly that fully restricts the vertical movement of groundwater in an area. It would be incorrect to consider this scenario as representative of conditions over the entire region. However, the council has used the Scenario 3 drawdown map as the worst-case scenario in its assessment of affected parties, which is discussed later in this report.

The most likely drawdown scenario (Scenario 2) resulting from the cumulative effects of these applications, along with existing takes, will result in a maximum drawdown in the deep shell bed aquifer of around 0.5 to 1.5 metres (m) in most of the aquifer subsections, except for the Sweetwater subsection. In this subsection, the maximum drawdown increases to between 3.5 to 6 m, which is largely due to the combined effect with the large consented FNDC groundwater take for Kaitaia.

For the less likely Scenario 3, the maximum drawdown in the deep aquifer was between 1 to 4.5 m over most aquifer subsections, except the Sweetwater subsection. In this subsection the maximum drawdown increased to between 2.5 to 9 m over most of the subsection, with the largest drawdown near the existing consented FNDC take and the existing consented and proposed Te Rarawa Farming Ltd/Te Make Farms Ltd takes.

The model was again repeated to determine the drawdown in the shallow aquifer using the Scenario 2 parameters that are considered the most conservative for the shallow aquifer. This resulted in a worst-case scenario drawdown of less than 0.5 m over most of the aquifer subsections, which increased to 1 m in the Houhora subsection in close proximity to the proposed Te Aupouri Commercial Development Ltd bores. The Sweetwater subsection showed the highest potential maximum drawdown of between 1 to 1.5 m in close proximity to the existing consented FNDC take and the existing consented and proposed Te Rarawa Farming Ltd/Te Make Farms Ltd takes.

The thickness and depth of the deep shell bed aquifer varies at different locations in the aquifer. The groundwater in the shell bed aquifer is also under pressure which adds an additional “head” to the groundwater that increases the theoretical available drawdown in the aquifer. As a general observation, bores that are taking water from only the shell bed aquifer have a greater than 50 m drawdown. In context of this available drawdown, the modelled cumulative drawdown for Scenario 2 (the most likely scenario at a regional scale) will have little adverse effect on the overall deep shell bed aquifer levels. For the shallow aquifer, the modelled drawdown is minimal in respect of the depth of the shallow aquifer and the adverse effects on groundwater levels will be minor. The adverse effects on surface water features due to the groundwater drawdown are discussed later in this section.

The localised drawdown on groundwater levels which could potentially affect the use of existing bores is discussed later in this report.

Ground settlement (Subsidence)

WWLA have provided assessments in each application of the potential for ground settlement to occur as a result the groundwater take. The outcome of these assessments was that the predicted settlement within the shell bed aquifer from the proposed groundwater takes would be in the order of a few millimetres and is so small that it would very difficult to measure in the field. Given the same general geology for the location of the applications that were not prepared by WWLA, it is considered that the same conclusion would be reached for the potential ground settlement from these takes.

The conclusion of the technical assessments was that the adverse effects of the predicted land settlement from the proposed groundwater takes on the structural integrity of buildings and infrastructure would be less than minor.

Effects on surface water features.

The dune lakes and wetlands that feature in multiple locations throughout the modelled area of the Aupouri aquifer are perched on hard pans. Each application's AEE assessed the adverse effects of their take on the surface water features in their respective aquifer subsection and concluded that the effects would be no more than minor. This conclusion was based on the known minimal connectivity between the deep aquifer and the over lying shallow aquifer, and that the surface water features largely occur on hard pans that minimise the linkage to the shallow aquifer. For example, in the Sweetwater area water levels in Lakes Heather and Rotoroa are around 30 m above sea level, while groundwater levels in the shallow sand aquifer are around 20 metres lower.

The water level in surface water features also naturally fluctuates with seasons. During a 1 in 50 year drought, which is the modelled worst case scenario, it is expected that many of the surface water features will be severely affected by such a sustained dry period. It is considered that the expected drawdown of 0.5 m in shallow groundwater level over the majority of the Aupouri aquifer model area would not add to the effects on surface water features during such a drought period. It is also considered unlikely that any additional adverse effects on the ecology and habitat of surface water features will occur as a result of these takes during such a drought period.

The most significant surface water feature in the Aupouri aquifer is the Kaimaumau wetland complex. There are no new applications for groundwater takes in the Waiparera subsection of the aquifer where the majority of the Kaimaumau wetland lies. There are 3 relatively small proposed takes at Motutangi, and another larger take on the Motutangi/Houhora subsection boundary. These takes all lie largely to the north of the Kaimaumau wetland.

As part of the recent decision on a combined application for 17 groundwater takes known as MWWUG, the Environment Court granted the consents with an extensive monitoring regime and adaptive management approach to avoid any adverse effects on the wetland. This monitoring regime will also prevent any adverse effects from occurring on the wetland as result of these proposed new 24 groundwater takes as it is relies on set trigger levels for groundwater levels and salinity indicators.

Saline intrusion

Along the coastal margin, fresh groundwater flowing from inland areas meets with saline water from the sea resulting in a natural transition from fresh to brackish to saline with distance offshore. Under natural conditions, the hydraulic gradient from inland recharge results in seepage of fresh groundwater out into the sea at, and off-shore of, the coastal margin. In shallow unconfined aquifers the fresh groundwater at the water table and sea water form an interface close to the costal margin. However, at greater depths, the location and geometry of the interface between the fresh groundwater and the sea water is largely determined by the hydraulic gradients in the aquifer and the density difference between fresh and saline water (with groundwater typically becoming more brackish with depth).

Abstraction of groundwater has the potential to reduce the volume and pressure of the groundwater flow which can result in saline water moving both further inland (lateral migration) and upwards so that it is closer to the surface of the aquifer. This process is referred to as saline intrusion and may adversely impact on groundwater quality in coastal areas if not appropriately managed.

The potential for saline intrusion to occur in the Aupouri Aquifer has been assessed by WWLA using a numerical groundwater model that simulates the effect of existing and proposed pumping on groundwater levels and flows. While there is always a degree of uncertainty inherent in model predictions, the assessment provides a useful tool to assess relative changes in groundwater levels resulting from groundwater abstraction and identify areas most sensitive to saline intrusion.

Lateral migration along the interface between the shell bed and basement rocks was assessed using the WWLA model's calibrated Scenario 2 (leaky scenario). The model identified some locations on the coastal margins where, under drought conditions, saline water may be present at the base of the aquifer along the coastal margin even when there are no groundwater takes occurring (naturalised scenario). These locations are generally at the confluence between water courses and the coastal marine area, or in estuarine areas, and may be viewed in maps in the document entitled "Aupouri Aquifer Groundwater Model – Saline Intrusion Assessment for Combined Applications, WWLA, 16 May 2019".

The WWLA model assessed the cumulative effects of the proposed new takes and existing takes, relative to the Scenario 1 baseline, on the potential for saline intrusion at these locations. This assessment does not indicate any major changes in the potential for saline intrusion to occur, compared to baseline conditions. WWLA concluded that the relative change in extent and frequency of occurrence is no more than minor relative to the naturally occurring existing state.

Council's technical peer reviewer, LWP, agreed with this conclusion but recommended that monitoring would need to be undertaken at the most sensitive locations identified in the assessment to verify model predictions. This management approach is consistent with National Guidelines for management of saline intrusion[1] and was part of the adaptive management approach agreed to by the Environment Court for the MWWUG consents.

WWLA have agreed in principle to a groundwater monitoring and contingency plan similar to that required for the MWWUG consents, that will be further developed to establish appropriate trigger values for groundwater levels and quality at key locations to avoid any adverse effects from saline intrusion.

Sustainability of the abstraction

The council has set allocation limits in Policy H.4.4 of the Proposed Regional Plan (PRP) for the subsections of the Aupouri Aquifer that are deemed to be operative. These limits assist in council achieving one of the objectives of the PRP which is to avoid "*adverse effects associated with saline intrusion and land subsidence above are avoided*".

These allocation limits were based on the recommendations of a report commissioned by council and prepared by Lincoln Agritech in 2015, which modelled the recharge and the likely limitations, constraints and sensitivities within each subsection, and recommended conservative allocation limits that reflected these constraints and unknowns in the respective subsections. A submission on the PRP requesting an increase in the allocation of some aquifer subsections based on the modelled outcomes associated with the MWWUG consent applications in 2017-2018 was subsequently approved in April 2019. The allocation limits in the PRP meet the requirements of the NPS for Freshwater Management (2014).

Council has assessed the volumes requested by the new applications against the available allocation in the relevant subsections of the aquifer. Council is satisfied that the applications will not result in any over allocation.

It is noted that some subsections will be approaching full allocation if all the applications are granted. This will not however prevent a person from taking water under Section 14 of the RMA for an individual's reasonable domestic needs or the reasonable needs of their animals for drinking water.

[1] Pattle Delamore Partners Ltd, 2011; New Zealand Guidelines for the Monitoring and Management of Sea Water Intrusion Risk. Envirolink Project 420-NRLC50, June 2011.

Cultural

These applications do not result in any physical disturbance or destruction of any surface water bodies or cultural sites. There is however no assessment on the cultural and spiritual connection with these features and the potential adverse effects on the Iwi, Hapu and Marae that have these connections. These effects are discussed later in this report as part of the affected party assessment.

STEP 9 Special Circumstances

Is it considered that special circumstances exist in relation to the application that would warrant the application being publicly notified?

Note: "Special Circumstances" are those that are unusual or exceptional and those where there are indications that a case is out of the ordinary. If what is proposed is specifically envisaged by the Plan, it cannot be described as being out of the ordinary and giving rise to special circumstances. The fact that some persons have concerns about a proposal does not of itself give rise to "special circumstances" but may be a contributing factor.

☑ No ➔ Go to **Step 10**.

☐ Yes ➔ State reasons below. Go to **Step 21**. Tick the **Publicly Notified** box as the application may be publicly notified as required by section 95A(9) of the RMA.

Reasons:

STEP 10 Customary Rights and Customary Marine Title Groups

Note: These are a right or groups which are recognised by the Crown by either an order or an agreement.

Could the activity have adverse effects on a group with a protected customary right or a customary marine title?

☑ No ➔ State reasons below. Go to **Step 11**.

☐ Yes ➔ State protected customary right and/or customary marine title group and reasons below. Go to **Step 11**.

Reasons:

Not a coastal permit.

STEP 11 Statutory Acknowledgements

Is the activity on or adjacent to, or may affect, land that is the subject of a statutory acknowledgement?

☐ No ➔ State reasons in below. Go to **Step 15**.

☑ Yes ➔ State statutory acknowledgement area and Iwi group below. Go to **Step 12**.

Reasons:

Settlement Acts for Te Aupouri, Te Rarawa, Ngai Takoto, Ngati Kahu and Ngati Kuri cover the areas where the proposed groundwater takes are located. There are multiple statutory acknowledgements in the modelled area of effects from these groundwater take applications.

STEP 12 Trustees of Statutory Acknowledgement

Will the activity have a minor, or more than minor adverse effect, on the trustees of the Statutory Acknowledgement?

☐ No ➔ State reasons below. Go to **Step 15**.

☑ Yes ➔ State reasons below. Go to **Step 13**.

Reasons:

It is noted that Te Rarawa, Ngai Takoto and Te Aupouri are applicants, and that Ngai Takoto was also an applicant in the previous MWWUG applications.

The physical and/or spiritual adverse effects on the trustees of the statutory acknowledgements as a consequence of any adverse effects that may occur to surface water features that have a statutory acknowledgement is unknown. Therefore, these iwi groups are considered to be affected parties.

STEP 13 Written Approvals

Has the applicant provided the written approval of every group and trustees of a statutory acknowledgement who has been deemed to be affected by the activity in **Steps 10** and **12**?

☐ Yes ➔ Complete the table below. Go to **Step 15**.

☑ No ➔ Complete the table below. Go to **Step 14**.

The following are considered to be affected by this activity:

Name of Affected Group	Written Approval Provided? (Y/N)
Te Aupouri	N
Te Rarawa	N
Ngai Takoto	N
Ngati Kahu	N
Ngati Kuri	N

STEP 14 Unreasonable to get Written Approvals

Is it considered unreasonable in the circumstances to require the applicant to obtain the written approval of every group and trustees of a statutory acknowledgement who has not provided their written approval?

☑ No ➔ Go to **Step 21**. Tick the **Limited Notified** box. Serve notice of the application on those groups and trustees that have not provided written approval. Then go to **Step 15**.

☐ Yes ➔ State reasons below. Go to **Step 15**.

Reasons:

STEP 15 National Environmental Standard (NES)

Is there a NES that precludes the limited notification for each activity to other persons?

☑ No ➔ Go to **Step 16**.

☐ Yes ➔ Name of NES: **INSERT NAME**. Go to **Step 20 – Special Circumstances**.

STEP 16 Plan Provisions Regarding Limited Notification

Is there a rule or provision in a Regional Plan that precludes the limited notification of this type of application to other persons?

☑ No ➔ Go to **Step 17**.

☐ Yes ➔ Rule **INSERT RULE**. Go to **Step 20 – Special Circumstances**.

STEP 17 Other Affected Persons

Will the activity's adverse effects be minor or more than minor (but not less than minor) on any other persons?

Note: The requirements of section 95E of the RMA shall be taken into account when determining affected persons.

☑ Yes ➔ List persons and reasons in table for Step 19. Go to **Step 18**.

☐ No ➔ State reasons below then go to **Step 20 – Special Circumstances**.

Reasons:

Council has used the worst-case scenario drawdown of Scenario 3 (least leaky) as the basis for determining other affected persons. Scenario 3 models conditions where hard pans and other localised anomalies provide less leaky characteristics which results in a greater modelled drawdown in the deep shell bed aquifer than calculated using a model calibrated to more general conditions across the wider aquifer. Scenario 3 has applied these characteristics over the entire model domain. As these layers are intermittent and only occur in localised situations, they don't apply over the entire region and therefore the modelled drawdowns are extremely conservative.

While applicant's technical consultants consider the effects of the activities are less than minor, based on the assumed available drawdown in the deep aquifer of between 55-100m and other persons bores being fully efficient (fully penetrating the aquifer), they did not consider the actual drawdown associated with the 'affected' bore take itself, nor the depth of the bore users pump. Any variation in another person's bore, whether the requirement is to drill deeper to make a fully efficient bore or to lower the pump, incurs costs to that person. This additional cost is considered by council to be at least a minor adverse effect on that person.

In addition, the council's bore log database is neither accurate nor complete, and it is considered likely that there will be existing bores on properties throughout the aquifer that the council has no knowledge of. The effects on the owners of these bores cannot be determined as no details of the bores are known.

The same consideration is given to person who may take water from a surface water feature. While the adverse effects on the actual surface water feature may be no more than minor, there is no information on whether the adverse effect will be less than minor on a person who may take water from the surface water feature.

Council does not have a record of all permitted activity takes from groundwater or surface water, so it has determined that the applications will be limited notified to all property owners and occupiers in the

modelled area of effects. A person however may only make a submission as an affected person if they have an existing water take from a bore or a surface water feature.

These applications were circulated to all Iwi/Hapu groups who had registered with council as having an interest in the area that the application is located.

Responses were received from Waiora Marae on a number of applications in its rohe opposing the applications. No responses were received from any other Marae that were circulated copies of applications.

The applications do not provide any assessment of the potential adverse effects on the cultural values of Tangata Whenua. As representatives of local Maori, council has determined that the committees of the Marae located in the modelled area of effects are affected persons, as council cannot make a decision that the adverse effects on them, and the people they represent, are less than minor.

The Department of Conservation (DoC) also has statutory responsibilities for land within the modelled area of effects, including a number of significant dune lakes and the Kaimaumau wetland. The cumulative effects assessment has concluded that the effects on surface water features will be minor. However, council has no information to decide that the adverse effects on the Director General of Conservation, in respect to the land that is administered by DoC and its statutory responsibilities, are less than minor.

Check the following:

☑ All persons we have protocols with have been sent a copy of the application for comment.

STEP 18 Written Approvals

Has the applicant provided the written approval of every other person who is adversely affected by the activity?

☐ Yes ➔ Complete the table below, then go to **Step 20 – Special Circumstances**.

☑ No ➔ Complete the table below, then go to **Step 19**.

Note:
Council has identified approximately 4000 property owners/occupiers in the modelled area of effects. A table of affected parties cannot therefore be presented in this report. The mailing list for the notification is on the application file.

STEP 19 Unreasonable to get Written Approvals

Is it considered unreasonable in the circumstances to require the applicant to obtain the written approval of the adversely affected person(s) who has/have not provided written approval?

☑ No ➔ Go to **Step 21**. Tick the **Limited Notified** box and serve notice of the application on those persons that have not provided written approval. Then go to **Step 20 – Special Circumstances**.

☐ Yes ➔ State reasons below, then go to **Step 20 – Special Circumstances**.

Reasons:

STEP 20 Special Circumstances

Is it considered that special circumstances exist in relation to the application that would warrant notification of this application to any other person not already determined to be eligible for limited notification?

Note: "Special Circumstances" are those that are unusual or exceptional and those where there are indications that a case is out of the ordinary. If what is proposed is specifically envisaged by the Plan, it cannot be described as being out of the ordinary and giving rise to special circumstances. The fact that some persons have concerns about a proposal does not of itself give rise to "special circumstances" but may be a contributing factor.

☑ No ➔ Go to **Step 20**.

☐ Yes ➔ State reasons below. Go to **Step 20**. Tick the **Limited Notified** box as the application may be limited notified as required by section 95A(10) of the RMA.

Reasons:

STEP 21 Notification Decision

☐ **Non-notified**

☑ **Limited Notified**

☐ **Publicly Notified**

Signed: _____ Date: 29 August 2019

Angela Stride
Water & Waste Management Officer

Authorised under delegated authority by:

Signed: _____ Date: 29 August 2019

Stuart Savill
Consents Manager

ATTACHMENT 3

Groundwater Monitoring and Contingency Plan for the Waihopo and northern Houhora sub-areas of the **Aupōuri** Aquifer Management Unit

July 2020

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GLOSSARY OF TERMS

Saline/saltwater intrusion	For the purposes of this Groundwater Monitoring and Contingency Plan, saline/saltwater intrusion refers to changes in salinity at nominated monitoring locations that exceed thresholds established to indicate elevated potential for adverse effects on groundwater quality for potable supply and/or irrigation use
Efficient bore takes	An efficient bore take is when a bore fully penetrates the water bearing layer and takes water from the base of the aquifer.
Sub-aquifer	The Aupōuri Aquifer system is divided into 12 separate sub-aquifer units for the purposes of setting tailored aquifer-specific allocation limits.[1]
First in-first served	Under the Resource Management Act 1991, applications for water take are processed in the order in which they are lodged. The rights of parties associated with this Groundwater Monitoring and Contingency Plan are prioritised according to the order in which their permits are granted and added to this Plan.

[1] Policy H.4.4 of the Proposed Regional Plan for Northland (Appeals Version) June 2020.

1. INTRODUCTION

1.1 Scope and Objective of the GMCP

This document comprises a groundwater monitoring and contingency plan for the groundwater takes in the Waihopo and Houhora sub-aquifers of the Aupōuri aquifer management unit (GMCP) that comprise part of the Aupouri Aquifer Water User Group (AAWUG) application. The GMCP covers the implementation and monitoring of the groundwater take consents listed in **Table 1** (the Consent Holders) and is a programme of adaptive management that is suitable to provide a platform for the implementation of the abstractions listed in **Table 1**.

An adaptive management regime requires reasonably clear objectives against which the effects and management progress may be evaluated against. The objective of this GMCP is that;

Objective 1: **The abstractions must, individually and cumulatively, avoid:**

(a) **saltwater intrusion into the Aupouri aquifer;**

(b) **adverse effects on the hydrological functioning of dune lakes and natural wetlands;**

(c) **adverse effects on the significant indigenous vegetation and habitats in dune lakes and natural wetlands; and**

(d) **lowering of the groundwater levels of the Aupouri aquifer such that existing efficient bore takes operating as a permitted activity or in accordance with resource consent conditions cannot access groundwater of the quantity authorised.**

Extensive environmental monitoring is required to ensure the effects listed above do not result from groundwater abstraction, and to support the proposed 'adaptive management' approach (including the staged implementation of groundwater extraction). The purpose of the GMCP is to formalise specific monitoring requirements, establish groundwater level and groundwater quality monitoring triggers and outline a process for implementation of appropriate mitigation and remediation measures if nominated trigger values are exceeded.

The GMCP is intended to allow the early detection of any adverse impact on the quality or quantity of groundwater resources of the Aupouri Aquifer management unit, particularly within the Waihopo and Houhora sub-aquifers associated with the exercise of groundwater take consent(s), by:

- Requiring regular monitoring of the groundwater system both on and off-site;
- Setting monitoring criteria (trigger levels) to indicate potential adverse impacts on the groundwater system;
- Implementing mitigation measures including changes to the pumping regime if trigger levels are reached to ensure that Objective 1 continues to be met;
- Reviewing monitoring data before and after a step level increase in pumping rate;
- Ensuring that the monitoring data is available for regular review by the Council;
- Detailing a Contingency Plan to be implemented if an unanticipated impact(s) are identified;
- Providing information to quantify the actual effects of the abstraction on the groundwater resource; and

- Enabling validation of the numerical model by the Consent Holders for any replacement groundwater take consent applications.

1.2 Parties Associated with this GMCP

The parties who have been deemed to be associated with this GMCP at its inception are the Council, the Consent Holders in **Table 1**, and the Director-General of Conservation.

The following provides a brief description of the roles and responsibilities of each party associated with this GMCP.

Should any of these parties change during the implementation of this GMCP, either through addition or removal, the process as set out in **Section 1.3** below shall be applied.

The rights of parties associated with this GMCP are prioritised according to the order in which their permits are granted and added to this GMCP, in accordance with the first in-first served approach to water allocation under the Resource Management Act 1991.

1.2.1 Northland Regional Council

The Council will undertake the ongoing monitoring requirements of the GMCP on behalf of the Consent Holders. The actual and reasonable cost of undertaking the ongoing monitoring of these consents for the Consent Holders will be charged in accordance with Council's Charging Policy.

The installation of sentinel bores and monitoring equipment is the responsibility of the Consent Holders.

1.2.2 Consent Holders

The Consent Holders identified within this GMCP at **Table 1** are required to exercise their Water Permits in accordance this GMCP.

The exercise of the Water Permits will be in accordance with Council initiated instructions which will be issued once the actions and process established through this GMCP have been undertaken.

The Consent Holders may seek changes to the GMCP through either of the processes set out in **Section 1.3**.

1.2.3 Director-General of Conservation

The Director-General of Conservation is responsible for administering land and waterbodies subject to reserve status under the Reserves Act 1977 and conservation or stewardship area status under the Conservation Act 1987. Within the Waihopo and Houhora sub-aquifers of the Aupouri Aquifer management unit these areas include:

- The Te Ramanuka Conservation Area

The Director-General of Conservation is a party to this GMCP to ensure that the relevant provisions of these Acts, which the Director-General of Conservation administers, in particular that Objective 1(b) and 1(c) matters are to be met.

1.3 Changes to the GMCP

This GMCP may be amended at any time to:

- Incorporate new or replacement water permits, or remove water permits, within the Waihopo and Houhora sub-aquifers of the Aupōuri aquifer management unit that have overlapping and/or additional monitoring requirements or which are subject to different trigger levels or trigger levels based on monitoring described in this GMCP;
- Alter the nature and scope of the required monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels;
- Incorporate or remove parties who are, or may need to be, a part of this GMCP to ensure Objective 1 is met.

If either the Council or a Consent Holder wishes to amend the GMCP, then it must provide notice in writing of the proposed changes, along with any supporting technical documents, to the other Consent Holders, and the Director-General of Conservation.

Parties, given notice by Council of a change to the GMCP, have 20 working days to provide a response to the Council on the proposed changes to the GMCP.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusion of the report.

If any party does not agree with the proposed change, that party shall engage a suitably qualified hydrogeologist and/or an ecologist to prepare a report detailing the reasons for the disagreement which shall be provided to Council within 30 working days from the date that the written notice of the proposed changes was sent to the party.

Any change to the GMCP will only be authorised by Council if the technical or administrative assessment of the proposed change clearly indicates that the change will meet Objective 1 of the GMCP.

Council will provide a report to the Consent Holders detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement. If the change would affect the interests of the Director-General of Conservation, then the report will also be provided to this party.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation.

2. FRAMEWORK FOR ADAPTIVE MANAGEMENT

In summary, the following adaptive management techniques are applied in this GMCP;

(a) Baseline monitoring – a monitoring programme has been developed for Stage 1 of the **Table 1** abstractions to establish a robust existing environment baseline. This monitoring programme is specified? in this GMCP, however, some monitoring detail is still required and this is indicated by the acronym 'TBC'.

(b) Early warning systems - Trigger levels (TLs) will be established to set up an early warning system that provides a response mechanism when differences between predicted and actual water levels, and/or salinity concentrations occur. A trigger level is an environmental criterion that if reached or met, requires a certain response to be actioned.

(c) Staged development - Abstraction volumes will progressively be increased in a staged manner, with expansion contingent on compliance with yet to be established trigger levels and on regular reviews of groundwater level, freshwater ecology hydrology, and salinity monitoring results.

It is noted that the consent documentation requires that all development starts at Stage 1 volumes whether or not others have progressed to Stage 2 or further, and that takes must be implemented for the minimum period of Stage 1 before progressing to Stage 2. This is an essential mechanism for staging as an adaptive management response.

(d) Stage 1 / Year 1 management – Until such time as there is adequate data to enable adaptive management to commence and for Objective 1 of this GMCP to be achieved, the abstractions during this stage will be subject to interim groundwater level and saline trigger levels and Trigger Exceedance Report procedures;

(e) Tiered approach to monitoring – Monitoring effort is proposed to increase if trigger levels are exceeded. Likewise, monitoring intensity may decrease with evidence of sustained compliance and stability or to reflect improved characterisation of the hydrogeological environment by way of the process outlined in **Section 1.3** of this GMCP; and

(f) Ongoing adaptive management – The abstractions will be managed adaptively within the term of consent and, in the event of trigger level exceedance, through the implementation of the recommendations of a Groundwater Trigger Exceedance Report (GTER) prepared by Council.

(g) Suspension of abstractions – Should compliance with Objective 1 of this GMCP not be achieved, then the exercise of some or all of the consents to abstract and use groundwater may be suspended until such time as Council confirms in writing that compliance can be achieved.

The following sections provide detailed information relating to the adaptive management framework to be imposed for the exercise of the consents listed in **Table 1**.

2.1 Staged Implementation

The uptake of water by the Consent Holders will be over 4 stages in accordance with the following factors:

Level of current orchard development – the following orchards are already well established;

[list consent number and applicants]

[Variation application number] replaces existing consents held by to take and use water. Other consent holders that have established their orchards have been irrigating their trees under temporary consents issued by the Council.

Rate of orchard development - will occur at differing rates depending on the owner's cashflow and access to plants; and

Tree maturity - approximately nine years to full maturity and plant water usage, hence irrigation requirements commensurately increase with tree growth.

The progressive increase in irrigation requirements on developing orchards, provides an opportunity to apply an adaptive management approach that establishes a baseline and allows the original hypotheses of avoidance of effects to be periodically re-evaluated to ensure Objective 1 of this GMCP continues to be met as development occurs.

The management approach provides a series of responses to be taken based on the monitoring results, including where monitoring shows that Objective 1 of this GMCP is not being met, as discussed in **Section 2.2**.

The uptake by Consent Holders of the consented total allowable water volumes will be permitted in four stages over seven years, as shown in **Table 1** below, unless the outcome of the Staged Implementation and Monitoring Programme Review detailed in **Section 2.1.1** shows that there should be a delay in moving to the next stage, or that the next stage should not occur.

The development stages reflect:

- A combination of horticultural and pasture irrigation development for APP.039859.01.01
- Anticipated planting schedules and resultant increases in water demand for horticultural irrigation associated with remaining water permit applications.

Table 1. Summary of staged implementation annual volumes

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7-full consent term)*
Waihopo sub area management unit					
APP.039859.01.01	Te Aupōuri commercial development ltd				
APP.040601.01.01**	WAIKOPU AVOCADOS LTD				
APP017428.02.01**	HENDERSON BAY AVOCADOS LTD				
APP.040600.01.01	FAR NORTH AVOCADOS LTD				
APP.041211.01.01	P MCLAUGHLIN				
Houhora sub area management unit					
APP.039859.01.01	TE AUPŌURI COMMERCIAL DEVELOPMENT LTD				
APP.040121.01.01	NE EVANS TRUST & WJ EVANS & J EVANS				
APP 040231.01.01	P & G ENTERPRISES (PJ & GW MARCHANT)				

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7-full consent term)*
APP 040652.01.01	SE & LA BLUCHER				
APP.039644.01.01	MP DOODY & DM WEDDING				
APP.040397.01.01	A MATTHEWS				
APP.040558.01.01	MV EVANS (1)				
APP040979.01.01	MV EVANS (2)				
TOTAL					
% of Total		**25%**	**50%**	**80%**	**100%**
Note: *The staged implementation is based on years when irrigation occurs following the granting of the consents.					

2.1.1 Staging: Implementation and Monitoring Programme Review

A "Staged Implementation and Monitoring Programme Review" (SIMPR) will be required for Council to decide whether Consent Holders proceed to the next allocation stage. The volume of abstraction authorised will be reviewed against the staged implementation outlined in **Section 2.1** at the minimum intervals of:

End of Stage 1 – a period of not less than 12 months following date of commencement of the consents during which a full 12 months of baseline monitoring data is collected, and during which Stage 1 abstraction has been implemented over a full irrigation season;

End of Stage 2 - 3 irrigation seasons following date of commencement of the consents;

End of Stage 3 - 6 irrigation seasons following date of commencement of the consents; and

The main purpose of the SIMPR is to assess whether proceeding to the next stage would comply with Objective 1 of the GMCP.

The SIMPR will be commissioned by the Council and shall be prepared by a suitably qualified hydrogeologist with experience and knowledge of the locality

The SIMPR shall include a detailed assessment of all environmental monitoring data including groundwater levels, salinity indicators, and water quality, and include consideration of spatial and temporal trends including potential effects of groundwater abstraction on water levels in lakes and surface water bodies administered by the Department of Conservation. If the potential for more than minor effects on surface waterbodies is identified, then the SIMPR will also include assessment of the likely significance of those effects prepared by a suitably qualified ecologist. The SIMPR shall assess whether Objective 1 of this GMCP is being met at the current level of abstraction, and whether Objective 1 will be met at the next stage level of abstraction. The SIMPR may also consider the nature and scope of continued monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels.

The SIMPR will provide recommendations based on the assessment of the environmental monitoring data to date on:

- the setting or alteration of the trigger levels;
- whether any changes to the monitoring programme are required; and

- whether to advance to the next stage of abstraction or to remain at the current level of abstraction, or to reduce the level of abstraction.

A copy of the SIMPR will be provided to the Consent Holders listed in **Table 1** and the Director General of Conservation a minimum of three months prior to the anticipated commencement of the subsequent irrigation season utilising volumes defined for the subsequent development stage as stated in **Table 1**. The Consent Holders and Director General of Conservation have 20 working days to provide a response to the Council on the conclusions and recommendations of the SIMPR.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusions of the report.

If any party does not agree with the conclusions and recommendations of the SIMPR, then a report by a suitably qualified hydrogeologist and/or ecologist, both with experience and knowledge of the locality if possible, detailing the reasons for the disagreement shall be provided to Council within 30 working days from the date that the assessment was sent to the party.

An increase in the volume of abstraction to the next development stage and any change to the monitoring programme will only be authorised by Council if the technical assessment of the monitoring data clearly indicates that the increase in the allocation and change to GMCP would meet Objective 1 of this GMCP.

Council will provide a report to the Consent Holders and the Director General of Conservation detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation within 5 working days of the change being authorised as final.

A summary of the above process is also included in the conditions of each consent that is covered by this GMCP.

2.1.2 Stage 1 (Year 1) Management Regime

Stage 1 is the initial development stage comprising a minimum period of 12 months (comprising at least 1 full irrigation season) following issue of the consents listed in Table 1. During this development stage abstraction will be limited to less than 25% of the full volume sought while baseline information is collected to enable monitoring of groundwater levels and quality (at monitoring sites not already established) to enable setting of trigger levels.

During Stage 1 interim triggers for groundwater levels and salinity indicators will be established at all monitoring sites following the methodology outlined in Section 2.1.2.1 (for new monitoring bores) and Sections 3.2.5.3 and 3.3.1 below (for existing monitoring bores).

Council is to notify the Consent Holders and the Director-General of Conservation of the interim trigger (and default management parameters) for Stage 1 (Year 1) 3 months prior to the commencement of abstraction. The Consent Holders and Director-General of Conservation have 10 working days to provide responses to the Council on the default management parameters once notified.

The monitoring specified in Table 3 will be undertaken during Stage 1 to ensure interim triggers are not exceeded (i.e., to ensure compliance with Objectives 1(a), (b), and (c)). Exceedance of interim trigger levels during Stage 1 will result in the implementation of the trigger level exceedance measures outlined in **Section 4** below.

2.1.2.1 Saline Intrusion & Groundwater Level: Monitoring and Triggers

Saline intrusion monitoring for Stage 1 (Year 1) is proposed within the sentinel and monitoring bores identified in **Table 4** of this GMCP. As each sentinel or monitoring bore is drilled, groundwater level and salinity indicators will be measured and recorded. This information will be used to set interim trigger levels for these parameters as per the methodology established in **Section 2.2** below. Interim trigger levels must be set prior to exercise of any of the consents.

The saline intrusion and groundwater level monitoring trigger levels for Stage 1 (Year 1) shall be inserted into the GMCP through the process set out in **Section 1.3** of this GMCP prior to the exercise of any consents.

2.1.2.2 Trigger Level Responses

In the event of an exceedance of a Trigger Level applicable in Stage 1 (Year 1), the Trigger Level Exceedance response plan contained in **Section 4** of this GMCP shall apply.

2.1.2.3 Ceasing Interim Stage 1 (Year 1) Management Regime

This interim management regime shall remain in place until such time as Council has given authorisation to proceed to the next stage (Stage 2) as set out under **Section 2.1.1** above or where the setting of trigger levels as per **Section 2.2** below has been given effect to through amendment to this GMCP in accordance with the change process established in **Section 1.3** above.

2.2 Trigger Level System

2.2.1 Timeframe for setting of trigger levels

The setting of trigger level values for each parameter (where TBC is indicated in the monitoring plan tables in **Section 3** Monitoring Programme) will be based either on current baseline data (for sites with existing monitoring) or data collected during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents. This approach recognises that:

- There is historical monitoring data available for some parameters to characterise the response of groundwater levels and quality to current levels of abstraction.
- In some areas, no baseline data has been established by the consent holder(s) or any of the key stakeholders in the area; and
- The manifestation of any effects from the exercising of these consents will steadily progress with time in accordance with the staged development process outlined in Table 1. The scale of abstraction during the baseline data collection period (i.e. 12 months following granting of consent) will not vary significantly from existing conditions (limited to no greater than 25% of the total volume covered by this GCMP).

2.2.2 Method for setting of trigger levels

A two-tier trigger level system will be implemented on the consents:

- **TL1** - The first-tier trigger level establishes when an individual monitoring parameter is exhibiting a [?] departure from baseline conditions. If this trigger level is breached, then additional monitoring will be undertaken by the Council. This additional monitoring will assist characterisation of the nature and significance in changes to the baseline condition of the groundwater resource

- **TL2 -** The second-tier trigger level is set at a threshold defining a 'significant' departure from baseline conditions and/or conditions where the risks of adverse environmental effects are increased. If this trigger level is breached, then the Consent Holders will be required to reduce their daily water take volume in a staged manner over a set period of time.

The TL parameters required under this GMCP for the various suites are summarised in **Table 3.**

Table 2: Summary trigger level parameters by monitoring suite

Monitoring Suite	Parameters
Groundwater level and salinity monitoring	Groundwater level, electrical conductivity
Saline intrusion monitoring	Electrical conductivity, chloride, sodium, total dissolved solids.

2.2.3 Response to exceeding trigger levels

The actions required should TL's be exceeded are set out in **Section 4** (Contingency Plan).

3. MONITORING PROGRAMME & TRIGGER LEVEL SETTING

3.1 Bore Locations and Details

A consolidated summary of the schedule of bores that are required to be monitored as part of this GMCP is provided in **Table 4.** Along with the bores identified for monitoring, the table provides key details relating to the bores' physical attributes and parameters to be monitored. The locations of the monitoring bores are shown on Figure 1 The following sections of the GMCP provide the monitoring schedules (frequency and trigger levels) for the bores. The monitoring schedule comprises four components:

- Two sentinel monitoring sites along the coastal margin, seaward of areas where abstraction is concentrated. The sentinel bores will provide the primary reference sites for monitoring and management of potential saline intrusion effects. Each sentinel bore will comprise two piezometers, accessing the shallow unconfined aquifer and the shellbed respectively. Instrumentation in each piezometer will enable continuous monitoring of groundwater levels and electrical conductivity (EC), and provide for telemetry of monitoring data to NRC.
- Groundwater levels in the unconfined and shellbed aquifers will be monitored manually on a monthly basis at selected locations inland of Pukenui and in the Waihopo area. This monitoring will be undertaken either in existing bores (if suitable sites can be identified and access obtained) or in new piezometers. These sites will enable ongoing monitoring of groundwater levels and provide data to characterise both localised and cumulative drawdown in response to abstraction and be used to inform the staged implementation process.
- Salinity indicators will be measured on a quarterly basis in each piezometer at the two sentinel bores, augmented by an additional monitoring bore in the Waihopo area. These sites will be monitored on a quarterly basis for the parameters listed in Table 2 and provide a secondary baseline to characterise any changes in aquifer salinity along the coastal margin.

The locations of the production bores in **Table 3** are also shown in **Figure 1**. An error accuracy level of +/- 50 metres is applicable to these bore locations. Any differentiation in the location by greater than 50 metres will result in a requirement for an application to the Council for a change of consent condition pursuant to Section 127 of the Resource Management Act 1991 (RMA). Assessment of the effects on the environment of the change will be required pursuant to Schedule 4 of the RMA.

Table 3: Schedule of monitoring facility and production bore details.

MONITORING BORES									
Bore Details		**Bore Owner**	**Coordinates (NZTM 2000)**		**Depth (m)**	**Dia. (mm)**	**Piezo. No.**	**Target aquifer**	**Purpose***
Name (Fig 1)	**NRC ref.**		**Easting**	**Northing**					
Fishing Club	LOC.200250	NRC	1611411	6146928	79			Shellbed	SI;
Waterfront	LOC.200210	NRC	1611712	6146689	19	32	1	Unconfined	GL_c, EC
Waterfront	LOC.200210	NRC	1611712	6146689	74	32	4	Shellbed	GL_c, EC_c
Houhora Sentinel (shallow)	TBC	NRC	1609900	6149600	<10	50	1	Unconfined	GL_c; EC_c, SI
Houhora Sentinel (deep)	TBC	NRC	1609900	6149600	80-100 (TBC)	50	2	Shellbed	GL_c; EC_c, SI
Lamb Road (shallow)[a]	TBC	NRC	1609750	6147300	<20	50	1	Unconfined	GL_m
Lamb Road (deep)[a]	TBC	NRC	1609750	6147300	80-100	50	2	Shellbed	GL_m
Burnage Road	LOC.200209	NRC	1611325	6145090	17	50	1	Unconfined	GL_m
			1611325	6145090	97	50	4	Shellbed	GL_m
Browne	LOC.200208	NRC	1610733	6144031	16	50	1	Unconfined	GL_m
			1610733	6144031	59	50	4	Shellbed	GL_m
Waihopo Level/Quality[a]	TBC	TBC	1606950	6153600	TBC	TBC		Shellbed	GL_m, SI
Houhora Heads[b]	LOC.200068	Private	1613368	6146558	21.3	100		Unconfined	GL_m, SI

PRODUCTION BORES									
Bore Details		**Bore Owner**	**Coordinates (NZTM 2000)**		**Depth (m)**	**Dia. (mm)**	**Piezo No.**	**Target**	**Purpose**
Name (Figure 1)	**NRC Ref.**		**Easting**	**Northing**					
Henderson Bay Avocados	TBC	Henderson Bay Avocados	1605623	6154872				Shellbed	GL_m, EC_m
Far North Avocados	TBC	Far North Avocados	1605981	6154581				Shellbed	GL_m, EC_m

Waikopu Avocados	TBC	Waikopu Avocados	1603347	6153388				Shellbed	GL_m, EC_m
Te Raite Station - Other	TBC	Te Aupōuri commercial development ltd	1603898	6151179				Shellbed	GL_m, EC_m
Te Raite Station - Waihopo 1	TBC		1605333	6151462				Shellbed	GL_m, EC_m
Te Raite Station - Waihopo 2	TBC		1607102	6150752				Shellbed	GL_m, EC_m
McGlaughlin	TBC	McGlaughlin	1606049	6150294				Shellbed	GL_m, EC_m
P&G Enterprises	TBC	P & G Enterprises (PJ & GW Marchant)	1609182	6148952				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 1	TBC	Te Aupōuri commercial development ltd	1608383	6148854				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 2	TBC		1607182	6148084				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 3	TBC		1609287	6148271				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 4	TBC		1609016	6147852				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 5	TBC		1607771	6147949				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 6	TBC		1609655	6147078				Shellbed	GL_m, EC_m
Te Raite Station - Houhora 7	TBC		1609296	6147373				Shellbed	GL_m, EC_m
Evans Trust	TBC	NE Evans Trust & WJ Evans & J Evans	1609492	6148850				Shellbed	GL_m, EC_m
S&L Blucher	TBC	S. & L. Blucher	1610145	6148091				Shellbed	GL_m, EC_m
A. Matthews	TBC	A. Matthews	1611038	6146087				Shellbed	GL_m, EC_m
Wedding & Doody	TBC	MP Doody & DM Wedding	1610297	6145328				Shellbed	GL_m, EC_m
M Evans 1 & 2	TBC	MV Evans	1610554	6145121				Shellbed	GL_m, EC_m

Notes:

[a] Nominal location only

[b] Private bore subject to access agreements

TBC = to be confirmed within 15 months of the date of commencement of these consents.

* Purpose key:

GL_c = Continuous Groundwater Level;

GL_m = Manual (monthly) Groundwater Level;

EC_c = Continuous Electrical Conductivity;

EC_m = Manual (monthly) Electrical Conductivity;

SI = Salinity Indicators (quarterly);

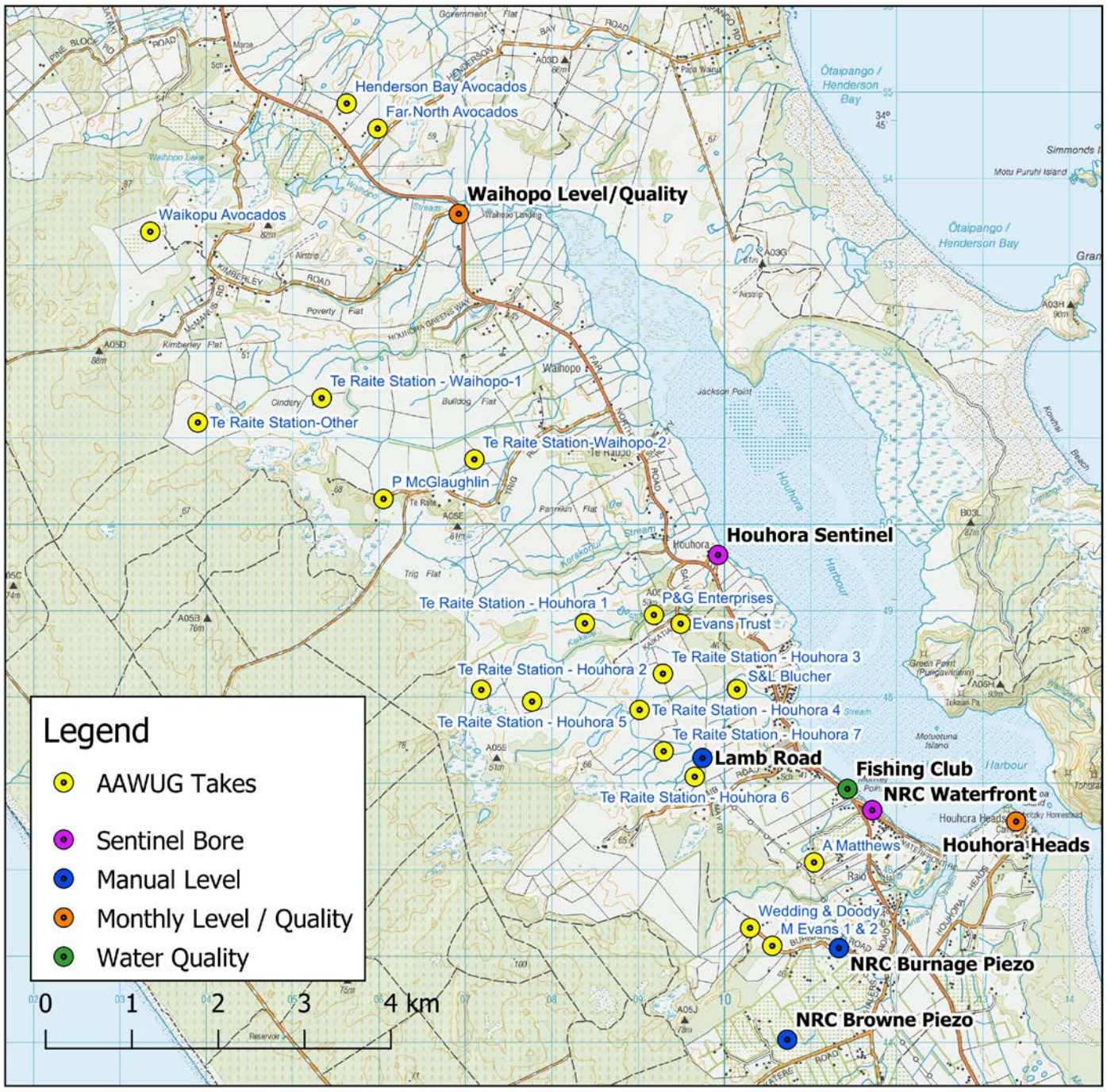

Figure 1. Monitoring and Production Bore Location Map

3.2 Groundwater Level and Salinity Monitoring

3.2.1 Sentinel Monitoring Bores

Sentinel bores will be utilised as the primary reference sites for regional monitoring of potential effects associated with saline intrusion. These bores will provide early detection or warning of:

- Groundwater levels around the coastal margin approaching a threshold that could indicate a greater risk of saline intrusion; and
- Any reduction in water quality that could indicate the landward migration of the saline interface.
- Groundwater levels in the shallow sand aquifer lowering and having a potential adverse effect on surface water bodies

Details of the sentinel bores are summarised in **Table 4** below. These sentinel bores will collect data continuously for water levels and electrical conductivity in individual piezometers. This data will be telemetered to NRC. A two-tier trigger level system (TL1 and TL2) for groundwater levels and electrical conductivity will be set in these bores.

TL1 and TL2 trigger levels for groundwater level and EC in the NRC Waterfront piezometers are specified in Table 4 below. The setting of TL1 and TL2 trigger levels values for remaining piezometers will be undertaken during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents and replace the interim trigger levels outlined in Section 2.1.2.1 above. The trigger level values that are shown in **Table 4** are based on existing data and will be reconfirmed by Council when the remaining trigger levels are confirmed.

All sentinel monitoring bores listed in **Table 4** will be installed prior to the exercise of the consents.

Checking of the sensors required for continuous monitoring will be undertaken on a monthly basis, and any faults will be recorded and remedied immediately. Data will be collected, processed and managed in accordance with NRC quality standards.

Table 4: Schedule of sentinel monitoring bores for groundwater level and/or salinity indicators

Sentinel Bore Name	Depth (m)	Piezo. No.	Target aquifer	Units	Frequency	Trigger Levels	
						TL1	TL2
Waterfront	19	4	Unconfined	mAMSL	Continuous	2.3maMSL EC TBC	0.5 maMSL EC TBC
	74	1	Shellbed	mAMSL	Continuous	4.4 maMSL EC TBC	1.8 maMSL EC TBC
Houhora	<10	1	Unconfined	mAMSL	Continuous	TBC	TBC
				µS/cm	Continuous	TBC	TBC
	80-100 (TBC)	2	Shellbed	mAMSL	Continuous	TBC	TBC
				µS/cm	Continuous	TBC	TBC

Notes:

TBC = to be confirmed within 15 months of the date of commencement of these consents.

GL TL1s (where provided) have been calculated from long term monitoring data.

GL TL2s (where provided) have been interpolated from Table F1, WWA Groundwater Modelling Report.

3.2.2 Manual Groundwater Level Monitoring

Groundwater levels will be monitored manually in the shallow sand and shellbed aquifers to:

- Quantify the magnitude of drawdown resulting from the proposed abstraction in the shellbed and unconfined aquifers to ensure it is within the magnitude anticipated in the AEE and does not result in adverse effects on surface water environment, existing groundwater users and long-term aquifer storage volumes.
- Ensure coastal groundwater levels are not adversely affected by the proposed abstraction

Details of the groundwater level monitoring bores are listed in Table x below. The bores include two existing NRC piezometer installations (Burnage Road and Browne) plus new piezometers installed at Lamb Road and Waihopo. An existing private bore at Houhora Heads is also included (subject to access agreement).

The primary value of data collected from manual groundwater level monitoring will be to establish medium to longer-term variations in groundwater levels in response to groundwater abstraction. This information will be utilised to inform the Staged Implementation and Monitoring Programme Review (Section 2.1.1) and Annual Environmental Monitoring Report (Section 3.5).

Trigger levels will also be established for groundwater levels in the unconfined and shellbed aquifers at the Lamb Road monitoring site to ensure cumulative drawdown in the shellbed and unconfined aquifers remains within the range predicted in the AEE and ensure the reliability of supply for existing efficient bore takes in the Pukenui area is not adversely affected by the proposed abstraction.

Table 5. Schedule of Manual Groundwater Monitoring Bores

Monitoring Bore	NRC ID	Easting	Northing	Depth (m)	Aquifer
NRC Burnage Road (shallow)	LOC.200209	1611325	6145090	17	Unconfined
NRC Burnage Road (deep)	LOC.200209			97	Shellbed
NRC Browne piezo (shallow)	LOC.200208	1610733	6144031	16	Unconfined
NRC Browne piezo (deep)	LOC.200208			59	Shellbed
Lanb Road (shallow)	TBC	1609900	6149600	<20	Unconfined
Lamb Road (deep)	TBC			80-100	Shellbed
Houhora Heads	LOC.200068	1613368	6146558	21.3	Unconfined
Waihopo	TBC	1606950	6153600	TBC	Shellbed

3.2.3 Setting of Groundwater Level and EC Triggers

As a general guide TL2 for deep shell bed groundwater levels should be no less than 1.0 mAMSL at sentinel monitoring sites (noting that changes in EC are also a key indicator of saline intrusion).

Groundwater level triggers at the Lamb Road monitoring site will be based on measured static water levels prior to exercise of the water permits listed in Table 1 minus the maximum magnitude of cumulative drawdown calculated to result from the proposed abstraction outlined in Aupouri Model Report.

3.2.3.1 Electrical Conductivity Triggers

Electrical conductivity triggers in sentinel bores will be no greater than:

- **TL1** - Median (weekly rolling average) EC from baseline monitoring period +25%
- **TL2** - Median (weekly rolling average) EC from baseline monitoring period + 50%

3.3 Saline Intrusion Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 6** below will be undertaken at 6 weekly intervals[2]:

- Electrical conductivity;
- Chloride;
- Sodium;
- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

3.3.1 Setting of Saline Intrusion Triggers

As an initial guide, trigger levels for individual determinants will be established as follows:

- **TL1** - Median concentration from the baseline monitoring period +25%.
- **TL2** - Median concentration from the baseline monitoring period + 50%.

3.3.1.1 Ongoing Monitoring

Sampling at the frequencies specified for the following salinity indicators will take place in the bores listed in **Table 6** below:

- Electrical conductivity;
- Chloride;
- Sodium;
- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

Table 6: Monitoring Schedule – Saline Intrusion

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
Fishing Club	79	1	Shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Houhora	<20	1	Unconfined	EC	µS/cm	Continuously	TBC	TBC

[2] This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
(Sentinel)				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
	80-100	2	Shellbed	EC	µS/cm	Continuously	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
Waihopo	TBC	1	TBC	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Houhora Heads	21.3	1	Unconfined	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC

Notes:

* Parameter key: GL = Groundwater Level; EC = Electrical Conductivity; SI = Salinity Indicators; TDS = Total Dissolved Solids.

TBC = to be confirmed within 15 months of the date of commencement of these consents.

3.4 Production Bore Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 7** below will be undertaken at 6 weekly intervals[3].

3.4.1 Trigger levels

Electrical conductivity trigger levels will be established in the production bores listed in **Table 7** below.

During the initial 12-month monitoring period Electrical Conductivity Triggers will be no greater than:

- **TL1** – Departure exceeding 25% of the EC value from the initial monitoring round
- **TL2** – Departure exceeding 50% of the EC value from the initial monitoring round

Long-term EC triggers for individual production bores will be established following the initial 12-month monitoring period based on an assessment of spatial and temporal variation in EC observed during the initial period, in a manner consistent with EC trigger levels established in the sentinel monitoring bores.

No trigger levels will be established for groundwater levels in the production bores as water levels in the production bores can be impacted by well efficiency and pumping schedules so are not necessarily representative of groundwater levels in the surrounding aquifer.

3.4.2 Ongoing monitoring

Monthly water level monitoring will be undertaken in the production bores listed in **Table 7 d**uring the winter months (nominally May to September). This monitoring will provide information to identify any inter-annual variations in aquifer storage which may be anomalous compared to regional trends.

[3] This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

Electrical conductivity values will also be measured at monthly intervals from the production bores during the irrigation season to check on any changes in salinity induced by the pumping. Requirements to continue monitoring of groundwater levels and electrical conductivity in individual production bores after Stage 1 will be addressed in the Staged Implementation and Programme Review (Section 2.1.1).

Table 7: Monitoring Schedule – Production Bore Water Levels and Electrical Conductivity

Bore Name	Depth (m)	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
						TL1	TL2
Henderson Bay Avocados	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Far North Avocados	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Waikopu Avocados	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Other	TBC	Shellbed	GL, SI	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Waihopo 1	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Waihopo	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
McGlaughlin	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
P&G Enterprises	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 1	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 2	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 3	TBC	Shellbed	GL, EC	mAMSL	Continuous	EC TBC	EC TBC
Te Raite Station - Houhora 4	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 5	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 6	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Te Raite Station - Houhora 7	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Evans Trust	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
S&L Blucher	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
A. Matthews	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Wedding & Doody	TBC	Shellbed	GL; EC	mAMSL	Monthly	EC TBC	EC TBC
M Evans 1 & 2	TBC	Shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC

Notes:

* Purpose key: GL = Groundwater Level; EC = Electrical Conductivity.

All trigger limit values in this Table to be confirmed by Council.

3.5 Environmental Monitoring Report

At the end of each irrigation season, the Council will commission the preparation of an Annual Environmental Monitoring Report (AEMR) by a suitably qualified hydrogeologist with experience and knowledge of the locality. A copy of the AEMR will be provided to the Consent Holders and the Director General of Conservation by 31 July each year.

The purposes of the Annual Environmental Monitoring Report are to;

- provide a summary of the monitoring results for the previous year, including trends, against Objective 1 of the GMCP;
- assess the monitoring undertaken over the previous year against the standards set out in Objective 1;

- Identify any changes/amendments to monitoring locations/parameters/frequencies that could be incorporated in future SIMPR
- report on any issues apparent with the monitoring and
- identify any improvement that could be made with respect to the monitoring.

The AEMR will also contain an evaluation of whether the observed effects of the groundwater takes are consistent with the predictions of environmental response contained in the *Aupouri Aquifer Groundwater Model, Factual Technical Report – Modelling. WWLA0184, Rev 3*, prepared by Williamson Water & Land Advisory and dated 5 February 2020 (hereafter referred to as the 'Aupouri Model Report').

4. CONTINGENCY PLAN

Exercise of the consents is subject to compliance with Objective 1 of this GMCP.

As described in **Section 2**, a trigger level system is used to define environmental criteria that signal changes may be occurring outside of what is normal (TL1) or at a point where remedial action is required to avoid Objective 1 not being met (TL2).

This section details the responses that will be undertaken where TLs are exceeded under any of the monitoring suites discussed in **Sections 2.1.2.1, 2.1.2.2, 3.2, 3.3, and 3.4**.

Where a trigger level is exceeded the Council will commission a Groundwater Trigger Exceedance Report (GTER). The objective of the GTER is to establish the cause of a trigger level exceedance and to recommend a programme of action to end the exceedance.

A GTER shall:

- Include a review of the monitoring results collected including an assessment of why the trigger level exceedance has occurred;
- set out requirements for increased monitoring;
- update the report on a regular basis as more data becomes available; and
- recommend actions to end the trigger level exceedance, which could include;
    - a staged reinstatement of abstraction to pre-exceedance rates and volumes,
    - reduced levels of abstraction for all or some of the consent holders covered by the GMCP, or
    - suspension of abstraction by all or some of the consent holders covered by the GMCP.
    - Amendment of the trigger level exceeded

4.1 Exceedance of TL1

In the event of a TL1 exceedance, which may represent declining groundwater levels or rising salinity indicators, the following actions must be undertaken:

(a) The Council will notify the Consent Holders within two working days of when the TL1 exceedance became known.

(b) If the exceedance is of a salinity indicator in the bores listed in **Table 5**, then sampling of the monitoring bore(s) in exceedance shall immediately be upgraded to a weekly frequency for four weeks following the first exceedance of the TL1. Weekly monitoring shall continue until sample results are consistently below TL1 values for a period of four weeks or as directed by Council.

(c) If after four weeks following the first exceedance of the TL1, the initiation of seawater intrusion and/or water level decline cannot be discounted to the satisfaction of the Council, then a Groundwater Trigger Exceedance Report (GTER) by a suitably qualified Hydrogeologist shall be commissioned by Council.

(d) The GTER shall assess the significance of the exceedance against the requirements of Objective 1 of the GMCP. The GTER shall assess why TLs have been breached, identify the

pumping bores in the area(s) of effect and will review all of the available data collected in the affected area(s), in particular the data collected pursuant to this GMCP.

4.2 Exceedance of TL2

In the event of a TL2 exceedance, which represents a significant departure from normal groundwater conditions, with either continuously declining groundwater levels or rising salinity indicators:

(a). Council will immediately inform the Consent Holders upon a TL2 exceedance becoming known.

(b). Consent Holders reduce their abstraction to 50% of the current average daily quantity, as calculated using the previous month's water use records required to be kept in accordance with the conditions of its groundwater take consent as directed by Council. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only. The council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

Given the geographic distribution of water permits included in this GCMP, direction by Council for individual Consent Holders to reduce their abstraction will be include consideration of:

- The location, nature and extent of the trigger level exceedance.
- State and trends in the same or related indicator parameters at other monitoring sites listed in Table 3.
- The location, rate and volume of abstraction by individual water permits.

(c). A GTER by a suitably qualified hydrogeologist (and ecologist if the exceedance concerns dune lakes or natural wetlands) shall be commissioned by Council. The GTER shall assess why the TL2 has been breached, identify the pumping bores in the area of effect, and include a review of all available data collected for the affected area(s), in particular, the data collected under this GMCP.

(d). Once (b) above has been complied with, the Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council approval of an alternative reduction value will only be given if it is satisfied that relevant TL2 values will not be exceeded. The Council will use the GTER to inform its decision on any alternative reduction value for a Consent Holder.

(e). If the TL2 exceedance is in a bore(s) that is/are not continuously monitored, then weekly groundwater level measurements and/or sampling of saline intrusion (depending on which trigger level is breached) in all bores where TL2 trigger levels are breached will commence within one week of the TL2 trigger level exceedance. Monitoring will continue until such time as:

- Three consecutive samples in an individual monitoring bore are below all TL2 thresholds established for that piezometer; or
- As directed by Council.

(f). If salinity indicators continue to increase or groundwater levels continue to decline after 21 days following the implementation of (b), then the Consent Holder's abstraction must be reduced to 25% of the current average daily quantity, as calculated for (b) above. The council

will advise the Consent Holder in writing of this further reduction and the required reduction in the daily water take volume.

(g). If (f) is implemented, then the Council will commission a review and update of the GTER report by a suitably qualified hydrogeologist with a longer-term programme of recommended responses incorporating observed responses to interim pumping rate reductions. The updated GTER will include a specific programme (including timeframes) of actions which would achieve compliance with Objective 1 of this GMCP. The actions may include, but not be limited to incremental reductions in the daily quantity of groundwater taken as a percentage of the allowable daily pumped volume, as well as testing of domestic/stock water supplies in bores that are efficiently utilising the aquifer and are potentially impacted by saline intrusion, and if necessary, the provision of temporary water supplies to any affected parties (excluding any of the Consent Holders) in the event that Chloride concentrations exceed 250 mg/L (being the guideline value for taste prescribed in New Zealand Drinking Water Standards for New Zealand 2005 (Revised 2008)). The GTER will also identify a methodology which Council will utilise to increase abstraction back to the volumes applicable to the relevant stage of taking (see Section 2.1), where this can be done such that Objective 1 of this GMCP will be met. If it is not possible to increase abstraction back to the relevant stage of taking, then the GTER will identify a methodology to increase abstraction to a lesser volume such that Objective 1 of the GMCP will be met.

(h). Actions arising from the GTER shall continue as long as the issue continues.

(i). Implement additional remedial measures as directed by Council, including the suspension of taking.

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Groundwater Monitoring and Contingency Plan for the Paparore, Waiparera, Motutangi and Houhora sub-areas of the Aupōuri Aquifer Management Unit

July 2020

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1. INTRODUCTION

1.1 Scope and Objective of the GMCP

This document comprises a groundwater monitoring and contingency plan for the Waiharara, Motutangi and Houhora sub-areas of the Aupōuri aquifer management unit (GMCP). The GMCP covers the implementation and monitoring of the groundwater take consents listed in **Tables 1** and **1A** (hereafter referred to as the Consent Holders) and is a programme of adaptive management that is suitable to provide a platform for the implementation of these abstractions.

The Consent Holders listed in Table 1 are MWWUG and were granted their consents first. These Consent Holders have been grouped as Priority A consents. The Consent Holders listed in Table 1A are a group of consents that have been jointly granted subsequent to the MWWUG consents. These consents have been grouped as Priority B consents.

An adaptive management regime requires reasonably clear objectives against which the effects and management progress may be evaluated against. The objective of this GMCP is that:

Objective 1: **The abstractions must, individually and cumulatively, avoid:**

(a) **saltwater intrusion into the Aupouri aquifer;**

(b) **adverse effects on the hydrological functioning of the Kaimaumau-Motutangi wetland;**

(c) **adverse effects on the significant indigenous vegetation and significant habitats of indigenous fauna in terrestrial and freshwater environments of the Kaimaumau-Motutangi wetland; and**

(d) **lowering of the groundwater levels of the Aupouri aquifer such that existing efficient bore takes cannot access groundwater from these sub-aquifers.**

Extensive environmental monitoring is required to achieve avoidance of the effects listed above, and to support the proposed 'adaptive management' approach including a staged implementation of groundwater extraction. The purpose of the GMCP is to formalise specific monitoring requirements, establish groundwater level and groundwater quality monitoring triggers and outline a process for implementation of appropriate mitigation and remediation measures in the event that nominated trigger values are exceeded.

The GMCP is intended to allow the early detection of any impact to the Waiharara, Motutangi and Houhora sub-aquifers of the Aupōuri aquifer management unit and the Kaimaumau-Motutangi wetland (Kaimaumau Wetland) associated with the exercise of groundwater take consent(s), by:

- Ensuring regular monitoring of the groundwater system both on and off-site;
- Setting monitoring criteria (trigger levels) to indicate potential impact(s) on the groundwater system and Kaimaumau Wetland;
- Changing the pumping regime if trigger levels are reached to ensure that Objective 1 continues to be met;
- Reviewing monitoring data before and after a step level increase in pumping rate;
- Ensuring that the monitoring data is available for regular review by the Council;
- Detailing a Contingency Plan to be implemented if an unanticipated impact(s) is identified;

- Providing information to quantify the actual effects of the abstraction on the groundwater resource; and
- Enabling validation of the numerical model by the Consent Holders for any replacement groundwater take consent applications.

1.2 Parties Associated with this GMCP

The parties who have been deemed to be associated with this GMCP at its inception are the Council, the Consent Holders, and the Director-General of Conservation.

The following provides a brief description of the roles and responsibilities of each party associated with this GMCP.

Should any of these parties change during the implementation of this GMCP, either through addition or removal, the process as set out in **Section 1.3** below shall be applied.

1.2.1 Northland Regional Council

The Council will undertake the ongoing monitoring requirements of the GMCP on behalf of the Consent Holders. The actual and reasonable cost of undertaking the ongoing monitoring of these consents for the Consent Holders will be charged in accordance with Council's Charging Policy.

The installation of sentinel bores and monitoring equipment is the responsibility of the Consent Holders.

1.2.2 Consent Holders

The Consent Holders are required to exercise their Water Permits in accordance this GMCP.

The exercise of the Water Permits will be in accordance with Council initiated instructions which will be issued once the actions and process established through this GMCP have been undertaken.

The Consent Holders may seek changes to the GMCP through either of the processes set out in **Section 1.3**.

1.2.3 Director-General of Conservation

The Director-General of Conservation is responsible for administering parts of the Kaimaumau Wetland subject to scientific reserve status under the Reserves Act 1977 and stewardship area status under the Conservation Act 1987.

The Director-General of Conservation is a party to this GMCP to ensure that the relevant provisions of these Acts, which the Director-General of Conservation administers, in particular Objective 1(b) and 1(c) matters are to be met.

1.3 Changes to the GMCP

This GMCP may be amended at any time to:

- Incorporate new or replacement water permits, or remove water permits, in the Waiharara, Motutangi or Houhora sub-aquifers of the Aupōuri aquifer management unit that have overlapping and/or additional monitoring requirements or which are subject to different trigger levels or trigger levels based on monitoring described in this GMCP:

- Alter the nature and scope of the required monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels;
- Incorporate or remove parties who are, or may need to be, a part of this GMCP to ensure Objective 1 is met.

If either the Council or a Consent Holder wishes to amend the GMCP, then it must provide notice in writing of the proposed changes, along with any supporting technical documents, to the other Consent Holders, and the Director-General of Conservation.

Parties, given notice by Council of a change to the GMCP, have 20 working days to provide a response to the Council on the proposed changes to the GMCP.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusion of the report.

If any party does not agree with the proposed change, that party shall engage a suitably qualified hydrogeologist and/or an ecologist to prepare a report detailing the reasons for the disagreement which shall be provided to Council within 30 working days from the date that the written notice of the proposed changes was sent to the party.

Any change to the GMCP will only be authorised by Council if the technical or administrative assessment of the proposed change clearly indicates that the change will meet Objective 1 of the GMCP.

Council will provide a report to the Consent Holders detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement. If the change would affect the interests of the Director-General of Conservation, then the report will also be provided to this party.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation.

2. FRAMEWORK FOR ADAPTIVE MANAGEMENT

In summary, the following adaptive management techniques are applied in this GMCP:

(a) Baseline monitoring – a monitoring programme has been developed for Stage 1 of the Consent Holders abstractions to establish robust existing environment baseline. This monitoring programme is contained in this GMCP, however, some monitoring detail is still required and this is indicated by the acronym 'TBC'.

(b) Early warning systems - Trigger levels (TLs) will be established to set up an early warning system that provides a response mechanism when differences between predicted and actual water levels, and/or salinity concentrations occur. A trigger level is an environmental criterion that if reached or met, requires a certain response to be actioned.

(c) Staged development - Abstraction volumes will progressively be increased in a staged manner, with expansion contingent on compliance with yet to be established trigger levels and on regular reviews of groundwater level, wetland ecology and hydrology, and salinity monitoring results. It is noted that the consent documentation requires that all development starts at Stage 1 volumes whether or not others have progressed to Stage 2 or further. This is an essential mechanism for staging as an adaptive management response.

(d) Stage 1 / Year 1 management – Until such time as there is adequate data to enable adaptive management to commence and for Objective 1 of this GMCP to be achieved, the abstractions during this stage will be subject to interim wetland water level and saline trigger levels and Trigger Exceedance Report procedures; and

(e) Tiered approach to monitoring –Monitoring effort is proposed to increase if and when site trigger levels are approached or exceeded. Likewise, monitoring intensity may decrease with evidence of sustained compliance and stability and only by way of the process outlined in **Section 1.3** of this GMCP; and

(f) Ongoing adaptive management – The abstractions will be managed adaptively within the term of consent, in the event of trigger level exceedance through the implementation of the recommendations of a Groundwater Trigger Exceedance Report (GTER) prepared by Council.

(g) Suspension of abstractions – Should compliance with Objective 1 of this GMCP not be achieved, then the exercise of the consents to abstract and use groundwater may be suspended until such time as Council confirms in writing that compliance can be achieved.

The following sections provide detailed information relating to the adaptive management framework to be imposed for the exercise of the consents.

2.1 Staged Implementation

The uptake of water by the Consent Holders will be over 4 stages in accordance with the following factors:

Level of current orchard development – the following orchards are already well established:

AUT.038650.01.01 – Tony Hewitt;

AUT.039345.01.01 – Ian McLarnon & Jason McLarnon;

AUT.038380.01.01 – Damien & Katherine Holloway;

AUT.038589.01.01 – Neil & Alma Violet Thompson, and Steven and Josephine Suzanne Thompson;

AUT.038610.01.01 – Mapua Avocados Limited;

AUT.027391.01.02 – Ivan Anthony Stanisich;

AUT.038471.01.01 – Honeytree Farms Limited

AUT.038420.01.01 – Largus Orchard Limited Partnership; and

AUT.038591.01.01 – Cypress Hills Limited.

Only AUT.027391.01.02, held by Mr Stanisich replaces an existing consent to take and use water. The other holders of consent that have established their orchards have been irrigating their trees under temporary consents issued by the Council.

Rate of orchard development - will occur at differing rates depending on the owner's cashflow and access to plants; and

Tree maturity - approximately nine years to full maturity and plant water usage, hence irrigation requirements commensurately increase with tree growth.

The steady progressive development of the orchards, particularly the new large developments, provides an opportunity to apply an adaptive management approach that establishes a baseline and allows the original hypotheses of avoidance of effects to be re-evaluated, specifically that Objective 1 of this GMCP is being met.

The management approach provides a series of responses based on the monitoring results, including where monitoring shows that Objective 1 of this GMCP is not being met, as discussed in **Section 2.2**.

The uptake by Consent Holders of the consented total allowable water volumes will be permitted in four stages over nine years, as shown in **Table 1** below, unless the outcome of the Staged Implementation and Monitoring Programme Review detailed in **Section 2.1.1** shows that there should be a delay in moving to the next stage, or that the next stage should not occur.

Table 1. Priority A - Summary of staged implementation annual volumes

Application Number	Consent Holder	Allowable Annual Volume (m^3)				
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7- 9)*	
Houhora sub area management unit						
APP.038610.01.01	MAPUA AVOCADOS LIMITED (3)	34,000	96,000	198,000	209,000	
APP.039244.01.01	KEVIN WAYNE THOMAS AND DANNIELLE O'CONNOR	34,000	59,600	59,600	59,600	
APP.039381.01.01	JONATHAN CHARLES BRIEN & CAROL NADINE CARR	14,900	14,900	14,900	14,900	
APP.039345.01.01	IAN GORDON MCLARNON AND JASON IAN MCLARNON	23,520	23,520	23,520	23,520	
APP.038732.01.01	KATHERINE YVONNE VALADARES	22,350	22,350	22,350	22,350	
Motutangi sub area management unit						
APP.038610.01.01	MAPUA AVOCADOS LIMITED (1 and 2),	34,000	96,000	198,000	418,000	
APP.039332.01.01	LJ KING LIMITED	34,000	78,400	78,400	78,400	
APP.038589.01.01	NEIL THOMPSON, ALMA VIOLET THOMPSON, STEVEN THOMPSON, AND JOSEPHINE	34,000	35,280	35,280	35,280	

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7- 9)*
	SUZANNE THOMPSON				
APP.038591.01.01	CYPRESS HILLS LIMITED	34,000	35,280	35,280	35,280
Waiharaha sub area management unit					
APP.038471.01.01	HONEYTREE FARMS LIMITED	34,000	96,000	198,000	346,425
APP.038410.01.01	GEORGINA TUI COVICH AND MATE NICKOLAS COVICH	34,000	96,000	198,000	223,500
APP.038420.01.01	LARGUS ORCHARD LIMITED PARTNERSHIP	34,000	96,000	193,700	193,700
APP.038513.01.01	TE RŪNANGA O NGĀI TAKOTO	34,000	96,000	193,700	193,700
APP.038454.01.01	ELBURY HOLDINGS LIMITED	34,000	96,000	113,700	113,700
APP.038650.01.01	ANTHONY WILLIAM HEWITT AND DIANE ELEANOR HEWITT	34,000	39,200	39,200	39,200
APP.038328.01.01	BERNARD KIM SHINE AND SHERYL DIANNE SHINE	34,000	39,200	39,200	39,200
APP.038380.01.01	DAM2IEN KENNETH HOLLOWAY AND KATHERINE ANNE HOLLOWAY	14,900	14,900	14,900	14,900
AUT.02391.01.02**	IVAN ANTHONY STANISICH	120,000	120,000	120,000	120,000
TOTAL		517,670	1,034,630	1,655,730	2,060,655
% of Total		**25%**	**50%**	**80%**	**100%**

Note: *The staged implementation is based on years when irrigation occurs following the granting of the consents.

** Staged implementation does not apply to this consent as no change to the original consented annual volume has occurred as a result of the Section 127 of the RMA change of conditions.

Table 2A. Priority B - Summary of staged implementation annual volumes

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7- 9)*
Houhora sub area management unit					
APP.040919.01.01	NA BRYAN ESTATE, SG BRYAN, CL BRYAN, KY BRYAN VALADARES &D BRYAN (1)				
Motutangi sub area management unit					
APP.040130.01.01	TUSCANY VALLEY AVOCADOS LTD (M BELLETTE)				
APP.040918.01.01	NA BRYAN ESTATE, SG BRYAN, CL BRYAN, KY BRYAN VALADARES &D BRYAN (2)				
APP.008647.01.06**	AVOKAHA LTD (c/- K PATERSON & A NICHOLSON)				
APP.039628.01.04**	KSL LTD (c/- S SHINE)				
Paparore sub area management unit					

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7- 9)*
APP.040361.01.01	TIRI AVOCADOS LTD				
APP.040362.01.01	VALIC NZ LTD				
APP.040363.01.01	WATAVIEW ORCHARDS (GREEN CHARTERIS FAMILY TRUST)				
Aupōuri - Other sub area management unit					
APP.039841.01.02	MATE YELAVICH & CO LTD				
APP.040368.01.01	ROBERT PAUL CAMPBELL TRUST				
TOTAL					
% of Total		**25%**	**50%**	**80%**	**100%**
Note: *The staged implementation is based on years when irrigation occurs following the granting of the consents.					

2.1.1 Staging: Implementation and Monitoring Programme Review

A "Staged Implementation and Monitoring Programme Review" (SIMPR) will be required for Council to decide whether Consent Holders proceed to the next allocation stage. At the following times, the volume of abstraction authorised will be reviewed against the staged implementation outlined in **Section 2.1** at the minimum intervals of:

End of Stage 1 – 1 full irrigation season following date of commencement of the consents;

End of Stage 2 - 3 irrigation seasons following date of commencement of the consents;

End of Stage 3 - 6 irrigation seasons following date of commencement of the consents; and

End of Stage 4 - 9 irrigation seasons following date of commencement of the consents.

The main purpose of the SIMPR is to assess whether proceeding to the next stage would comply with Objective 1 of the GMCP.

The SIMPR will be commissioned by the Council and shall be prepared by a suitably qualified hydrogeologist and, in relation to monitoring of the Kaimaumau Wetland, a suitably qualified wetland ecologist. The Council will endeavour to ensure that both the hydrogeologist and the ecologist will have experience and knowledge of the locality.

The SIMPR will include a detailed assessment of all environmental monitoring data including groundwater levels, salinity indicators, and water quality, and include consideration of spatial and temporal trends including potential effects of groundwater abstraction on water levels in Kaimaumau Wetland and the effect of these on the ecology of the wetland. The SIMPR will assess whether Objective 1 of this GMCP is being met at the current level of abstraction, and whether Objective 1 will be met at the next stage level of abstraction. The SIMPR may also consider the nature and scope of continued monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels.

The SIMPR will provide recommendations based on the assessment of the environmental monitoring data to date on:

- the setting or alteration of the trigger levels;

- whether any changes to the monitoring programme are required; and
- whether to advance to the next stage of abstraction or to remain at the current level of abstraction, or to reduce the level of abstraction.

A copy of the SIMPR will be provided to the Consent Holders and the Director-General of Conservation a minimum of three months prior to the anticipated commencement of the subsequent irrigation season utilising volumes defined for the subsequent development stage. The Consent Holders and Director-General of Conservation have 20 working days to provide a response to the Council on the conclusions and recommendations of the SIMPR.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusions of the report.

If any party does not agree with the conclusions and recommendations of the SIMPR, then a report by a suitably qualified hydrogeologist and/or an ecologist, both with experience and knowledge of the locality if possible, detailing the reasons for the disagreement shall be provided to Council within 30 working days from the date that the assessment was sent to the party.

An increase in the volume of abstraction to the next development stage and any change to the monitoring programme will only be authorised by Council if the technical assessment of the monitoring data clearly indicates that the increase in the allocation and change to GMCP would meet Objective 1 of this GMCP.

Council will provide a report to the Consent Holders and the Director General of Conservation detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation within 5 working days of the change being authorised as final.

A summary of the above process is also included in the conditions of each consent that is covered by this GMCP.

2.1.2 Stage 1 (Year 1) Management Regime

Stage 1 is the minimum period of the first full irrigation season after a consent is first exercised. To ensure that Objective 1 is met during Stage 1 (Year 1), this will require the identification of:

- an interim minimum water level trigger for the Kaimaumau-Motutangi wetland; and
- interim trigger levels for minimum groundwater levels and salinity indicators in the Sentinel bores identified in **Table 5**.

These baseline figures are recognised as the 'default position' upon which a specific two-tier trigger level and contingency plan system will be implemented during Stage 1 (Year 1) only.

An establishment phase of monitoring will be required to identify default trigger levels for Kaimaumau-Motutangi wetland water level, groundwater levels and saline intrusion. These default trigger level parameters will apply to Stage 1 (Year 1) only.

Council is to notify the Consent Holders and the Director-General of Conservation of the default management parameters for Stage 1 (Year 1). The Consent Holders and Director-General of Conservation have 10 working days to provide responses to the Council on the default management parameters once notified.

Ongoing monitoring will be required to ensure that Objectives 1(a), (b), and (c) are met by implementing trigger level exceedance measures. These trigger level exceedance measures are those which sit in **Section 4** below.

The interim management regime established for Stage 1 (Year 1) will be superseded by the Monitoring and Trigger Level Setting components set out in **Section 2.2** of this GMCP.

2.1.2.1 Kaimaumau Wetland: Monitoring and Triggers

In order to provide a baseline management regime to achieve Objectives 1(b) and 1(c) of this GMCP for Stage 1 (Year 1), the following events have been recognised by the Environment Court as being events that will necessitate further investigations by both wetland ecologists, hydrologists, and hydrogeologists.

- **Trigger Level 1 Year 1 (TL1Y1) –** At any time, a decrease of greater than 25 millimetres from the relative water level.
- **Trigger Level 2 Year 1 (TL2Y1) –** At any time, a decrease of greater than 50 millimetres from the relative water level.

The relative water level which TL 1Y1 and TL2Y1 reference must be a representative level, taking into account seasonal variation and any existing use and existing development of resources at the time of the grant of consent for the water takes which could affect the water levels in the Kaimaumau wetland. The relative water level which TL 1Y1 and TL2Y2 reference must be confirmed in **Table 2** prior to Stage 1 exercise of any ·of the consents.

The Kaimaumau Wetland standing water level monitoring and trigger levels for Stage 1 (Year 1) shall be inserted into the GMCP through the process set out in Section 1.3 of this GMCP.

Table 3: Kaimaumau Wetland Stage 1 (Year 1) Monitoring and Trigger Levels.

Monitoring Installation	Depth (m)	Piezo No.	Target	Units	Frequency	Trigger Levels	
						TL1Y1	TL2Y1
Kaimaumau Wetland - South	<5	1	Wetland water levels	mAMSL	Continuous	Water level recession exceeding a weekly average of 5 mm/day	Water level recession exceeding a weekly average of 6.25 mm/day

Due to access constrains at the northern site (helicopter access only), interim wetland water level triggers are for the Kaimaumau Wetland - South monitoring site only. Available data indicates temporal response at both sites are virtually identical. If TL1 is exceeded at the Kaimaimau Wetland – South monitoring site, data will be collected from the Kaimaumau Wetland – North site to confirm trigger exceedance at this site.

2.1.2.2 Saline Intrusion & Groundwater Level: Monitoring and Triggers

Saline intrusion monitoring for Stage 1 (Year 1) is proposed within the sentinel bores identified in **Table 4** of this GMCP. As each sentinel bore is drilled, groundwater level and salinity indicators will be measured and recorded. This information will be used to set interim trigger levels for these parameters as per the methodology established in **Section 2.2** below. Interim trigger levels must be set prior to exercise of any of the consents.

The saline intrusion and groundwater level monitoring trigger levels for Stage 1 (Year 1) shall be inserted into the GMCP through the process set out in **Section 1.3** of this GMCP prior to the exercise of any consents.

2.1.2.3 Trigger Level Responses

In the event of an exceedance of a Trigger Level applicable in Stage 1 (Year 1), the Trigger Level Exceedance response plan contained in **Section 4** of this GMCP shall apply.

2.1.2.4 Ceasing Interim Stage 1 (Year 1) Management Regime

This interim management regime shall remain in place until such time as Council has given authorisation to proceed to the next stage (Stage 2) as set out under **Section 2.1.1** above or where the setting of trigger levels as per **Section 2.2** below has been given effect to through amendment to this GMCP in accordance with the change process established in **Section 1.3** of this GMCP.

2.2 Trigger Level System

2.2.1 Timeframe for setting of trigger levels

The setting of trigger level values for each parameter (where TBC is indicated in the monitoring plan tables in **Section 3** Monitoring Programme) will be undertaken during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents. This approach recognises that:

- There is historical monitoring data available for some parameters;
- In some areas, no baseline data has been established by the consent holder(s) or any of the key stakeholders in the area; and that
- The manifestation of any effects from the exercising of these consents will steadily progress with time in accordance with the stages of orchard developments and age of the crop. The scale of abstraction during the baseline data collection period (i.e. 12 months following granting of consent) will not vary significantly from existing conditions.

2.2.2 Method for setting of trigger levels

A two-tier trigger level system will be implemented on the consents:

- **TL1** - The first-tier trigger level establishes whether the parameter of concern is approaching outer limits of baseline data (e.g. Median ±2 times the standard deviation, or some other criteria determined with agreement of Council). If this trigger level is breached, then additional monitoring will be undertaken by the Council;
- **TL2** - The second-tier trigger level is set at a threshold defining a 'significant' departure from baseline conditions and/or conditions where the risks of adverse environmental effects are increased. If this trigger level is breached, then the Consent Holders will be required to reduce their daily water take volume in a staged manner over a set period of time.

The TL parameters required under this GMCP for the various suites are summarised in **Table 3.**

Table 4: Summary trigger level parameters by monitoring suite

Monitoring Suite	Parameters
Groundwater level and salinity monitoring	Groundwater level, electrical conductivity
Saline intrusion monitoring	Electrical conductivity, chloride, sodium, total dissolved solids.
Kaimaumau-Motutangi Wetland water level	Groundwater level in shallow sand aquifer.

2.2.3 Response to exceeding trigger levels

The actions required should TL's be exceeded are set out in **Section 4** (Contingency Plan).

3. MONITORING PROGRAMME & TRIGGER LEVEL SETTING

3.1 Bore Locations and Details

A consolidated summary of the schedule of bores that are required to be monitored as part of this GMCP is provided in **Table 4.** Along with the bores identified for monitoring, the table provides key details relating to the bores' physical attributes and parameters to be monitored. The resultant wetland monitoring location is to be hydrologically connected with the full range of water levels in the open water habitat of the Kaimaumau Wetland. The following sections of the GMCP provide the monitoring schedules (frequency and trigger levels) for the bores.

The locations of the production bores in **Table 4** are shown in **Figure 1**. An error accuracy level of +/- 50 metres is applicable to these bore locations. Any differentiation to the location by greater than 50 metres will result in a requirement of an application to the Council for a change of consent condition pursuant to Section 127 of the Resource Management Act 1991 (RMA). Assessment of the effects on the environment of the change will be required pursuant to Schedule 4 of the RMA.

Table 5: Schedule of monitoring facility and production bore details.

Bore Name		Bore Owner	Coordinates (NZTM 2000)		Depth (m)	Dia. (mm)	Piezo. No.	Target aquifer	Purpose*
Generic	NRC ref.		Easting	Northing					
MONITORING BORES									
Fishing Club	LOC.200250	NRC	1611411	6146928	79			Deep shellbed	SI; MI
Waterfront	LOC.200210	NRC	1611712	6146689	19	32	1	Shallow sand	GL_c, EC_c
			1611712	6146689	74	32	4	Deep shellbed	GL_c, EC_c
Motutangi	TBC	NRC	1615677	6139811	<10	50	1	Shallow sand	GL_c; EC_c
			1615676	6139821	80-100 (TBC)	50	2	Deep shellbed	GL_c; EC_c
Norton Road	TBC	NRC	1619875	6134377	80-100 (TBC)	50	2	Deep shellbed	GL_c; EC_c
Kaimaumau	LOC.316222	NRC	1622445	6134482	20		1	Shallow sand	GL_c; EC_c; SI; MI
	LOC.315766	NRC	1622426	6134466	72		2	Deep shellbed	GL_c; EC_c; SI; MI
Kaimaumau Wetland	TBC	NRC	1616379	6140758	<1.5	50	1	Standing water in wetland	GL_c
Honeytree	TBC	NRC	1618911	6136120	6	50	2	Shallow sand	GL_c
Paparore	TBC	NRC	1619100	6130600	<10			Shallow sand	GL_c; EC_c
	TBC	NRC	1619100	6130600	80-100 (TBC)			Deep shellbed	GL_c; EC_c
Kaimaumau Settlement	TBC	NRC	1624250	6135897	<20		1	Shallow sand	GL_m, SI
	TBC	NRC	1624250	6135897	>50 (TBC)		2	Deep shellbed	GL_m, SI
PRODUCTION BORES									
Brien & Carr	TBC	J. Brien & C. Carr	1610058	6147313	TBC		1	Deep shellbed	GL_m, EC_m
Valadares	TBC	K. Valadares	1612533	6142943	TBC		1	Deep shellbed	GL_m, EC_m
McLarnon	TBC	I. & J. McLarnon	1611284	6144679	TBC		1	Deep shellbed	GL_m, EC_m
Elbury Holdings	TBC	Elbury Holdings Limited	1617409	6133139	TBC		1	Deep shellbed	GL_m;, EC_mSI
Holloway	TBC	Huanui Avocados Ltd	1619886	6134694	TBC		1	Deep shellbed	GL_m, EC_m
Ngai Takoto	TBC	Te Runanga o Ngai Takoto	1619097	6135520	TBC		1	Deep shellbed	GL_m, EC_m
			1618987	6135795	TBC		1	Deep shellbed	GL_m, EC_m

Cypress Hills	TBC	Cypress Hills Ltd	1614898	6138495	TBC		1	Deep shellbed	GL_m, EC_m
Stanisich	TBC	I.A. Stanisich	1618046	6133608	TBC		1	Deep shellbed	GL_m, EC_m
			1617839	6133475	95	104	1	Deep shellbed	GL_m, EC_m
Honeytree	TBC	Honeytree Farms Limited	1618894	6136120	112	310	1	Deep shellbed	GL_m, EC_m
			1618552	6136318	111	310	3	Deep shellbed	GL_m, EC_m
Thompson	TBC	N. & A. V. Thompson and S. & J.S. Thompson	1614798	6138773	TBC		1	Deep shellbed	GL_m, EC_m
LJ King Ltd	TBC	LJ King Limited	1614723	6139203	TBC		1	Deep shellbed	GL_m, EC_m
Mapua	TBC	Mapua Avocados Ltd	1612579	6141738	111	100	1	Deep shellbed	GL_m, EC_m
			1613011	6142457	122	100	2	Deep shellbed	GL_m, EC_m
			1612468	6142348	97	100	3	Deep shellbed	GL_m, EC_m
Hewitt	TBC	T. Hewitt	1617409	6132267	TBC		1	Deep shellbed	GL_m, EC_m
Shine	TBC	B. K. & S. D. Shine	1619774	6134083	TBC		1	Deep shellbed	GL_m, EC_m
Largus	TBC	Largus Orchard Ltd Partnership	1617905	6132480	TBC	100	2	Deep shellbed	GL_m, EC_m
			1617919	6132263	94	100	1	Deep shellbed	GL_m, EC_m
Covich	TBC	G.T. & M. N. Covich	1617353	6136859	TBC		1	Deep shellbed	GL_m, EC_m
			1617128	6136793	TBC		1	Deep shellbed	GL_m, EC_m
Thomas	TBC	K. Thomas & D. O'Connor	1610222	6147542	TBC		1	Deep shellbed	GL_m, EC_m
Bryan Estate 1	TBC	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valdares & D Bryan (1)	1613415	6143424	TBC		1	Deep shellbed	GL_m, EC_m
Bryan Estate 2	TBC	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valdares & D Bryan (1)	1613901	6142132	TBC		1	Deep shellbed	GL_m, EC_m
KSL	TBC	KSL Ltd	1614333	6138477	TBC		1	Deep shellbed	GL_m, EC_m
Tuscany Avocados	TBC	Tuscany Valley Avocados Ltd	1614490	6138367	TBC		1	Deep shellbed	GL_m, EC_m
Robert Campbell	TBC	Robert Paul Campbell Trust	1615813	6135787	TBC		1	Deep shellbed	GL_m, EC_m
Yelavich	TBC	Mate Yelavich & Co Ltd	1616833	6133996	TBC		1	Deep shellbed	GL_m, EC_m

Wataview	TBC	Wataview Orchards (Green Charteris Family Trust)	1619441	6132282	TBC		1	Deep shellbed	GL_m, EC_m
Tiri 1	TBC	Tiri Avocados Ltd	1618056	6130290	TBC		1	Deep shellbed	GL_m, EC_m
Tiri 2	TBC	Tiri Avocados Ltd	1618856	6130196	TBC		2	Deep shellbed	GL_m, EC_m
Valic 4	TBC	Valic NZ Ltd	1617589	6129130	TBC		1	Deep shellbed	GL_m, EC_m

Notes:

TBC = to be confirmed within 15 months of the date of commencement of these consents.

* Purpose key:

GL_c = Continuous Groundwater Level;

GL_m = Manual (monthly) Groundwater Level;

EC_c = Continuous Electrical Conductivity;

EC_m = Manual (monthly) Electrical Conductivity;

SI = Salinity Indicators (quarterly);
MI = Major Ions (quarterly).

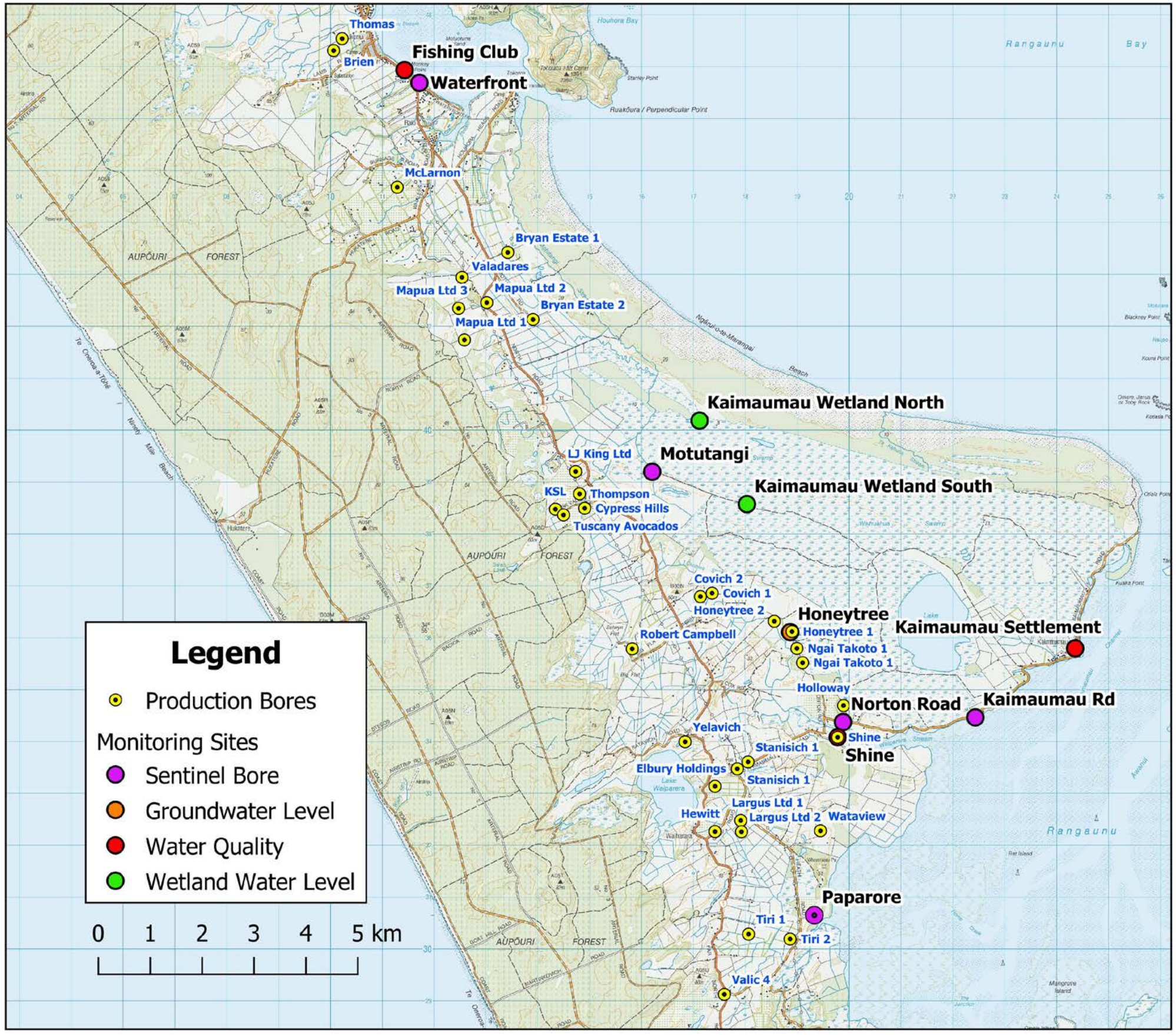

Figure 1. **Monitoring and Production Bore Location Map**

3.2 Groundwater Level and Salinity Monitoring

Sentinel bores will be utilised as the primary reference sites for regional groundwater level and salinity monitoring. These bores will provide early detection or warning of:

- Groundwater levels around the coastal margin lowering and approaching a threshold that could indicate a greater risk of saline intrusion; and
- Any reduction in water quality that could indicate the landward migration of the saline interface.
- Groundwater levels in the shallow sand aquifer lowering and having a potential adverse effect on the Kaimaumau-Motutangi wetland due to a decline in standing water level.

Details of the sentinel bores are summarised in **Table 5** below. These sentinel bores will collect data continuously for water levels and electrical conductivity in individual piezometers. A two-tier trigger level system (TL1 and TL2) for groundwater levels and electrical conductivity will be set in these bores.

Monitoring of groundwater levels in the "shallow sand" aquifer in bores listed in **Table 5** will enable identification of the potential for effects on the Kaimaumau-Motutangi wetland due to a decline in standing water level resulting from groundwater abstraction. It is also useful for understanding the overall response of the groundwater system to abstraction effects and to saline intrusion risks.

The setting of TL1 and TL2 trigger levels values for each parameter will be undertaken during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents. The current trigger limit values that are shown in **Table 5** are based on existing data and will be reconfirmed by Council when the other trigger levels are confirmed.

All sentinel monitoring bores listed in **Table 5** will be installed prior to the exercise of the consents.

Checking of the sensors required for continuous monitoring will be undertaken on a monthly basis, and any faults will be recorded and remedied immediately.

Table 6: Schedule of sentinel monitoring bores for groundwater level and/or salinity indicators

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Units	Frequency	Trigger Levels	
						TL1	TL2
Waterfront	21	4	Shallow sand	mAMSL	Continuous	0.75	0.65
				µS/cm		744	892
	72	1	Deep shellbed	mAMSL	Continuous	2.55	2.35
				µS/cm		555	666
Motutangi	8	1	Shallow sand	mAMSL	Continuous	6.35	6.25
				µS/cm	Continuous	412	495
	83	2	Deep shellbed	mAMSL	Continuous	6.10	5.90
				µS/cm	Continuous	681	818
Norton Road	80-100 (TBC)	1	Deep shellbed	mAMSL	Continuous	4.25	4.05
				µS/cm	Continuous	572	687
Paparore	<20	1	Shallow sand	mAMSL	Continuous	TBC	TBC
				µS/cm	Continuous	TBC	TBC
	80-100	2	Deep shellbed	mAMSL	Continuous	TBC	TBC
				µS/cm	Continuous	TBC	TBC
Kaimaumau	20	1	Shallow sand	mAMSL	Continuous	1.25	1.15

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Units	Frequency	Trigger Levels	
						TL1	TL2
				µS/cm	Continuous	286	345
	72	2	Deep shellbed	mAMSL	Continuous	1.70	1.50
				µS/cm	Continuous	435	520

Notes:

TBC = to be confirmed within 15 months of the date of commencement of these consents.

GL TL1s (where provided) have been calculated from long term monitoring data.

GL TL2s (where provided) have been interpolated from Table F1, WWA Groundwater Modelling Report.

3.2.1 Setting of Groundwater Trigger Levels

3.2.1.1 Shallow Sand Aquifer

After a period of 12 months of monitoring from the date of commencement of these consents, the Council will commission an assessment of the potential impact of shallow groundwater decline on the Kaimaumau-Motutangi Wetland by a suitably qualified and experienced Hydrogeologist and a suitably qualified and experienced Ecologist. This assessment shall be undertaken in consultation with Consent Holders and the Director General of Conservation, and shall include, but not be limited to:

- Analysis of a single round of radon samples collected in accordance with https://www.gns.cri.nz/Home/Services/Laboratories-Facilities/Tritium-and-Water-Dating-Laboratory/Introduction-to-Water-Dating-and-Tracer-Analysis/Radon following a two week period of no significant rainfall at four representative points in and around the area of the Kaimaumau Wetland **(Figure 1)** containing standing water, within six months of the date of commencement of these consents;
- Analysis of temporal groundwater level variations in the shallow Motutangi piezometer and the Kaimaumau Wetland piezometer (**Table 4**); and
- Analysis of variation in shallow groundwater levels in response to pumping from the Honeytree Farms production bore.
- The results of the wetland vegetation survey required by **Section 3.4.3**Error! Reference source not found..

A copy of the above assessment will be provided to the Consent Holders covered by this GMCP and the Director-General of Conservation. The Consent Holders and Director-General of Conservation have 20 working days to provide a response to the Council on the conclusions of the assessment.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusion of the report.

If any party does not agree with the conclusions of the assessment, then a report by a suitably qualified hydrogeologist and/or an ecologist detailing the reasons for the disagreement shall be provided to council within 30 working days from the date that the assessment was sent to the party.

Council will set trigger levels for “shallow sand” groundwater levels in the sentinel bores if the technical assessment of the potential impact of shallow groundwater decline on the Kaimaumau Wetland clearly

indicates that adverse effects on the wetland[1] as a result of the groundwater takes cannot be avoided without trigger level response measures. A precautionary approach will be taken to the decision on whether to set trigger levels or not.

If groundwater level triggers are required for the "shallow sand" monitoring bores identified in **Table 5**, then they will be set as follows:

- TL1 – Will be determined based on the median ground water level minus 2 standard deviations of the baseline data. The baseline dataset will comprise 12 months of monitoring data combined with actual historical monitoring data synthesised from an appropriate nearby shallow bore.
- TL2 – Will be determined based on the median ground water level minus 3 standard deviations of the baseline data. The baseline dataset will comprise 12 months of monitoring data combined with actual historical monitoring data synthesised from an appropriate nearby shallow bore. TL2 will be no less than 0.5 mAMSL in the shallow aquifer.

Council will provide a report to the Consent Holders and the Director-General of Conservation detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement.

3.2.1.2 Deep Shell bed Aquifer

As a general guide TL2 for deep shell bed groundwater levels should be no less than 1.0 mAMSL (noting that changes in EC are also a key indicator of saline intrusion).

3.2.1.3 Electrical Conductivity Triggers

Electrical conductivity triggers will be no greater than:

- **TL1** - Median (weekly rolling average) EC from baseline monitoring period +25%
- **TL2** - Median (weekly rolling average) EC from baseline monitoring period + 50%

3.2.2 Ongoing monitoring

Ongoing monitoring of groundwater and electrical conductivity levels will be undertaken continuously via individual piezometers in sentinel monitoring bores.

3.3 Saline Intrusion Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 6** below will be undertaken at 6 weekly intervals[2]:

- Electrical conductivity;
- Chloride;
- Sodium;

1 Assessment of effects on wetland ecology shall be guided by a suitably qualified wetland ecologist approved by NRC, considering such matters as area of wetland impacted due to lowering of wetland water levels (cognisant of the relationship between aquifer porosity and open body water levels).

2 This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

3.4 Setting of Saline Intrusion Triggers

As an initial guide, trigger levels for individual determinants will be established as follows:

- **TL1** - Median concentration from the baseline monitoring period +25%.
- **TL2** - Median concentration from the baseline monitoring period + 50%.

3.4.1.1 Ongoing Monitoring

Sampling at the frequencies specified for the following salinity indicators will take place in the bores listed in **Table 6** below:

- Electrical conductivity;
- Chloride;
- Sodium;
- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

Table 7: Monitoring Schedule – Saline Intrusion

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
Fishing Club	79	1	Deep shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Kaimaumau (Sentinel)	20	1	Shallow sand	EC	µS/cm	Continuously	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
	72	2	Deep shellbed	EC	µS/cm	Continuously	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
Kaimaumau Settlement	<20 (12)	1	Shallow sand	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
	>50 (TBC)	2	Deep shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Elbury Holdings	TBC	1	Deep shellbed	EC	µS/cm	Quarterly	TBC	TBC

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC

Notes:

* Parameter key: GL = Groundwater Level; EC = Electrical Conductivity; SI = Salinity Indicators; TDS = Total Dissolved Solids.

TBC = to be confirmed within 15 months of the date of commencement of these consents.

3.5 Production Bore Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 7** below will be undertaken at 6 weekly intervals[3].

3.5.1 Trigger levels

Electrical conductivity trigger levels will be established in the production bores listed in **Table 7** below.

During the initial 12-month monitoring period Electrical Conductivity Triggers will be no greater than:

- **TL1** – Departure exceeding 25% of the EC value from the initial monitoring round
- **TL2** – Departure exceeding 50% of the EC value from the initial monitoring round

Long-term EC triggers for individual production bores will be established following the initial 12-month monitoring period based on an assessment of spatial and temporal variation in EC observed during the initial period, in a manner consistent with EC trigger levels established in the sentinel monitoring bores.

No trigger levels will be established for groundwater levels in the production bores as water levels in the production bores can be impacted by well efficiency and pumping schedules so are not necessarily representative of groundwater levels in the surrounding aquifer.

3.5.2 Ongoing monitoring

Monthly water level monitoring will be undertaken in the production bores listed in **Table 7**. During the winter months (nominally May to September) this monitoring will provide information to identify any inter-annual variations in aquifer storage which may be anomalous compared to regional trends. During the irrigation season, water level measurements will be undertaken a minimum of eight hours following the cessation of pumping.

Electrical conductivity values will also be measured at monthly intervals from the production bores during the irrigation season to check on any changes in salinity induced by the pumping.

Continuous water level monitoring is required in a shallow observation bore adjacent to the production bore for AUT.038471.01.01 to quantify any localised drawdown effects in the shallow sand aquifer in the vicinity of a relatively large abstraction proximal to Kaimaumau Wetland. This shallow aquifer monitoring will enable comparison between the shallow aquifer impact as modelled in the Model Report and the data from the shallow piezometers in the sentinel bores listed in **Table 5.**

[3] This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

Table 8: Monitoring Schedule – Production Bore Water Levels

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
Lamb Road	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Valadares	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
McLarnon	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Elbury Holdings	TBC	1	Deep shellbed	GL, SI	mAMSL	Monthly	EC TBC	EC TBC
Holloway	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Ngai Takoto	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Cypress Hills	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Stanisich	95	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Honeytree	112	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
	6	2	Shallow sand	GL, EC	mAMSL	Continuous	EC TBC	EC TBC
	111	3	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Thompson	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
L J King Limited	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Mapua	111	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
	122	2	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
	97	3	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Hewitt	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Shine	TBC	1	Deep shellbed	GL; EC	mAMSL	Monthly	EC TBC	EC TBC
Largus	94	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Covich	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Thomas	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Bryan Estate 1	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Bryan Estate 2	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
KSL	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Tuscany Avocados	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Robert Campbell	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Yelavich	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Wataview	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Tiri 1	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Tiri 2	TBC	2	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC
Valic 4	TBC	1	Deep shellbed	GL, EC	mAMSL	Monthly	EC TBC	EC TBC

Notes:

* Purpose key: GL = Groundwater Level; EC = Electrical Conductivity.

All trigger limit values in this Table to be confirmed by Council.

3.5.3 Wetland Vegetation Survey

3.5.3.1 Initial Survey

Within six months of the date of commencement of these consents the Council, in consultation with the Director-General of Conservation and the Consent Holders, will commission a suitably qualified and

experienced ecologist to catalogue the values and attributes of the significant indigenous vegetation and significant habitats of indigenous fauna of the Kaimaumau Wetland, including the standing water area of the Kaimaumau Wetland that is being monitored by the standing water level monitoring station required by Table 5. Initial survey work should take place in the months of September, October, or early November.

The main plant communities in the standing water shall be delineated on high quality aerial photographs of the wetland area at a suitable scale. The mapped vegetation types shall be classified and. named using an appropriate system of classification such as the Atkinson system (1985).

Following the mapping of vegetation types and plant communities an assessment of the composition and structure of wetland vegetation, and associated wetland soil chemistry, shall be carried out.

The methodology will include an assessment of the overall wetland condition using the Wetland Condition Index described in Clarkson et al. (2004) that includes a semi-quantitative evaluation of the following indicators:

- Changes in hydrological integrity.
- Changes in physiochemical parameters,
- Changes in ecosystem intactness,
- Changes in browsing. predation and harvesting regimes.
- Changes in the dominance of native plants.

Reference shall also be made to other pressures which may be impacting on the wetland:

- Modifications to catchment hydrology.
- Water quality within the catchment.
- Animal access,
- Key undesirable species.
- % catchment in introduced vegetation.

Detailed assessment of vegetation composition and structure in the standing water area will be undertaken using a series of three vegetation transects established across the standing water area, applying the Scott Height Frequency (SHF) method (Scott, 1965; Rose, 2012) supplemented with wetland soil monitoring.

The vegetation transects must encompass the complete hydrological gradient across the standing water area (littoral zone/shallow water and deep water habitats), and run perpendicular from the dune system at the north of the standing water, in a south west direction. The three vegetation transects must be geographically spaced apart to ensure vegetation monitoring covers all habitats in the standing water area.

Application of the SHF method must ensure that the transects are permanently marked to enable accurate resurvey.

Application of the SHF method must ensure that as a minimum wetland plant composition and height is recorded every 1.0m for a transect distance of 1OOm across the hydrological gradient. In addition, wetland plots of plots (5m x 5m) (Scott, 1965; Rose, 2012) must be undertaken every 20m (5 per transect) to assess variation in vegetation cover abundance.

Within each of the wetland plots, wetland soil cores must be collected for analysis at an accredited laboratory. Wetland soil chemistry analyses must include: pH, conductivity, total carbon, total phosphorus, total nitrogen,

and bulk density. These are standard wetland soil analyses for vegetation monitoring (Clarkson et al. 2004) and are required to inform assessment of vegetation changes in relation to water level variation.

The information shall be recorded using standard forms and applying the scoring system, such as that from Clarkson et al. (2004) for the index of wetland condition, and the SHF method templates (Scott, 1965; Rose, 2012).

3.5.3.2 Repeat Survey

The Council shall. commission, in consultation with the Director-General of Conservation and the Consent Holders, a suitably qualified and experienced ecologist to undertake wetland vegetation survey and subsequent reporting every 5 years from the original date of survey at around the same time of year as the original survey. The repeat survey's must be designed in a way that enables ecologically meaningful and statistically robust scoring of the wetland condition in order to analyse changes to the wetlands condition resulting from the groundwater abstraction.

This repeat survey must be completed once after the initial vegetation survey (to provide an accurate baseline) but thereafter will only take place where technical assessment carried out according to Section 2.1.1 confirms that there is a decline in standing water level of the Kaimaumau Wetland resulting from groundwater abstraction.

A decline in standing water level of the Kaimaumau Wetland attributable to groundwater abstraction will be determined from the monitoring and analysis of temporal groundwater level variations in the shallow Motutangi piezometer in relation to the Kaimaumau Wetland Standing Wetland Water Level facilities as described in **Table 4** above.

3.6 Environmental Monitoring Report

At the end of each irrigation season, the Council will commission the preparation of an Annual Environmental Monitoring Report (AEMR) by a suitably qualified hydrogeologist and, in relation to monitoring of the Kaimaumau Wetland, a suitable qualified wetland ecologist. The Council will endeavour to ensure that, if possible, both the hydrogeologist and the ecologist will have experience and knowledge of the locality. A copy of the AEMR will be provided to the Consent Holders and the Director General of Conservation by 31 July each year.

The purposes of the Annual Environmental Monitoring Report are to:

- Provide a summary of the monitoring results for the previous year, including trends, against Objective 1 of the GMCP;
- Assess the monitoring undertaken over the previous year against the standards set out in Objective 1;
- Report on any issues apparent with the monitoring and
- Identify any improvement that could be made with respect to the monitoring.

The AEMR will also contain an evaluation of whether the observed effects of the groundwater takes are consistent with the predictions of environmental response contained in the *Motutangi-Waiharara Groundwater Model, Factual Technical Report – Modelling. Motutangi-Waiharara Water User Group. WWA0026: Final – Rev. 9*, dated 31 August 2017 (hereon in referred to as the 'Model Report').

4. CONTINGENCY PLAN

Exercise of the consents is subject to compliance with Objective 1 of this GMCP.

As described in **Section 2**, a trigger level system is used to define environmental criteria that signal changes may be occurring outside of what is normal (TL1) or at a point where remedial action is required to avoid Objective 1 not being met (TL2).

This section details the responses that will be undertaken where TLs are exceeded under any of the monitoring suite discussed in **Sections 2.1.2.1, 2.1.2.2, 3.2, 3.3, and 3.4**.

Where a trigger level is exceeded the Council will commission a Groundwater Trigger Exceedance Report (GTER). The objective of the GTER is to establish the cause of a trigger level exceedance and to recommend a programme of action to end the exceedance.

A GTER shall include:

- Review of the monitoring results collected and establish why the breach has occurred;
- Set out requirements for more intense monitoring of the breach;
- Update the report on a regular basis as more data becomes available; and
- Recommend actions to end the breach, this could include;
    - A staged reinstatement of abstraction levels to pre-breach levels,
    - Reduced levels of abstraction for all or some of the consent holders covered by the GMCP, or
    - Suspension of abstraction by all or some of the consent holders covered by the GMCP.

4.1 Exceedance of TL1

In the event of a TL1 exceedance, which may represent declining groundwater levels, Kaimaumau wetland water levels, or rising salinity indicators, the following actions must be undertaken:

(a) The Council will notify the Consent Holders within two working days of when the TL1 exceedance became known.

(b) If the exceedance is of a salinity indicator in the bores listed in **Table 5**, then sampling of the monitoring bore(s) in exceedance shall immediately be upgraded to a weekly frequency for four weeks following the first exceedance of the TL1. Weekly monitoring shall continue until sample results are consistently below TL1 values for a period of four weeks or as directed by Council.

(c) If after four weeks following the first exceedance of the TL1, the initiation of seawater intrusion and/or water level decline cannot be discounted to the satisfaction of the Council, then a Groundwater Trigger Exceedance Report (GTER) by a suitably qualified Hydrogeologist (and ecologist if the exceedance concerns the Kaimaumau wetland) shall be commissioned by Council.

(d) The GTER shall assess the significance of the exceedance against the requirements of Objective 1 of the GMCP. The GTER shall assess why TLs have been breached, identify the pumping bores in the area(s) of effect and will review all of the available data collected in the affected area(s), in particular the data collected pursuant to this GMCP.

4.2 Exceedance of TL2

In the event of a TL2 exceedance, which represents significant departure from normal groundwater and/or Kaimaumau Wetland conditions, with either continuously declining groundwater levels and/or Kaimaumau Wetland water levels, or rising salinity indicators:

(a) Council will immediately inform the Consent Holders upon TL2 exceedance becoming known.

(b) All Consent Holders must reduce their abstraction to 50% of the current average daily quantity, as calculated using the previous months water use records required to be kept in accordance with the conditions of its groundwater take consent. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only. The council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

(c) A GTER by a suitably qualified hydrogeologist (and ecologist if the exceedance concerns the Kaimaumau wetland) shall be commissioned by Council. The GTER shall assess why the TL2 has been breached, identify the pumping bores in the area of effect, and include a review of all available data collected for the affected area(s), in particular, the data collected under this GMCP.

(d) Once (b) above has been complied with, a Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council approval for an alternative reduction value will only be given if it is satisfied that relevant TL2 values will not be exceeded. Approval for an alternative reduction will be given to Priority A Consent Holders first. The Council will use the GTER to inform its decision on any alternative reduction value for a Consent Holder.

(e) If the TL2 exceedance is in a bore(s) that is/are not continuously monitored, then weekly groundwater level measurements and/or sampling of saline intrusion (depending on which trigger level is breached) in all bores where TL2 trigger levels are breached will commence within one week of the TL2 trigger level exceedance. Monitoring will continue until such time as:

- Three consecutive samples in an individual monitoring bore are below all TL2 thresholds established for that piezometer; or
- As directed by Council.

(f) If salinity indicators continue to increase or groundwater levels continue to decline after 21 days following the implementation of (b), then Consent Holder's abstraction must be reduced to 25% of the current average daily quantity, as calculated for (b) above. The council will advise the Consent Holder in writing of this further reduction and the required reduction in the daily water take volume.

(g) If (f) is implemented, then the Council will commission a review and update of the GTER report by a suitably qualified hydrogeologist (and ecologist if the exceedance concerns the Kaimaumau-Motutangi wetland) with a longer-term programme of recommended responses incorporating observed responses to interim pumping rate reductions. The updated GTER will include a specific programme (including timeframes) of actions which would achieve compliance with Objective 1 of this GMCP. The actions may include, but not be limited to incremental reductions in the daily quantity of groundwater taken as a percentage of the allowable daily pumped volume, as well as testing of domestic/stock water supplies in bores that are efficiently utilising the aquifer and are potentially impacted by saline intrusion, and if necessary, the provision of temporary water supplies to any affected parties (excluding any of the Consent Holders) in the event that Chloride concentrations exceed 250 mg/L (being the guideline value for taste prescribed in New Zealand Drinking Water Standards for New Zealand 2005 (Revised 2008)). The GTER will also identify a methodology which Council will utilise to increase abstraction back to the

volumes applicable to the relevant stage of taking (see Section 2.1), where this can be done such that Objective 1 of this GMCP will be met. If it is not possible to increase abstraction back to the relevant stage of taking, then the GTER will identify a methodology to increase abstraction to a lesser volume such that Objective 1 of the GMCP will be met. Any increase in abstraction will be provided to Priority A Consent Holders first.

(h) Actions from the GTER shall continue as long as the issue continues.

(i) Implement additional remedial measures as directed by Council, including of the suspension of taking.

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Groundwater Monitoring and Contingency Plan for the Sweetwater and Ahipara sub-aquifers of the **Aupōuri** Aquifer Management Unit

July 2020

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GLOSSARY OF TERMS

Saline/saltwater intrusion	For the purposes of this Groundwater Monitoring and Contingency Plan, saline/saltwater intrusion refers to changes in salinity at nominated monitoring locations that exceed thresholds established to indicate elevated potential for adverse effects on groundwater quality for potable supply and/or irrigation use
Efficient bore takes	An efficient bore take is when a bore fully penetrates the water bearing layer and takes water from the base of the aquifer.
Sub-aquifer	The Aupōuri Aquifer system is divided into 12 separate sub-aquifer units for the purposes of setting tailored aquifer-specific allocation limits.[1]
First in-first served	Under the Resource Management Act 1991, applications for water take are processed in the order in which they are lodged. The rights of parties associated with this Groundwater Monitoring and Contingency Plan are prioritised according to the order in which their permits are granted and added to this Plan.

[1] Policy H.4.4 of the Proposed Regional Plan for Northland (Appeals Version) June 2020.

1. INTRODUCTION

1.1 Scope and Objective of the GMCP

This document comprises a groundwater monitoring and contingency plan for the Sweetwater and Ahipara sub-aquifers of the Aupōuri aquifer management unit (GMCP). The GMCP covers the implementation and monitoring of the groundwater take consents listed in **Table 1** (the Consent Holders) and is a programme of adaptive management that is suitable to provide a platform for the implementation of the abstractions listed in **Table 1**.

An adaptive management regime requires reasonably clear objectives against which the effects and management progress may be evaluated against. The objective of this GMCP is that;

Objective 1: **The abstractions must, individually and cumulatively, avoid:**

(a) **saltwater intrusion into the Aupouri aquifer;**

(b) **adverse effects on the hydrological functioning of dune lakes and natural wetlands;**

(c) **adverse effects on the significant indigenous vegetation and habitats in dune lakes and natural wetlands; and**

(d) **lowering of the groundwater levels of the Aupouri aquifer such that existing efficient bore takes operating as a permitted activity or in accordance with resource consent conditions cannot access groundwater of the quantity authorised.**

Extensive environmental monitoring is required to achieve avoidance of the effects listed above, and to support the proposed 'adaptive management' approach including a staged implementation of groundwater extraction. The purpose of the GMCP is to formalise specific monitoring requirements, establish groundwater level and groundwater quality monitoring triggers and outline a process for implementation of appropriate mitigation and remediation measures in the event that nominated trigger values are exceeded.

The GMCP is intended facilitate the proposed 'adaptive management' approach by enabling early detection of adverse impacts on the quality and quantity of the Aupōuri aquifer, particularly within the Sweetwater and Ahipara sub-aquifers of the Aupōuri aquifer management unit associated with the exercise of groundwater take consent(s), by:

- Requiring regular monitoring of the groundwater system both on and off-site;
- Setting monitoring criteria (trigger levels) to indicate potential adverse impacts on the groundwater system;
- Implementing mitigation measures including changes to the pumping regime if trigger levels are reached to ensure that Objective 1 continues to be met;
- Reviewing monitoring data before and after a step level increase in pumping rate;
- Ensuring that the monitoring data is available for regular review by the Council;
- Detailing a Contingency Plan to be implemented if an unanticipated impact(s) is identified;
- Providing information to quantify the actual effects of the abstraction on the groundwater resource; and

- Enabling validation of the numerical model by the Consent Holders for any replacement groundwater take consent applications.

1.2 Parties Associated with this GMCP

The parties who have been deemed to be associated with this GMCP at its inception are the Council, the Consent Holders in **Table 1**, the Far North District Council, and the Director-General of Conservation.

The following provides a brief description of the roles and responsibilities of each party associated with this GMCP.

Should any of these parties change during the implementation of this GMCP, either through addition or removal, the process as set out in **Section 1.3** below shall be applied.

1.2.1 Northland Regional Council

The Council will undertake the ongoing monitoring requirements of the GMCP on behalf of the Consent Holders. The actual and reasonable cost of undertaking the ongoing monitoring of these consents for the Consent Holders will be charged in accordance with Council's Charging Policy.

The installation of sentinel bores and monitoring equipment is the responsibility of the Consent Holders.

1.2.2 Consent Holders

The Consent Holders identified within this GMCP at **Table 1** are required to exercise their Water Permits in accordance this GMCP.

The exercise of the Water Permits will be in accordance with Council initiated instructions which will be issued once the actions and process established through this GMCP have been undertaken.

The Consent Holders may seek changes to the GMCP through either of the processes set out in **Section 1.3**.

1.2.3 Far North District Council

Far North District Council (FNDC) holds an existing consent to take groundwater from two bores at Sweetwater for the purpose of potable water supply for the Kaitaia community. FNDC is a party to this GMCP to enable discussions regarding demand and potential impacts on the existing municipal supply abstraction.

1.2.4 Director-General of Conservation

The Director-General of Conservation is responsible for administering land and waterbodies subject to reserve status under the Reserves Act 1977 and conservation or stewardship area status under the Conservation Act 1987. Within the Sweetwater and Ahipara sub-aquifers of the Aupouri Aquifer these areas include:

- The Sweetwater Dune Lakes Conservation Area
- Lake Ngatu Recreation Reserve

- Waipapakauri Beach Recreation Reserve

The Director-General of Conservation is a party to this GMCP to ensure that the relevant provisions of these Acts, which the Director-General of Conservation administers, in particular that Objective 1(b) and 1(c) matters are to be met.

1.3 Changes to the GMCP

This GMCP may be amended at any time to:

- Incorporate new or replacement water permits, or remove water permits, within the Sweetwater and Ahipara sub-aquifers of the Aupōuri aquifer management unit that have overlapping and/or additional monitoring requirements or which are subject to different trigger levels or trigger levels based on monitoring described in this GMCP;
- Alter the nature and scope of the required monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels;
- Incorporate or remove parties who are, or may need to be, a part of this GMCP to ensure Objective 1 is met.

If either the Council or a Consent Holder wishes to amend the GMCP, then it must provide notice in writing of the proposed changes, along with any supporting technical documents, to the other Consent Holders, and the Director-General of Conservation.

Parties, given notice by Council of a change to the GMCP, have 20 working days to provide a response to the Council on the proposed changes to the GMCP.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusion of the report.

If any party does not agree with the proposed change, that party shall engage a suitably qualified hydrogeologist and/or an ecologist to prepare a report detailing the reasons for the disagreement which shall be provided to Council within 30 working days from the date that the written notice of the proposed changes was sent to the party.

Any change to the GMCP will only be authorised by Council if the technical or administrative assessment of the proposed change clearly indicates that the change will meet Objective 1 of the GMCP.

Council will provide a report to the Consent Holders detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement. If the change would affect the interests of the Director-General of Conservation, then the report will also be provided to this party.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation.

2. FRAMEWORK FOR ADAPTIVE MANAGEMENT

In summary, the following adaptive management techniques are applied in this GMCP;

(a) Baseline monitoring – existing environmental and resource consent compliance monitoring in the Sweetwater sub-aquifer provides a baseline for evaluating the potential effects of the proposed abstraction. The monitoring programme developed for Stage 1 of the **Table 1** abstractions is intended to continue key components of the existing monitoring programme while also providing greater focus on monitoring and management of groundwater levels and quality along the coastal margin. This monitoring programme is contained in this GMCP, however, some monitoring detail is still required and this is indicated by the acronym 'TBC'.

(b) Early warning systems - Trigger levels (TLs) will be established to set up an early warning system that provides a response mechanism when differences between predicted and actual water levels, and/or salinity concentrations occur. A trigger level is an environmental criterion that if reached or met, requires a certain response to be actioned.

(c) Staged development - Abstraction volumes will progressively be increased in a staged manner, with expansion contingent on compliance with yet to be established trigger levels and on regular reviews of groundwater level, freshwater ecology and hydrology, and salinity monitoring results. The proposed staging recognises that a significant portion of the abstraction covered by this GCMP is already authorised by existing water permit AUT.020995.01.03.

It is noted that the consent documentation requires that all development starts at Stage 1 volumes whether or not others have progressed to Stage 2 or further, and that takes must be implemented for the minimum period of Stage 1 before progressing to Stage 2. This is an essential mechanism for staging as an adaptive management response.

(d) Stage 1 / Year 1 management – Until such time as there is an adequate monitoring record to establish trigger levels in new monitoring bores, the abstractions during this stage will be subject to interim groundwater level and saline trigger levels and Trigger Exceedance Report procedures; and

(e) Tiered approach to monitoring –Monitoring effort is proposed to increase if site trigger levels are approached or exceeded. Likewise, monitoring intensity may decrease with evidence of sustained compliance and stability or to reflect improved characterisation of the hydrogeological environment by way of the process outlined in **Section 1.3** of this GMCP; and

(f) Ongoing adaptive management – The abstractions will be managed adaptively within the term of consent and, in the event of trigger level exceedance, through the implementation of the recommendations of a Groundwater Trigger Exceedance Report (GTER) prepared by Council.

(g) Suspension of abstractions – Should compliance with Objective 1 of this GMCP not be achieved, then the exercise of some or all of the consents to abstract and use groundwater may be suspended until such time as Council confirms in writing that compliance can be achieved.

The following sections provide detailed information relating to the adaptive management framework to be imposed for the exercise of the consents listed in **Table 1**.

2.1 Staged Implementation

The uptake by Consent Holders of the consented total allowable water volumes will be permitted in four stages over nine years, as shown in **Table 1** below, unless the outcome of the Staged Implementation and Monitoring Programme Review detailed in **Section 2.1.1** shows that there should be a delay in moving to the next stage, or that the next stage should not occur.

The development stages reflect:

- A combination of existing allocation (2,317,000 m^3/year) and proposed future development of pastoral and horticultural for APP.020995.01.04
- The progressive increase in water requirements for the proposed orchard associated with APP.040364.01.01

Table 1. Summary of staged implementation annual volumes

Application Number	Consent Holder	Allowable Annual Volume (m^3)			
		Stage 1 (Year 1)*	Stage 2 (Year 2-3)*	Stage 3 (Year 4-6)*	Stage 4 (Year 7-9)*
APP.040364.01.01	ELBURY HOLDINGS LTD (C/- KJ & FG KING)	50,000	100,000	150,000	200,000
APP.020995.01.04	TE RARAWA FARMING LTD AND TE MAKE FARMS LTD	2,317,000	2,317,000	3,093,000	3,093,000
TOTAL		2,367,000	2,417,000	3,243,000	3,293,000
Note: *The staged implementation is based on years when irrigation occurs following the granting of the consents.					

2.1.1 Staging: Implementation and Monitoring Programme Review

A "Staged Implementation and Monitoring Programme Review" (SIMPR) will be required for Council to decide whether Consent Holders proceed to the next allocation stage. The volume of abstraction authorised will be reviewed against the staged implementation outlined in **Section 2.1** at the minimum intervals of:

End of Stage 1 – a period of not less than 12 months following the date of commencement of the consent during which a full 12 months of baseline monitoring data has been collected and the consent has been exercised over a full irrigation season;

End of Stage 2 - 3 irrigation seasons following date of commencement of the consents;

End of Stage 3 - 6 irrigation seasons following date of commencement of the consents; and

End of Stage 4 - 9 irrigation seasons following date of commencement of the consents.

The main purpose of the SIMPR is to assess whether abstraction increasing to the subsequent development stage would remain compliant with Objective 1 of the GMCP.

The SIMPR will be commissioned by the Council and shall be prepared by a suitably qualified hydrogeologist with experience and knowledge of the locality.

The SIMPR shall include a detailed assessment of all environmental monitoring data including groundwater levels, salinity indicators, and water quality, and include consideration of spatial and temporal trends including potential effects of groundwater abstraction on water levels in dune lakes and natural wetlands. If the potential for more than minor effects on dune lakes and natural wetlands

is identified, then the SIMPR will also include assessment of the likely significance of those effects prepared by a suitably qualified ecologist. The SIMPR shall assess whether Objective 1 of this GMCP is being met at the current level of abstraction, and whether Objective 1 will be met at the next stage level of abstraction. The SIMPR may also consider the nature and scope of continued monitoring (i.e. monitoring frequency and intensity (type and number of samples)) and associated trigger levels.

The SIMPR will provide recommendations based on the assessment of the environmental monitoring data to date on:

- the setting or alteration of the trigger levels;
- whether any changes to the monitoring programme are required; and
- whether to advance to the next stage of abstraction or to remain at the current level of abstraction, or to reduce the level of abstraction.

A copy of the SIMPR will be provided to the Consent Holders listed in **Table 1** and the Director General of Conservation a minimum of three months prior to the anticipated commencement of the subsequent irrigation season utilising volumes defined for the subsequent development stage as stated in **Table 1**. The Consent Holders and Director General of Conservation have 20 working days to provide a response to the Council on the conclusions and recommendations of the SIMPR.

If no response is received from a party within the stated timeframe, then Council will consider that the party has no concerns with the conclusions of the report.

If any party does not agree with the conclusions and recommendations of the SIMPR, then a report by a suitably qualified hydrogeologist and/or ecologist, both with experience and knowledge of the locality if possible, detailing the reasons for the disagreement shall be provided to Council within 30 working days from the date that the assessment was sent to the party.

An increase in the volume of abstraction to the next development stage and any change to the monitoring programme will only be authorised by Council if the technical assessment of the monitoring data clearly indicates that the increase in the allocation and change to GMCP would meet Objective 1 of this GMCP.

Council will provide a report to the Consent Holders and the Director General of Conservation detailing the reasons for its decision, including the identification and discussion of areas of agreement and disagreement.

If any changes are made to the GMCP, then a copy of the amended GMCP will be provided to the Consent Holders and the Director General of Conservation within 5 working days of the change being authorised as final.

A summary of the above process is also included in the conditions of each consent that is covered by this GMCP.

2.1.2 Stage 1 (Year 1) Management Regime

Stage 1 is the initial development stage comprising a minimum period of 12 months (comprising at least 1 full irrigation season) following issue of the consents listed in Table 1. This stage is intended to maintain abstraction at similar levels to those currently authorised while trigger levels are established for all sentinel monitoring bores. The Stage 1 process applies any new or additional take beyond that already authorised prior to the granting of these consents; i.e. the existing volume of take at Sweetwater Farms authorised by AUT.020995.01.03 is excluded from the requirements of Stage 1.

Council is to notify the Consent Holders, FNDC and the Director-General of Conservation of the default management parameters for Stage 1 (Year 1) 3 months prior to the commencement of

abstraction. The Consent Holders, FNDC and Director-General of Conservation have 10 working days to provide responses to the Council on the default management parameters once notified.

Ongoing monitoring will be required to ensure that Objectives 1(a), (b), and (c) are met by implementing trigger level exceedance measures. These trigger level exceedance measures are those which sit in **Section 4** below.

The interim management regime established for Stage 1 (Year 1) will be superseded by the Monitoring and Trigger Level Setting components set out in **Section 2.2** of this GMCP.

2.1.2.1 Saline Intrusion and Groundwater Level: Monitoring and Triggers

To ensure that Objective 1 is met during Stage 1 (Year 1) interim trigger levels for minimum groundwater levels and salinity indicators will be established in all Sentinel bores identified in **Table 4.** These trigger levels will be established either based on existing baseline data (for existing compliance monitoring bores associated with water permit AUT.020995.01.03) or determined from preliminary data once each new sentinel bores is installed, following the methodology established in **Section 2.2** below.

Interim trigger levels must be set prior to exercise of any of the consents and apply to Stage 1 (Year 1) only.

The saline intrusion and groundwater level monitoring trigger levels for Stage 1 (Year 1) shall be inserted into the GMCP through the process set out in **Section 1.3** of this GMCP prior to the exercise of any consents.

2.1.2.2 Trigger Level Responses

In the event of an exceedance of a Trigger Level applicable in Stage 1 (Year 1), the Trigger Level Exceedance response plan contained in **Section 4** of this GMCP shall apply.

2.1.2.3 Ceasing Interim Stage 1 (Year 1) Management Regime

This interim management regime shall remain in place until such time as Council has given authorisation to proceed to the next stage (Stage 2) as set out under **Section 2.1.1** above or where the setting of trigger levels as per **Section 2.2** below has been given effect to through amendment to this GMCP in accordance with the change process established in **Section 1.3** of this GMCP.

2.2 Trigger Level System

2.2.1 Timeframe for setting of trigger levels

The setting of trigger level values for each parameter (where TBC is indicated in the monitoring plan tables in **Section 3** Monitoring Programme) will be undertaken based either on current baseline data (for sites with existing monitoring) or data collected during Stage 1. This approach recognises that:

- There is significant historical monitoring data available to characterise the response of groundwater levels and quality to current levels of abstraction.;
- The manifestation of any effects from the exercising of these consents will steadily progress with time in accordance with the staged development process outlined in Table 1. The scale of abstraction during Stage 1 (i.e. 12 months following granting of consent) will not vary significantly from existing conditions.

2.2.2 Method for setting of trigger levels

A two-tier trigger level system will be implemented on the consents:

- **TL1** - The first-tier trigger level establishes when an individual monitoring parameter is exhibiting a departure from baseline conditions. If this trigger level is breached, then additional monitoring will be undertaken by the Council;
- **TL2 -** The second-tier trigger level is set at a threshold defining a 'significant' departure from baseline conditions and/or conditions where the risks of adverse environmental effects are increased. If this trigger level is breached, then the Consent Holders will be required to reduce their daily water take volume in a staged manner over a set period of time.

The TL parameters required under this GMCP for the various suites are summarised in **Table 2.**

Table 2: Summary trigger level parameters by monitoring suite

Monitoring Suite	Parameters
Groundwater level and salinity monitoring	Groundwater level, electrical conductivity
Saline intrusion monitoring	Electrical conductivity, chloride, sodium, total dissolved solids.

2.2.3 Response to exceeding trigger levels

The actions required should TL's be exceeded are set out in **Section 4** (Contingency Plan).

3. MONITORING PROGRAMME & TRIGGER LEVEL SETTING

3.1 Bore Locations and Details

A consolidated summary of the schedule of bores that are required to be monitored as part of this GMCP is provided in **Table 3.** Along with the bores identified for monitoring, the table provides key details relating to the bores' physical attributes and parameters to be monitored. The locations of the monitoring bore are shown on Figure 1[2].

The following sections of the GMCP provide the monitoring schedules (frequency and trigger levels) for the bores. The monitoring schedule comprises four components:

- Three sentinel bores located along the coastal margin seaward of areas where abstraction is concentrated. The sentinel bores will provide the primary reference sites for monitoring and management of potential saline intrusion effects. Each sentinel bore will comprise two piezometers accessing the shallow unconfined aquifer and the shellbed respectively. Instrumentation in each piezometer will enable continuous monitoring of groundwater levels and electrical conductivity (EC), and provide for telemetry of monitoring data to NRC.
- An existing NRC piezometer with a long monitoring record (Lake Heather No. 1 (105 m)) will be the primary reference site for management of cumulative well interference effects. Instrumentation in the piezometer will enable continuous monitoring of groundwater levels and provide for telemetry of monitoring data to NRC.
- Groundwater levels will be monitored manually on a monthly basis in existing compliance monitoring bores on Sweetwater Station, along with an existing NRC piezometer at Lake Heather (Lake Heather No. 1 (29 m)) and a private bore at Sweetwater Nursery (LOC.201424). These sites will provide ongoing monitoring of groundwater levels and provide data to characterise both localised and cumulative drawdown in response to abstraction and be used to inform the staged implementation process.
- Salinity indicators will be measured on a quarterly basis in each piezometer at the three sentinel bores, augmented by an additional monitoring bore at Waipapakauri Beach (if access to a suitable existing bore can be established). These sites will be monitored on a quarterly basis for the parameters listed in Table 2 and provide a secondary baseline to characterise any changes in aquifer salinity along the coastal margin.

[2] Note: the locations shown for the two new sentinel bores are indicative. Final locations may depend on physical access available for piezometer installation.

Table 3: Schedule of monitoring bore details.

MONITORING BORES								
Bore Details		**Bore Owner**	**COORDINATES**		**Depth (m)**	**Dia. (mm)**	**Target Aquifer**	**Purpose[b]**
Name (Fig 1)	**NRC Ref.**		**Eastin**	**Northin**				
MW1a	LOC.210522	Sweetwater Station	1617843	6119772	13.3		Unconfined	GLm
MW1b	LOC.209755	Sweetwater Station	1617597	6119793	94.0		Shellbed	GLm
MW2a	LOC.210523	Sweetwater Station	1620419	6120014	15.0		Unconfined	GLm
MW2b	LOC.210524	Sweetwater Station	1620422	6120015	59.0		Shellbed	GLm
MW4a	LOC.210527	Sweetwater Station	1616386	6119031	25.0		Unconfined	GLc, ECc, SI
MW4b	LOC.209753	Sweetwater Station	1616404	6119040	92.0		Shellbed	GLc, ECc, SI
MW5a		Sweetwater Station	1617811	6114690	6.0		Unconfined	GLm
MW5b	LOC.209759	Sweetwater Station	1617644	6114898	61.0		Shellbed	GLm
MW6	LOC.320452	Sweetwater Station	1617451	6118946	14.4		Unconfined	GLm
Lake Heather No 1 (29 m)	LOC.200226	NRC	1617605	6121325	29		Unconfined	GLm
Lake Heather No 1 (105 m)		NRC			105.5		Shellbed	GLc
Waipapapakauri Sentinel (shallow)	TBC	NRC	1616020	6121100	TBC		Unconfined	GLc, ECc, SI
Waipapapakauri Sentinel[a] (deep)	TBC	NRC	1616020	6121100	TBC		Shellbed	GLc, ECc, SI
Waipapakauri Quality[a]	TBC	Private?	1615500	6122500	TBC		Shellbed	SI
Ahipara Sentinel (shallow)	TBC	NRC	1615750	6112150	TBC		Unconfined	GLc, ECc, SI
Ahipara Sentinel (deep)	TBC	NRC	1615750	6112150	TBC		Shellbed	GLc, ECc, SI
Sweetwater Nursery[a]	LOC.201424	Private	1618734	6122288	82		Shellbed	GLm

[a] Monitoring site equivalent to that specified in Schedule 1 to AUT.25683.01.03

[b] Purpose Key
GLc = Continuous Groundwater Level (Telemetered)
GLm = Manual (monthly) groundwater level
ECc = Continuous Electrical Conductivity (Telemetered)
SI = Salinity Indicatory (Quarterly)
MI = Major Ions (Quarterly)

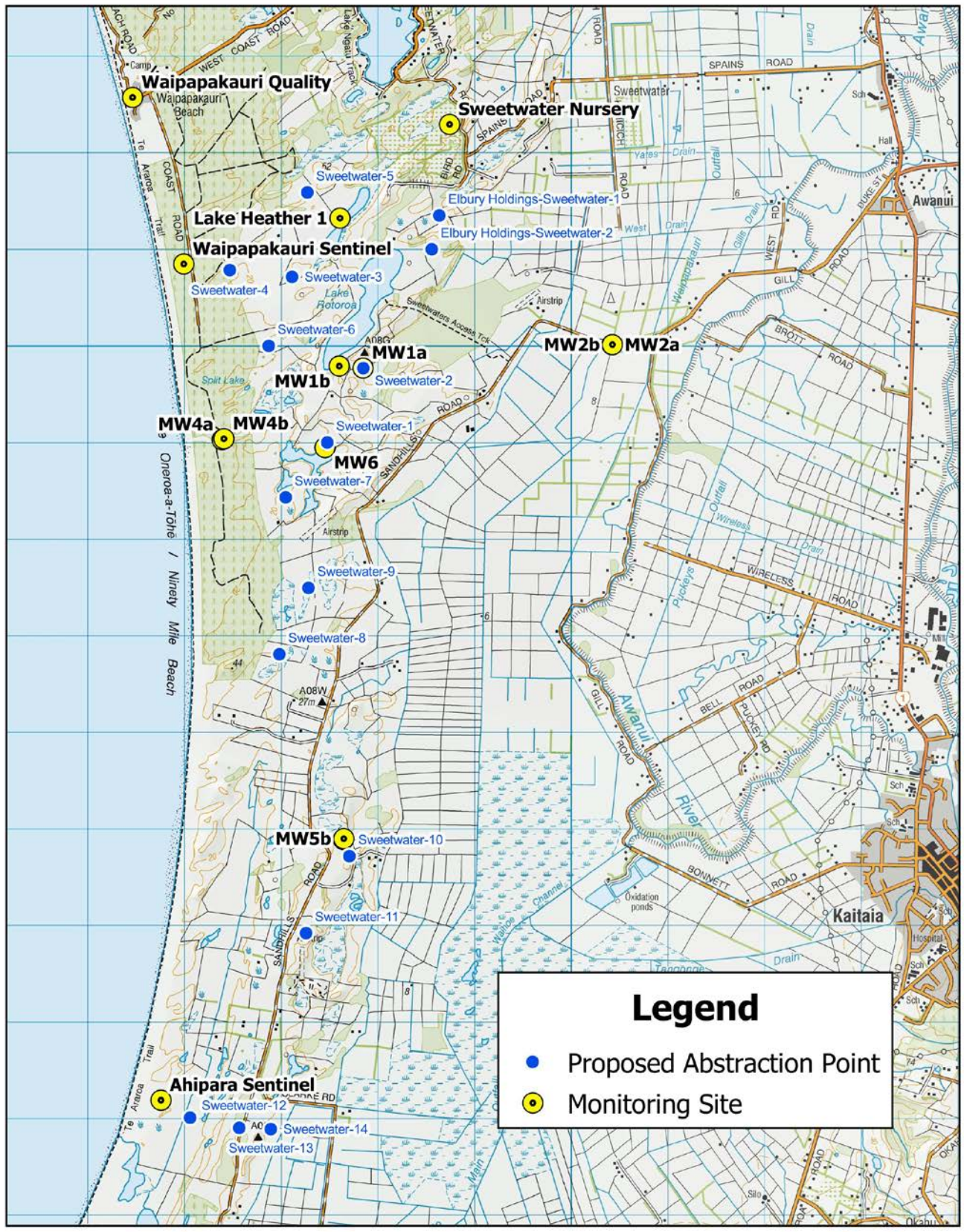

Figure 1. **Groundwater Monitoring and Production Bore Location Map**

3.2 Groundwater Level and Salinity Monitoring

3.2.1 Sentinel Monitoring Bores

Sentinel bores will be utilised as the primary reference sites for monitoring of potential effects associated with saline intrusion. These bores will be positioned between existing/proposed abstraction and the coastline to provide early detection or warning of:

- Groundwater levels around the coastal margin approaching a threshold that could indicate a greater risk of saline intrusion; and
- Any reduction in water quality that could indicate the landward migration of the saline interface.

Details of the sentinel bores are summarised in **Table 4** below. These sentinel bores will collect data continuously for water levels and electrical conductivity in individual piezometers. This data will be telemetered to NRC. A two-tier trigger level system (TL1 and TL2) for groundwater levels and electrical conductivity will be set in these bores.

TL1 and TL2 trigger levels for groundwater level and EC in MW4b are specified in Table 4 below. The setting of TL1 and TL2 trigger levels for the remaining piezometers will be undertaken during the first implementation stage after 12 months of monitoring data has been collected and within 15 months of the date of commencement of these consents and replace the interim trigger levels outlined in Section 2.1.2.1 above. The current trigger levels that are shown in **Table 4** are based on existing data and will be reconfirmed by Council when the other trigger levels are confirmed.

All sentinel monitoring bores listed in **Table 4** will be installed prior to the exercise of the consents.

Data will be collected, processed and managed in accordance with NRC quality standards.

Table 4: Schedule of saline intrusion sentinel monitoring bores

Bore Name	Depth (m)	Target aquifer	Units	Frequency	Trigger Levels	
					TL1	TL2
Sweetwater MW4a	25	Shallow sand	mAMSL	Continuous	TBC	TBC
			µS/cm	Continuous	TBC	TBC
Sweetwater MW4b	92	Shellbed	mAMSL	Continuous	2.5	2.0
			µS/cm	Continuous	500	600
Waipapakauri Sentinel Shallow	TBC	Shallow sand	mAMSL	Continuous	TBC	TBC
			µS/cm	Continuous	TBC	TBC
Waupapakauri Sentinel Deep	TBC	Deep shellbed	mAMSL	Continuous	TBC	TBC
			µS/cm	Continuous	TBC	TBC
Ahipara Sentinel Shallow	TBC	Shallow sand	mAMSL	Continuous	TBC	TBC
			µS/cm	Continuous	TBC	TBC
Ahipara Sentinel Deep	TBC	Deep shellbed	mAMSL	Continuous	TBC	TBC
			µS/cm	Continuous	TBC	TBC

Notes:

TBC = to be confirmed within 15 months of the date of commencement of these consents.

GL TL1s (where provided) have been calculated from long term monitoring data.

GL TL2s (where provided) have been calculated from long-term monitoring data

3.2.2 Continuous Groundwater Level Monitoring

The existing NRC Lake Heather No.1 (105 m) piezometer will be utilised as the primary reference site to determine the magnitude of cumulative well interference effects. Groundwater levels will be monitored on a continuous basis and telemetered to NRC.

Trigger levels for cumulative drawdown will be established and, if require, utilised to manage cumulative pumping rates to ensure priority access to the groundwater resource by existing groundwater users is not derogated by the proposed abstraction. Trigger levels will be established subject to agreement between parties to this GCMP and FNDC (holders of water permit AUT.25683.01.03).

3.2.3 Manual Groundwater Level Monitoring

Groundwater levels will be monitored manually in the shallow sand and shellbed aquifers to:

- Ensure groundwater abstraction does not result in a reduction in the reliability of supply for AUT.025683.01.03
- Quantify the magnitude of drawdown resulting from the proposed abstraction in the shellbed and unconfined aquifers to ensure it is within the magnitude anticipated in the AEE and does not result in adverse effects on surface water environment, existing groundwater users and long-term aquifer storage volumes.

Details of the groundwater level monitoring bores are listed in Table x below. Majority of the bores listed (MW1a to MW6) are existing compliance monitoring bores on Sweetwater Station that have been monitored manually on a monthly basis since 2013 as part of consent compliance for water permit AUT.020995.01.03. It is proposed to continue the existing monitoring regime for these bores, with the addition of the existing NRC Lake Heather No 1 (29 m) piezometer and a private bore at Sweetwater Nursery.

No trigger levels will be established for manual groundwater level monitoring sites. However, data from these sites will be utilised for annual reporting (Section x) and as part of the

Table 5. Schedule of Manual Groundwater Monitoring Bores

Monitoring Bore	NRC ID	Easting	Northing	Depth (m)	Aquifer
MW1a	LOC.210522	1617843	6119772	13.3	Unconfined
MW1b	LOC.209755	1617597	6119793	94.0	Shellbed
MW2a	LOC.210523	1620419	6120014	15.0	Unconfined
MW2b	LOC.210524	1620422	6120015	59.0	Shellbed
MW5a		1617811	6114690	6.0	Unconfined
MW5b	LOC.209759	1617644	6114898	61.0	Shellbed
MW6	LOC.320452	1617451	6118946	14.4	Unconfined
Lake Heather No. 1 (29 m)	LOC.200226	1617605	6121325	29.0	Unconfined
Sweetwater Nursery	LOC.201424	1618734	6122288	82.0	Shellbed

3.2.4 Groundwater Quality (Salinity Indicator) Monitoring

Monitoring for salinity indicators listed in Table 2 will be undertaken in the monitoring bores listed in Table 6. The purpose of this monitoring is intended to provide additional context for the evaluation of any changes in aquifer salinity resulting from the proposed groundwater abstraction (i.e. to augment continuous EC monitoring).

Table 6. Schedule of Salinity Indicator Monitoring Bores

MW4a	LOC.210527	Sweetwater Station	1616386	6119031	25.0		Unconfined
MW4b	LOC.209753	Sweetwater Station	1616404	6119040	92.0		Shellbed
Waipapapakauri Sentinel (shallow)	TBC	NRC	1616020	6121100	TBC		Unconfined
Waipapapakauri Sentinel[a] (shallow)	TBC	NRC	1616020	6121100	TBC		Shellbed
Ahipara Sentinel (shallow)	TBC	NRC	1615750	6112150	TBC		Unconfined
Ahipara Sentinel (deep)	TBC	NRC	1615750	6112150	TBC		Shellbed
Waipapakauri Quality[a]	TBC	Private?	1615500	6122500	TBC		Shellbed

3.2.5 Setting of Groundwater Trigger Levels

3.2.5.1 Shallow Sand Aquifer

Council will set trigger levels for groundwater levels in the unconfined aquifer in each of the three sentinel bores. As a general guide TL2 for the shallow sand aquifer should be no less than 1.0 mAMSL (noting that changes in EC are also a key indicator of saline intrusion).

3.2.5.2 Deep Shell bed Aquifer

Groundwater level triggers will be established in the deep shellbed aquifer as follows:

In the three sentinel bores TL1 and TL2 will be based on historical groundwater levels, allowing for the predicted magnitude of drawdown resulting from existing and proposed abstraction outlined in the Assessment of Environmental Effects. If necessary, water level records for individual sentinel bores will be correlated with existing monitoring sites to provide historical context for estimating the trigger levels.

As a general guide TL2 for deep shell bed groundwater levels should be no less than 1.5 mAMSL (noting that changes in EC are also a key indicator of saline intrusion).

3.2.5.3 Electrical Conductivity Triggers

Electrical conductivity triggers in individual sentinel monitoring bores will be no greater than:

- **TL1** - Median (weekly rolling average) EC from baseline monitoring period +25%
- **TL2** - Median (weekly rolling average) EC from baseline monitoring period + 50%

3.2.6 Ongoing monitoring

Ongoing monitoring of groundwater and electrical conductivity levels will be undertaken continuously via individual piezometers in sentinel monitoring bores. Monitoring data will be telemeted to NRC on a twice daily basis. All monitoring data will be collected, managed and processed in accordance with NRC quality standards.

3.3 Saline Intrusion Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 7** below will be undertaken at quarterly intervals[3]:

- Electrical conductivity;
- Chloride;
- Sodium;
- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

3.3.1 Setting of Saline Intrusion Triggers

As an initial guide, trigger levels for individual determinants will be established as follows:

- **TL1** - Median concentration from the Stage 1 monitoring period +25%.
- **TL2** - Median concentration from the baseline monitoring period + 50%.

3.3.1.1 Ongoing Monitoring

Sampling at the frequencies specified for the following salinity indicators will take place in the bores listed in **Table 7** below:

- Electrical conductivity;
- Chloride;
- Sodium;
- Total Dissolved Solids.

The samples will be collected in accordance with A National Protocol for State of the Environment Groundwater Sampling in New Zealand (Ministry for the Environment, 2006).

Table 7: Monitoring Schedule – Saline Intrusion

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
MW4	25	a	Unconfined	EC	µS/cm	Continuously	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC

[3] This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

Bore Name	Depth (m)	Piezo. No.	Target aquifer	Parameter*	Units	Frequency	Trigger Levels	
							TL1	TL2
	92	b	Deep shellbed	EC	µS/cm	Continuously	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
Waipapakauri Sentinel	TBC	1		EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
	>50 (TBC)	2	Deep shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Ahipara Sentinel	TBC	1	Unconfined	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
	> 50 TBC	2	Deep Shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC
Waipapakauri Quality	TBC	1	Deep shellbed	EC	µS/cm	Quarterly	TBC	TBC
				Chloride	mg/L	Quarterly	TBC	TBC
				Sodium	mg/L	Quarterly	TBC	TBC
				TDS	mg/L	Quarterly	TBC	TBC

Notes:

* Parameter key: GL = Groundwater Level; EC = Electrical Conductivity; SI = Salinity Indicators; TDS = Total Dissolved Solids.

TBC = to be confirmed within 15 months of the date of commencement of these consents.

3.4 Production Bore Monitoring

During the initial 12-month monitoring period, sampling for the following salinity indicators in the bores listed in **Table 8** below will be undertaken at 6 weekly intervals[4].

3.4.1 Trigger levels

Electrical conductivity trigger levels will be established in the production bores listed in **Table 8** below.

During the initial 12-month monitoring period Electrical Conductivity Triggers will be no greater than:

- **TL1** – Departure exceeding 25% of the EC value from the initial monitoring round
- **TL2** – Departure exceeding 50% of the EC value from the initial monitoring round

Long-term EC triggers for individual production bores will be established following an initial 12-month monitoring period, based on an assessment of observed spatial and temporal variation in EC in

[4] This frequency applies to the initial 12-month monitoring period for the establishment of baseline information. The frequencies specified in Table 6 are for ongoing monitoring specifications.

baseline and sentinel bore monitoring data, in a manner consistent with EC trigger levels established in the sentinel monitoring bores.

No trigger levels will be established for groundwater levels in the production bores as water levels in the production bores can be impacted by well efficiency and pumping schedules so are not necessarily representative of groundwater levels in the surrounding aquifer.

3.4.2 Ongoing monitoring

Monthly water level monitoring will be undertaken in the production bores listed in **Table 8**. During the winter months (nominally May to September) this monitoring will provide information to identify any inter-annual variations in aquifer storage which may be anomalous compared to regional trends. During the irrigation season, water level measurements will be undertaken a minimum of eight hours following the cessation of pumping.

Electrical conductivity values will also be measured at monthly intervals from the production bores during the irrigation season to check on any changes in salinity induced by the pumping.

Table 8: Monitoring Schedule – Production Bore Water Levels and Electrical Conductivity

Bore Name	Parameter*	Units	Frequency	Trigger Levels	
				TL1	TL2
Sweetwater 1	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 2	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 3	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 4	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 5	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 6	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 7	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 8	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 9	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 10	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 11	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 12	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 13	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Sweetwater 14	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Elbury Holdings Sweetwater-1	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC
Elbury Holdings Sweetwater-2	Water Level	mASL	Monthly	TBC	TBC
	Electrical Conductivity	mS/m	Monthly	TBC	TBC

Notes:

* Purpose key: GL = Groundwater Level; EC = Electrical Conductivity.

All trigger limit values in this Table to be confirmed by Council.

3.5 Environmental Monitoring Report

At the end of each irrigation season, the Council will commission the preparation of an Annual Environmental Monitoring Report (AEMR) by a suitably qualified hydrogeologist. The Council will endeavour to ensure that, if possible, both the hydrogeologist and the ecologist have experience and knowledge of the locality. A copy of the AEMR will be provided to the Consent Holders and the Director General of Conservation by 31 July each year.

The purposes of the Annual Environmental Monitoring Report are to;

- provide a summary of the monitoring results for the previous year, including trends, against Objective 1 of the GMCP;
- assess the monitoring undertaken over the previous year against the standards set out in Objective 1;
- Identify any changes/amendments to monitoring locations/parameters/frequencies that could be incorporated in future SIMPR
- report on any issues apparent with the monitoring and
- identify any improvement that could be made with respect to the monitoring.

The AEMR will also contain an evaluation of whether the observed effects of the groundwater takes are consistent with the predictions of environmental response contained in the *Aupouri Aquifer Groundwater Model, Factual Technical Report – Modelling. WWLA0184, Rev 3*, prepared by Williamson Water & Land Advisory and dated 5 February 2020 (hereafter referred to as the 'Aupouri Model Report').

4. CONTINGENCY PLAN

Exercise of the consents is subject to compliance with Objective 1 of this GMCP.

As described in **Section 2**, a trigger level system is used to define environmental criteria that signal changes may be occurring outside of what is normal (TL1) or at a point where remedial action is required to avoid Objective 1 not being met (TL2).

This section details the responses that will be undertaken where TLs are exceeded under any of the monitoring suites discussed in **Sections 2.1.2.1, 3.2, 3.3, and 3.4**.

Where a trigger level is exceeded the Council will commission a Groundwater Trigger Exceedance Report (GTER). The objective of the GTER is to establish the cause of a trigger level exceedance and to recommend a programme of action to end the exceedance.

A GTER shall:

- Include a review of the monitoring results collected including an assessment of why the trigger level exceedance has occurred;
- set out requirements for increased monitoring of the breach;
- update the report on a regular basis as more data becomes available; and
- recommend actions to end the trigger exceedance, which could include;
    - a staged reinstatement of abstraction levels to pre-exceedance levels,
    - reduced levels of abstraction for all or some of the consent holders covered by the GMCP, or
    - suspension of abstraction by all or some of the consent holders covered by the GMCP.
    - Amendment of the trigger level exceeded.

4.1 Exceedance of TL1

In the event of a TL1 exceedance, which may represent declining groundwater levels or rising salinity indicators, the following actions must be undertaken:

(a) The Council will notify the Consent Holders within two working days of when the TL1 exceedance became known.

(b) If the exceedance is of a salinity indicator in the bores listed in **Table 4**, then sampling of the monitoring bore(s) in exceedance shall immediately be upgraded to a weekly frequency for four weeks following the first exceedance of the TL1. Weekly monitoring shall continue until sample results are consistently below TL1 values for a period of four weeks or as directed by Council.

(c) If after four weeks following the first exceedance of the TL1, the initiation of seawater intrusion and/or water level decline cannot be discounted to the satisfaction of the Council, then a Groundwater Trigger Exceedance Report (GTER) by a suitably qualified Hydrogeologist (and ecologist if the exceedance concerns surface water bodies) shall be commissioned by Council.

(d) The GTER shall assess the significance of the exceedance against the requirements of Objective 1 of the GMCP. The GTER shall assess why TLs have been breached, identify the

pumping bores in the area(s) of effect and will review all of the available data collected in the affected area(s), in particular the data collected pursuant to this GMCP.

4.2 Exceedance of TL2

In the event of a TL2 exceedance, which represents a significant departure from normal groundwater conditions, with either continuously declining groundwater levels or rising salinity indicators:

(a). Council will immediately inform the Consent Holders upon a TL2 exceedance becoming known.

(b). All Consent Holders must reduce their abstraction to 50% of the current average daily quantity, as calculated using the previous month's water use records required to be kept in accordance with the conditions of its groundwater take consent. If the exceedance occurs within one month of a Consent Holder first taking water for irrigation purposes within an irrigation season, then the average shall be calculated using the water use records for this period only. The council will advise the Consent Holder in writing of any breach and the required reduction in the daily water take volume.

(c). A GTER by a suitably qualified hydrogeologist (and ecologist if the exceedance concerns dune lakes or natural wetlands) shall be commissioned by Council. The GTER shall assess why the TL2 has been breached, identify the pumping bores in the area of effect, and include a review of all available data collected for the affected area(s), in particular, the data collected under this GMCP.

(d). Once (b) above has been complied with, the Consent Holder may apply to the Council's Compliance Manager for an alternative reduction in its daily water take volume. Council approval of an alternative reduction value will only be given if it is satisfied that relevant TL2 values will not be exceeded. The Council will use the GTER to inform its decision on any alternative reduction value for a Consent Holder.

(e). If the TL2 exceedance is in a bore(s) that is/are not continuously monitored, then weekly groundwater level measurements and/or sampling of saline intrusion (depending on which trigger level is breached) in all bores where TL2 trigger levels are breached will commence within one week of the TL2 trigger level exceedance. Monitoring will continue until such time as:

- Three consecutive samples in an individual monitoring bore are below all TL2 thresholds established for that piezometer; or
- As directed by Council.

(f). If salinity indicators continue to increase or groundwater levels continue to decline after 21 days following the implementation of (b), then the Consent Holder's abstraction must be reduced to 25% of the current average daily quantity, as calculated for (b) above. The council will advise the Consent Holder in writing of this further reduction and the required reduction in the daily water take volume.

(g). If (f) is implemented, then the Council will commission a review and update of the GTER report by a suitably qualified hydrogeologist (and ecologist if the exceedance concerns surface water bodies) with a longer-term programme of recommended responses incorporating observed responses to interim pumping rate reductions. The updated GTER will include a specific programme (including timeframes) of actions which would achieve compliance with Objective 1 of this GMCP. The actions may include, but not be limited to incremental reductions in the daily quantity of groundwater taken as a percentage of the

allowable daily pumped volume, as well as testing of domestic/stock water supplies in bores that are efficiently utilising the aquifer and are potentially impacted by saline intrusion, and if necessary, the provision of temporary water supplies to any affected parties (excluding any of the Consent Holders) in the event that Chloride concentrations exceed 250 mg/L (being the guideline value for taste prescribed in New Zealand Drinking Water Standards for New Zealand 2005 (Revised 2008)). The GTER will also identify a methodology which Council will utilise to increase abstraction back to the volumes applicable to the relevant stage of taking (see Section 2.1), where this can be done such that Objective 1 of this GMCP will be met. If it is not possible to increase abstraction back to the relevant stage of taking, then the GTER will identify a methodology to increase abstraction to a lesser volume such that Objective 1 of the GMCP will be met.

(h). Actions arising from the GTER shall continue as long as the issue continues.

(i). Implement additional remedial measures as directed by Council, including the suspension of taking.

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ATTACHMENT 4

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AAWUG_Aupouri.doc

18 June 2020

Water Permit Application - Aupōuri Aquifer Water User Group

1. Northland Regional Council (NRC) has received water permit applications from 24 parties collectively referred to as the Aupōuri Aquifer Water User Group (AAUWG). The applications seek authorisation to enable abstraction of groundwater for horticultural and pastoral at a combined maximum rate of 43,168 m³/day, up to a seasonal volume of 4,606,260 m³/year. The proposed takes are distributed across the Aupōuri Peninsula from Ngataki in the north, to the Sweetwater area west of Kaitāia, and are located in six sub-areas of the Aupōuri Aquifer Management Unit defined in Policy H.4.4 of the Proposed Regional Plan for Northland (pRPN). As outlined in Table 1 below, the proposed takes represent a combination of new takes (19) and applications to increase the rate and volume of abstraction for existing water permits (5).

Table 1. *Proposed AAWUG Water Permit Applications*

Application Number	Applicant	Daily Volume (m³/day)	Annual Volume (m³/year)	Sub-area
APP.040601.01.01[a]	Waikopu Avocados Ltd	736	83,360	Waihopo
APP.017428.02.01[a]	Henderson Bay Avocados	178	19,000	Waihopo
APP.040600.01.01	Far North Avocados Ltd	240	32,000	Waihopo
APP.041211.01.01	P McGlaughlin	700	78,400	Waihopo
APP.039859.01.01	Te Aupouri Commercial Development Ltd	10,400	1,170,000	Waihopo /Houhora / Other
APP.040121.01.01	NE Evans Trust & WJ Evans & J Evans	1,675	160,000	Houhora
APP.040231.01.01	P&G Enterprises (PJ & GW Marchant)	350	28,000	Houhora
APP.039644.01.01	MP Doody & DM Wedding	2,375	304,000	Houhora
APP.040397.01.01	A Matthews	95	12,000	Houhora
APP.040652.01.01	SE & LA Blucher	720	96,000	Houhora
APP.040919.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valdares and D Bryan (Property 1)	500	80,000	Houhora
APP.040558.01.01	MV Evans (Property 1)	1,675	126,000	Houhora
APP.040979.01.01	MV Evans (Property 2)	350	36,400	Houhora

Application Number	Applicant	Daily Volume (m^3/day)	Annual Volume (m^3/year)	Sub-area
APP.040130.01.01	Tuscany Valley Avocados Ltd	375	36,000	Motutangi
APP.040918.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valadares & D Bryan (Property 2)	1,000	160,000	Motutangi
APP.008647.01.06[a]	Avokaha Ltd	70	4,800	Motutangi
APP.039628.01.02[a]	KSL Ltd	90	3,600	Motutangi
APP.040361.01.01	Tiri Avocados Ltd	3,876	581,250	Paparore
APP.040362.01.01	Valic NZ Ltd	1,158	173,700	Paparore
APP.040363.01.01	Green Charteris Family Trust	225	33,750	Paparore
APP.039841.01.02	Mate Yelavitch & Co Ltd	450	52,000	Other
APP.040386.01.01	Robert Paul Campbell Trust	3,350	360,000	Other
APP.040364.01.01	Elbury Holdings Ltd	1,875	200,000	Sweetwater
APP.020995.01.04[a]	Te Rarawa Farming Ltd and Te Make Farms Ltd	10,705	776,000	Sweetwater
	Cumulative Total	**43,168**	**4,606,260**	

[a] Application to increase the volume of abstraction for an existing water permit

2. The applications are supported by an Assessment of Environmental Effects (AEE) prepared by Williamson Water and Land Advisory (WWLA). The assessment provided in the AEE is largely based on modelling of potential effects of the proposed abstraction undertaken using a numerical model developed by WWLA. The following report provides a technical review of the assessment provided to support the application, with particular focus on the groundwater modelling utilised for estimating individual and cumulative effects on the environment.

1. Environmental Setting

3. The Aupōuri Aquifer covers a land area of approximately 75,000 hectares extending along the whole length of Ninety Mile Beach on the west coast, and from Kōkōta (The Sandspit) to Waimanoni on the east coast. It also includes the low-lying land between Waimanoni and Ahipara.

4. The landform of the Aupōuri Peninsula comprises a relatively thick sequence of sedimentary deposits which have formed as a tombolo (essentially a sand bar accumulated due to wave and current action) connecting outcrops of basement rocks at either end of Ninety Mile Beach. The subsurface geology of the area consists of Pleistocene and Holocene unconsolidated sedimentary materials deposited in beach and dune environments and associated alluvial, intertidal estuarine, shallow marine, lakebed and wetland environments. These deposits overlie Cretaceous basement rocks of the Mount Camel Terrain, which typically comprises hard grey to dark green / black igneous rocks described in Isaac

(1996)[1] as intercalated basalt and basaltic andesite lava, pillow lava, rhyolitic tuff, tuff-breccia, conglomerate, sandstone and mudstone to the east, and Caples Terrane, comprising tuffaceous sandstone and mudstone with intercalated massive or pillowed basalt, siliceous mudstone and chert, to the west (Stagpoole, et al, 2012[2]).

5. The unconsolidated sedimentary deposits of the Aupōuri Peninsula host a spatially extensive aquifer system. As described in the AEE, the sedimentary deposits can be broadly classified into two primary hydrostratigraphic units:

- The upper unit comprising 40 to 120 metres of fine-grained sands, interspersed with sporadic iron pan, peat, lignite, silt, gravel and shellbeds. With distance inland from the coast, the sand deposits become progressively older and exhibit a higher degree of compaction and weathering compared to younger foredune sands at the coast. These shallow, fine sand dominated deposits host a low yielding unconfined aquifer.
- In many areas, the lower 5 to 30 metres of the sedimentary sequence (overlying the basement rocks) comprises fine to medium sand containing a high percentage of relatively coarse shell fragments. These deposits are commonly referred to as 'shellbeds' and exhibit significantly higher permeability than the overlying sands so are typically the target for larger scale groundwater development.

6. While there is no well-defined, laterally continuous confining layer, the occurrence of numerous, low-permeability layers within the sand deposits (e.g., iron pan, brown (organic) sand, silt and peat) that vary in depth and thickness, collectively provide a degree of confinement to the shellbed aquifer. As a result, the shellbed is best characterised as a semi-confined aquifer that exhibits varying degrees of hydraulic connection to the overlying sand deposits depending on the local geological setting (e.g. depth and lateral continuity of low permeability layers within the sand deposits at a local scale).

7. Groundwater underlying the Aupōuri aquifer is recharged by infiltration of rainfall through the surficial sand deposits. Localised perched water tables (and associated dune lakes and wetlands) occur in areas where infiltration is impeded by the accumulation of fine-grained sediments (typically silt or organic-rich sediments deposited in interdune areas) or the formation of laterally continuous iron-pan. The rate of recharge may also be significantly influenced by overlying landcover, particular plantation forestry which reduces recharge due to canopy interception.

[1] Isaac, M.J. (compiler), 1996: *Geology of the Kaitāia area*. Institute of Geological & Nuclear Sciences 1:250 000 geological map 1. 1 sheet + 43 p. Lower Hutt, New Zealand. GNS Science.

[2] Stagpoole, V.M., Christie, A.B., Caratori Tontini, F., Cox, S.C., Edbrooke, S.E., Davy, B.W., Soengkono, S., Isaac, M.J., 2012; *Northland airborne and radiometric survey: a geological interpretation*. GNS Science Report 2011/54, April 2012.

8. The water table is mounded under areas of higher dunes along the central axis of the Aupōuri Peninsula. Groundwater flow is interpreted to occur perpendicular to this flow divide toward the east and western coastlines respectively (HydroGeo Solutions, 2000[3]). The overall hydraulic gradient is determined by the elevation difference between the water table along the axis of the peninsula and sea level along the coastal margin. As a result, areas such as Kaimaumau which extend laterally some distance from the central axis exhibit a low hydraulic gradient toward the eastern coastline.

9. The Proposed Regional Plan for Northland (pRPN) defines the groundwater resources of the Aupōuri Aquifer as forming the Aupōuri Aquifer Management Unit. For the purposes of managing groundwater quantity this management unit is divided into 10 sub-areas, each with an allocable volume specified under Policy H.4.4.

2. Numerical Model Development

10. In 2015 NRC commissioned a study by Lincoln Environmental to collate available information on geology, hydrostratigraphy, hydraulic properties and spatial and temporal groundwater level variations of the Aupōuri Peninsula to develop a regional-scale numerical groundwater model of the Aupōuri Peninsula to assist establishing limits for sustainable groundwater abstraction. The model was used to evaluate predictive scenarios and develop recommendations for sub-regional groundwater allocation limits that were ultimately incorporated into the pRPN.

11. Development of the numerical groundwater model (referred to as the Aupōuri Aquifer Groundwater Model or AAGM) used to assess potential effects associated with the proposed AAWUG abstractions occurred separately from the modelling undertaken for the Council. While the same modelling package (USGS Modflow) was utilised, conceptualisation of the hydrogeological setting, delineation and parameterisation of hydrostratigraphic units, recharge flux and boundary conditions differ between the two models.

12. Development of the AAUM has been an iterative process, reflecting the timing and location of individual water permit applications, as well as modifications to layer geometry, aquifer hydraulic and configuration of boundary conditions that either incorporate updated information defining the physical characteristics of the Aupōuri Aquifer Management Unit, or enable improved calibration to measured water levels. For background, the following provides a summary of the AAGM development process:

    - In 2017, a numerical groundwater model developed by WWLA was utilised to assess a group of 17 water permits (collectively referred to as the Motutangi-Waiharara Water Users Group (MWWUG)). The model domain encompassed the Motutangi and Waiharara sub-areas and the southern section of the Houhora sub-area to the north.

[3] HydroGeo Solutions, 2000; *Aupouri Aquifer Sustainable Yield Groundwater Modelling Study*. Report prepared for Northland Regional Council.

- In August 2018, a numerical model developed by WWLA was utilised to provide an assessment of three water permit applications located in the Paparore sub-area. This model utilised a similar architecture to the MWWUG model (e.g., model layering, hydraulic properties, boundary configuration, recharge assessment), with the model domain covering the Paparore sub-area and the southern part of the Waiharara sub-area (i.e., some overlap with the MWWUG model domain).
- In November 2018, a third groundwater model was developed to support the water permit application by Te Aupōuri Commercial Development Ltd. This model utilised a similar architecture to the two prior models, with the model domain extending across the Houhora and Waihopo sub-areas.
- In early 2019 a revised groundwater model (the Aupōuri Aquifer Groundwater Model (AAGM)) was utilised to provide an updated assessment for the Te Aupōuri Commercial Development Ltd application (APP.039859.01.01) in response to requests for further information by NRC. This iteration essentially combined the three existing models into a single regional-scale model extending from Ngataki to Ahipara.
- In mid-2019 the AAGM was utilised to provide an updated assessment of the cumulative effects of all current and proposed abstraction including the proposed abstraction for Te Rarawa Farming Ltd and Te Make Farms Ltd (APP.020995.01.04). This version of the model included revisions to the configuration of the constant head boundary around the coastline to provide a revised assessment of potential saline intrusion, as well as addition of data from existing compliance monitoring on Sweetwater Farms to improve model calibration.
- In February 2020 a further update to the AAGM was provided following recalibration of the model to incorporate updated topographic elevations from a NRC LIDAR survey, revised datums for existing groundwater level monitoring sites and data from groundwater level monitoring sites installed as part of compliance monitoring for the MWWUG consents.

13. The various model iterations that preceded the current (February 2020) version of the AAGM reflect a combination of the sequential nature of the current water permit applications and the consequent extension of the model domain to enable evaluation of cumulative effects across the Aupōuri Aquifer Management Unit. This iterative model development process has also enabled incorporation of updated geological, topographical and groundwater monitoring data into the model set-up and calibration.

14. Documentation of the AAGM is provided in WWLA (2020a[4]). The following sections provide a technical review of the set-up and application of the AAGM, following the format outlined in Chapter 9 of the Australian Groundwater Model Guidelines[5].

[4] WWLA, 2020a; Aupouri Aquifer Groundwater Model. Factual Technical Report - Modelling. Williamson Water and Land Advisory Report WWLA0184 | 4, 28 February 2020.

[5] Sinclair Knight Merz and National Centre for Groundwater Research and Training, 2012; *Australian groundwater modelling guidelines*. Waterlines Report Series No. 82, June 2012.

3. Aupōuri Aquifer Groundwater Model

15. The AAGM domain extends across an area of approximately 535 km^2, encompassing 9 sub-areas of the Aupōuri Aquifer Management Unit. The northern boundary cuts across the Aupōuri Peninsula approximately 2.5 kilometres north of Ngataki, following the northern boundary of the Aupōuri sub-area. The southern boundary of the model follows the lateral extent of water-bearing sediments along the southern margin of the Awanui and Ahipara sub-areas. Lateral boundaries of the model follow the western and eastern coastlines of the Aupōuri Peninsula. All proposed takes lie within the model domain, at a sufficient distance from the northern and southern boundaries to avoid effects associated with assumed no-flow boundaries along these margins[6].

16. The model is constructed using an unstructured grid to enable refinement of mesh size in the vicinity of proposed abstraction points and other points of interest. Grid spacing ranges from 40 m at the highest resolution, centred around large groundwater extraction points, to 1,000 m in the north-western portion of the model domain where limited data is available to constrain geology and there is little or no groundwater abstraction.

3.1 Conceptual Model

17. As outlined in Section 1 above, at a regional to sub-regional scale, the hydrogeological setting of the Aupōuri Aquifer is relatively simple. A surficial layer of fine to medium sand between 40 to 120 metres thick containing discontinuous layers of silt, peat (organics) and iron-pan forms a stratified aquifer which becomes increasingly well confined with depth. A relatively thin sequence (generally <15 to 30 m thick) of sand containing abundant shell fragments (locally referred to as shellbeds) toward the base of this sequence form the primary water-bearing layers targeted for development on the Aupōuri Peninsula. These sediments overlie low permeability sandstone, mudstone and volcanic basement rocks (assumed to have little or no hydrological interaction with the overlying sedimentary deposits).

18. However, at a local-scale, the complexity of the hydrogeological system increases due to the variable thickness and discontinuous nature of low permeability layers within the sedimentary sequence. This variability reflects the progressive change in depositional environment from marine shellbeds to shallow marine and estuarine fine sand and mud, through to fine-grained aeolian sand containing accumulations of silt and organic materials formed between mobile dunes. Consequently, there is no single, well defined confining layer (or layers) evident at a sub-regional scale. Rather, the aquifer system becomes progressively confined with depth reflecting the influence of multiple, localised, low-permeability layers, with the nature and degree of aquifer confinement varying spatially. The variability in confinement of the shellbed aquifer is reflected in vertical hydraulic gradients observed across the model domain. Towards the central axis of the Aupōuri Peninsula (under areas of higher dunes) downward hydraulic gradients of between 2 to 10 metres are observed between the shallow unconfined aquifer and shellbed. In contrast, on lower-elevation coastal areas upward hydraulic gradients of less than 2 metres are recorded.

[6] Such effects are evident from cross comparison of modelled groundwater levels between overlapping parts of earlier sub-regional models.

19. Heterogeneity within the sand deposits also influences aquifer recharge and the degree and nature of interaction between the aquifer and overlying waterbodies. The rate and volume of land surface recharge varies spatially between areas of unconsolidated sands where rainfall can readily infiltrate from the land surface (typically in areas of mobile dunes along central and western areas) and low-lying coastal areas where near-surface layers of iron-pan or organics significantly reduce surface infiltration. Similarly, surface waterbodies (lakes and wetlands) typically occur in areas where near-surface low permeability layers are common and are generally perched above (and therefore disconnected from) the surrounding regional water table. Landcover, particularly plantation forestry, may also exert a significant and temporally variable influence on recharge during crop rotation.

20. I consider the overall conceptualisation of the hydrogeological setting utilised to develop the AAGM (outlined in Section 2 of WWLA (2020a)) is consistent with available data and provides an appropriate basis for construction of a regional-scale numerical model.

3.1.1 Topography

21. The original sub-regional groundwater models developed for the Aupōuri Peninsula utilised the LINZ 8m digital elevation model (DEM). This data set had variable accuracy, particularly in areas with limited topographical control. In late 2019 an updated DEM with sub 1m accuracy generated from a recent LIDAR survey was made available by NRC. This data was incorporated into the most recent (February 2020) version of the AAGM to provide a more accurate representation of the topographical surface and update model layer geometry (based on geology recorded on bore logs referenced to local ground level). Following the LIDAR survey, datums at individual NRC groundwater level monitoring sites were re-surveyed, resulting in modifications to previously calculated relative groundwater levels at some locations. These updated (relative) groundwater levels were utilised to refine model calibration.

3.1.2 Model set-up and layer geometry

22. To represent the hydrogeological conceptualisation, the sedimentary sequence of the Aupōuri Peninsula was subdivided into four hydrostratigraphic units (comprising 7 layers) representing:

- Unit 1: a thick (40 to 70 m thick) sequence of unconsolidated fine sand interspersed with discontinuous layers of iron pan, silt and peat. This stratigraphic unit was represented in the model by four spatially variable layers reflecting the spatial and depth distribution and associated hydraulic properties of coastal sand, weathered sand and low-lying coastal plains and wetlands/estuaries.
- Unit 2: medium sand containing a high percentage (>40%) shell fragments forming the upper shell bed (i.e., an upper shellbed aquifer).
- Unit 3: a fine to medium sand layer of variable thickness separating the two shell bed layers.
- Unit 4: a sequence of shellbeds exhibiting coarser texture than the upper shellbed unit (i.e., a lower shellbed aquifer).

23. Basement rocks underlying the sedimentary sequence were effectively designated as a no-flow boundary forming the base of the model domain. Although in some areas these basement materials exhibit sufficient permeability to host a low-yielding groundwater resource[7], they are unlikely to form a major component of the overall water balance and can reasonably be excluded from the primary model domain.

24. The thickness of individual layers within Unit 1 were arbitrarily defined based on a nominal elevation, with the occurrence of the different units varying spatially to represent the varying surface and subsurface geological environments across the model domain. The geometry of model layers 1-3, 4, 5 and 6 was determined by interpolation of geological logs to develop a layer base elevation surface for each model layer. Surfaces for each model layer are illustrated on Figures 12 to 15 of WWLA (2020a), with schematic cross sections showing the geometry of the interpolated hydrostratigraphic units along various section lines across the model domain presented in Figures 16 to 24. As noted in the previous section, the geometry of the various model layers has been updated in the latest iteration of the AAGM by incorporation of topography from the NRC LIDAR survey.

25. The potential effects of geological heterogeneity on aquifer confinement are simulated in the AAGM by varying vertical anisotropy within the various model layers (ranging from 90 in weathered sand to 1 in the shellbeds). It is noted that this approach differs from that utilised by Lincoln Agritech (2015) who utilised a specific layer in their model (layer 2) to represent a laterally continuous leaky confining layer between the shellbed and overlying sand aquifers. Given the local-scale heterogeneity evident in the sedimentary sequence, I consider the approach varying vertical hydraulic conductivity through a combination of horizontally and vertically discrete layers enables local-scale geological anisotropy to be incorporated into the model in a manner that may be more difficult to replicate with a single, laterally continuous aquitard.

26. I consider the architecture of the AAGM is consistent with available geological and hydrogeological data and provides an appropriate representation of the conceptual model, although the following points are noted:

- While geological control is relatively good in areas where significant groundwater development has historically occurred (e.g., Pukenui, Sweetwater), limited information is available in other areas of the model domain.
- Even where geological data is available, depth to basement (i.e. the base of the aquifer system) may be uncertain in some areas. From recent drilling it appears that in some areas deeper, consolidated shellbed sediments (colloquially termed '*shell rock*') have historically been interpreted as representing geological basement rocks, rather than the lower portion of the water-bearing) sedimentary sequence.

  For example, the interpolated basement surface in the AAGM at the site of the MWWUG Norton Road sentinel bore (LOC.323722) occurs at a similar depth to the base of unconsolidated shellbed sediments (approximately -80 m) recorded on the bore log. However, the log from this bore shows the lower shellbed is underlain by a further layer of 'shell rock' to a depth of -116 m.

[7] Observed for example in fractured basalts of the Mt Camel formation in the Waihopo sub-area.

A review of other recent bore logs intercepting basement suggests that there may be similar localised variation in the basement surface that is not captured by the model interpolation.

Given sediments near the base of the sedimentary sequence are typically exhibit highest permeability, localised variance in depth to basement may increase uncertainty in predictions that rely on interpolated aquifer thickness (e.g., assessment of saline intrusion potential[8] and drawdown in response to pumping[9]).

- The geometry of the shellbeds assumed in the AAGM (i.e. two separate layers separated by a fine sand parting) is not laterally consistent across the entire model domain. In some areas (e.g., Waiharara) the shellbeds comprise two (or more) separate units separated by a thick layer of sand, while in others (e.g., Pukenui) they effectively comprise a single unit. Bore logs also indicate that shellbeds are thin or absent in some areas toward the northern and southern extents of the model domain (e.g., Waihopo, Ahipara).
- The sedimentary sequence thins and shellbed sediments pinch out in the Waihopo sub-area toward the northern end of the model domain. Many existing bores in this area[10] draw water from the underlying basement rocks (typically fractured basalt of the Mt Camel Formation). However, the model is configured so bores in this area draw water from a thin shellbed layer (nominal thickness 3 m) at the base of the sedimentary sequence. As noted in Section 2.3 of WWLA (2020a), the effect of this assumption is likely to be conservative with respect to groundwater effects in the Waihopo area because actual abstraction occurs from the basement rocks rather than the overlying sedimentary sequence.
- Previous hydrogeological investigations ((NRC (1991) and Lincoln Agritech (2015)) identified the potential for significant displacement in the basement structure along a NW-SE trending fault crossing the Aupōuri Peninsula. While it is clear there is significant variation in the depth of the geological basement across the model domain, the influence of this structure (if any) on groundwater flow is poorly constrained.

27. Overall, I consider the set-up and layer geometry utilised in the AAGM represents a reasonable approach to replicating a geological environment that exhibits considerable local scale heterogeneity. It is however noted that such uncertainty needs to be considered in the context of application of the model for predictive simulations, particularly those (related to seawater intrusion) reliant on the accuracy of model geometry.

3.1.3 Boundary Conditions

28. Boundary conditions were assigned as constant head, general head, drain and no-flow boundaries around or within the model domain as follows:

[8] Further discussed in Section 4.3 below.

[9] Modelling will tend to over-estimate drawdown where thickness of the shellbed aquifer is under-estimated.

[10] Including those for Henderson Bay Avocados (LOC.316843) and Far North Avocados production bores (LOC.209329)

- Constant head boundaries were assigned an elevation of 0 m asl in cells in Layer 1 along the eastern and western coastlines to simulate discharge from the shallow unconfined aquifer to the coastal margin. The geometry of the boundaries was amended in later versions of the AAGM to more accurately reflect the geometry of the coastline around the model domain.
- General Head Boundaries (GHBs) were assigned to cells around the coastal margin in Layers 2 to 6. Heads in the coastal GHB cells were specified as 0 m asl, with conductance values varied to reflect the greater impedance to discharge from deeper layers and calibrate to measured coastal water levels[11].

  GHBs were also assigned to 22 lakes/wetlands in the model domain, with head assigned to each based on lake stage elevations derived from the DEM. Conductance values were assigned to simulate slow seepage from these features to the underlying water table via intervening low permeability (iron pan) layers reflecting their separation from the underlying regional water table.
- No-flow boundaries were assigned along the northern and southern margins of the model.
- Drain boundaries were assigned to surface waterways crossing the model domain. Bed elevations were set as equivalent to the DEM elevation minus 2 m for drains crossing farmland and conductance values set relatively high to simulate the significant role of these features in the hydrology of low-lying coastal areas.

29. All boundaries appear to have been assigned in a manner consistent with the overall conceptual model and available hydrogeological data. Coastal boundaries are established at mean sea level, with lower conductance values assigned to deeper layers to reflect the greater impedance to outflow due to hydraulic resistance from overlying sedimentary layers. Similarly, GHBs representing lakes and/or wetlands reflect the substantial head differences observed between lake/wetland stage and groundwater levels in the surrounding unconfined aquifer throughout the model domain. Drain boundaries also appear appropriately applied to the surface drainage network.

3.1.4 Hydraulic Properties

30. Appendix A of WWLA (2020a) summarises aquifer hydraulic properties derived from analysis of aquifer tests and utilised for previous modelling studies. The data indicate hydraulic conductivity values are relatively well constrained, ranging between 1 and 10 m/day in the sand aquifer and between 20 to 40 m/day in the shellbed layers. Aquifer storage ranges from 0.1 in shallow parts of the unconfined aquifer to between 0.0001 to 0.001 in deeper water-bearing layers (both in the sand and shellbed aquifers).

[11] As a consequence, re-calibration of the AAGM to account for the datum change at the NRC Waterfront monitoring site resulted in adjustment of conductance values in adjacent GHBs.

31. WWLA (2020c[12]) provides a summary of aquifer hydraulic properties for the various model layers across four calibration zones[13] in the calibrated model and notes changes made to hydraulic properties to accommodate the updated topographical and water level monitoring data in the previous (late 2019) model iteration. All values listed are within the range calculated from aquifer testing and utilised for previous modelling studies.

32. A key parameter utilised in the AAGM to replicate the conceptual hydrogeological setting is anisotropy in individual model layers. This parameter reflects the ratio of horizontal to vertical hydraulic conductivity and is the primary means by which the progressive increase in aquifer confinement with depth is replicated in the model. Anisotropy values utilised range from 1 in the shellbed layers (i.e., uniform hydraulic conductivity in all directions) to between 10 to 100 in the overlying sand aquifer. While it is not possible to comment on the specific anisotropy values assigned, a significant reduction in vertical hydraulic conductivity in parts of the sand aquifer is consistent with the presence of discontinuous layers of lower permeability materials (silt, peat and iron-pan) within the shallow sand aquifer that cumulatively provide confinement for the shellbed layers.

3.1.5 Recharge

33. A land surface (rainfall) recharge time series was developed for the model using the Soil Moisture Water Balance Model (SMWBM) described in Appendix B of WWLA (2020a) using a time series of climate data and various input parameters to represent the hydraulic characteristics of different soil materials in the model domain. Generic classifications were utilised to divide the model domain based on four soil types (Figure 3, WWLA (2020a)), each with varying recharge characteristics. The soil types range from loose, highly permeable, unconsolidated sands along central and western areas of the Aupōuri Peninsula (i.e., recent mobile dunes) to very poorly drained wetland soils along the east coast. To develop a recharge time series, the model domain was divided into four climate zones and representative rainfall and evapotranspiration applied to individual soil types within each climate zone.

34. Results of this modelling estimate groundwater recharge on average comprises 43% of rainfall in the coastal sand zone, 38% of rainfall in the weathered sand zone, 26% of rainfall in the southern plains zone and 10% of rainfall in the peat/wetlands zone (where surface runoff is appreciably higher). Average land surface recharge across the model domain was estimated at 441 mm/year, equivalent to a cumulative volume of 236 million m^3/year (approximately 35% of average rainfall). For comparison, previous estimates of land surface recharge by Lincoln Agritech (2015) calculated rainfall recharge as equal to 500 mm/year (equivalent to 39% of average annual recharge).

35. Overall, recharge estimates utilised in the AAGM appear reasonable. The modelling takes account of both spatial variations in both climate and soil hydraulic properties and is consistent with previous estimates.

12 WWLA, 2020c; Aupouri Aquifer Groundwater Model Update Based on LIDAR Survey. Letter to NRC, 28 February 2020.

13 Illustrated on Figure 26 of WWLA (2020a))

36. However, one potentially relevant matter noted in the model documentation is that the modelling does not address is the potential for temporal variations in recharge associated with changes in vegetative cover, particularly plantation forestry which covers approximately 40% of the total area of the Aupōuri Peninsula. Historical groundwater level records from the Houhora sub-zone indicate that in addition to climate, temporal variations in groundwater levels also may be influenced by forest harvest cycles. Given it is difficult to accurately account for the historical influence of landcover on groundwater recharge on the Aupōuri Peninsula, historical estimates of cumulative recharge (and associated variations in aquifer storage) should be considered in light of this potential variance.

3.1.6 Groundwater Use

37. To evaluate potential effects of groundwater abstraction, a data set was constructed to represent historical groundwater use. Due to the limited data available to quantify actual groundwater use, historical groundwater use was developed using an irrigation scheduling module in the SWBM, applied to historical water permits. This model simulated likely irrigation demand based on the volume of water required to maintain soil moisture deficit above a nominal threshold. Results of this modelling were applied to existing and historical consents where no actual use data was available to generate a historical pumping series for model calibration.

38. A separate pumping time series was developed for predictive simulations that include all existing and proposed groundwater takes. This data set was generated in a similar manner to the historical use timeseries, based on nominal irrigation demand calculated from rainfall and evapotranspiration data over the period January 1960 to June 2018 applied to each individual water permit. Figure 1 illustrates part of the abstraction timeseries developed for two of the larger water permit applications (APP.020995.01.04 and APP0.39859.01.01). The figure shows modelled seasonal water use varies from between 20 to 100% of seasonal volume over the period shown, reflecting seasonal climate conditions. Usage equivalent to the maximum proposed seasonal volume is simulated three times during the period illustrated[14]. This is consistent with criteria adopted by NRC whereby seasonal volumes for irrigation consents are established to provide approximately 90% reliability (i.e. sufficient water to meet irrigation demand in 9 out of 10 years on average). Average seasonal water use for the two consents illustrated is approximately 60% of the proposed seasonal allocation. Again, this figure is broadly consistent with available horticultural water use data in the Northland Region.

[14] It is noted that modelled seasonal water usage varies between the individual consents reflecting variation in climate between the various clime zones utilised for the recharge modelling.

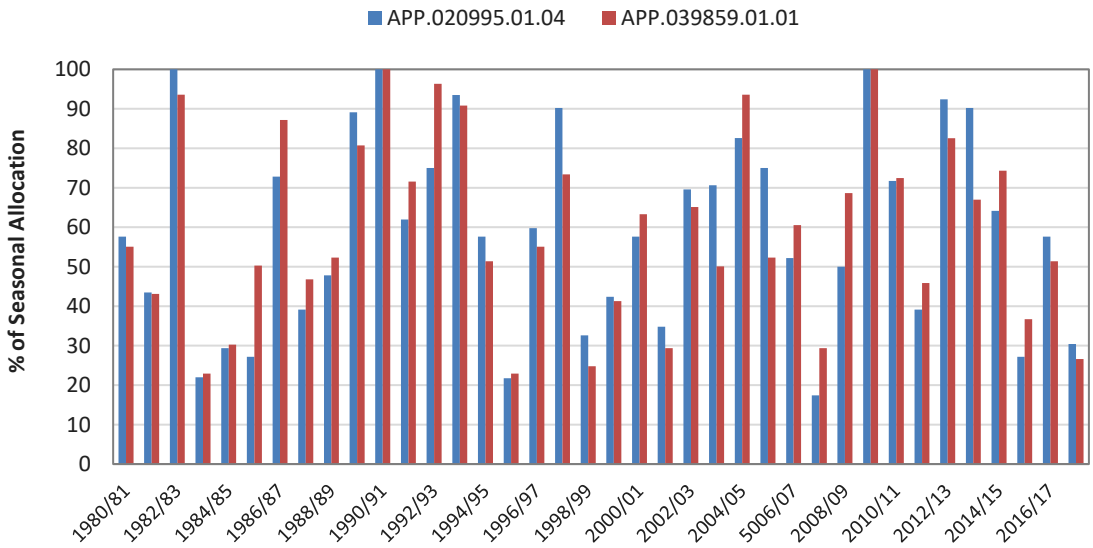

Figure 1. *Modelled seasonal water use for APP.020995.01.04 and APP.039859.01.01 utilised for predictive scenarios.*

39. Figure 2 shows an equivalent plot of the maximum rate of groundwater abstraction simulated in the pumping data set for APP.020995.01.04. In this case, the assumed rate of pumping is, in part, an artifact of the timesteps utilised in the modelling whereby volumetric abstraction is averaged over periods of several weeks. Consequently, the modelled abstraction rate (in m^3/day) averages only 38% of the proposed maximum for the period illustrated, with only 15% of years where modelled abstraction rate exceeds 80% of maximum. In contrast, actual water use data tends to indicate abstraction at higher rates (often close to 100% of maximum) occurs on an intermittent basis, particularly during periods of high demand.

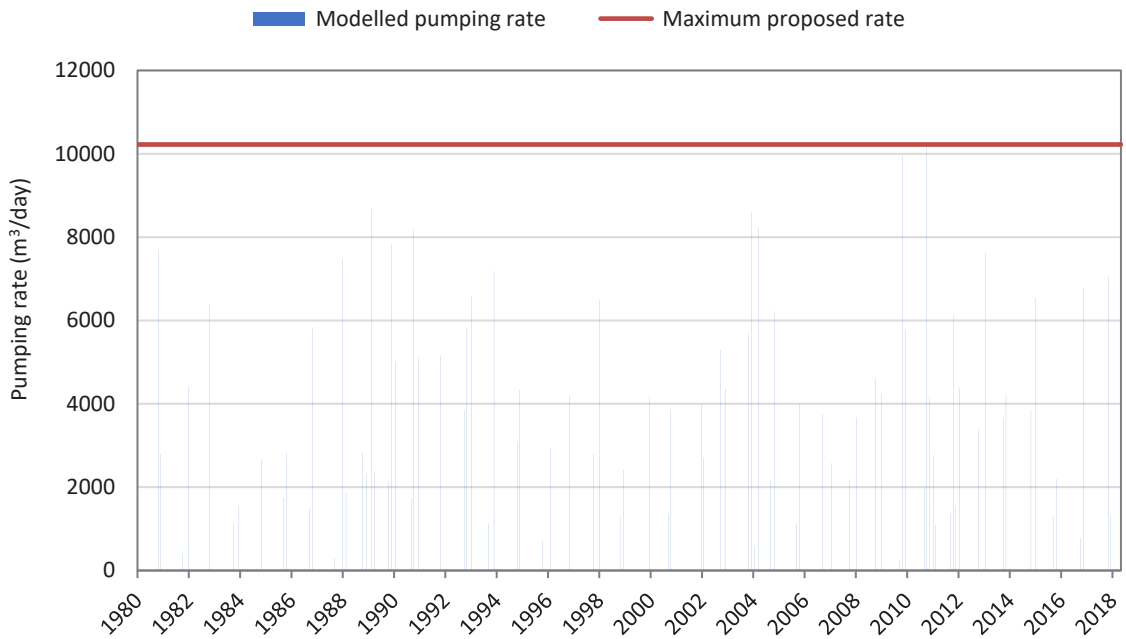

Figure 2. *Modelled abstraction rate (m^3/day) for APP.039859.01.01*

40. Overall, the water use data utilised for predictive modelling appears to provide a reasonable approximation of potential seasonal water use which is consistent with available water use data, while assumed maximum (i.e., short-term) pumping rates may be lower than those typically observed during operational pumping. This results from averaging of volumetric abstraction over timesteps of extended duration and is a result of temporal discretisation in the model. Consequently, while the abstraction timeseries utilised for is appropriate for assessing long-term effects of abstraction on the groundwater resource, model predictions may under-estimate localised effects (such as well interference) associated with short periods of high rate abstraction other than during years (such as 2010/11 and 2011/12) when modelled pumping rates are close to the maximum proposed.

3.1.7 Overall comments on model conceptualisation

41. Table 1 provides an overall assessment of the conceptualisation, design and construction of the AAGM based on criteria outlined in SKM (2012).

Table 2. *AAGM Conceptualisation, design and construction comments*

Review Question	Yes/No	Comment
General		
Are the project objectives stated	No	Project objectives are outlined in accompanying AEE.
Are the model objectives stated?	No	Model documentation does not define specific objectives for the modelling (other than to the support water permit applications) or any limitations and/or exclusions.
Are planned limitations and exclusions of the model stated?	No	
Conceptualisation		
Has a literature review been completed, including evaluation of prior investigations?	Yes	Model documentation refers to previous hydrogeological investigations and modelling.
Is the aquifer system adequately described including:		
- Hydrostratigraphy	Yes	Model documentation includes detailed description of hydrostratigraphic interpretation, spatial extent and boundaries.
- Lateral extent, boundaries and significant internal features	Yes	
- Aquifer geometry including layer elevations and thickness	Yes	Process for determining layer geometry and elevations described.
- Unconfined or confined conditions and variation in space and time	Yes	Spatial and depth variation in conditions responsible for aquifer confinement characterised.
Have data on groundwater stresses been collected and analysed?	Yes	
- Rainfall recharge	Yes	Estimates of land surface recharge are reasonable and take into account spatial variation in climate and soil types. Temporal effects of landcover variation are not assessed.
- River or lake stage heights	Yes	The nature and occurrence of permanent surface water features is described including comparison of stage height with surrounding groundwater levels.

Review Question	Yes/No	Comment
- Groundwater usage	Yes	Estimates of historical pumping are utilised for model calibration and a temporal data set for all existing and proposed abstraction applied to predictive simulations. The data set appears to provide a reasonable estimate of seasonal usage, but may under-estimate peak (daily) rates due to time-step averaging, other than in specific drought years (such as 2009/10).
Have groundwater level observations been collected and analysed?	No	Analysis of groundwater hydrographs is not presented as part of hydrogeological conceptualisation. Effect of pumping stress on selected hydrographs analysed in documentation of MWWUG model. 'Naturalised' model scenario groundwater levels are used to represent the piezometric surface.
Have flow observations been collected and analysed?	No	No flow measurements or regionalised estimates have been utilised to quantify surface flows.
Is measurement error or data uncertainty reported?		
- Directly measured parameters	No	Groundwater level and quality data collection is primarily undertaken by NRC and existing consent holders. Model documentation does not address potential errors or uncertainties in measured data (other than revision of topographic datums).
- Spatial variability and/or heterogeneity of parameters	Partly	Heterogeneity in aquifer hydraulic properties is described but specific details (e.g., uncertainties in geological interpretation on drillers logs) is not specifically addressed.
- Data interpolation	No	Uncertainty in surfaces generated from geological data not discussed.
Have consistent data units and geometric datum been used?	Yes	All heights are referenced to a common datum which has been updated to utilise the recent LIDAR survey and corrected relative groundwater levels.
Is there a clear description of the conceptual model?	Yes	The conceptual model is adequately documented although no graphical representation is provided.
Is the conceptual model based on all available, relevant data?	Yes	The conceptual model is based on, and consistent with, available hydrogeological data.
Have alternative conceptual models been investigated?	No	The model report does not describe alternative conceptual models, rather it builds on an existing model utilised for previous modelling studies.
Design and Construction		
Is design consistent with the conceptual model?	Yes	Design of the model utilises vertical anisotropy to replicate progressive aquifer confinement rather than a single aquitard layer.
Is the choice of numerical method and software appropriate?	Yes	
Are the spatial domain and discretisation appropriate?	Yes	Spatial discretisation reflects available data and hydrogeological conceptualisation.

Review Question	Yes/No	Comment
Is temporal discretisation appropriate?	Yes	Timesteps utilised for predictive simulations are relatively coarse which reduces resolution of short-term pumping effects but is appropriate for consideration on medium to longer-term effects (seasonal/inter-annual).
Are the boundary conditions plausible and sufficiently unrestrictive?	Yes	Boundary conditions are plausible. Major effect is to constrain coastal heads to 0 m asl.
Is the implementation of boundary conditions consistent with the conceptual model?	Yes	Boundary conditions are consistent with hydrogeological conceptualisation.
Are the initial conditions appropriate?	Yes	Initial conditions based on median water levels from available water level monitoring sites.

3.2 Model Calibration

3.2.1 Steady-State Calibration

42. An initial steady-state calibration of the AAGM was undertaken to validate the model conceptualisation, obtain approximate values of the model parameters, and to obtain initial heads for transient model simulation. To assist calibration the various model layers were divided into 4 geographical areas (Fig 26, WWLA (2020a)) creating 32 material zones distributed spatially and with depth across the model domain. Automated calibration was undertaken using PEST, with median groundwater levels recorded at 56 monitoring sites distributed across the model domain as the calibration target.

43. Results indicate the steady-state model is capable of replicating overall spatial and depth variation in water levels, although some discrepancies are noted for individual bores, particularly in areas where either topographic elevations are low (water levels tend to be over-predicted), or where there is some uncertainty regarding the perched nature of shallow groundwater levels (e.g., Lake Heather and Sweetwaters Piezometers).

3.2.1.1 Groundwater Level Datum Correction

44. It is noted that steady-state calibration of the AGGM was undertaken using available groundwater level data prior to the correction of groundwater level datums following release of NRC LIDAR DEM in late 2019. Release of this data set identified potential discrepancies in datums historically applied at individual groundwater monitoring sites. As previously described, to resolve these discrepancies all NRC monitoring sites were re-surveyed in early 2020 resulting in updates to site datums (and hence calculated relative groundwater levels)[15]. While updated/corrected groundwater levels were utilised for transient calibration, the steady-state calibration was not redone so it is likely that these datum errors contribute to some of the discrepancy observed between modelled and measured groundwater levels.

[15] The major discrepancy identified was a +2.5 m offset in the historical datum applied to groundwater levels at the NRC Waterfront monitoring site at Pukenui. This site was utilised as the primary calibration target for northern sections of the model domain in previous (2017 to late 2019) model iterations.

3.2.2 Transient Calibration

45. A transient model of the Aupōuri Aquifer was developed covering the period from 1 Jan 1960 to 31 July 2018 (58 years 7 months).

46. The simulation period was divided into 371 stress periods of varying length ranging from 13 to 185 days duration (average 58 days). Stress periods following the end of the irrigation season (typically April) have the longest duration (average 90 days) with those at the start of the irrigation season having the shortest (average 22 days), with average stress period duration increasing over the course of the irrigation season. Overall, temporal discretisation of the simulation period is appropriate for a long-term sub-regional scale simulation of groundwater levels.

47. Calibrated parameters from the steady-state model were used as the starting point for calibration of the transient model. Heads from sequential model runs were utilised as initial conditions in subsequent model runs to help minimise initial variations in heads and flux. Temporal groundwater levels measured at the 56 groundwater level monitoring sites were utilised as the primary calibration target (due to little or no data to characterise groundwater flux), with vertical and horizontal hydraulic conductivity being the main parameters modified to adjust model calibration.

48. WWLA (2020c) provides a summary of re-calibration of the AAGM to incorporate groundwater levels revised following the release of the LIDAR DEM and subsequent re-survey of NRC monitoring site datums. Updates to model set-up as a result of this revision included:

- Land surface elevation
- Aquifer base and layer geometry
- Revised groundwater levels for model calibration
- Inclusion of additional groundwater level monitoring sites[16]

49. In early 2020 the AAGM was calibrated to the updated groundwater levels following the release of the LIDAR survey (including additional groundwater level observation points) primarily via adjustment of assumed aquifer hydraulic conductivity (horizontal and vertical) in several areas of the model. As outlined in Table 3 below, the revised model calibration exhibited a significantly improved fit to the available water level monitoring data. Root mean square error (RMSE) for all sites reduced by 15% in the unconfined aquifer, 50% in the shellbed aquifer, and approximately 30% across the whole model. This equates to a scaled RMSE equivalent to 5% or less of the observed range of groundwater levels across the model domain. WWLA (2020a) notes a scaled RMSE of <10% is typically considered an acceptable calibration for a regional-scale groundwater model.

[16] Groundwater level compliance monitoring sites established for the MWWUG in 2018.

***Table 3**. Summary statistics for AAGM calibration (modified from WWLA (2020c))*

Analysis Metric		AAGM Model Version		
		2019	**2020**	**% change**
Full Model RMSE (m)	All sites	1.89	1.31	-31
	All observations	2.10	1.47	-30
Upper Aquifer RMSE (m)	All sites	1.78	1.51	-15
	All observations	2.08	1.61	-23
Shellbed RMSE (m)	All sites	2.01	1.02	-49
	All observations	2.15	1.05	-51

50. While calibration statistics indicate the AAGM provides a reliable means to simulate absolute groundwater levels across the model domain, comparison of temporal variation at inland monitoring sites with modelled groundwater levels (particularly along the Hukatere transect) indicates natural variability that is not universally captured in the model simulation. This discrepancy between measured and modelled temporal groundwater levels response in inland piezometers along the Hukatere transect (Hukatere and Forest piezometers) is noted in Section 4.4.1 of WWLA (2020a) which observes:

> *The groundwater model has been set up with recharge rates that were simulated based on a constant land use over the model period. However, land use changes and the associated spatial distributions of land cover will affect the quantity and quality of water being recharged to the groundwater system. In fact, the plantation forestry felling cycles on the western side of the peninsula may significantly affect the variation of groundwater recharge.*

And further notes that:

> *Reconstructing historical land use change would be a separate study in its own right and it was therefore not currently possible within the timeframe and budget of this project scope, to incorporate the transient variability of recharge into the*

51. While the departure between measured and modelled groundwater levels may, in part, reflect variations in recharge associated with land use change, it is noted that groundwater levels recorded at many of the piezometers with long monitoring records appear to follow temporal variation in rainfall relatedly well particularly prior to 2010. After this time, changes in (plantation forest) landcover more clearly exert a significant influence on groundwater levels, particularly in inland areas across the northern section of the model domain. It is therefore uncertain if departure between modelled and measured groundwater levels prior to 2010 reflects variations in landcover or other factors influencing the recharge calculation.

52. Another key feature of the Aupōuri Aquifer is the observed spatial variation in hydraulic gradient between central and coastal parts of the aquifer system. From a review of the data provided (small-scale hydrographs) it appears the ability of the model to replicate measured hydraulic gradients varies spatially, possibly reflecting the overall heterogeneity of the geological environment at a local scale. While modelled hydraulic gradients at some sites (e.g., Waterfront, Sweetwater 2) appear to match measured data very well, other sites both over-estimate (e.g., Parapore, Valic 3) and under-estimate (e.g., Forest, Sweetwater 3) gradients. A direct comparison of modelled vs measured head gradients would have been a useful addition to the documentation (along with discussion of any corresponding implications for model calibration).

53. Overall, the AAGM exhibits a reasonable ability to simulate both temporal and depth variation in groundwater levels in the Aupōuri Aquifer. However, it does appear that both temporal variations in groundwater levels and hydraulic gradients are not universally well simulated at all points across the model domain. This may reflect localised variations in the geological and hydrogeological environment that are not captured by the model and which contribute to overall uncertainty in model predictions. It may also reflect temporal variations in recharge flux and/or aquifer storage that are not captured in the model simulation.

3.2.3 Model Water Budget

54. Section 4.4.2 of WWLA (2020a) provides a long-term average water budget for the transient model calibration. The data presented indicate the water budget is dominated by rainfall recharge. The calculated recharge volume of 650,741 m^3/day equates to an annual volume of 238 million m^3 (or 443 mm/year across the model domain). Aside from temporal variation aquifer storage (reflecting the seasonal nature of aquifer recharge/discharge) other inputs to the model are minor.

55. The water budget indicates discharge from streams and wetlands is the largest discharge accounting for a volume of 278,778 m^3/day (3.2 m^3/s) or 35% of the model water budget. Shallow coastal discharge (i.e., from Layer 1) accounts for 275,249 m^3/day, equivalent to 34% of the average daily water budget. Around the 115 km coastal margin, this discharge equates to around 2,400 m^3/day/km. Deeper coastal discharge (i.e., from Layers 2 to 6) is equivalent to 80,743 m^3/day, equating to approximately 700 m^3/day per kilometre of coastline. Total coastal discharge is therefore equivalent to slightly over 3,000 m^3/day/km.

56. Cumulative allocation (permitted, consented and proposed) recorded by NRC in the model domain equates to 12,829,430 m^3/year which is equivalent to 4.3% of the annual model water budget, or 5.3% of average annual rainfall recharge.

57. Overall, the model mass balance outlined in Section 4.4.2 of WWLA (2020a) appears reasonable and is consistent with the underlying conceptual model. Groundwater recharge is almost entirely derived from rainfall recharge while discharge is evenly divided between discharge to drains and wetlands and along the coastal margin. Coastal discharge is dominated by throughflow in the upper part of the sand aquifer, with discharge from deeper water-bearing layers restricted by the hydraulic resistance of overlying sediments. The long-term water budget is also closed, with negligible difference between long-term inflows and outflows.

3.2.4 Sensitivity

58. Section 5 of WWLA (2020a) notes that a sensitivity analysis was performed which determined that hydraulic conductivity was the most sensitive model parameter, followed by vertical anisotropy. However, no details of sensitivity analysis performed are contained in the model documentation. Given the model is calibrated solely to heads, as noted in SKM (2012), it is reasonable to expect that modelled heads are likely to be "*appreciably sensitive to both changes in aquifer transmissivity and recharge"*. Documentation of model sensitivity would also have assisted evaluation of model uncertainty.

59. Scenario 3 (outlined in the following section) is described in WWLA, 2020b as a 'sensitivity analysis'. This predictive scenario was undertaken using a version of the AAGM with the hydraulic connectivity between the shellbed and shallow sand aquifer significantly reduced. This version of the model is not calibrated (it is unlikely to calibrate could be achieved given it is unlikely to reflect hydraulic properties of the aquifer materials at a sub-regional scale) but was undertaken to recognise that:

> *…the calibrated model errs on the side of over-simulation of vertical leakage. This was deliberately built into the model in the absence of a single, well defined low permeability horizon in the field, but rather a series of multi-layered and discontinuous iron pans and other low permeability horizons within the sedimentary sequence that in combination act as a barrier between the deeper groundwater system and surface drains and wetlands.* [WWLA, 2020b, Section 3.0]

60. As such, I consider Scenario 3 functions more as a guide to a likely upper bound estimate of localised drawdown in the shellbed aquifer, rather than as a true sensitivity analysis.

3.2.5 Summary

61. Table 4 provides summary comments on calibration and sensitivity of the AAGM.

Table 4. *AAGM Calibration and Sensitivity review comments*

Review Question	Yes/No	Comment
Calibration and Sensitivity		
Are all available types of observations used for calibration?	Yes	Observations are limited to groundwater levels. No flux measurements are available.
Does the calibration methodology conform to best practice?	Yes	Calibration utilised PEST to modify vertical and horizontal hydraulic conductivity values to achieve calibration targets subject to constraints based on measured aquifer properties.
Is a sensitivity of key model outcomes assessed?	Partly	Model documentation makes reference to results of a 'sensitivity analysis' but does not provide details.
Have the calibration results been adequately reported?	Yes	Model calibration results are reported in statistical, tabular and graphical form.

Review Question	Yes/No	Comment
Is it clear whether observed or assumed vertical head gradients have been replicated by the model?	Partly	Calibration hydrographs provided appear to show the model has a reasonable ability to replicate measured hydraulic gradients, although not at all locations. Documentation and discussion of hydraulic gradients would improve documentation
Are calibration statistics reported in a reasonable manner?	Yes	Although small scale of hydrographs makes visual comparison difficult.
Is the model sufficiently calibrated	Yes	Results indicate the model is generally able to replicate spatial and depth variation in heads. The ability to replicate long-term variations in aquifer storage is generally OK, although medium-term trends in rainfall may not be universally well replicated in modelled groundwater levels at all sites (particularly inland).
Are the calibrated parameters reasonable?	Yes	Calibrated parameters are within range indicated by aquifer testing and consistent with previous modelling studies.
Are the volumes and fluxes in the water balance realistic?	Yes	The model water balance appears reasonable and is consistent with the underlying conceptual model.
Has the model been verified?	No	Due to the limited period of monitoring data available, no model verification was undertaken

3.3 Model Predictive Simulations

62. The calibrated AAGM was used to run a range of predictive simulations representing natural conditions, as well as aquifer response to existing and proposed groundwater abstraction. The scenarios run include:

- Scenario 1 - the model was run from 1/1/1960 to 31/7/2018 with no abstraction simulated. This scenario was utilised to characterise aquifer water balance and temporal variation in groundwater levels under 'naturalised' conditions to provide a comparison with pumped scenarios.
- Scenario 2 - the calibrated model was run from 1/1/1960 to 31/7/2018 for two pumping scenarios:
    1. Existing consented abstraction ('permitted baseline').
    2. Existing and proposed (AAWUG) abstraction
- Scenario 3 - a model scenario run from 1/1/1960 to 31/7/2018 for two pumping scenarios (with vertical hydraulic conductivity of Layer 2 halved to simulate a laterally extensive, low permeability layer in the sand aquifer):
    1. Existing consented abstraction ('permitted baseline')
    2. Existing and proposed (AAWUG) abstraction

63. Again, it is important to note that Scenario 3 does not represent the calibrated model. Rather, it is a scenario developed as a means to evaluate potential heterogeneity in hydraulic properties whereby the aquifer is more well confined on a localised basis (for example due to an area of hard pan or peat 'lens') than it is across the wider aquifer system. Consequently, drawdown predicted under Scenario 3 is intended to reflect 'worst case' drawdown on a localised basis and may therefore over-estimate drawdown on a sub-aquifer basis.

64. Results of predictive modelling are presented in the AEE (Figures 4 to 6, 9 and 10 in WWLA, 2020b) in the form of maps showing cumulative drawdown of groundwater levels in the shellbed and shallow sand aquifers at the end of the 2010 irrigation season resulting from all existing and proposed abstraction (relative to the naturalised scenario), and resulting from the proposed AAWUG abstraction (relative to the effects of existing abstraction). The 2010 irrigation season represents a season when the full seasonal volume of abstraction was simulated with abstraction occurring at the maximum (daily) abstraction rate (i.e., representing the maximum proposed rate and volume of abstraction). WWLA (2020c) also provides hydrographs of groundwater levels from Scenario 1 (naturalised) and Scenario 2 (all existing and proposed abstraction) at nominated points across the aquifer system for the full simulation period.

65. The simulation period spans a range of climate conditions. As illustrated in Figure 3 below the 1960 to 2018 simulation period includes a range of climate conditions varying from very wet seasons with limited soil moisture deficit (e.g., 1979/80 and 2001/02) to years with significant and persistent 'drought' conditions (1973/74 and 2009/10). The 2009/10 season utilised as the basis for evaluation of cumulative effects of the proposed abstraction therefore represents effects during a very dry season when groundwater levels where close to the mid-point of the historical range observed since the late 1980s.

66. It is also noted that the data shown in Figure 3 also show limited temporal trend in the magnitude of cumulative seasonal soil moisture deficit over the simulation period suggesting little, if any, change in the incidence of 'drought' conditions over the past ~50 years (although it is not uncommon for the Aupōuri Peninsula to experience consecutive years of above or below normal rainfall). The figure also shows that the cumulative (Nov to Mar) soil moisture deficit recorded at Waiharara during the 2019/20 year was higher than all but two years during the simulation period.

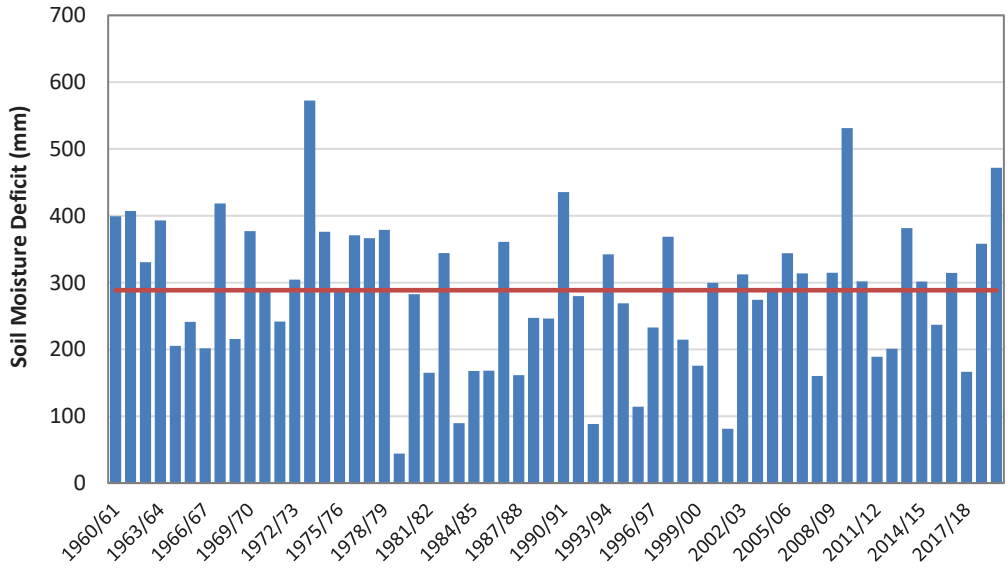

Figure 3. *Cumulative (Nov to March) soil moisture deficit at Waiharara 1960/61 to 2019/20. Red line indicates median seasonal deficit (Data sourced from NIWA CliFlo site A43921).*

3.3.1 Climate Change

67. The effects of climate change have not been explicitly incorporated into modelling of the potential effects of the 24 proposed groundwater takes on the Aupōuri Peninsula. This reflects several considerations including:

- There are no data sets available that provide local climate data (e.g. rainfall and potential evapotranspiration) incorporating climate change effects at the resolution (daily) required to generate a synthetic future recharge time series. As noted by Lincoln Agritech (2015), and still relevant currently:

  "In theory it is possible to make quantitative predictions about the influence that climate change will have on groundwater resources. To do this would require either the generation of generic synthetic rainfall and evapotranspiration, or the application of corrections to historical datasets. These records could then be used as input datasets for our soil moisture balance model to estimate groundwater recharge and irrigation demand. However, guidance on generating region-specific records for predicting future rainfall intensity and frequency are not yet available for New Zealand, let alone for specific regions. More generalised regional-scale predictions are currently the best information we have available, so any assessment of future climate impacts on groundwater resources can only be made at a qualitative level"

- Data from a range of climate model projections[17] indicate that the potential effect of climate change on rainfall (as a major driver of groundwater sustainability) will be relatively minor across the Aupōuri Peninsula (<15% seasonally and 0 to 5% annually). Variability of this magnitude is well within the range of historical inter-annual rainfall fluctuations observed in this area and is likely to be significantly less than that associated with other factors influencing historical recharge (e.g. particularly effects associated with changes in landcover resulting from forest harvest cycles);
    - As illustrated on Figure 4 below, scaled climate model predictions for a range of RCP scenarios indicate that seasonal and annual rainfall totals may increase slightly across the Aupōuri Peninsula. Utilisation of historical rainfall as the basis for recharge estimates may, if anything, introduce a degree of conservatism into the modelling of potential future recharge.

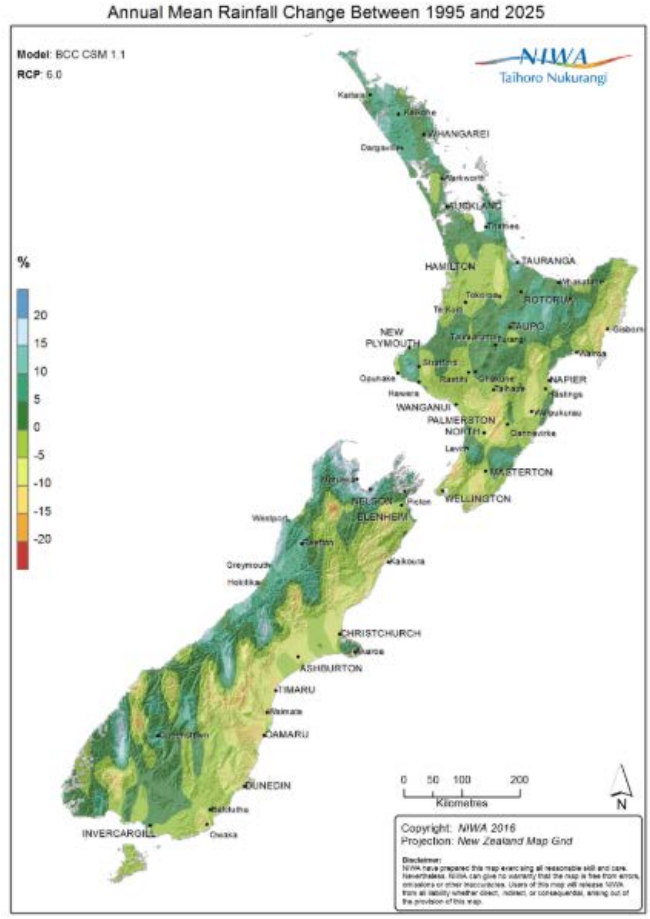

Figure 4. *Projected changes in annual precipitation 1986-2005 to 2016-2035 across New Zealand (Source: NIWA, RCP 4.5, 6-model ensemble mean[18]).*

17 For example, https://ofcnz.niwa.co.nz/#/nationalMaps

18 https://ofcnz.niwa.co.nz/images/maps/RAIN_PDIFF_VCSN/200dpi/ANN_RAIN_PDIFF_VCSN_ENS_AV_2016_2035_RCP4_5_pcs.png

- As further discussed below, it is proposed that the current applications by the AAWUG be subject to a Groundwater Monitoring and Contingency Plan (GCMP) similar to that applied to the MWWUG consents. The GCMP specifies a range of monitoring (including groundwater levels and groundwater quality) at key locations across the Aupōuri Peninsula. Each monitoring site is subject to triggers that initiate mitigation actions (including a reduction in the volume of abstraction) once a specified threshold is reached. These triggers are established to manage uncertainties associated with modelling heterogenous regional-scale aquifer systems but would equally cover effects associated with temporal variations in climate that are not accounted for in the current modelling.

3.3.2 Uncertainty

68. Due to the overall heterogeneity of the geological environment and the limited data available to characterise the physical characteristics of the groundwater resource of the Aupōuri Peninsula, there is inevitably uncertainty inherent in any regional-scale numerical simulation of the aquifer system. Documentation of the AAGM does not provide any qualitative evaluation of predictive uncertainty, although the AEE provides a qualitative description of generalised uncertainty whereby:

> *…, the model exaggerates the effects of the proposed abstraction on the groundwater levels in the shallow aquifer and at the surface. Conversely, the model may slightly under-predict the local-scale drawdown in the deeper aquifer.*

3.3.3 Predictive simulations

69. Overall, I consider the approach utilised for predictive modelling is suitable for assessment of cumulative effects of proposed abstraction. Model predictions allow comparison of both:

- potential cumulative effects of all existing and proposed groundwater abstraction against the ‘naturalised’ condition of the resource (i.e., with no pumping occurring), and
- the potential cumulative effect of the 24 current applications compared to that occurring in response to existing allocation.

70. Model simulation period spans a range of climate conditions that can reasonably be expected to occur over the near-term. The irrigation season utilised to evaluate potential cumulative drawdown effects (2009/10) represents drought conditions under which abstraction is simulated as occurring at the maximum rate and volume proposed.

Table 5 provides review comments on predictive simulation and uncertainty associated with the AAGM.

Table 5. *Review comments on AAGM prediction and uncertainty*

Review Question	Yes/No	Comment
Prediction		
Are the model predictions designed in a manner that meets the model objectives?	Possibly	Model objectives are not stated but model predictions are focused on characterising cumulative impacts on aquifer storage
Is predictive uncertainty acknowledged and addressed?	No	Predictive uncertainty is noted but not quantified. However, Scenario 3 provides a useful means of evaluating predictive uncertainty in modelled drawdown associated with local-scale geological heterogeneity.
Are the assumed climatic stresses appropriate?	Yes	Predictive scenarios utilise historical climate data which include several significant low rainfall (drought) events. It is not possible to reliably simulate potential future effects on climate change on aquifer recharge.
Is a null scenario defined?	Yes	Predictive scenarios for proposed and cumulative (existing and proposed) abstraction are referenced against a baseline '*naturalised*' scenario that does not simulate any abstraction.
Are the scenarios defined in accordance with the model objectives?	Possibly	Model objectives are not defined but predictive scenarios are targeted at defining cumulative effects of both existing and proposed abstraction at the maximum rate and volume consented / proposed.
Are the pumping stresses similar in magnitude to those of the calibrated model?	Yes	Results of pumping scenarios are presented in terms of drawdown at the end of the 2010 irrigation season which represents a period when simulated abstraction occurs at the maximum proposed rate until the entire seasonal volume is utilised for all takes.
Are the assumed stresses and timescale appropriate?	Yes	Model scenarios are appropriate to characterise seasonal drawdown effects
Uncertainty		
Is some qualitative or quantitative measure of uncertainty associated with the prediction reported together with the prediction?	No	Predictive uncertainty is not characterised in model documentation
Are potential sources of uncertainty discussed?	Partly	Geological heterogeneity is identified as a source of potential uncertainty. However, other sources are not model predictions (and associated assessment of potential effects) are not characterised in model documentation or AEE.

3.4 Summary

3.4.1 Model fitness for purpose

71. Overall, the numerical groundwater model described in the modelling report is appropriately constructed and provides a useful tool to assess potential effects associated with groundwater abstraction at a regional scale. The model does have some acknowledged limitations with regard to its ability to predict vertical leakage (and associated water level drawdown in shallow and deep groundwater) due to the irregular and discontinuous nature of iron pans and other low permeability horizons within the sedimentary sequence. These limitations are, in part, addressed by Scenario 3. However, it is noted that model predictive uncertainty is not well characterised in model documentation. This will be addressed in subsequent review comments.

4. Potential effects on the environment

72. As outlined in the AEE (WWLA, 2020b), assessment of potential effects on the environment were undertaken using outputs of the AAGM predictive simulations to quantify:

- Potential effects on surface water resources.
- Potential cumulative drawdown across the aquifer system.

4.1 Effects on surface waterbodies

73. Section 3.1 of the AEE provides an assessment of the potential effects of the proposed groundwater abstraction on discharge from drains and wetlands across the model domain. The assessment compares annual cumulative minimum flows in drain cells across the model domain between Scenario 2 (all existing and proposed abstraction) and the 'naturalised' Scenario 1. The assessment indicates a maximum reduction of 4.3% in mean annual low flow which the assessment notes is considerably lower than the threshold of effect for small rivers specified in Table 23 of the pRPN.

74. With regard to the assessment of effects on surface water, the following points are noted:

- As discussed in Section 3 above, available data indicate that wetlands and lakes across inland parts of the Aupōuri Peninsula form in areas where subsurface drainage is significantly impeded by near-surface low permeability layers (typically iron pan, silt or peat). Such features are typically perched above the regional water table, so it is reasonable to conclude they are unlikely to be impacted by the proposed groundwater abstraction.
- Limited monitoring data is available to characterise discharge in surface waterways across the model domain. It is therefore difficult to assess the overall quantum of discharge predicted by the model scenarios.

- Anecdotal evidence suggests the surface flows in some catchments appear to be largely maintained by discharge of perched water tables (i.e., groundwater occurring above the regional water table, perched on laterally continuous iron pan[19]). Such discharge will not be captured in the model and inevitably result in discrepancies in the magnitude of modelled vs actual discharge.
- The assessment does not attempt to spatially differentiate effects on individual waterways, rather it relies on a global water balance for the entire model domain. Given the spatial extent of drawdown (discussed in the following section), assessment on a global basis appears reasonable, at least to establish the overall magnitude of effect. Assessment of impacts on discharge at a catchment-scale would be more relevant if assessment indicated drawdown was likely to occur on a localised basis.
- The relationship between groundwater, wetland levels and surface discharge are potentially complicated in low-lying coastal areas such as around the Kaimaumau Wetland. The AEE does not directly address potential effects on the Kaimaumau Wetland, instead relying on the assessment utilised for wetland areas more generally across the model domain. However, given the potential nature of interconnection between the wetland and the groundwater system, it not clear that the spatial and temporal resolution of a regional-scale model such as the AAGM is particularly well suited to resolving what may potentially be relatively subtle, local-scale effects. In order to better characterise potential local-scale effects further assessment of the hydrology of the Kaimaumau Wetland and the potential for hydraulic connection to the surrounding aquifer system will be provided in subsequent review comments once monitoring data for the 2019/20 summer is available.

4.2 Cumulative Drawdown Effects

75. The potential for well interference (drawdown) resulting from the proposed abstraction to adversely affect existing groundwater users is addressed in Section 3.2 of the AEE. This assessment utilises the various groundwater model predictive scenarios to calculate the maximum drawdown likely to occur in response to:

- Cumulative drawdown from all existing and proposed groundwater abstraction relative to the non-pumped ('naturalised') condition of the aquifer, and
- Cumulative drawdown resulting from the 24 current water permit applications relative to effects resulting from current allocation (i.e., 'permitted baseline' abstraction).

76. Drawdown for cumulative and proposed abstraction was assessed in both the shellbed and unconfined aquifer for Scenario 2, and for the shellbed aquifer for Scenario 3[20]. Figure 5 below illustrates the modelled cumulative drawdown in the shellbed aquifer resulting from all existing and proposed abstraction (Scenario 2) compared to the 'naturalised' scenario. The assessment identifies relatively minor drawdown (<1 m) in the shellbed aquifer occurring across much of the Aupōuri Aquifer

[19] See, for example, investigations into the lateral extent of iron pan and its relation to surface waterways outlined in OPUS (2018); Assessment of Environmental Effects. Application for Water Permit to take and use groundwater Te Aupouri Commercial Development Ltd

[20] Given the low hydraulic conductivity assumed in Layer 2, this scenario effectively results in negligible drawdown in the shallow unconfined aquifer (i.e., drawdown is essentially restricted to the shellbed aquifer).

management zone, with the magnitude of drawdown increasing in the vicinity of individual large-scale abstractions, particularly in the Sweetwater area.

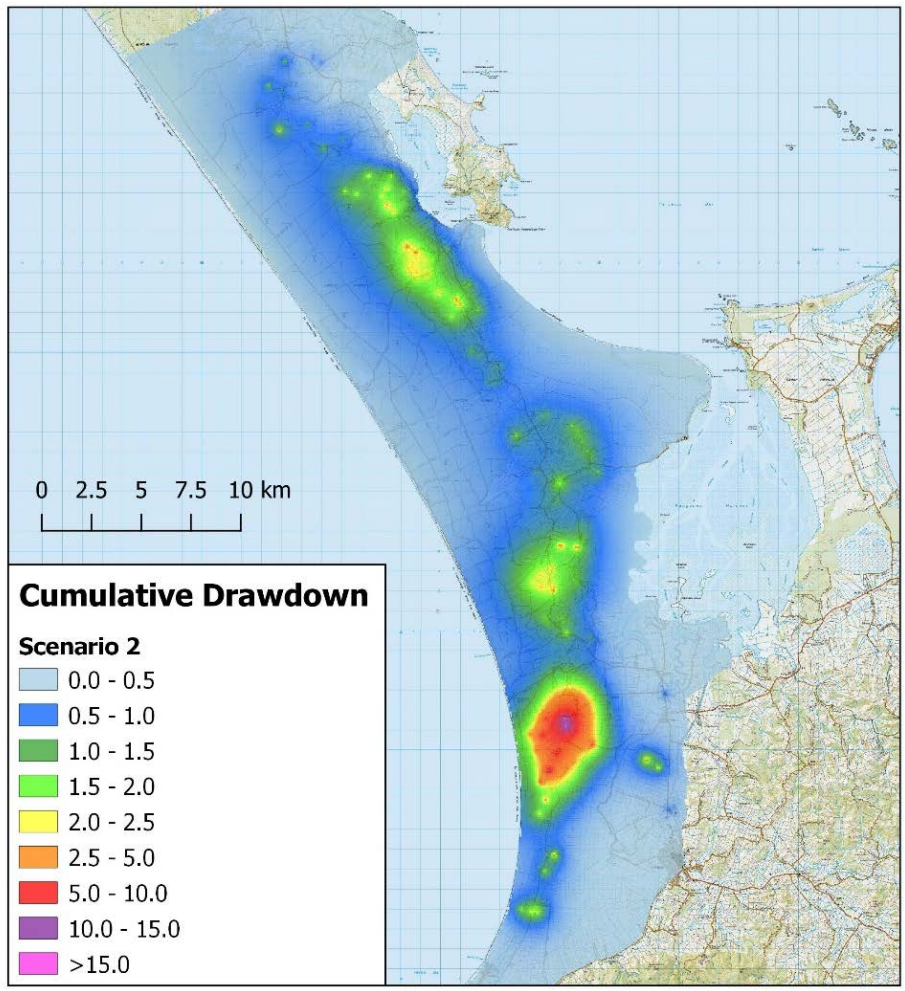

Figure 5. *Maximum cumulative drawdown in the Shellbed Aquifer (Scenario 2)*

77. Overall, I consider the methodology utilised to evaluate potential well interference effects is reasonable. It provides an assessment of both cumulative drawdown (from all current and proposed abstraction), as well as that specifically associated with the AAWUG applications. The assessment is based on modelled drawdown at the end of the 2009/10 irrigation season which represents a significant drought event during which pumping (both existing and proposed) is simulated to occur on a continuous basis at the maximum rate and volume proposed.

78. The assessment utilises the calibrated model (Scenario 2) to calculate cumulative drawdown resulting from the proposed abstraction in both the shellbed and shallow sand aquifer and also includes a scenario (Scenario 3) which effectively simulates 'worst case' drawdown in the shellbed aquifer that could arise as a result of local confinement of the shellbed aquifer not captured in the model calibration at a regional-scale (i.e., Scenario 2).

4.2.1 Assessment of effects on existing groundwater users

79. Policy 10.5 (1) of the Regional Water and Soil Plan (RWSP) requires Council to:

> *"....ensure the sustainable use of groundwater resources, by avoiding groundwater takes that exceed recharge which result in any of the following:*
>
> *(b) A lowering of the groundwater table below existing efficient bore takes;*

80. Explanation to the policy notes the policy promotes "*efficient bore takes*" which are illustrated by an example where:

> *.....a bore fully penetrates the water bearing layer and takes water from the base of the aquifer. The water level in a bore, which is only partially penetrating an aquifer or is drawing water from the top of the aquifer, may be drawn below the bottom of that bore as a result of water being taken (at a sustainable rate) from another deeper bore. The user of the shallow bore has not lost his or her use of the groundwater resource. Rather, the method of extraction is no longer effective.*

81. While the pRPN does not specifically address well interference, the recent Environment Court decision on the MWWUG application[21] provided suggested wording for inclusion in the MWWUG GCMP intended to provide clarity in the interpretation of well interference effects whereby abstractions must, individually and cumulatively, avoid:

> *Lowering of the groundwater levels of the Aupōuri aquifer such that existing bores operating as a permitted activity or in accordance with resource consent conditions cannot access groundwater of the quality and quantity authorised.*

82. However, this wording does not address the issue of partial penetration which is defined in the RWSP and which is a major consideration for assessment of well interference effects. As a result, it is my opinion that a combination of both the RWSP definition and the suggested Environment Court wording would be an appropriate benchmark to assess well interference effects to ensure '*efficient bore takes'* operating as *'a permitted activity or in accordance with resource consent conditions'* can *'access groundwater of the quality and quantity authorised'.*

83. Drawdown was assessed at the end of the 2010 irrigation season at a total of 410 bores recorded on the NRC groundwater database that lie within the AAGM domain. Calculated drawdown in the shellbed aquifer at each bore location is listed in Appendix A of the AEE[22] for both Scenario 2 and Scenario 3.

[21] ENV-2018-AKL-126

[22] It is noted that shallower bores screened in the sand aquifer will experience significantly less drawdown however the assessment does not differentiate between bores screened in the respective water-bearing layers.

84. Results indicate maximum cumulative drawdown under Scenario 2 (calibrated regional model) ranging from <0.1m to 14.4 metres. As shown on Figure 5 above, under this scenario drawdown exceeding 10 metres is limited to a cluster of 4 bores screened in the shellbed aquifer in the vicinity of the existing FNDC take (AUT.025683.01.03) located near the western end of Bird Road, Sweetwater, while calculated drawdown exceeding 2.5 metres are limited to bores across the wider Sweetwater area (where a significant volume of current and proposed abstraction is concentrated). The figure also indicates areas with calculated drawdown of up to 2.5 metres in the shellbed aquifer occur around concentrations of existing and proposed abstraction in the Sweetwaters, Pararore and Houhora sub-areas. Calculated drawdown in the shallow aquifer (i.e., that experienced by bores screened in the shallow sand aquifer) are less than 1 metre, except for a small area in the vicinity of proposed abstractions on Te Raite Station (APP.039859.01.01).

85. Under Scenario 3, maximum drawdown ranges from 0.5 to 19.4 metres, with a similar spatial distribution to that calculated under Scenario 2. Calculated drawdowns exceeding 5 metres are limited to the Sweetwater area, with drawdown of the order of 3 to 5 metres calculated in the vicinity of concentrations of existing and proposed abstraction in the Sweetwaters, Pararore, Houhora and Waihopo sub-zones. Due to the low hydraulic conductivity assumed under Scenario 3, modelled drawdowns in the shallow sand aquifer are negligible (i.e., all drawdown occurs in the shellbed).

86. A similar process is utilised in Section 3.2.3 of the AEE to assess the specific drawdown associated with the 24 proposed takes against the '*permitted baseline*' (i.e., existing consented groundwater abstraction). This assessment indicates the incremental effect of the proposed abstraction on cumulative drawdown is less than 0.1 m over much of the model domain, with drawdown >0.5 m limited to areas immediately surrounding the larger proposed abstractions. Under Scenario 3 the assessed effect increases appreciably, particularly in the vicinity of the proposed Te Aupouri Development Ltd takes (APP.039859.01.01) in the Houhora and Waihopo sub-areas.

87. The AEE notes that bores screened in the shellbed aquifer typically have between 60 to 100 metres of available drawdown (i.e., the depth of the water column between the static water level and the top of the screened interval), while the maximum cumulative drawdown for existing bores averages 1.30 under Scenario 2 and 3.38 m under Scenario 3 (i.e., <2% and 6% of the minimum available drawdown respectively). A maximum cumulative drawdown of 14.23 m under Scenario 2 and 19.53 m under Scenario 3 is modelled in the FNDC #2 production bore. This drawdown is calculated to represent between 20 to 27 percent of the available drawdown in this bore.

88. Based on the assessment provided, calculated drawdown in existing bores screened in the shellbed (<2.5 m under Scenario 2 and <5m under Scenario 3) equates to between 5 and 8 percent of the available drawdown (assuming a minimum of 60 m of available drawdown). A drawdown of this magnitude is unlikely to adversely affect the reliability of supply or yield from bores screened in the shellbed aquifer.

89. While many existing bores screened in the shallow sand aquifer have appreciably less drawdown available than those screened in the shellbed, the calculated drawdown in the shallow aquifer is also significantly less than that in the deeper aquifer. Assuming shallow bores have at least 10 metres of available drawdown[23], the interference effect of abstraction from the shellbed aquifer is again unlikely to be of sufficient magnitude to adversely affect yield or reliability of supply[24].

90. In order to ensure that potential well interference effects for the AAWUG consents are appropriately managed, is recommended Council consider the following:

- Developing specific conditions relating to the management of well interference effects for proposed abstractions in the vicinity of the existing FNDC abstraction at Sweetwater (AUT.025683.01.03);
- Establishing monitoring of groundwater levels in nominated bores (ideally un-pumped monitoring bores) in the vicinity of large-scale abstractions to validate predicted drawdown and ensure the magnitude of effects does not exceed those modelled in the AEE, as part of a GCMP developed for the AAWUG consents
- Establishing a process in the AAWUG GCMP to:
  - Provide for review groundwater level monitoring information (collected by NRC and for resource consent compliance purposes) to ensure the magnitude of drawdown observed is consistent with AAGM predictions, as part of a staged development process.
  - Respond to complaints regarding the magnitude of localised well interference effects in the vicinity of AAWUG takes.

4.3 Effects on Saltwater Intrusion

91. Along the coastal margin, fresh groundwater flowing from inland areas meets with saline water from the sea resulting in a natural transition from fresh to brackish to saline with increasing distance offshore. Under natural conditions, the hydraulic gradient from inland recharge results in seepage of fresh groundwater around, and offshore of, the coastal margin. In shallow unconfined aquifers fresh groundwater at the water table and sea water form a broad interface the follows the costal margin. However, at depth, the location and geometry of the interface between the fresh groundwater and the sea water is largely determined by the hydraulic gradients in the aquifer and the density difference between fresh and saline water (with groundwater typically becoming more brackish with depth).

[23] This figure is used as a conservative example as, in reality, shallow bores would likely require significantly greater available drawdown to satisfy the requirements for of *efficient bore takes* in the RWSP (i.e. be screened toward the base of the shallow aquifer). Data stored on the NRC groundwater database records 60 known bores (15%) are shallower than 20 m within the AAGM domain. It is unknown how many of these bores are utilised for water supply, although it is noted a significant number of these are utilised for monitoring of existing resource consents.

[24] It is noted that anecdotal reports indicate localised issues with reliability of supply in shallow bores during historical drought events. Groundwater level monitoring data available to NRC does not indicate historical reductions in shallow groundwater levels of sufficient magnitude to result in adverse effects on *efficient bore takes,* so it is possible that the issues reported relate to bore yield rather that low groundwater levels (i.e., inability of low yielding bores to maintain draw-off during extended periods of low rainfall, rather than bores physically going 'dry')

4.3.1 Lateral migration

92. Given the hydrogeological setting of the Aupouri Peninsula, the most plausible mechanism for seawater intrusion to occur is via lateral migration whereby depressurisation of the aquifer reduces the head of freshwater overlying the saltwater interface, effectively allowing it to migrate inland. Section 3.3.1 of the AEE provides an assessment of the potential for lateral migration of the saline interface in response to the proposed abstraction based on the using the Ghyben-Herzberg principal. The Ghyben-Herzberg principal is a simple relationship between the relative densities of fresh and sea water that can be used to estimate the likely depth of the saline interface at any point based on the known head of freshwater in an aquifer.

93. The assessment utilises the Ghyben-Herzberg relation to estimate the groundwater head required (referred to as the *'required head'*) to ensure the saline interface remains below the interpolated base of the shellbed aquifer at a large number of nominal points distributed around the eastern and western coastlines of the Aupouri Peninsula. The assessment then compares 90-day average groundwater levels from the Scenario 1 and Scenario 2 simulations, with the *required head* at each point to provide an assessment of the relative potential for saline intrusion around the coastal margin. This comparison is undertaken at two time periods (30 April 2010 and 20 May 1994) representing the period of maximum abstraction and minimum (historical) groundwater levels respectively. The assessment notes the 90-day average groundwater level is utilised to reflect seawater intrusion being:

> *…a gradual process requiring prolonged reduction in groundwater level below a critical level to initiate the landward migration of the saline interface*

94. Results of the assessment are detailed in Table 4 of the AEE. In summary these show:

- Under naturalised (i.e. non-pumped) conditions groundwater levels are at or below the required head along a significant section of the eastern coastline north of Kaimaumau township (with the exception of the area around Pukenui) and around the mouth of the Awanui River. Modelled heads are farthest below the required head around Houhora Heads and toward the southern end of East Beach. Cumulative (existing and proposed) groundwater abstraction only results in a minor reduction in groundwater levels (typically less than 0.1 m) in areas where naturalised groundwater levels are below the required head. A drawdown of this magnitude is unlikely to result in significant movement of the saline interface from its location under existing abstraction and is likely to be well within the natural range of water level variations.
- Groundwater levels remain above the required head in the Sweetwaters area (i.e., where the concentration of abstraction is highest and modelled drawdown greatest) except for a short section of coastline west of Lake Heather simulated under 1994 conditions. This location is the only point where groundwater abstraction is observed to reduce groundwater levels below required the required head (i.e., at all other points where residual head is negative, this is a natural occurrence). It is also noted that an existing groundwater level and EC compliance

monitoring site (Sweetwater Station MB4) is located along the coastal margin in this area and will have water level and salinity triggers established in the AAWUG GCMP[25].

- Modelled groundwater levels are below the required head along 90 Mile Beach toward the northern extent of the model domain but are essentially unaffected by abstraction.

95. A series of hydrographs outlined in WWLA (2020c) showing temporal variations in modelled groundwater levels at nominal locations across the model domain also provide useful context to evaluate temporal variations in groundwater levels around the coastal margin in response to temporal variations in abstraction and climatic conditions over the 1960 to 2018 simulation period.

96. With regard to application of the Ghyben-Herzberg relation, PDP (2011)[26] note the following:

> *Ghyben-Herzberg's equation is a simple and conservative guideline that does not represent a real groundwater system, because it assumes a direct permeable connection between a static body of fresh water and a static body of sea-water.*
>
> *The equation is perhaps best used to indicate a range of groundwater level pressures above which no sea water intrusion problems should exist. If groundwater pressures fall below the values that Ghyben-Herzberg indicate might be a problem, it should simply be used to indicate a set of circumstances where a greater intensity of monitoring should be undertaken.*

97. While it is noted that other methodologies (such as density dependant flow models) are available for assessment of seawater intrusion risk, due to the limited data available for calibration and verification, it is not certain their application would achieve a significant reduction in uncertainty regarding the magnitude and occurrence of seawater intrusion over that provided by the generalised Ghyben-Herzberg relation. Inevitably, the uncertainty associated with any modelling assessment based on currently available data would require validation by physical monitoring to ensure sustainable management of the groundwater resource. It is therefore recommended that the assessment of saline intrusion from the AAWUG assessment it utilised to guide the establishment of groundwater level and quality sentinel monitoring sites (with associated trigger levels), targeted to areas where the greatest potential for seawater intrusion is identified.

4.3.2 Up-coning

98. Aquifer salinity can also be adversely impacted by a process referred to as up-coning whereby saline or brackish water present near the base of an aquifer or in underlying sediments is drawdown upwards into the capture zone of a bore drawing freshwater from a shallower part of the aquifer.

[25] It is also noted that conditions on the FNDC Sweetwater consent (AUT.025683.01.03) require the establishment of an additional coastal monitoring site south of Waipapakauri (approximately 2 km north of the current Sweetwater Station MW4b monitoring bore prior) to exercise of this consent. Such a monitoring site would also be within (or close to) the area where maximum coastal drawdown is predicted.

[26] PDP, 2011; *New Zealand Guidelines for the Monitoring and Management of Sea Water Intrusion Risks on Groundwater*. Envirolink Project 420-NRLC50, June 2011.

99. The assessment of seawater intrusion outlined in the AEE does not provide specific consideration of the potential for up-coning of brackish water to occur in the context of the Aupouri Aquifer. Rather, the assessment concentrates on lateral migration as the primary mechanism for saline intrusion due to the low permeability of the basement rocks underlying the shellbed aquifer.

100. The hydraulic characteristics and the quality of groundwater hosted in basement rocks underlying the shellbed aquifer are not well characterised, although it is noted that fractured basalt in the Waihopo sub-area exhibit sufficient permeability to host a viable (fresh) groundwater resource. Consequently, it is difficult to reliably assess the potential for up-coning as a mechanism that could adversely affect groundwater quality in response to the proposed abstraction. However, due to the contrast in permeability with the shellbed aquifer it does not seem unreasonable to assume the volume of any brackish or connate water draw upwards from the geological basement will be small in comparison with the volume of water flowing laterally through the shellbed aquifer and therefore exert only a limited influence on overall water quality.

101. It is also noted that saltwater intrusion resulting from up-coning of water would typically be localised around individual abstraction points. It is recommended that a requirement for regular monitoring of electrical conductivity (EC) for all proposed production bores be included in the GCMP developed for the AAWUG consents[27]. This will enable identification of any localised variations in aquifer salinity resulting from up-coning of saline or brackish water that would otherwise not be identified in sentinel monitoring bores.

4.3.3 Summary

102. Overall, the seawater intrusion assessment outlined in the AEE provides a general indication of the relative potential for seawater intrusion to occur around the coastal margin of the Aupouri Peninsula under both natural conditions and in response to pumping. It is possibly best considered as a means to identify areas where there is an elevated 'risk' of seawater intrusion to occur and evaluate how the relative risk may change in response to the proposed abstraction to enable targeting of monitoring of groundwater levels and salinity indicators around the coastal margin, as well as in individual production bores. It is recommended that detailed requirements for monitoring of saline intrusion indicator parameters be developed in a Groundwater Contingency and Monitoring Plan for the AAWUG applications, similar in form to that applied to the recent MWWUG consents.

4.4 Effects on Land Subsidence

103. In sedimentary aquifers, aquifer compaction may occur as a result of dewatering and compression of fine-grained sediments (typically fine sands, silts and clays). As these fine-grained materials are dewatered, the resulting reduction in fluid pressure increases the effective stress associated with the weight of the overlying geological materials. This process can result in a rearrangement of grains within the geological media to balance the increased effective stress which can alter the hydrodynamics of the aquifer materials due to a reduction in porosity and/or permeability, and can also result in subsidence of the land surface as underlying sediments undergo compaction.

[27] Similar to requirements for monitoring of production bores outlined in Section 3.4 of the GCMP for the MWWUG consents.

104. Section 3.4 of the AEE provides an assessment of the potential magnitude of land subsidence resulting from the proposed abstraction using the Bouwer (1977) equation. The assessment calculates potential land settlement based on modelled drawdown and estimates of representative material properties for three separate layers (medium to fine sand, silty sand and shellbed) representing the hydrostratigraphic units identified on the conceptual hydrogeological model. Potential subsidence was calculated for both cumulative drawdown as well as drawdown specific to the proposed AAWUG abstractions.

105. Results of the assessment indicate cumulative settlement of up to 100 mm of settlement under Scenario 2 and 250 mm under Scenario 3 in the immediate vicinity of large-scale production bores on the Sweetwater Farms property. However, this settlement is associated with existing abstraction from these bores. Calculated subsidence in response to the proposed abstraction is less than 0.1 m at all proposed pumping locations. The assessment concludes subsidence of this magnitude is unlikely to result in adverse effects in a rural environment.

106. Overall, the assessment of subsidence appears reasonable. Maximum drawdown will occur in the shellbed aquifer which is matrix supported and therefore not prone to compaction due to a reduction in pore pressure (effective stress). Layers of finer-grained sediment in the overlying sand aquifer are more susceptible to subsidence but will experience significantly less depressurisation due to groundwater abstraction. The magnitude of subsidence associated with the proposed abstractions are relatively minor, even in the immediate vicinity of large-scale takes. It is also noted than any subsidence occurring at the land surface is likely to be sub-regional in nature and unlikely to result in differential subsidence which has greater potential to adversely impact on built structures.

5. Summary

107. The application by Aupouri Aquifer Water User Group (AAWUG) seeks authorisation for a total of 24 water permits for groundwater abstraction on the Aupouri Peninsula, up to a cumulative volume of 43,168 m^3/day and 4,606,260 m^3/year. The proposed abstraction will be sourced from a semi-confined aquifer system hosted in shellbed layers at the base of a sequence of unconsolidated sedimentary materials (primarily comprising fine-grained sands, interspersed with sporadic iron pan, peat, lignite, silt, gravel) which overlie low permeability basement rocks.

108. The modelling report and AEE prepared by WWLA provide a description of hydrogeological investigations and analysis undertaken to support the applications, as well as an assessment of potential effects on the environment. Based on this information, the AEE concludes that:

> *…cumulative impacts of the proposed groundwater abstraction on the Aupouri Aquifer are predicted to be no more than minor and do not pose significant risk in terms of surface water depletion, lowering groundwater levels at existing bores, potential saline intrusion, or land settlement.*

109. Overall, I consider the numerical model utilised for the assessment is appropriately constructed and calibrated, and that the predictive simulations outlined provide a reasonable means to characterise the potential magnitude and significance of effects resulting from the proposed abstraction. However, I also note that, due to the challenges associated with conceptualisation, parameterisation and calibration of a numerical groundwater model, there is a degree of uncertainty inherent in the simulation of the effects of groundwater abstraction in a complex geological, hydrogeological and hydrological environment such as the Aupouri Aquifer management unit. Although some of the limitations of the modelling approach utilised are acknowledged, such uncertainty is not well characterised in the assessment provided.

110. In order to address residual uncertainties in the assessment of effects on the environment resulting from the proposed AAWUG abstraction, it is recommended that Council develop a Groundwater Monitoring and Contingency Plan (GCMP) for the proposed abstraction. This document should adopt an overall management framework similar to, and if possible integrated with, the GCMP developed in for the MWWUG applications[28]. The GCMP should specify a monitoring and response framework that utilises an *'adaptive management*' approach to enable to proposed abstraction to occur in a staged manner, while ensuring effects are no greater than those predicted in the AEE and do not result in adverse effects on the environment.

111. It is also recommended that council develop specific conditions to ensure that the reliability of supply for existing resource users is not adversely affected by the proposed abstraction, particularly in the Sweetwater area where the magnitude of predicted cumulative well interference effects is greatest. Council should also ensure the proposed abstraction does not significantly reduce the reliability of supply for resource users currently subject to pumping controls established via existing water level and/or groundwater quality triggers.

Yours Sincerely

Brydon Hughes
Hydrogeologist

[28] Following modifications outlined in Environment Court decision ENV-2018-AKL-121

ATTACHMENT 5

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27 July 2020

AAWUG_Aupouri.doc

Water Permit Application - Aupōuri Aquifer Water User Group

1. Northland Regional Council (NRC) has received water permit applications from 24 parties collectively referred to as the Aupōuri Aquifer Water User Group (AAWUG). The applications seek authorisation to enable abstraction of groundwater for horticultural and pastoral irrigation at a combined maximum rate of 42,953 m³/day, up to a seasonal volume of 4,606,260 m³/year. The proposed takes are located across the Aupōuri Peninsula from Ngataki in the north, to the Sweetwater area west of Kaitāia, and are distributed across seven sub-aquifers of the Aupōuri Aquifer management unit defined in Policy H.4.4 of the Proposed Regional Plan for Northland (pRPN).

2. The applications are supported by an Assessment of Environmental Effects (AEE) prepared by Williamson Water and Land Advisory (WWLA). The assessment provided in the AEE is largely based on modelling of potential effects of the proposed abstraction undertaken using a numerical model developed by WWLA.

3. The following report provides a review of available groundwater monitoring and hydrogeological information to provide context for assessing potential cumulative effects of the proposed abstraction.

1. Groundwater allocation

4. To enable the sustainable management of groundwater resources, the Aupōuri Aquifer management unit is sub-divided into 10 separate sub-aquifers. Volumetric allocation limits are established for each individual sub-area in Policy H.4.4 of the pRPN.

5. The application by the AAWUG includes 24 separate water permits that are split between 48 individual production wells, distributed across seven sub-aquifers of the Aupōuri Aquifer management unit. The location of individual production bores specified in WWLA (2020a[1]) is illustrated on Figure 1 below, with proposed allocation in each sub-aquifer listed in Table 1. It is noted that two water permit applications (APP.039859.01.01 and APP.020995.01.04) include production bores distributed across two or more sub-aquifers. The cumulative rate and volume of abstraction sought under the AAWUG application is 42,953 m³/day and 4,606,260 m³/year.

[1] WWLA, 2020a; Aupōuri Aquifer Groundwater Model. Factual Technical Report - Modelling. Williamson Water and Land Advisory Report WWLA0184 | 4, 28 February 2020.

Figure 1. *Distribution of the proposed AAWUG takes (yellow dots) across sub-aquifers of the Aupōuri Aquifer management unit.*

Table 1. *Proposed AAWUG allocation in individual sub-aquifers of the Aupōuri Aquifer management unit*

Sub-aquifer	Application No	Name	Seasonal Volume (m^3)	Easting	Northing
Aupōuri-Waihopo	APP.017428.02.01	Henderson Bay Avocados	19,000	1605623	6154872
	APP.039859.01.01	Te Raite Station-Waihopo	60,000	1607102	6150752
	APP.039859.01.01	Te Raite Station - Waihopo	60,000	1605333	6151462
	APP.040600.01.01	Far North Avocados	32,000	1605981	6154581
	APP.040601.01.01	Waikopu Avocados	83,360	1603347	6153388
	APP.041211.01.01	P McGlaughlin	78,400	1606049	6150294
		Sub-Total	**332,760**		
Aupōuri-Houhora	APP.039644.01.01	Wedding & Doody	304,000	1610297	6145328
	APP.039859.01.01	Te Raite Station - Houhora	175,000	1608383	6148854
	APP.039859.01.01	Te Raite Station - Houhora	180,000	1609287	6148271
	APP.039859.01.01	Te Raite Station - Houhora	110,000	1607182	6148084
	APP.039859.01.01	Te Raite Station - Houhora	110,000	1607771	6147949
	APP.039859.01.01	Te Raite Station - Houhora	100,000	1609016	6147852
	APP.039859.01.01	Te Raite Station - Houhora	100,000	1609296	6147373
	APP.039859.01.01	Te Raite Station - Houhora	100,000	1609655	6147078
	APP.040121.01.01	J Evans	160,000	1609492	6148850
	APP.040231.01.01	P&G Enterprises	28,000	1609182	6148952
	APP.040397.01.01	A Matthews	12,000	1611038	6146087
	APP.040652.01.01	S&L Blucher	96,000	1610145	6148091
	APP.040919.01.01	Bryan Estate-1	80,000	1613415	6143424
	APP.040979.01.01	M Evans	126,000	1610554	6145121
	APP.040777.01.01	M Evans	36,400	1610554	6145121
		Sub-Total	**1,717,400**		
Aupōuri-Motutangi	APP.039628.01.02	KSL Ltd	3,600	1614333	6138477
	APP.040130.01.01	Tuscany Avocados	36,000	1614490	6138367
	APP.040918.01.01	Bryan Estate-2	160,000	1613901	6142132
	APP.008647.01.06	Avokaha Limited	4,800	1614554	6138575
		Sub-Total	**204,400**		
Aupōuri-Paparore	APP.040361.01.01	Tiri	290,625	1618056	6130290
	APP.040361.01.01	Tiri	290,625	1618856	6130196
	APP.040362.01.01	Valic-4	173,700	1617589	6129130
	APP.040363.01.01	Wataview	33,750	1619441	6131282
		Sub-Total	**788,700**		
Aupōuri-Sweetwater	APP.020995.01.04	Sweetwater-3	385,000	1617109	6120717
	APP.020995.01.04	Sweetwater-4	180,000	1616465	6120787
	APP.020995.01.04	Sweetwater-5	180,000	1617267	6121591
	APP.020995.01.04	Sweetwater-6	180,000	1616868	6120002
	APP.020995.01.04	Sweetwater-7	180,000	1617043	6118433
	APP.020995.01.04	Sweetwater-8	180,000	1616978	6116808

Sub-aquifer	Application No	Name	Seasonal Volume (m³)	Easting	Northing
	APP.020995.01.04	Sweetwater-9	180,000	1617279	6117495
	APP.020995.01.04	Sweetwater-10	105,000	1617702	6114717
	AUT.020995.01.03	Sweetwater-1	632,000	1617473	6119002
	AUT.020995.01.03	Sweetwater-2	436,000	1617846	6119771
	APP.040364.01.01	Elbury Holdings-Sweetwater-1	100,000	1618632	6121353
	APP.040364.01.01	Elbury Holdings-Sweetwater-2	100,000	1618554	6121002
		Sub-Total	**521,000**		
Aupōuri-Ahipara	APP.020995.01.04	Sweetwater-11	105,000	1617254	6113920
	APP.020995.01.04	Sweetwater-12	116,667	1616055	6112008
	APP.020995.01.04	Sweetwater-13	116,667	1616563	6111903
	APP.020995.01.04	Sweetwater-14	116,667	1616889	6111890
		Sub-Total[a]	**455,000**		
Aupōuri-Other	APP.039841.01.02	Yelavich	52,000	1616833	6133996
	APP.039859.01.01	Te Raite Station-Other	175,000	1603898	6151179
	APP.040386.01.01	Robert Campbell	360,000	1615813	6135787
		Sub-Total	**587,000**		
		Cumulative Total	**4,606,260**		

[a] The sub-total for the Aupōuri-Sweetwater sub-aquifer represents the net increase in allocation associated with replacement of existing water permit AUT.0202995.01.03 (wholly in the Ahipara-Sweetwater sub-area) with APP.020995.01.04 which seeks an increase in allocation of 776,000 m³/year but is split between the Aupōuri-Sweetwater and Aupōuri-Ahipara sub-areas.

6. Table 2 provides a summary of current and proposed cumulative allocation across various sub-aquifers of the Aupōuri Aquifer management unit. The figures show cumulative allocation including the proposed AAWUG abstraction is below the pRPN allocation limit in all sub-aquifers except Aupōuri-Sweetwater, where cumulative allocation totals 101.1 percent of the limit. Under Rule C.5.1.12 of the pRPN, abstraction of groundwater that is within an allocation limit is classified as a discretionary activity, while Rule C.5.1.14 specifies that the taking and use of water that would cause an allocation limit for an aquifer to be exceeded is classified as a non-complying activity.

Table 2. *Summary of current and proposed allocation in the various sub-areas of the Aupōuri Aquifer management unit associated with the proposed AAWUG abstractions.*

Sub-aquifer	pRPN Allocation Limit (m^3/year)	Current allocation (m^3/year)[a]	Proposed AAWUG allocation (m^3/year)	Cumulative allocation (m^3/year)	% pRNP allocation limit
Aupōuri-Waihopo	1,278,200	188,690	332,760	511,450	**40.0**
Aupōuri-Houhora	3,211,950	1,423,954	1,717,400	3,141,354	**97.8**
Aupōuri-Motutangi	1,604,400	958,842	204,400	1,163,242	**72.5**
Aupōuri-Paparore	3,787,500	1,211,252	788,700	1,999,952	**52.8**
Aupōuri-Sweetwater	4,675,000	4,206,982	521,000	4,727,982	**101.1**
Aupōuri-Ahipara	922,500	117,532	455,000	572,532	**62.1**
Aupōuri-Other	-	91,918	587,000	678,918	**-**

[a] Stuart Saville, Northland Regional Council, pers comm, 4 June 2020

7. When considering allocation from the Aupōuri Aquifer management unit, two additional considerations arise in addition to the geographic location of groundwater abstraction. Firstly, the boundaries of the various sub-aquifers of the Aupōuri Aquifer management unit represent arbitrary sub-divisions of a laterally continuous aquifer system. Consequently, abstraction of groundwater from a given sub-aquifer has the potential to affect the sustainability of abstraction from adjacent sub-aquifers. This is illustrated by the aquifer-scale drawdown calculated to result from existing groundwater abstraction (see Section 3 of the AEE). NRC have recently developed a methodology for calculating allocation that incorporates an allowance for such cross-boundary effects by apportioning the allocation associated with each individual abstraction point between adjacent sub-aquifers, based on a nominal radius of influence, scaled to reflect the volume of abstraction for each individual take.

8. Table 3 provides a summary of existing and proposed allocation calculated using the NRC methodology to account for cross boundary effects. The figures show allocation calculated using this methodology is less than 75% of the pRPN allocation limits across all sub-aquifers. Notable features of allocation calculated using the NRC cross-boundary methodology, compared that calculated solely based on geographic location (e.g., Table 2) include:

- A substantial increase in allocation in the Aupōuri-other sub-aquifer reflecting the location of several large takes along the central axis of the Aupōuri Peninsula, proximate to the Aupōuri-other sub-aquifer boundary (Figure 1)
- An increase in cumulative allocation from the Aupōuri-Waipārera and Aupōuri-Waipapakauri sub-aquifers despite no proposed allocation being physically located in these areas (i.e., reflecting potential cross-boundary effects).

9. It is also noted the figures in Table 3 show a decrease in allocation in the Aupōuri-Awanui sub-area associated with the AAWUG applications. This reflects the proposed relocation of existing allocation on Sweetwater Station under application (APP.020995.01.04) further from the Aupōuri-Awanui sub-aquifer boundary.

Table 3. *Summary of current and proposed allocation in the Aupōuri Aquifer management calculated using the NRC methodology to account for cross-boundary effects.*

Sub-area	pRPN Allocation Limit (m^3/year)	Current X-boundary allocation (m^3/year)[a]	Proposed AAWUG allocation (m^3/year)	Cumulative X-boundary allocation (m^3/year)	X-boundary % pRNP allocation limit
Aupōuri-Waihopo	1,278,200	181,526	322,760	479,891	**37.5**
Aupōuri-Houhora	3,211,950	1,404,763	1,717,400	1,642,964	**51.2**
Aupōuri-Motutangi	1,604,400	933,624	205,200	1,164,300	**72.6**
Aupōuri-Waipārera	3,468,300	2,415,746	0	2,597,284	**74.9**
Aupōuri-Paparore	3,787,500	967,865	788,700	1,569,816	**41.4**
Aupōuri-Sweetwater	4,675,000	2,902,060	521,000	3,429,108	**73.3**
Aupōuri-Waipakakauri	1,192,800	394,006	0	584,949	**49.0**
Aupōuri-Ahipara	922,500	108,457	455,000	370,670	**40.2**
Aupōuri-Awanui	4,675,000	1,393,888	0	1,276,118	**27.3**
Aupōuri-Other	-	803,602	587,000	1,469,313	**-**

10. In a coastal aquifer system such as the Aupōuri Aquifer, the potential for groundwater abstraction to result in seawater intrusion is a major consideration in determining the cumulative volume of groundwater abstraction that is sustainable (i.e., the maximum volume of groundwater that can be abstracted without resulting in adverse effects on the quality or quantity of the resource). For example, if abstraction is located close to the coast, limited volumes of water may be able to be abstracted without significantly increasing the potential for seawater intrusion to occur. Conversely, if a bulk of abstraction is located inland, it may be possible to abstract significantly greater volumes of groundwater without adversely affecting the overall sustainability of the resource. Volumetric allocation limits for coastal aquifers are generally established by simulating the effects of different volumes of abstraction on the potential for seawater intrusion to occur. Consequently, they are, at least in part, dependant on the geographic distribution of abstraction assumed in the pumping scenario utilised to establish the allocation limit.

11. This trade-off between the cumulative volume of abstraction which is 'sustainable' and the assumed location of abstraction is recognised in Policy H.4.4 1a) which, in addition to volumetric allocation limits, specifies that the effects of groundwater abstraction from the Aupōuri Aquifer management unit must maintain

> *….minimum groundwater levels along the coastal margin required to prevent adverse effects associated with saline intrusion.*

12. In my opinion, given the dependence of volumetric allocation limits on the assumed geographic distribution of abstraction utilised to derive them[2], this criterion is of greater importance in terms of ensuring the overall sustainability of abstraction from the Aupōuri Aquifer management unit than compliance with the volumetric allocation limits specified in the pRPN.

13. A methodology for ensuring practical compliance with minimum coastal heads will be outlined in a proposed Groundwater Contingency and Management Plan (GCMP) for the AAWUG applications.

2. Reasonable and Efficient Use of Water

14. A majority of the applications in the AAWUG seek authorisation to enable abstraction of groundwater to irrigate avocado orchards. The recent hearing decision on the Motutangi-Waiharara Water Users Group (MWWUG) application provides a useful benchmark for assessing reasonable and efficient water use for avocados on the Aupōuri Peninsula. With regard to maximum daily irrigation rates, the decision notes (paragraph 132):

> *....we have applied a maximum rate of 25 m³/ha/day to the Total Orchard Area. Whilst we agree that allocations should be based on canopy area (and have used that approach for the annual volumes discussed below), we recognise there are particularly hot days when extra water may be required and the Total Orchard Area, which can be up to 20% greater than the canopy area, provides an allowance for extremely high water demand days.*

15. While in respect to annual volumes the decision (paragraph 137) states that:

> *The fully developed orchard annual volume should not exceed 3,920 m³/canopy area in ha (equivalent to 392mm).*

16. Table 4 below provides a summary of maximum daily and seasonal application rates for individual applications based on Total Orchard Area (TAA) and canopy area listed in individual AEEs. The figures indicate a majority of applications are seeking rates and volumes of abstraction that are consistent with those utilised in the MWWUG decision. Two applications (APP.040231.01.01 and APP.008647.01.06) seek maximum daily application rates in excess of the MWWUG guideline value of 25 m³/ha/day based on TAA (31 and 28.75 m³/day/ha respectively). APP.008647.01.06 also seeks a seasonal application rate higher than the nominal 400 mm/year figure adopted by the remaining applications for avocado irrigation. This higher figure reflects the different methodology utilised to determine daily and seasonal volumes for this application (based on evapotranspiration and nominal crop co-efficient)[3].

[2] Which may, or may not, reflect the actual location of abstraction.

[3] Refer to Appendix B of the AEE for APP.008647.01.06.

17. The two largest applications (APP.0398059.01.01 and APP.020995.01.04) comprise a mix of pastoral and horticultural irrigation but do not specify the exact crop types and areas which will be determined as development occurs and which may change over time. However, over a total proposed irrigated area of 270 Ha, the daily volume of 10,735 m³/day sought under APP.0398059.01.01 equates to a maximum application rate of 39.8 m³/ha/day, and the seasonal volume of 1,170,000 m³ equates an a seasonal application depth of 433 mm/year. For APP.020995.01.04, the maximum daily abstraction rate equates to an application rate of 31.5 m³/day over the 832 Ha irrigated area and the cumulative seasonal volume of 3,093,000 m³ equates to a seasonal application depth of 372 mm. While these figures do not allow for differing water requirement between crop types, they are broadly consistent with rates and volumes sought for the remaining applications (taking into account the higher daily and seasonal application rates required for pasture compared to avocados[4]).

18. Overall, the rates and volumes sought under the respective applications are consistent generally consistent with established guidelines. It is however suggested that the seasonal volume for APP.008647.01.06 could be reduced in line with the 400 mm utilised by remaining applications for avocado irrigation.

[4] For example, the Irrigation New Zealand Irrigation *Irrigation Reasonable Use Database* indicates representative 90th percentile demand for pasture irrigation on Sweetwater Station (APP.020995.01.04) at 54 m³/ha/day and 630 mm/year, and on Te Raite Station (APP.0398059.01.01) at 58 m³/ha/day and 554 mm/year.

Table 4. *Maximum daily application rate and seasonal application rate for AAWUG applications based on Total Orchard Area (TAA) and canopy area*

Application Number	Applicant	Daily Volume (m^3/day)	Annual Volume (m^3/year)	Total Orchard Area (Ha)	Canopy Area (Ha)	Canopy % Total Orchard Area	Maximum Application Rate (m^3/ha/day)	Seasonal Application Rate (mm)
APP.040601.01.01	Waikopu Avocados Ltd[a]	1,000	128,000	40	32	80	25	400
APP.017428.02.01	Henderson Bay Avocados[a]	250	32,000	10	8	80	25	400
APP.040600.01.01	Far North Avocados Ltd	240	32,000	9.8	8	82	24.5	400
APP.041211.01.01	P McGlaughlin	700	78,400	28	19.6	70	25	400
APP.039859.01.01	Te Aupōuri Commercial Development Ltd	10,735	1,170,000	[b]	[b]			
APP.040121.01.01	NE Evans Trust & WJ Evans & J Evans	1,675	160,000	67	40	60	25	400
APP.040231.01.01	P&G Enterprises (PJ & GW Marchant)	350	28,000	11.3	7	62	31	400
APP.039644.01.01	MP Doody & DM Wedding	2,375	304,000	95	76	80	25	400
APP.040397.01.01	A Matthews	95	12,000	3.8	3	79	25	400
APP.040652.01.01	SE & LA Blucher	720	96,000	28.8	24	83	25	400
APP.040919.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valdares and D Bryan (Property 1)	500	80,000	25	20	80	20	400
APP.040558.01.01	MV Evans (Property 1)	1,125	126,000	45	31.5	70	25	400
APP.040979.01.01	MV Evans (Property 2)	350	36,400	14	9.1	65	25	400
APP.040130.01.01	Tuscany Valley Avocados Ltd	375	36,000	15	9	60	25	400
APP.040918.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valadares & D Bryan (Property 2)	1,000	160,000	50	40	80	20	400

Application Number	Applicant	Daily Volume (m^3/day)	Annual Volume (m^3/year)	Total Orchard Area (Ha)	Canopy Area (Ha)	Canopy % Total Orchard Area	Maximum Application Rate (m^3/ha/day)	Seasonal Application Rate (mm)
APP.008647.01.06	Avokaha Ltd[a]	230	32,000	8	6.5	81	28.75	480
APP.039628.01.02	KSL Ltd[a]	250	30,000	10	7.5	75	25	400
APP.040361.01.01	Tiri Avocados Ltd	3,876	581,250	155	145	94	25	401
APP.040362.01.01	Valic NZ Ltd	1,158	173,700	46	43	93	25.2	404
APP.040363.01.01	Green Charteris Family Trust	225	33,750	9	8.4	93	25	402
APP.039841.01.02	Mate Yelavitch & Co Ltd	450	52,000	18	13	72	25	400
APP.040386.01.01	Robert Paul Campbell Trust	3,350	360,000	134	90	67	25	400
APP.040364.01.01	Elbury Holdings Ltd	1,875	200,000	75	50	67	25	400
APP.020995.01.04	Te Rarawa Farming Ltd and Te Make Farms Ltd[a]	10,705	776,000	[b]	[b]			

[a] Maximum daily and seasonal application rates are calculated for the cumulative volume sought for those applications seeking variations to existing water permits.

[b] The proposed uses of water for APP.039859.01.01 and APP.020995.01.04 include a mix of horticultural and pasture irrigation. Given exact areas for horticultural irrigation are not specified in the respective applications it is difficult to specify exact application rates.

3. Qualitative validation of groundwater model simulation

3.1 Spatial variations in groundwater levels

19. Assessment of potential individual and cumulative effects of the proposed groundwater abstraction was undertaken using a numerical groundwater model developed by WWLA (referred to as the Aupōuri Aquifer Groundwater Model (AAGM)). This model was developed based on a conceptualisation of the hydrogeological setting of the Aupōuri Peninsula and calibrated to available groundwater level data.

20. As detailed in LWP (2020[5]), I consider the AAGM is appropriately constructed and applied to predictive simulations that provide a useful means of assessing potential effects of the proposed AAWUG abstraction at a regional scale. However, as noted, there is inevitably a degree of uncertainty associated with predictions made using such a regional-scale model. These uncertainties reflect a range of considerations inherent in the conceptualisation and parameterisation of a numerical model simulating a complex geological, hydrogeological and hydrological environment. Documentation of the model (WWLA, 2020a) does not attempt to characterise overall model uncertainty in a quantitative manner (although it does acknowledge potential uncertainties through the application of different model scenarios).

21. As outlined by SKM (2012)[6], verification of a numerical groundwater model involves comparison of model predictions with a set of measurements that were not used to calibrate the model. Calibration of the AAGM outlined in WWLA utilised all available data collected during the 1960 to mid-2018 simulation period. No verification of model predictions has been undertaken using groundwater levels data collected over the subsequent period.

22. To provide a simple qualitative evaluation of model predictive uncertainty, data utilised for impact analysis in Section 3.2 of the AEE (WWLA, 2020b), representing groundwater levels at the end of the 2010 irrigation season, was compared groundwater levels physically measured at the equivalent time (late April 2010), as well as those measured during the 2019-20 summer (i.e. outside the model calibration period). Model outputs used for this analysis were provided by the applicant, including raster coverages of:

- ‘Naturalised’ groundwater levels modelled under Scenario 2 and Scenario 3 at the end of the 2010 irrigation season (April 2010) in both the shellbed and shallow sand aquifers.
- Groundwater levels modelled under Scenario 2 and Scenario 3 at the end of the 2010 irrigation season (April 2010) assuming existing (‘permitted baseline’) abstraction in both the shellbed and shallow sand aquifers.
- Groundwater levels modelled under Scenario 2 and Scenario 3 at the end of the 2010 irrigation season (April 2010) assuming existing (‘permitted baseline’) abstraction and proposed (AAWUG) abstraction in both the shellbed and shallow sand aquifers.

5 LWP, 2020; Water Permit Application - Aupōuri Aquifer Water User Group. Letter to NRC, 20 June 2020.

6 SKM, 2012; Australian Groundwater Modelling Guidelines. Waterlines Report Series No. 82, June 2012.

23. Using this data, Table 5 provides a comparison between:

- Measured groundwater levels at the end of April 2010 and those at the equivalent time in 2020 (at monitoring sites operational over this period).
- Measured groundwater levels at the end of April 2010 and modelled 'naturalised' and 'permitted baseline' levels at the equivalent time.
- Measured groundwater levels at the end of April 2020 and modelled 'naturalised' and 'permitted baseline' levels (i.e., at the end of April 2010).

24. The data show measured groundwater levels in the shellbed aquifer were typically 0.5 to 1.5 m lower in late April 2020 across the southern portion of the model domain compared to April 2010, and 1.0 to 2.0 m higher in inland areas across northern portion of the model domain, compared to those that at the equivalent time in 2010. For reference, Figures 2 and 3 below illustrate temporal variation in groundwater levels over this period. Further discussion of temporal variations in aquifer storage (i.e., groundwater levels) is provided in Section 2.2 below.

25. Measured groundwater levels in 2010 were between 0.4 and 1.6 m below 'naturalised' levels in the shellbed aquifer simulated by the AAGM at the equivalent time, and between 1.8 metres lower and 4.4 m higher than simulated 'permitted baseline' levels[7]. In the shallow aquifer measured levels in 2010 were between 2 to 3 m lower than 'naturalised levels' across southern parts of the model domain and between 1.3 to 4.0 m higher than those modelled in inland areas across northern parts of the model domain. Levels under the 'permitted baseline' scenario were slightly closer to measured levels in southern areas and higher in northern areas than measured levels.

26. While 2020 is outside the model simulation period, comparison of departure from the 'naturalised' and 'permitted baseline' scenarios exhibit a variation consistent with the observed change in groundwater levels over the same period.

Table 5. *Comparison of measured and modelled groundwater levels*

Monitoring Site	Measured Groundwater Levels			April 2010 groundwater level		April 2020 groundwater level	
	April 2010	April 2020	Δ	Departure from Scenario 2 Naturalised	Departure from Scenario 2 Permitted baseline	Departure from Scenario 2 Naturalised	Departure from Scenario 2 Permitted baseline
Shellbed							
Sweetwater MW1b		-4.4[a]				-11.2	-4.1
Sweetwater MW2b		5.2				+1.6	+2.6
Sweetwater MW3b		5.4				+0.2	+0.4
Sweetwater MW4b		2.9				-0.5	+1.0

[7] The large (positive) departure in measured groundwater levels from the 'permitted baseline' scenario at the Lake Heather site reflects the simulated effect of the FNDC abstraction at Sweetwater which has not yet commenced operation.

Monitoring Site	Measured Groundwater Levels			April 2010 groundwater level		April 2020 groundwater level	
	April 2010	April 2020	Δ	Departure from Scenario 2 Naturalised	Departure from Scenario 2 Permitted baseline	Departure from Scenario 2 Naturalised	Departure from Scenario 2 Permitted baseline
Sweetwater MW5b		8.2				+0.7	+0.8
Lake Heather (105 m)	8.9	7.5	-1.4	-0.2	+4.4	-1.6	+3.0
Paparore Road (75 m)	6.3	6.8	-0.5	-1.6	-0.2	-1.1	-0.3
MWWUG Norton Road		4.1				-0.7	0
NRC Kaimaumau Rd		2.0				+0.7	+0.7
MWWUG Motutangi		6.5				-0.7	-0.4
Waterfront (76 m)	2.9	2.8	-0.1	-0.4	-0.1	-0.5	-0.2
Burnage Rd (97 m)	7.6	8.0	+0.4	-3.1	-1.8	-2.7	-1.4
Browne (59 m)	11.6	12.9	+1.3	-2.4	-0.7	-1.3	+0.6
Forest (79 m)	16.7	18.8	+2.1	-0.4	+0.1	+1.7	+2.2
Hukatere Rd (59 m)	13.6	14.7	+1.1	+1.9	+2.1	+3.0	+3.2
Unconfined Aquifer							
Sweetwater MW1a		9.7				-3.6	-1.2
Sweetwater MW2a		5.03				+1.4	+1.7
Sweetwater MW3a		7.17				+1.8	+1.8
Sweetwater MW4a		15.1				+11.9	+13.1
Sweetwater MW5a		15.0				+3.4	+3.4
Lake Heather 2	10.7	9.5	-1.2	-3.1	-1.5	-4.2	-2.9
Ogle Drive	15.4	14.2	-1.2	-3.2	-2.8	-4.4	-4.0
Paparore Rd (18 m)	6.6	5.8	-0.8	-2.1	-1.9	-2.9	-2.7
NRC Kaimaumau Rd		1.3				+0.9	+1.1
MWWUG Motutangi		6.3				+1.3	+1.4
Waterfront (21 m)	0.6	0.9	+0.3	-0.2	-0.2	+0.1	+0.1
Burnage Rd (17 m)	15.9	15.7	-0.2	+4.0	+4.5	+3.8	+4.3
Browne (16 m)	19.2	19.4	+0.2	+2.4	+3.2	+2.6	+3.4
Forest (16 m)	19.0	22.3	+3.3	+1.3	+1.8	+4.6	+5.1
Hukatere Rd (19 m)	15.0	16.5	+1.5	+3.0	+3.0	+4.5	+4.5

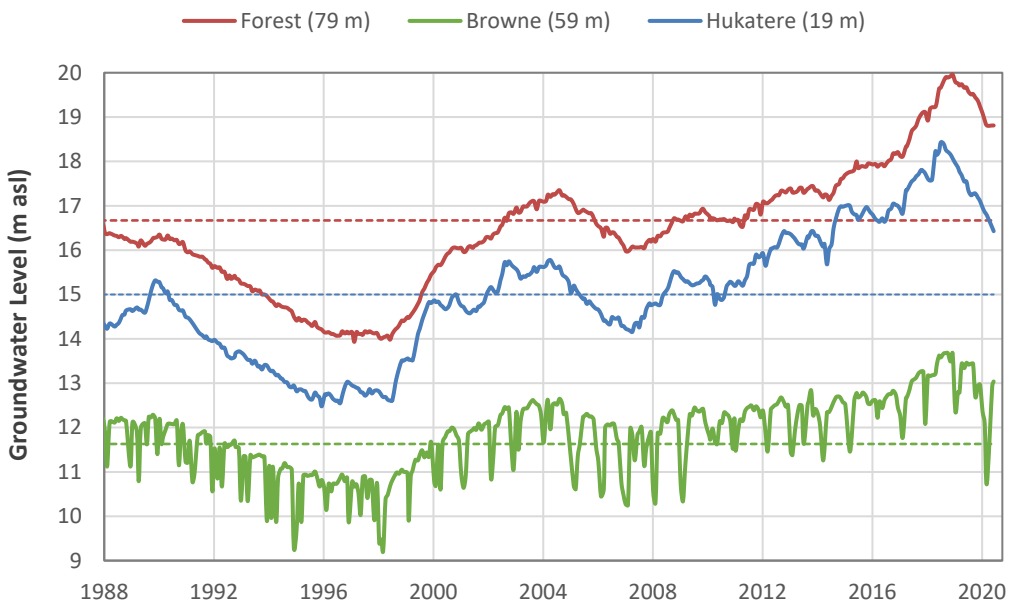

***Figure 2**. Groundwater levels recorded in the northern part of the AAGM domain, 1988-2020. Autumn 2010 level for each site denoted by dotted line.*

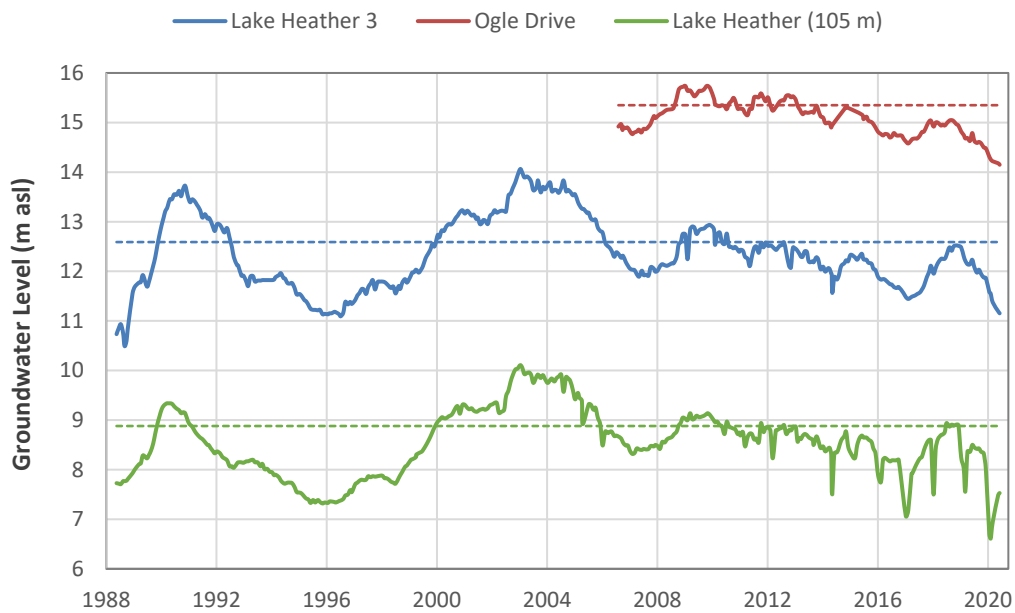

***Figure 3.** Groundwater levels recorded in the southern part of the AAGM domain, 1988-2020. Autumn 2010 level for each site denoted by dotted line.*

27. Overall, although complicated by localised (modelled and actual) pumping effects, observations from a comparison of modelled and measured groundwater levels indicate:

- The spatial distribution of modelled groundwater levels is generally consistent with observed groundwater levels.

- Modelled groundwater levels in the shellbed aquifer are generally within +/- 0.5 m of observed groundwater levels around the coastal margin, increasing to within +/- 2.5 m of observed groundwater levels in inland areas. Inland areas in the north of the model domain typically exhibit the largest departure between modelled and measured groundwater levels (possibly reflecting factors discussed in the following section).
- Variation between modelled and observed groundwater levels is slightly greater (+/- 3m) in the shallow aquifer. The model tends to over-predict levels in the southern portion of the model domain and under-predict levels to the north (possibly for the same reason as indicated under the previous bullet point).

28. These figures represent a basic qualitative assessment of model predictive uncertainty in the shellbed and shallow aquifers. The reduction in predictive uncertainty around the coastal margin likely reflects the natural range of groundwater levels being constrained by proximity to a constant head boundary (i.e., the sea), while the larger uncertainty in inland areas may, at least in part, reflect the effects of land use change that may not be captured in recharge modelling (as discussed in the following section).

3.2 Temporal variations in groundwater levels

29. While calibration statistics provided in WWLA (2020a[8]) suggest the AAGM provides a reasonable means to simulate absolute groundwater levels across the model domain, comparison of observed temporal variation in groundwater levels at inland monitoring sites with model predictions (particularly along the Hukatere transect) indicate the model simulation does not universally replicate natural variability over the whole simulation period. For example, Figure 4 shows the match between modelled and measured groundwater levels in shellbed aquifer at the NRC Lake Heather and Forest monitoring sites. The plots show that while the absolute magnitude (in mAMSL) of simulated groundwater levels are generally close to those measured, temporal variations in modelled levels (i.e., groundwater storage) are not always consistent with those observed throughout the whole simulation period.

[8] WWLA, 2020a; Aupōuri Aquifer Groundwater Model. Factual Technical Report - Modelling. Williamson Water and Land Advisory Report WWLA0184 | 4, 28 February 2020.

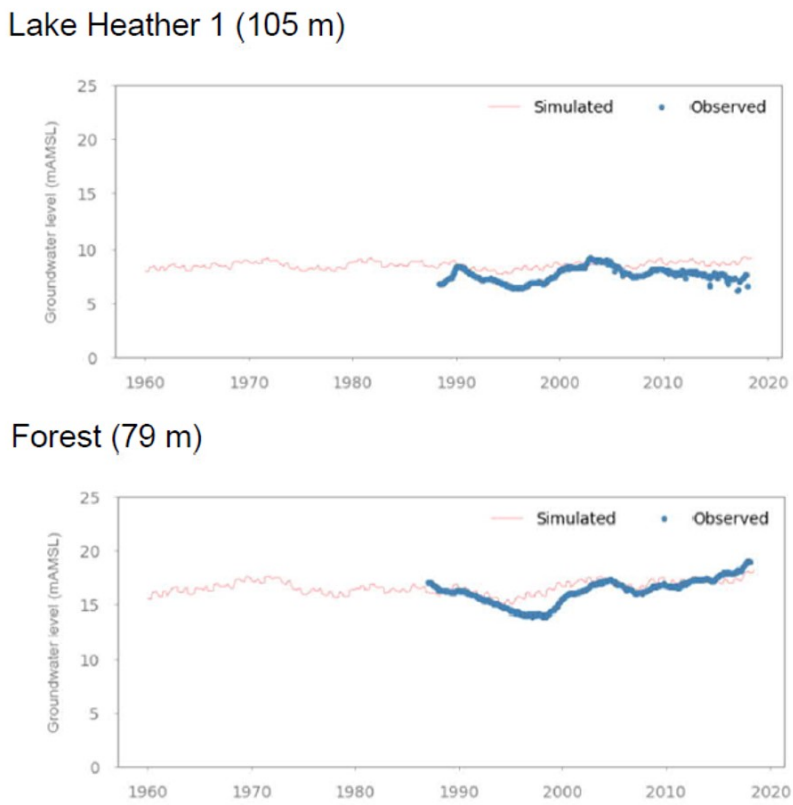

Figure 4. *Comparison of measured and modelled groundwater levels in the shellbed aquifer at the Lake Heather and Forest piezometers (from WWLA, 2020c[9]).*

30. This discrepancy between temporal variations in measured and modelled groundwater levels is noted in Section 4.4.1 of WWLA (2020a) which observes:

> *The groundwater model has been set up with recharge rates that were simulated based on a constant land use over the model period. However, land use changes and the associated spatial distributions of land cover will affect the quantity and quality of water being recharged to the groundwater system. In fact, the plantation forestry felling cycles on the western side of the peninsula may significantly affect the variation of groundwater recharge.*

31. And further notes that:

> *Reconstructing historical land use change would be a separate study in its own right and it was therefore not currently possible within the timeframe and budget of this project scope, to incorporate the transient variability of recharge into the and it was therefore not currently possible within the timeframe and budget of this project scope, to incorporate the transient variability of recharge into the groundwater model to reflect the land use change in the area.*

[9] WWLA, 2020c; Aupōuri Aquifer Groundwater Model Update Based on LIDAR Survey. Letter to NRC, 28 February 2020.

32. A review of available data indicates that groundwater levels in different areas of the Aupōuri Peninsula may be significantly influenced by changes in landcover over time. For example, Figures 5 and 6 below compare groundwater levels in the shellbed and shallow aquifers between northern and southern areas of the Aupōuri Peninsula. These data indicate temporal groundwater level variations were very similar in both the shellbed and shallow aquifer across the whole Aupōuri Peninsula from the late-1980s thorough to around 2010. However, from this time groundwater levels across northern and southern areas of the Aupōuri Peninsula exhibit divergent trends that are interpreted to reflect landcover changes associated with forest rotation (in particular the cutting of mature forest across a significant area in the north of the model domain).

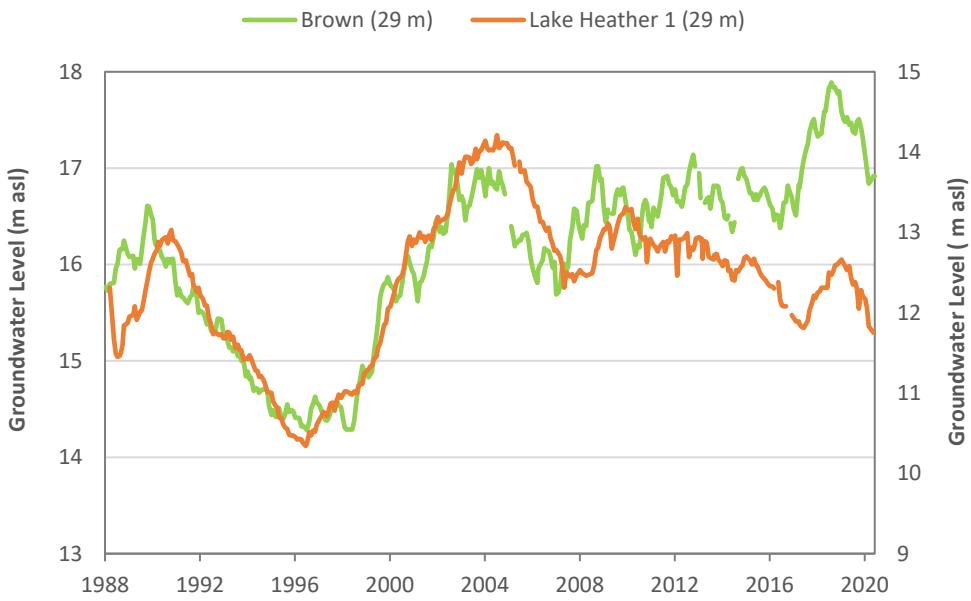

Figure 5. *Temporal variation in groundwater levels in northern (Browne) and southern (Lake Heather) areas of the Aupōuri Peninsula, 1988 to 2020.*

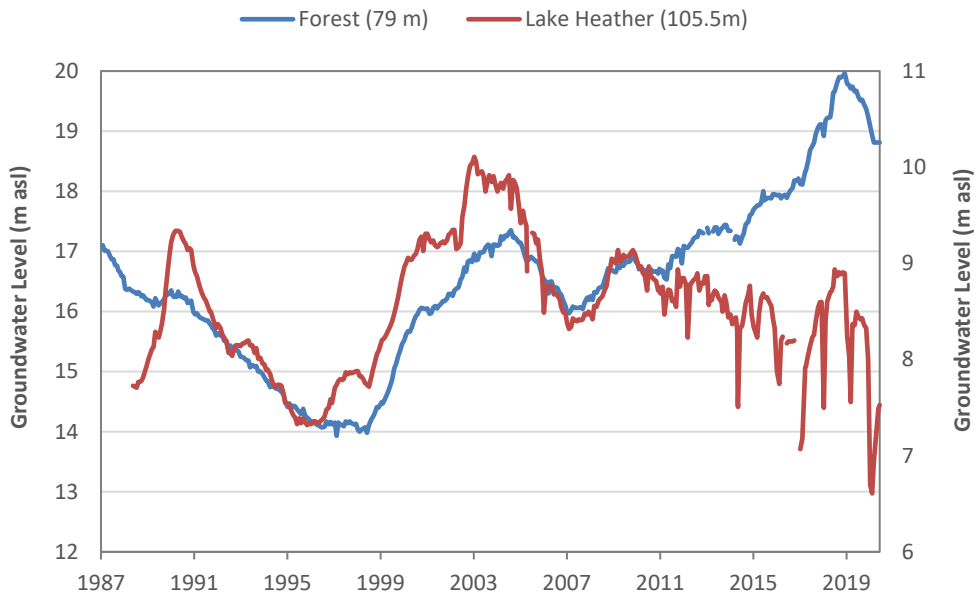

Figure 6. *Temporal variation in groundwater levels in northern (Forest) and southern (Lake Heather) areas of the Aupōuri Peninsula, 1987 to 2020.*

33. Given these observations, it is not unreasonable to infer that differences between measured and modelled groundwater levels post-2010 may reflect variations in recharge associated with land use change that is not accounted for in the recharge modelling undertaken for the AAGM.

34. However, it is noted that groundwater levels recorded in a majority of NRC piezometers with long monitoring records appear to be well correlated with temporal variations in rainfall prior to 2010. For example, as shown on Figures 7 and 8 below, groundwater levels in both the shallow sand and shellbed aquifers in the NRC Lake Heather 2 and Hukatere piezometers respectively appear to track temporal variations in rainfall (prior to ~2010 at the Hukatere site and for the entire monitoring record at Lake Heather)[10].

35. Although rainfall departure is only a simple proxy for groundwater recharge, these observations suggest rainfall (rather than changes in landcover) was the major driver of temporal variability in groundwater levels during the 1990s and 2000s. The noticeable departure between modelled and measured groundwater levels over this period (as shown on Figure 4 above), particularly during an extended period of below normal rainfall during the 1990s, may therefore reflect several factors including:

- Differences between actual and modelled recharge reflecting the performance of the recharge model.

[10] Other monitoring sites exhibit similar correlations between rainfall departure and groundwater levels, particular in inland northern area of the model domain.

- Differences between actual and modelled pumping during this period (although this is unlikely to influence groundwater levels in inland piezometers along the Hukatere transect where drawdown is minimal).
- Differences between actual and assumed aquifer storage that magnify or dampen temporal variations in groundwater levels in response to changes in recharge.

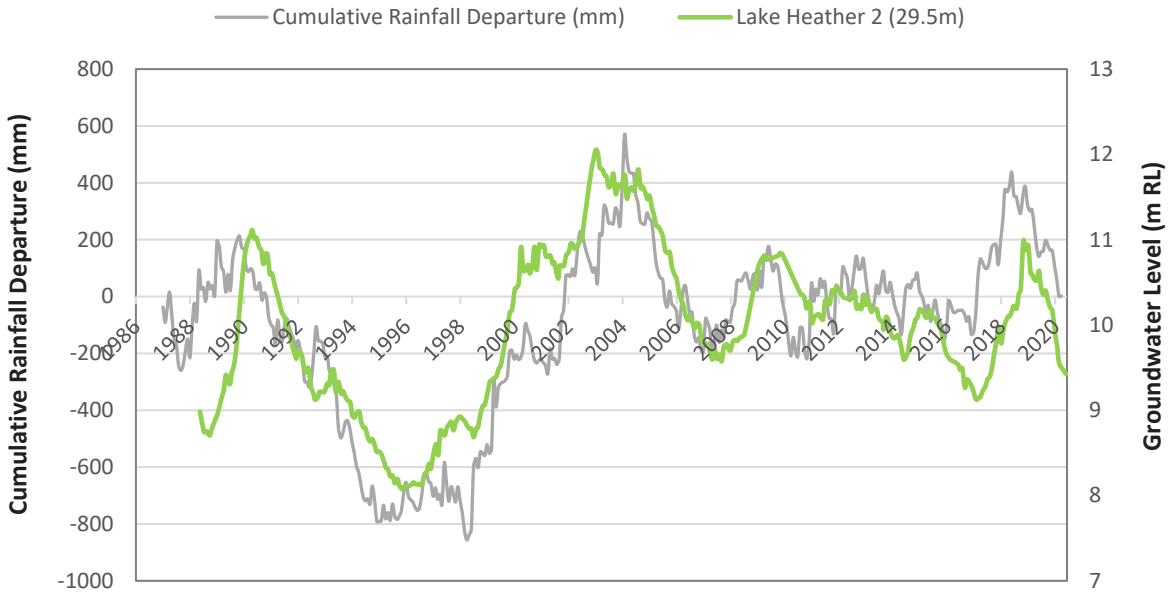

Figure 7. *Cumulative rainfall departure (mm) at Waiharara and groundwater levels in the shallow aquifer at the NRC Lake Heather 2 monitoring site, 1987 to 2020.*

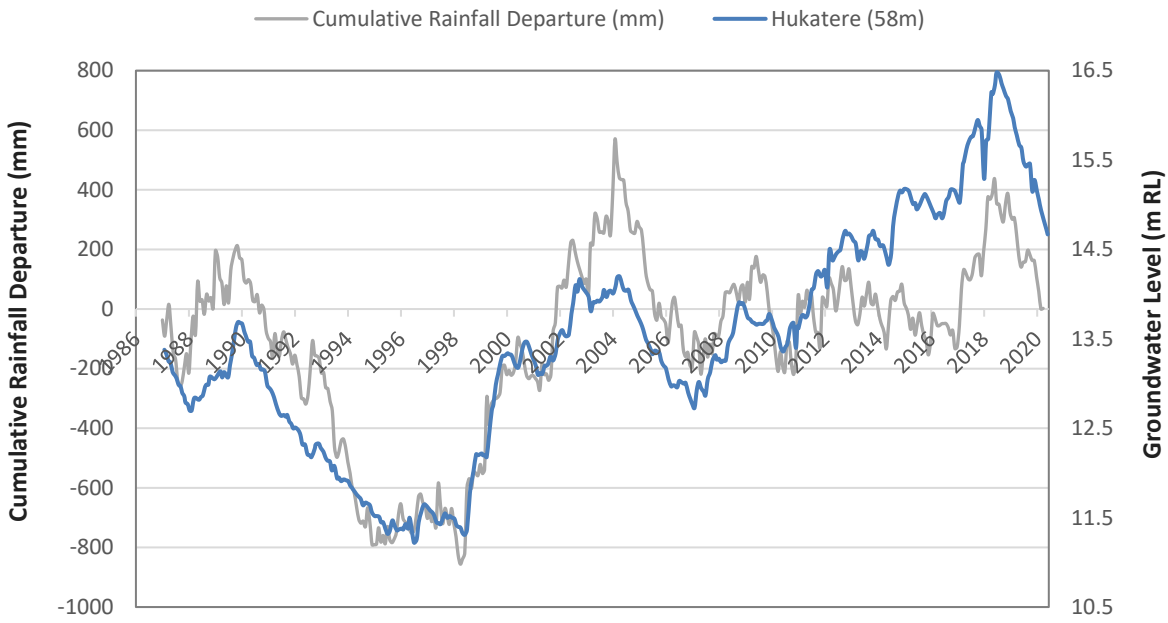

Figure 8. *Cumulative rainfall departure (mm) at Waiharara and groundwater level in the shellbed aquifer at the NRC Aupōuri at Hukatere monitoring site, 1987 to 2020.*

36. Overall, observed differences between modelled and measured groundwater levels since 2010 appear to primarily reflect changes in landcover associated with forest rotation (particularly in inland parts of the model domain). However, prior to 2010 groundwater levels across the entire model domain appear to be primarily influenced by temporal variations in rainfall. During this period, temporal variations in aquifer storage are not universally well replicated in model simulations at all monitoring sites.

3.3 Modelled response to groundwater abstraction

37. The following section provides a comparison of modelled drawdown in response to groundwater abstraction against observed groundwater level variations in response to pumping at NRC and resource consent compliance monitoring sites in the Aupōuri Aquifer management zone. This comparison is based on the 'permitted baseline' drawdown (i.e. that resulting from current allocation) calculated under Scenario 2 and Scenario 3 (low permeability). It should be noted that the modelled 'permitted baseline' drawdown is based on an assumption that the full volume of existing permits is utilised, whereas, in reality, many water permits are not fully utilised and several water permits included in the 'permitted baseline' assessment are yet to be exercised. However, taking into account these variations, the comparison provides a useful measure to validate the overall magnitude of drawdown predicted by the AAGM.

38. Figures 7, 8 and 9 below show examples of pumping induced drawdown recorded in groundwater level compliance monitoring data for the Valic (AUT.017045.01.02) and Sweetwater Farms (AUT.020995.01.03) water permits, and in the NRC Browne piezometer (located 3 km south-west of Pukenui). The data illustrated show pumping induced drawdown in the shellbed aquifer ranging from around 2 m in the Browne piezometer up to 15 m at the Valic-3 site.

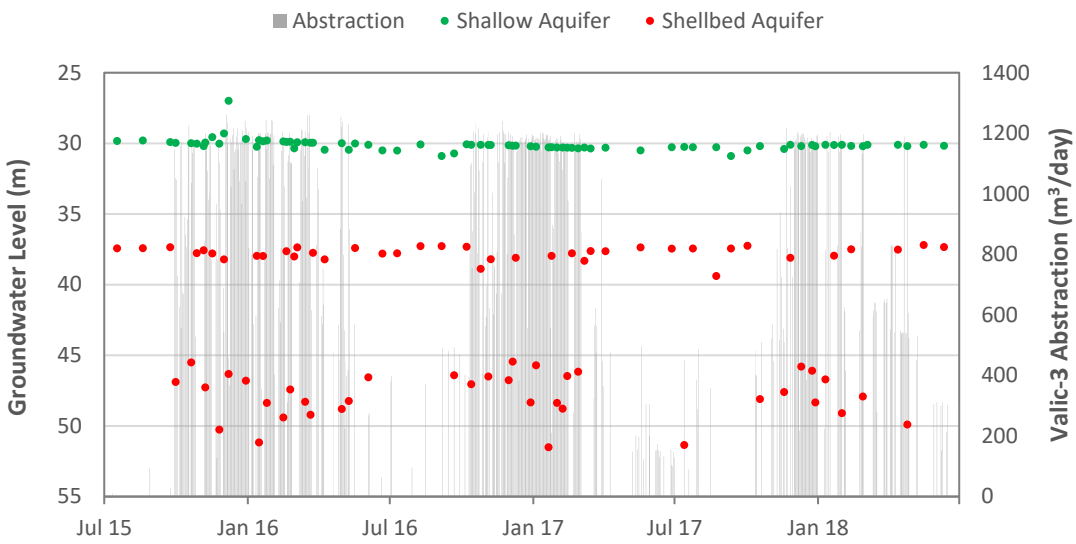

Figure 9. *Valic-3 (AUT.017045.01.02) groundwater level compliance monitoring data, July 2015 to July 2018. Grey shading indicates groundwater abstraction.*

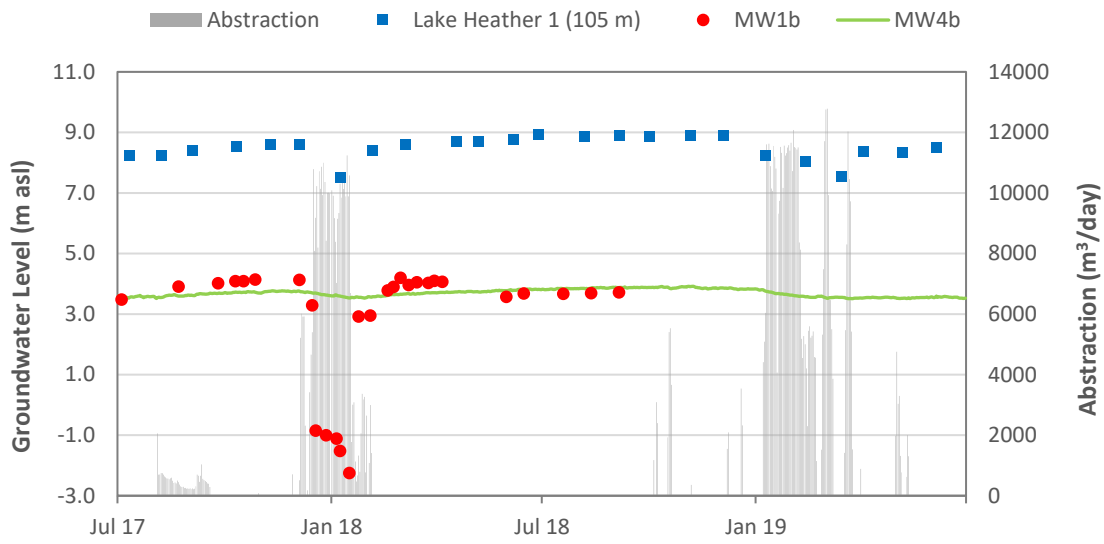

Figure 10. *Sweetwater Farms (AUT.020995.01.03) groundwater level compliance monitoring data, July 2015 to July 2018. Grey shading indicates groundwater abstraction.*

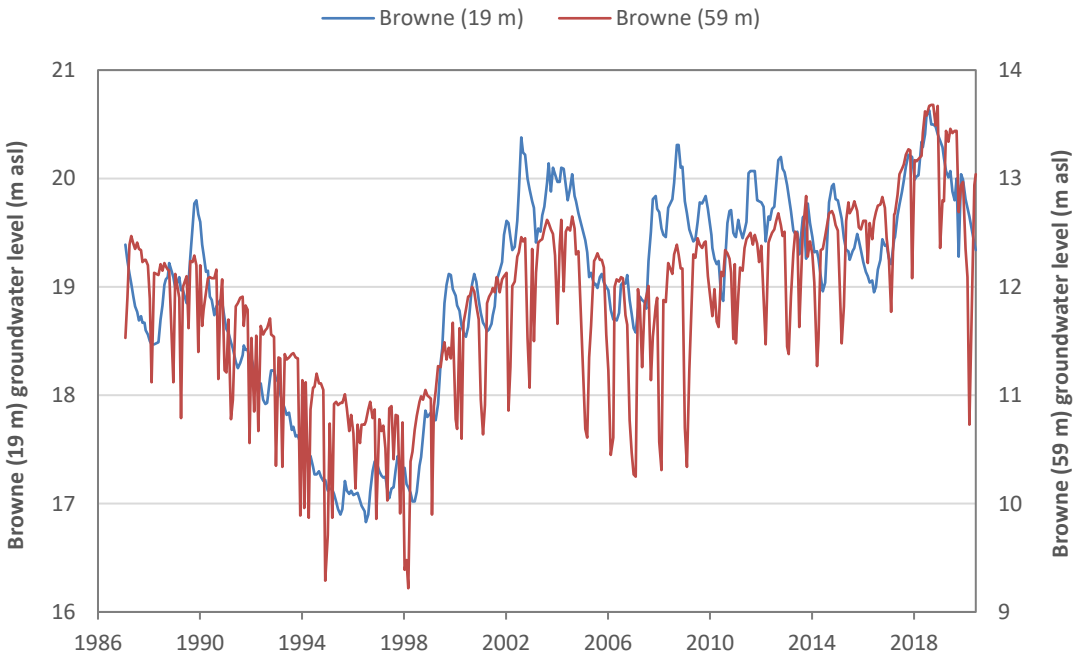

Figure 11. *Groundwater levels recorded in the NRC Browne piezometer, 1986 to 2020.*

39. Table 5 provides a comparison of observed pumping-induced drawdown against that calculated for 'permitted baseline' abstraction under Scenario 2 and Scenario 3. For a majority of sites observed drawdown is of a similar magnitude to that calculated under Scenario 2 and is likely to exceed modelled drawdown when current water use (compared to consented volumes) it taken into account. However, at some sites in the Pararore sub-area, observed drawdown exceeds that predicted under Scenario 3 (low permeability).

Table 6. *Comparison of observed pumping-induced drawdown with drawdown modelled under 'permitted baseline' scenarios.*

Monitoring site	Observed drawdown (m)	Drawdown Scenario 2 (m)	Drawdown Scenario 3 (m)	Comment
Sweetwater MW1b	6.4	9.2	14.0	Historical abstraction in the surrounding area is <50% of current allocation.
NRC Lake Heather	1.2	4.0	8.4	Historical abstraction in the surrounding area is <50% of current allocation.
Sweetwater MW4b	0.3	1.3	5.9	Observed drawdown is approximately 25% of that observed at Lake Heather which is a similar distance from current production wells, suggesting anisotropic drawdown response.
NRC Paparore Rd	3.3	0.9	2.5	Observed drawdown exceeds modelled response.
NRC Browne	2.0	2.1	3.8	
NRC Burnage Rd	1.5	1.2	2.6	
Valic - 1	6.0	1.7	3.2	Monitoring bore is close (~10 m) to production bore. Observed drawdown significantly exceeds modelled drawdown at lower abstraction rate.
Valic-2	13.9	1.5	2.9	Monitoring bore is close (~10 m) to production bore. Observed drawdown significantly exceeds modelled drawdown at lower abstraction rate.
Valic-3	8.2	1.7	3.1	Monitoring bore is close (~10 m) to production bore. Observed drawdown significantly exceeds modelled drawdown at lower abstraction rate.

40. In summary, comparison of observed pumping-induced drawdown with that calculated under AAGM 'permitted baseline' scenarios indicate that:

- Measured drawdowns are generally larger than those predicted under Scenario 2 (particularly when current levels of abstraction vs allocated volumes are taken into account).
- Observed drawdown at some sites in the Paparore sub-area is greater than that calculated under Scenario 3 (low leakage). This may indicate that aquifer storage values in some areas of the model are poorly constrained.
- Some compliance monitoring sites suggest drawdown in the shellbed aquifer may be anisotropic. For example, the NRC Lake Heather monitoring site exhibits a pumping induced drawdown of 1.2 m in response to current abstraction on Sweetwater Farms, approximately 4 times larger than that observed in the Sweetwater Farms MW4b piezometer which is located a similar distance from existing production bores (but to the west rather than north).

- At all monitoring sites no discernible drawdown due to pumping is observed in the shallow aquifer, even in close proximity to takes resulting in significant drawdown in the shallow aquifer. This indicates that drawdown in the shallow aquifer may be lower than that predicted under Scenario 2.

41. These observations are consistent with observations in Section 3 of the AEE which notes:

> *The sensitivity analysis [Scenario 3] was undertaken because the calibrated groundwater model [Scenario 2] errs on the side of over simulation of vertical leakage. This was deliberately built into the model in the absence of a single well-defined low permeability horizon in the field, but rather a series of multi-layered and discontinuous iron pans and other low permeability horizons within the sedimentary sequence that in combination act as a flow barrier between the deeper groundwater system and the surface drains and wetlands. As a result, the model exaggerates the effects of the proposed abstraction on the groundwater levels in the shallow aquifer and at the surface. Conversely, the model may slightly under-predict the local-scale drawdown in the deeper aquifer.*

42. It may therefore be reasonable to observe that drawdown in the shellbed aquifer under Scenario 2 (e.g., AEE Figures 4 and 6) may, at least on a localised basis, under-estimate the magnitude of actual drawdown likely to occur in response to both cumulative and proposed abstraction (hence the value of Scenario 3 for assessing an 'upper bound' for localised drawdown).

43. It is noted that Scenario 2 also forms the basis for the assessment of saline intrusion in Section 3 of the AEE. Combined with the conservative nature of the Ghyben-Herzberg relation, I consider that the assessment is possibly best utilised as a guide to identify the relative potential for seawater intrusion to occur across different areas of the model domain (to assist targeting of physical monitoring), rather than as an absolute indicator of seawater intrusion potential.

4. Groundwater Interaction with Surface Waterbodies

4.1 Kaimaumau Wetland

44. Potential effects of groundwater abstraction on Kaimaumau Wetland were a significant focus for the MWWUG hearing and subsequent appeals process. In order to validate predicted effects and better characterise the degree and nature of hydraulic connection between the Aupōuri Aquifer system and the Kaimaumau Wetland, groundwater and wetland water level monitoring sites were established at the locations shown in Figure 12 below, as part of the Groundwater Monitoring and Contingency Plan (GCMP) for the MWWUG consents. The monitoring comprises a shallow and deep piezometer (screened in the shallow sand and shellbed aquifer respectively) located along the western margin of the wetland and two water level monitoring sites established in open areas of standing water within the wetland itself.

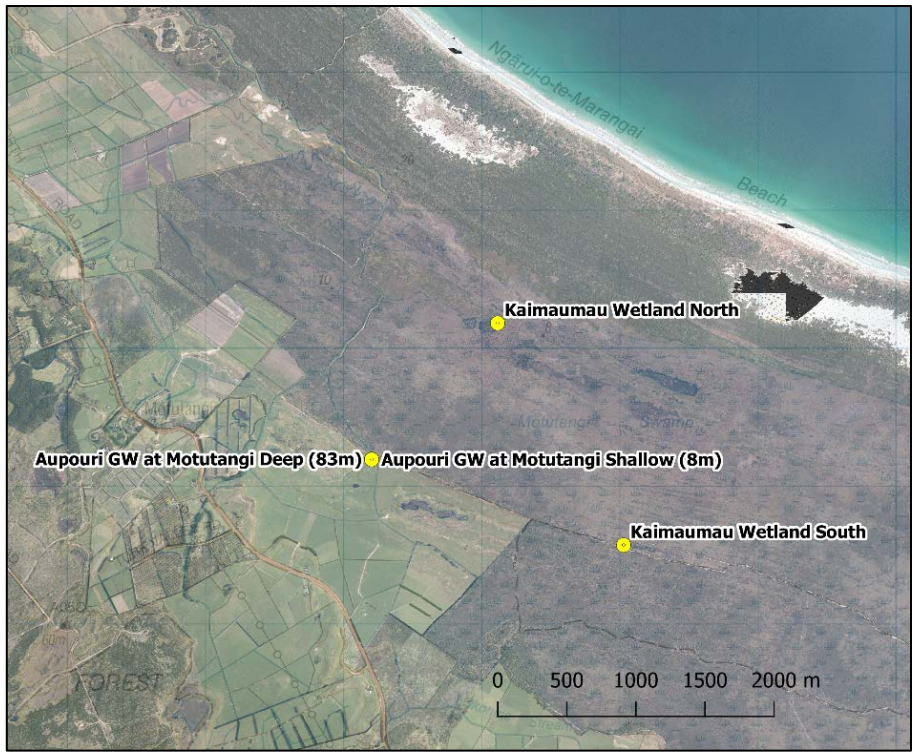

Figure 12. *Groundwater and wetland water level monitoring sites established in the Kaimaumau Wetland for the MWWUG GCMP.*

45. Water level monitoring was established at the MWWUG sites in mid-2019 so there is approximately 11 months of monitoring data available (at the time of writing) to characterise water level response over the 2019-20 year (which included an extended period of low rainfall between late December 2019 and mid-April 2020).

46. Figure 13 shows a plot of groundwater levels recorded in the Motutangi piezometers over the 2019-20 year. The data show groundwater levels in the shellbed and shallow aquifers followed a near identical seasonal trend from June through to mid-March, after which time the recession in the shallow aquifer continued before levelling out during May, whereas the shellbed aquifer exhibited a recovery of approximately 0.2 metres[11]. The observed water level recovery in the shellbed aquifer during autumn 2020 reversed the hydraulic gradient which had remained slightly downward over the preceding months.

[11] A similar water level response was also observed in the shellbed aquifer at other MWWUG monitoring sites.

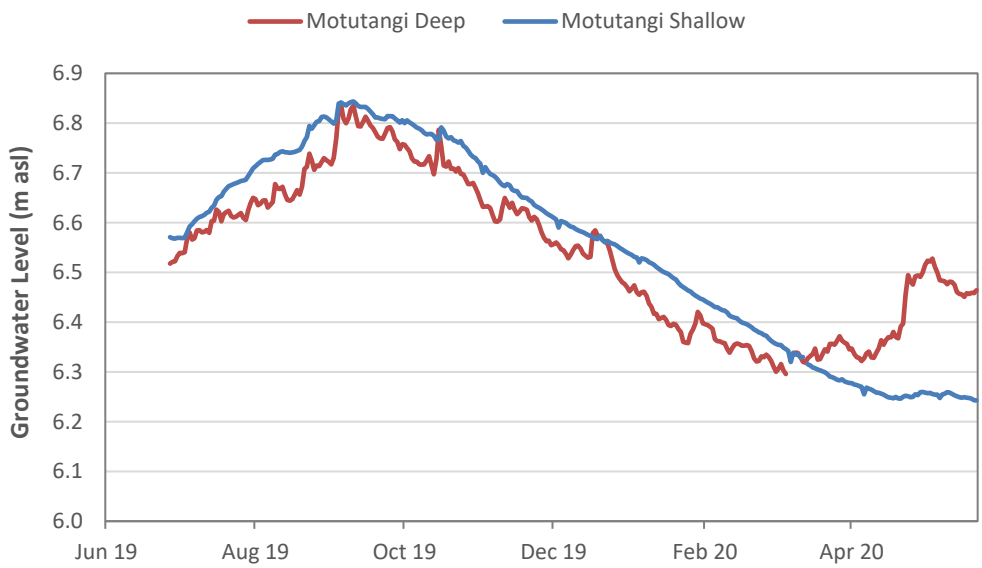

Figure 13. *Groundwater levels in the Motutangi shallow and deep piezometers, June 2019 to May 2020*

47. Figure 14 shows hydrographs from the two wetland sites over the 2019-20 year. While the data indicate an almost identical temporal response to rainfall events, relative water levels are offset vertically by approximately 2.8 metres between the two sites (indicating significant spatial variability in standing water levels within the wetland itself). The data indicate the loss of standing water at the higher elevation southern site in early February 2020, with standing water lost at the northern site in mid-March.

48. It is noted that the response of standing water levels in the wetland to individual rainfall events is relatively muted. For example, 95 mm of rainfall recorded at Waiharara from the 2nd to 4th May 2019 resulted in an increase in water levels of approximately 9mm at the southern monitoring site and 8mm at the northern monitoring site. During the period of low rainfall from late December 2019 to mid-April 2020 both wetland sites exhibited a near-identical linear recession of approximately 5.8 mm/day (prior to loss of standing water).

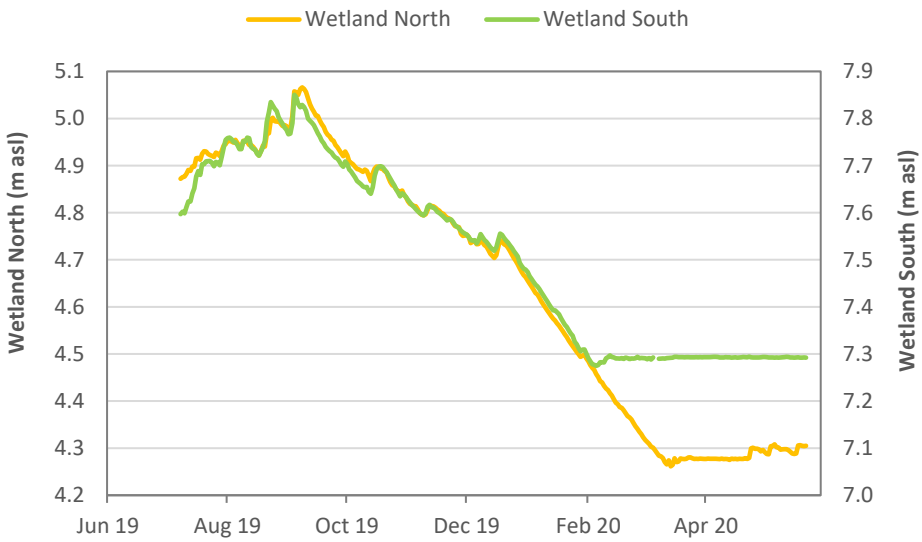

Figure 14. *Water levels at MWWUG monitoring sites in the Kaimaumau Wetland, June 2019 to May 2020*

49. Figure 15 shows a plot of water levels recorded in the Motutangi shallow piezometer and at the Wetland North monitoring site. The data indicate that:

- Shallow groundwater levels along the western margin of the wetland are approximately 1.8 m higher than those recorded at the northern MWWUG wetland monitoring site (and approximately 1 metre lower than observed at the southern monitoring site).
- The timing of the seasonal peak in shallow groundwater and wetland water levels coincides.
- The overall magnitude of water level variation in the wetland over the 2019-20 summer exceeds that observed in shallow groundwater (by approximately 0.2 metres at the time standing water was lost).
- Wetland water levels respond to larger rainfall events while shallow groundwater levels exhibit little, if any, immediate response to rainfall.
- The rate of water level recession in the wetland differs from that observed in shallow groundwater, particularly during the low rainfall period from mid-December 2019 when wetland water levels declined at an appreciably higher rate than groundwater levels.

50. Figure 16 shows a similar comparison between the Motutangi deep piezometer and the Wetland South monitoring site. In this case, while the magnitude and overall timing of seasonal water level variations are similar, wetland levels at the southern monitoring site are approximately 1.0 metres higher than those in the shellbed aquifer and show no indication of a response to the recovery in deep groundwater levels from mid-April 2020.

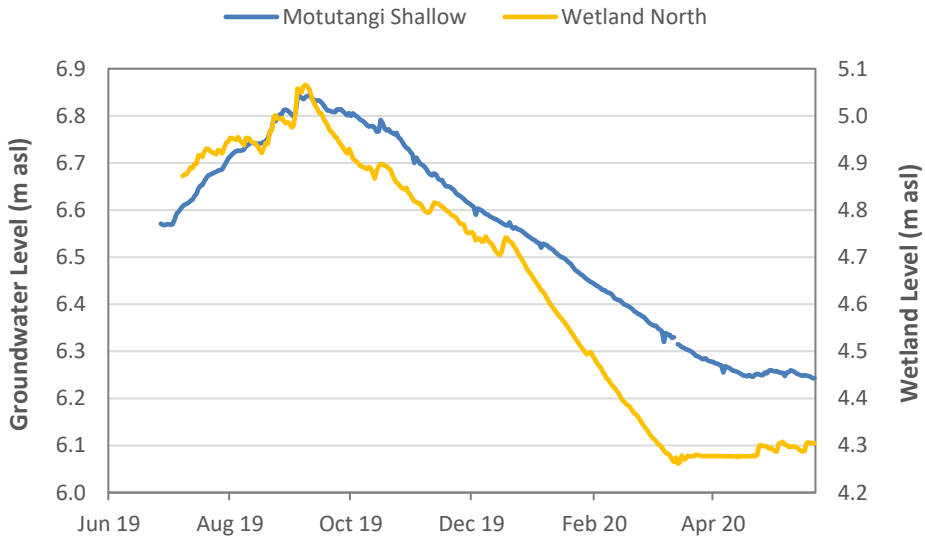

Figure 15. *Water levels in the MWWUG Motutangi shallow piezometer and at the Kaimaumau Wetland North monitoring site, June 2019 to May 2020.*

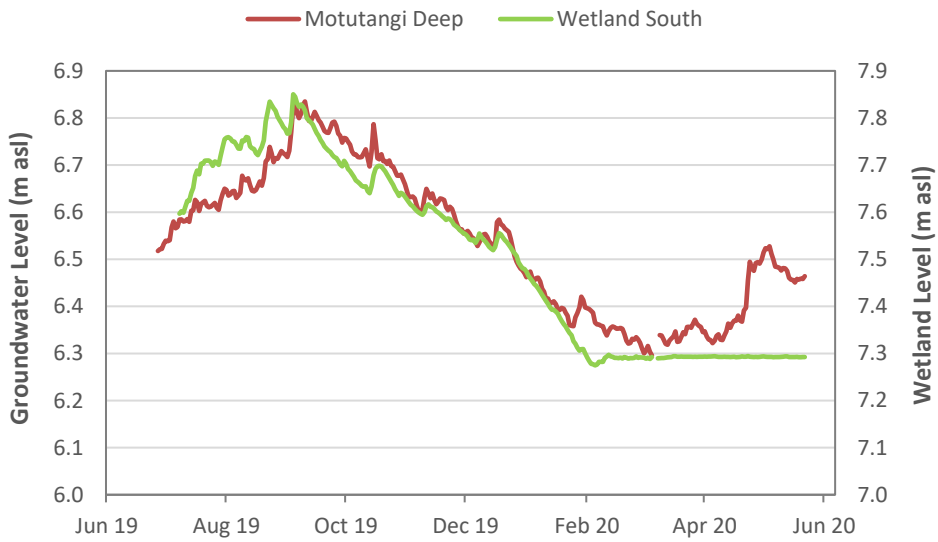

Figure 16. *Water levels in the MWWUG Motutangi deep piezometer and at the Kaimaumau Wetland South monitoring site, June 2019 to May 2020.*

51. The Department of Conservation (DOC) also maintains 10 water level monitoring sites in the Kaimaumau Wetland which have been operating since mid-2017. Figure 17 shows the location of the DOC monitoring sites with respect to the MWWUG monitoring locations. The figure shows that a majority of the DOC sites are located adjacent to the Selwyn Drain which flows through the western side of the Kaimaumau Wetland, with one site (KM9) located in the Baccia Drain close to the MWWUG Motutangi sentinel bore. Of DOC sites adjacent to Selwyn Drain, four measure drain stage heights (KM1, KM2, KM5 and KM8) while the remaining five (KM3, KM4, KM6, KM7 and KM11) record standing water levels in the wetland in relatively close proximity to the drain. The MWWUG Wetland North site is located 900 to 1,000 m east of the DOC Selwyn Drain sites, while the MWWUG Wetland South site is located approximately 2 kilometres east of the DOC Baccia Drain site (KM9) and 2.5 to 3 km south-east of the remaining DOC sites.

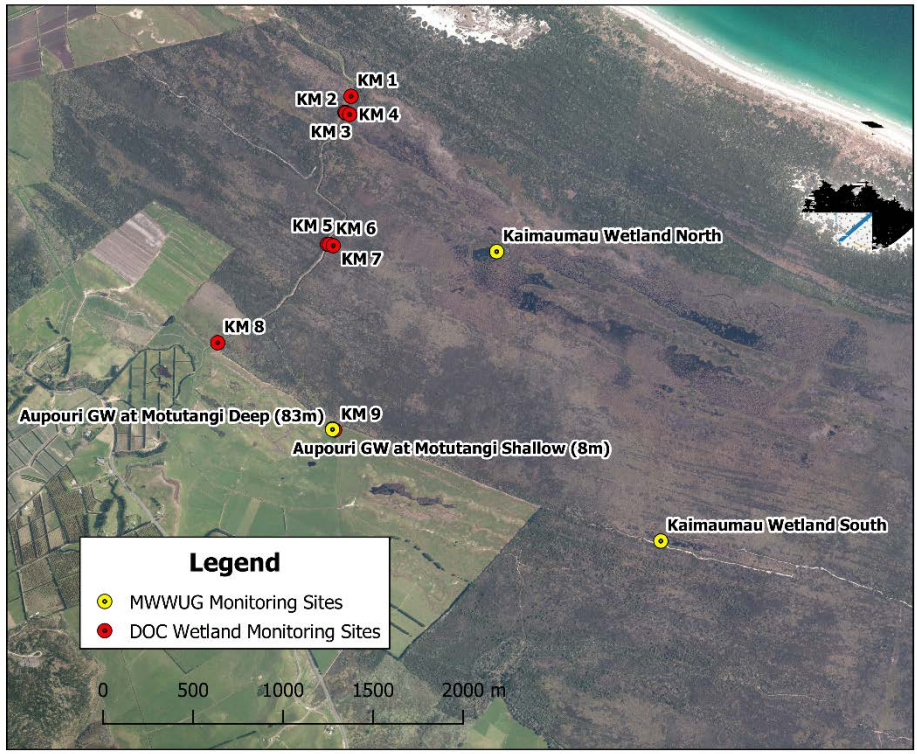

Figure 17. *MWWUG and DOC Kaimaumau Wetland water level monitoring sites.*

52. Figure 18 shows a plot of water levels recorded at DOC sites KM5, KM6 and KM7 between July 2017 and early 2020. KM5 records stage height in the Selwyn Drain, while KM6 and KM7 measure standing water levels in the wetland 5 and 30 metres from the drain respectively. The figure shows KM5 exhibits a typical stream hydrograph with rapid increases in stream stage following rainfall events, followed recession to baseflow. Water levels in the wetland 6 metres from the Selwyn Drain (KM6) are below stream stage for around 50% of the entire record, while KM7 (30 m from the drain) exhibits levels over 2 m higher than the drain stage height. Both wetland sites (KM6 and KM7) exhibit similar temporal variations, with water levels receding in a linear manner between rainfall events (i.e., similar to that observed at the two MWWUG sites). Although exhibiting a similar response to rainfall, it is noted the relative difference in water level between KM6 and KM7 varies over time suggesting a relatively poor lateral hydraulic connection between these two relatively closely spaced sites.

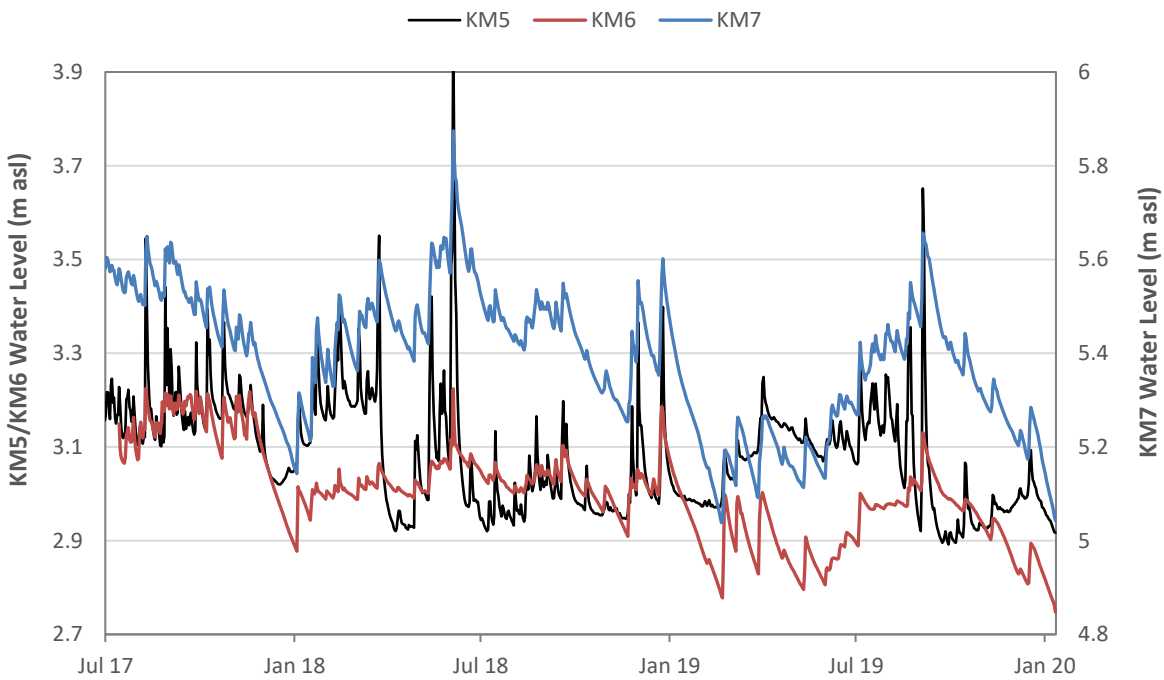

Figure 18. *Water levels in Kaimaumau Wetland at DOC monitoring sites KM5, KM6 and KM7, July 2017 to January 2020.*

53. Figure 19 shows a plot of water levels measured at KM7 and the MWWUG Wetland North site over the period of overlapping record (July 2019 to Jan 2020). These data indicate water levels are around 0.5 m higher at the KM7 site but exhibit an almost identical temporal response, with the magnitude of response to individual rainfall events slightly greater at KM7.

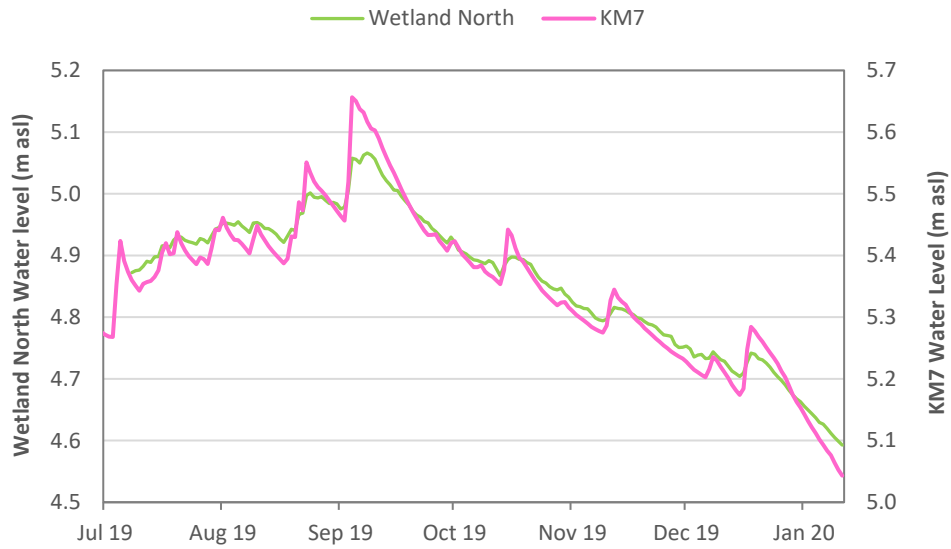

***Figure 19**. Standing water levels in Kaimaumau Wetland at the DOC KM7 and MWWUG Wetland North monitoring sites, July 2019 to January 2020.*

54. Water levels measured at other DOC monitoring sites exhibit a similar pattern to that observed at the KM5 to KM7 sites. Figure 20 shows water levels measured in, and adjacent to, the northern section of Selwyn Drain. These data indicate water levels in the wetland (KM3) are generally >0.5 m higher than stage height in the drain (KM2) and exhibit an appreciably different temporal response to rainfall. Again, the temporal variation standing water level in the wetland (KM3) is broadly similar to that observed at the Wetland North monitoring site.

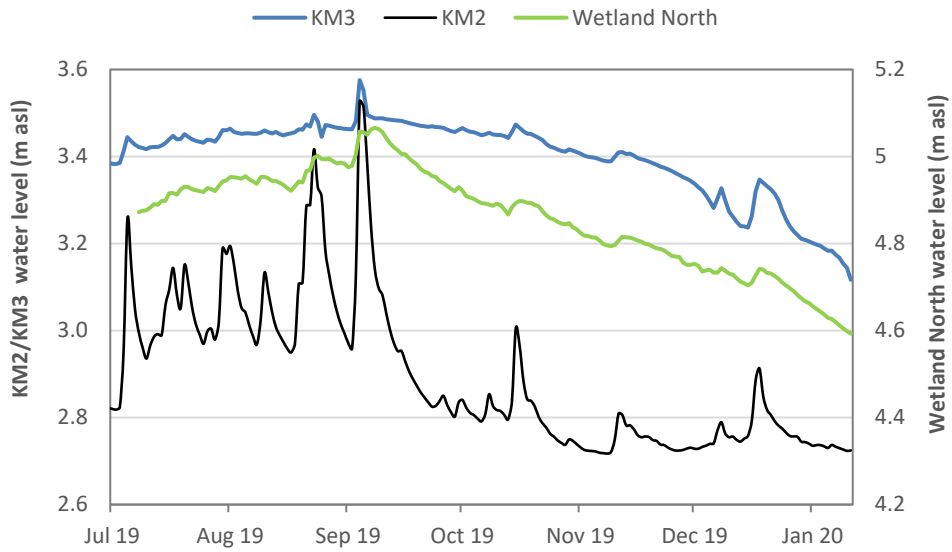

***Figure 20.** Water levels measured at the DOC KM2 and KM3 sites and at the MWWUG Wetland North site, July 2017 to January 2020*

55. In summary, data from water level monitoring undertaken by MWWUG and DOC indicate:

- Although the relative level of standing water in different areas of Kaimaumau Wetland varies spatially, all monitoring sites exhibit a similar temporal response characterised by an almost linear recession between individual rainfall events.
- Standing water levels in the wetland differ from stream stage in the Selwyn Drain (generally >0.5 m higher, with the exception of KM6) and exhibit a distinct temporal response, even at sites located along the immediate margin of the drain.
- Temporal response in standing water levels in the wetland differs from that observed in the underlying unconfined and shellbed aquifers.

56. Overall, although the monitoring period is short (particularly for the MWWUG sites), based on available data there are no clear indications of any substantial hydraulic connection between the Kaimaumau Wetland and the underlying Aupōuri Aquifer based on data from the MWWUG monitoring sites. Wetland water levels appear to function as a (relatively) linear storage that responds to rainfall events independently of the underlying groundwater system (which is also influenced by the same rainfall events). Selwyn Drain appears to act as a conduit for discharge of water draining areas inland of Kaimaumau Wetland, also potentially receiving discharge from wetland 'overflow', particularly when standing water levels are high.

57. Characterisation of wetland hydrology may also be assisted by simulation using a hydraulic model such as that developed by the applicant[12]. Results of this assessment appear to confirm that interconnection between the wetland underlying groundwater system is limited, with inflows derived from exclusively from rainfall and discharge primarily occurring via evapotranspiration, with smaller outputs via surface drains and overland flow.

4.2 Dune Lakes

58. A large number of dune lakes are recorded on the Aupōuri Peninsula, many of which are classified as having high or outstanding ecological values (e.g., Champion and de Winton, 2012[13]). These lakes typically form in low-lying areas between mobile dunes where surface runoff is impeded topography and vertical drainage is significantly restricted by accumulations of low permeability sediment (organic material and/or iron pan) on, or below, the lakebed. A majority of these lakes are perched above the underlying (regional) water table, and therefore not directly hydraulically connected to the Aupōuri Aquifer. However, where the low permeability materials are spatially extensive (e.g., areas of laterally continuous iron pan) they may be associated with localised unconfined aquifer systems perched on the same materials (i.e., localised unconfined aquifers that are similarly disconnected from the underlying regional groundwater system).

[12] WWLA, 2020d; Kaimaumau Wetland Modelling Report. Assessment of Wetland Water Level Behaviour. Report for Motutangi-Waiharara Water User Group WWA0026 | Rev 3, 24 June 2020.

[13] Champion, P., de Winton, M., 2012. Northland Lakes Strategy. NIWA Client Report prepared for Northland Regional Council, June 2012.

59. The Freshwater Environments of New Zealand (FENZ) database identifies 35 dune lakes within the AAGM domain. As shown on Figure 21, most of these lakes occur in areas of large dunes along the central axis of the Aupōuri Peninsula west of Ngataki, and between Waipārera and Sweetwater. The lakes range in size from 1 Ha to the 108 Ha Lake Waipārera and most are relatively shallow (median depth 8.0 metres) reflecting their geomorphological origins.

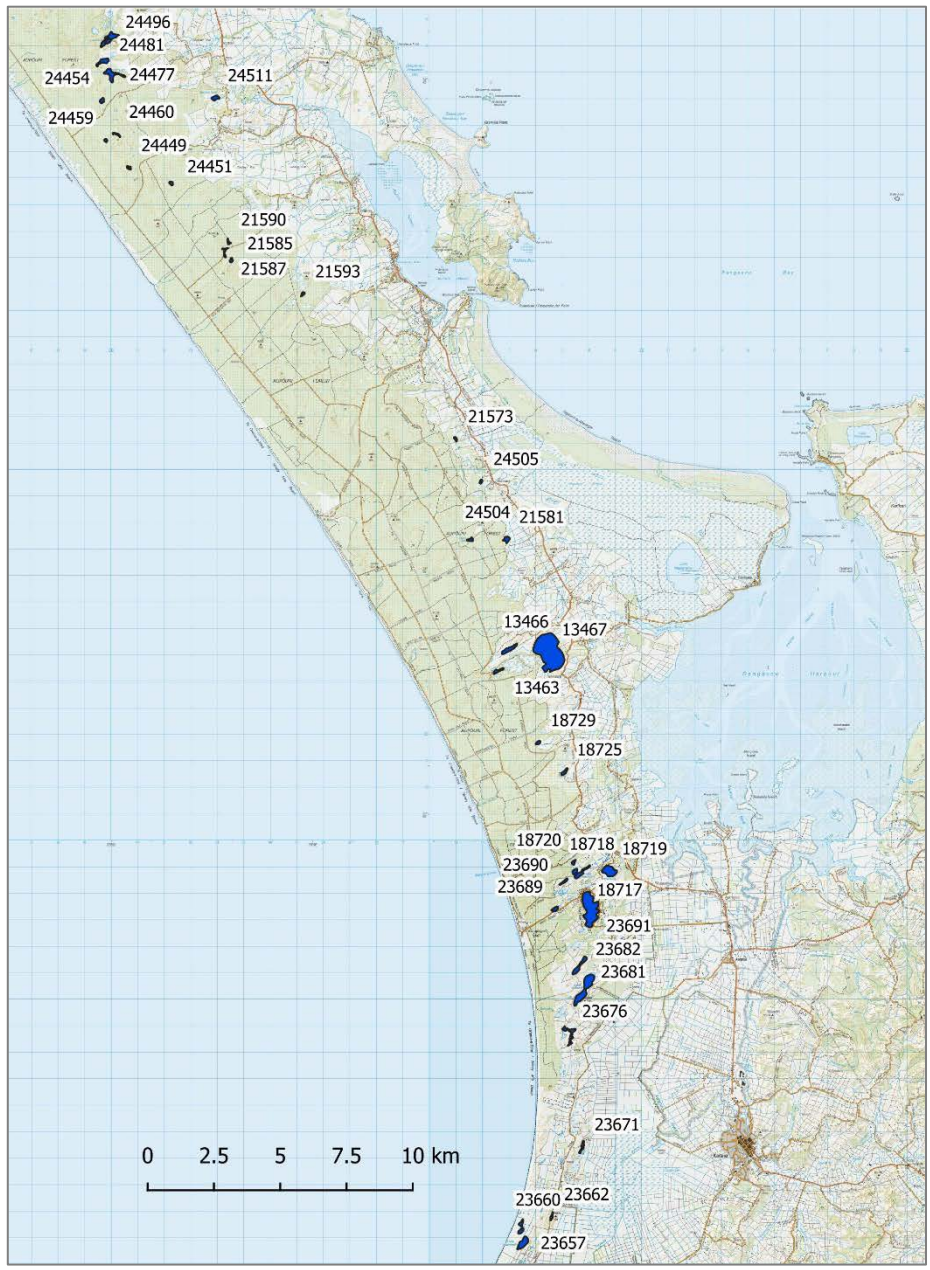

Figure 21. *Dune lakes within the AAGM domain recorded on the FENZ database (numbers indicate FENZ lake ID)*

60. Table 7 below lists attributes assigned to individual lakes in the FENZ database including area, volume, elevation and maximum depth, and compares the elevation of the lakebed (i.e., lake elevation minus maximum depth) with the 'naturalised' water table elevation calculated for the unconfined aquifer under AAGM Scenario 2. Results indicate a majority of dune lakes are perched well above the underlying water table, with an average elevation difference of approximately 10 metres.

61. Lakes identified as having the smallest difference between lakebed elevation and the underlying water table are located either towards the western side of the Aupōuri Peninsula west of Ngataki or along the coastal margin north of Ahipara, with 3 lakes calculated as having lakebed elevations below the water table (thereby increasing the potential for hydraulic connection with the unconfined aquifer[14]):

- 23660 - a coastal lake north of Ahipara which has a lakebed elevation approximately 3 metres below mean sea level
- 24454 - a small (2.2 Ha), relatively deep (13.85 m) lake on the western side of the Aupōuri Peninsula near the northern extent of the AAGM domain.
- 24459 - a small (1.1 Ha), relatively deep (10.4 m) lake on the western side of the Aupōuri Peninsula near the northern extent of the AAGM domain.

62. As illustrated on Figure 3 of the AEE (WWLA, 2020b) these areas are likely to experience limited amounts of drawdown in the shallow aquifer resulting from the cumulative effects of existing and proposed abstraction (particularly given the conservative nature of the AAGM Scenario 2 which, as described in Section 3 above, is likely to over-estimate drawdown in shallow groundwater).

63. In the area where the largest drawdown in shallow groundwater is predicted to occur as a result of current and proposed abstraction (i.e., toward the northern end of Sweetwater Station), monitoring of groundwater levels by NRC at Lake Heather since 1988 indicate a maximum water table elevation of approximately 14 m asl in the unconfined aquifer. The level is well below the calculated lakebed elevations in the nearby Lake Ngati (30.9 m), Lake Heather (32.25 m) and Lake Rotoroa (24.6 m).

64. Overall, comparison of relative lakebed and groundwater level elevations indicate that most dune lakes on the Aupōuri Peninsula are perched several metres above the underlying water table and therefore unlikely to be affected by changes in groundwater level resulting from groundwater abstraction, particularly in areas where the potential for drawdown in the unconfined aquifer is greatest. Areas where available data indicates there may be (or there is a potential for) hydraulic connection between dune lakes and the underlying regional groundwater system are generally in areas where shallow groundwater is unlikely to be significantly affected by the proposed abstraction.

[14] Although, as noted in the Kaimaumau Wetland, on its own this does not necessarily indicate a significant degree of hydraulic connection if intervening low permeability sediments are laterally continuous.

Table 7. *Comparison of the relative difference in lakebed elevation in dune lakes on the Aupōuri Peninsula (calculated from FENZ database attributes) with 'naturalised' water table elevation calculated using AAGM Scenario 2.*

FENZ Lake ID	Name	Lake Area (Ha)	Lake Volume (m^3)	Lake Elevation (m asl)	Maximum Depth (m)	Lake Base Elevation (m asl)	Water Table (m asl)	Elevation Difference (m)
13463		3.05	48306.8	39.99	4.75	35.24	13.31	+21.93
13466		6.94	261419	35.85	11.30	24.55	14.4	+10.15
13467	Lake Waipārera	108.58	2171540	31.26	6.00	25.26	14.05	+11.21
18717	Lake Ngakapua	6.06	105005	56.19			17.13	
18718		2.73	74740.6	51.64			16.59	
18719	Lake Rotokawau	15.15	606136	50.54			15.68	
18720		1.48	57093.8	55.87			16.77	
18725		2.83	118087	43.58	12.51	31.07	23.08	+7.99
18729		1.68	73163.9	39.99	13.07	26.92	15.73	+11.19
21573		1.09	22909.7	25.2	6.30	18.90	12.62	+6.28
21581		3.50	94609	21.6	8.11	13.49	11.35	+2.14
21585		1.41	63472.4	42.58	13.47	29.11	24.62	+4.49
21587		2.03	87920.5	39.53	12.97	26.56	24.4	+2.16
21590		1.20	52977.5	40	13.20	26.80	15.22	+11.58
21593		1.25	19839.2	40	4.75	35.25	24.34	+10.91
23657	Lake Waimimiha	10.04	66912.5	11.94	2.00	9.94	3.18	+6.76
23660		5.21	108900	3.1	6.27	-3.17	1.35	-4.52
23662		1.62	28031.9	37.22	5.18	32.04	10.39	+21.65
23671		2.66	74147.2	18.04	8.36	9.68	7.73	+1.95
23676		7.62	170884	20.73	6.73	14.00	9.32	+4.68
23681	Lake Rotoroa	27.68	738252	32.64	8.00	24.64	14.09	+10.55
23682		8.33	166575	37.85	5.60	32.25	14.58	+17.67
23689		2.61	77718.1	32.27	8.95	23.32	11.02	+12.30
23690		2.06	20632.6	54.98	3.00	51.98	12.8	+39.18

FENZ Lake ID	Name	Lake Area (Ha)	Lake Volume (m^3)	Lake Elevation (m asl)	Maximum Depth (m)	Lake Base Elevation (m asl)	Water Table (m asl)	Elevation Difference (m)
23691	Lake Ngatu	51.69	1119980	37.4	6.50	30.90	18.99	+11.91
24449		1.20	50584.1	38.88	12.65	26.23	22.51	+3.72
24451		1.41	24209.6	57.31	5.14	52.17	27.08	+25.09
24454		2.22	102518	38.2	13.85	24.35	27.97	-3.62
24459		1.07	37253.2	30.99	10.42	20.57	22.02	-1.45
24460		1.43	52420.2	37.1	11.02	26.08	25.46	+0.62
24477	Swan Lake	10.93	547207	50.38	15.01	35.37	31.25	+4.12
24481		5.81	303152	56.64	15.65	40.99	31.43	+9.56
24496	Lake Half	11.85	566623	55.81	14.34	41.47	33.61	+7.86
24504	Swan Lake	2.03	65294.1	39.95	9.64	30.31	13.71	+16.60
24505		1.11	25927.4	22.95	7.02	15.93	11.94	+3.99
24511	Waihopo Lake	3.48	34764.7	35.02			25.75	

5. Aquifer Salinity

65. Under natural conditions, the hydraulic gradient from inland recharge results in seepage of fresh groundwater into the sea at, and offshore of, the coastal margin. This process causes mixing of fresh groundwater and seawater resulting in a natural transition from fresh to brackish to saline water with distance offshore. This mixing zone is referred to as the saline interface. The geometry of the saline interface reflects the density difference between fresh and saline water, with less dense fresh water transitioning to denser, more saline water at depth and at greater distances offshore.

66. In shallow unconfined aquifers the saline interface typically occurs along the costal margin where groundwater discharges directly to the coast. However, in deeper semi-confined to confined aquifers, the location and geometry of the saline interface is largely determined by pressure gradients in an aquifer, and the consequent the rate of groundwater discharge to the coast. Under natural conditions the depth and location of the saline relative to the coastline can change over time reflecting seasonal and inter-annual variations in the rate of recharge and throughflow of groundwater reflected in groundwater levels).

67. Seawater intrusion refers to inland migration of brackish and saline waters in an aquifer system. This process typically occurs when there is a reduction in the freshwater head along the coastal margin due to groundwater abstraction (resulting in a consequent reduction in pressure head and discharge to the coast). Seawater intrusion has the potential to adversely affect the use of groundwater for consumptive uses such as drinking water and irrigation.

68. It is also however noted that the salinity of groundwater can be influenced by processes other than seawater intrusion associated with groundwater abstraction. Salinity can be naturally elevated due to the presence of connate waters which represent water effectively 'trapped' during the accumulation of sedimentary deposits which have not been subsequently 'flushed' by more recent groundwater throughflow. Saline water may also be associated with the circulation of geothermal fluids within bedrock materials, particularly along fault zones. The influence of both connate and geothermal waters on groundwater quality has recently been noted in some areas of Northland (LWP, 2020[15]).

69. Available water quality data indicates that a majority of groundwater on the Aupōuri Peninsula exhibits low salinity. Concentrations of indicator parameters (EC, Chloride and Sodium) are consistent with waters derived from land surface recharge of rainfall containing dilute marine aerosols, which are hosted in relatively inert aquifer media (i.e., dominated by silicate minerals).

[15] LWP, 2020; Rūāwai Aquifer Saline Intrusion Risk Assessment. Report prepared for Northland Regional Council, May 2020.

70. Figure 22 shows a map of mean groundwater EC values from groundwater samples collected by NRC as part of State of Environment monitoring and specific investigations[16]. The map shows a majority of sites exhibit EC values <50 mS/m, with a cluster of sites in the Norton Road area exhibiting slightly elevated values between 50 and 80 mS/m. Two bores located in Kaimaumau Settlement exhibiting EC values >4,500 mS/m are an obvious anomaly compared to the remainder of the Aupōuri Peninsula.

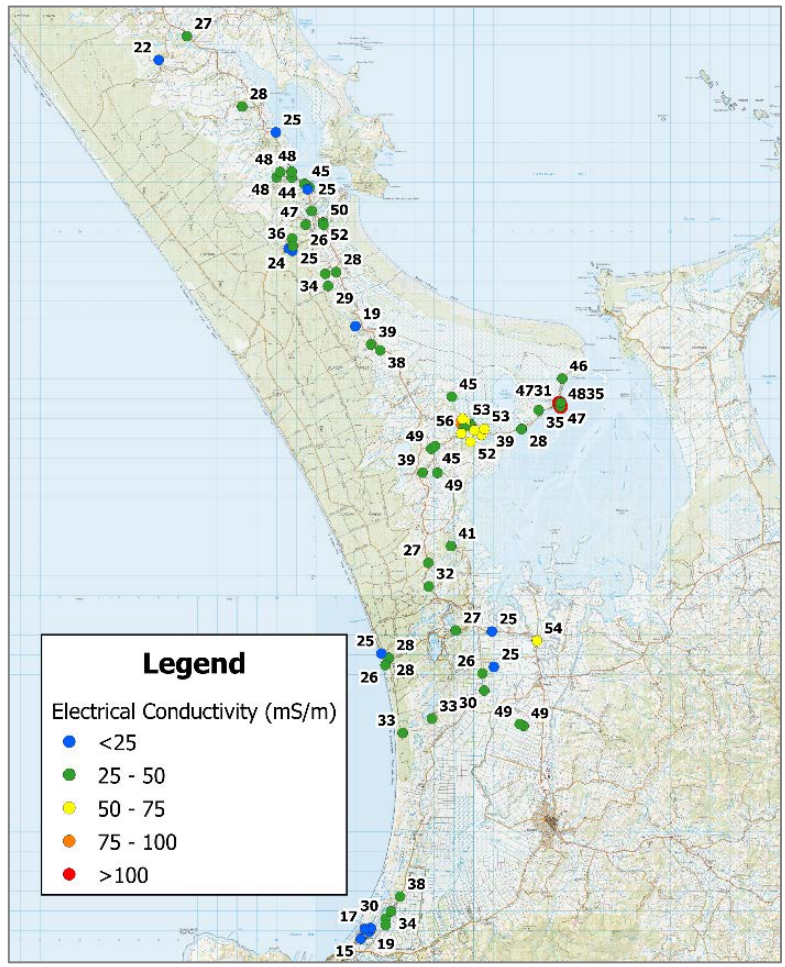

Figure 22. *Groundwater Electrical Conductivity values on the Aupōuri Peninsula*

[16] The data set used included 809 samples from 78 sites: 12 sites with >10 samples (74% of total samples), 20 sites with 6 to 10 samples (17% of total samples) and 46 sites with five or less samples (32 with a single sample only).

71. Figure 23 shows a similar pattern for groundwater Chloride concentrations. Approximately 50 percent of the sites sampled exhibit Chloride concentrations[17] less than 50 g/m³, with 90 percent exhibiting concentrations less than 75 g/m³. Bores around the northern margin of Rangaunu Harbour typically exhibit values between 50 and 75 g/m³, with a few bores around Pukenui also exhibiting values between 50 and 100 g/m³. Again, Chloride concentrations in excess of 15,000 g/m³ recorded in two bores in Kaimaumau Settlement are significantly anomalous compared to all other bores sampled.

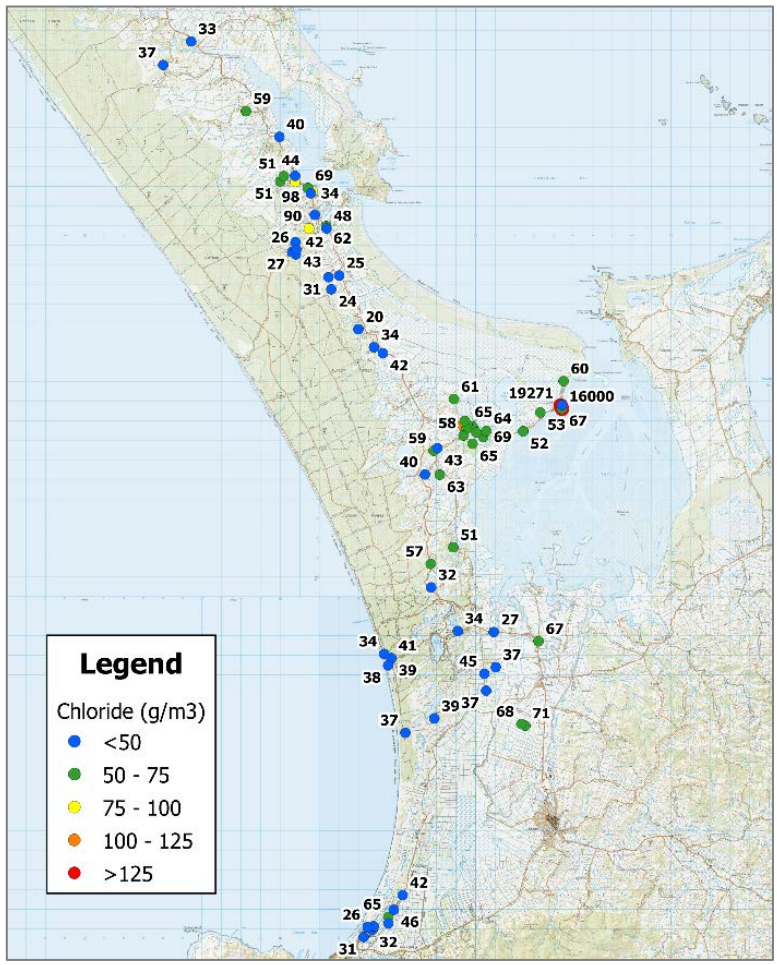

Figure 23. *Groundwater Chloride concentrations on the Aupōuri Peninsula*

72. Excluding data from the 'saline' Kaimaumau Settlement bores, Figure 24 shows the generalised relationship between EC and Chloride observed in groundwater on the Aupōuri Peninsula. Based on this relationship, Chloride concentrations are estimated to reach the New Zealand Drinking Water Standard Guideline Value of 250 g/m³ at EC values of approximately 240 mS/m[18].

[17] The New Zealand Drinking Water Standards specify a Guideline Value of 250 g/m³, above which the aesthetic quality (i.e., taste, corrosion) of water may be adversely affected.

[18] Groundwater quality data typically show measured sodium concentrations on the Aupōuri Peninsula around 0.8 times Chloride concentrations. This ratio indicates Chloride concentrations of 250 g/m³ are approximately equivalent to a Sodium concentration of 200 g/m³ (which is the NZDWS Guideline Value for Sodium).

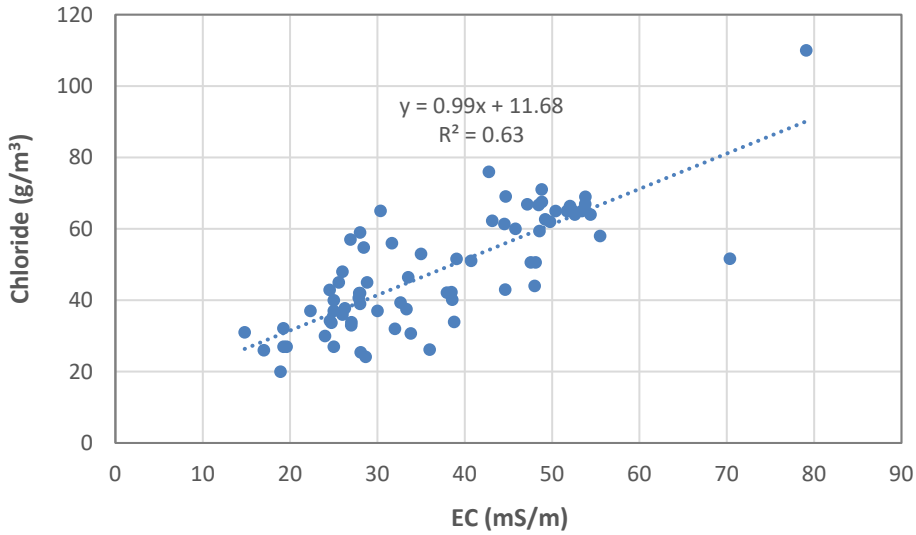

Figure 24. *Relationship between EC and Chloride observed in groundwater on the Aupōuri Peninsula*

73. Figure 25 shows a plot of EC and Chloride recorded shellbed aquifer at the Fishing Club monitoring site at Pukenui, along with groundwater levels recorded in the nearby NRC Waterfront piezometer. This site has the longest continuous groundwater quality monitoring record for a coastal monitoring site on the Aupōuri Peninsula. The data show EC values have remained relatively stable since 2003, while chloride concentrations exhibit greater temporal variability. Interestingly, Chloride concentrations exhibit a declining linear trend over the monitoring period while groundwater levels exhibit an increasing trend. The data show both EC and Chloride concentrations exhibit a slight rise in late 2019 but remained within the range of historical values, while groundwater levels over this period remained higher than those recorded during previous years (particularly prior to 2008).

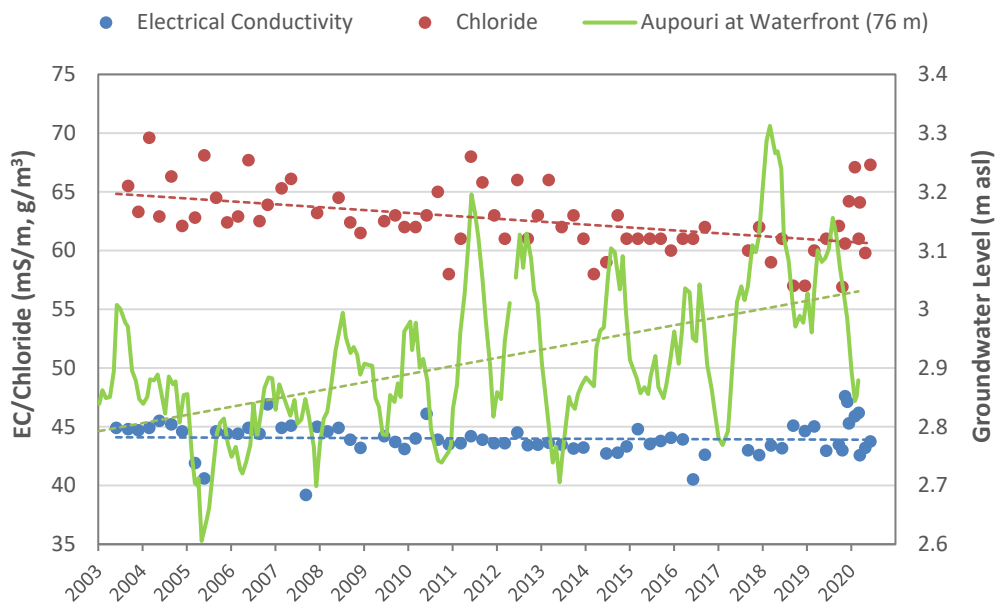

Figure 25. *Temporal variation in EC and Chloride observed at the Fishing Club site, Pukenui and groundwater level recorded at the nearby NRC Waterfront monitoring site, 2003 to 2020. Dotted lines indicate a linear regression fitted to each data set.*

74. To provide additional context regarding natural variability in groundwater levels and salinity observed on the Aupōuri Peninsula, Figure 26 and 27 below illustrate groundwater level and EC data recorded in sentinel bores located along the coast in the Sweetwaters and Pukenui areas over the 2019-20 year respectively. The figures indicate EC values are relatively low (40 to 50 mS/m) reflecting the 'fresh' nature of groundwater in these areas but exhibit some minor temporal variation in response to changes in aquifer water levels. Any transition to more brackish water (seawater has an EC of approximately 4,800 mS/m) would be clearly evident, illustrating the value of such monitoring at representative points around the coastal margin as tool for identifying even minor effects on groundwater quality associated with seawater intrusion.

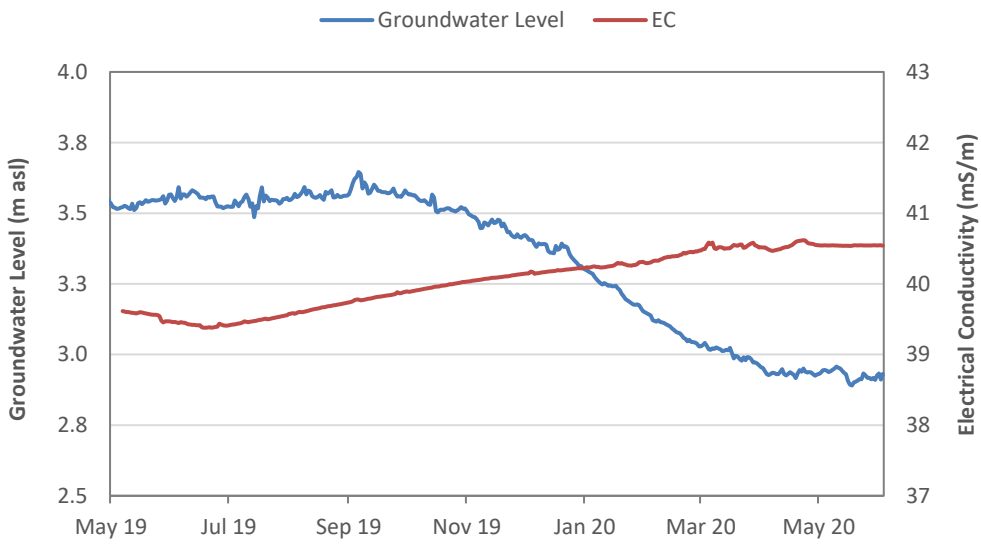

Figure 26. *Groundwater level and EC measured in the Sweetwater Farms MW4b sentinel bore, May 2019 to June 2020.*

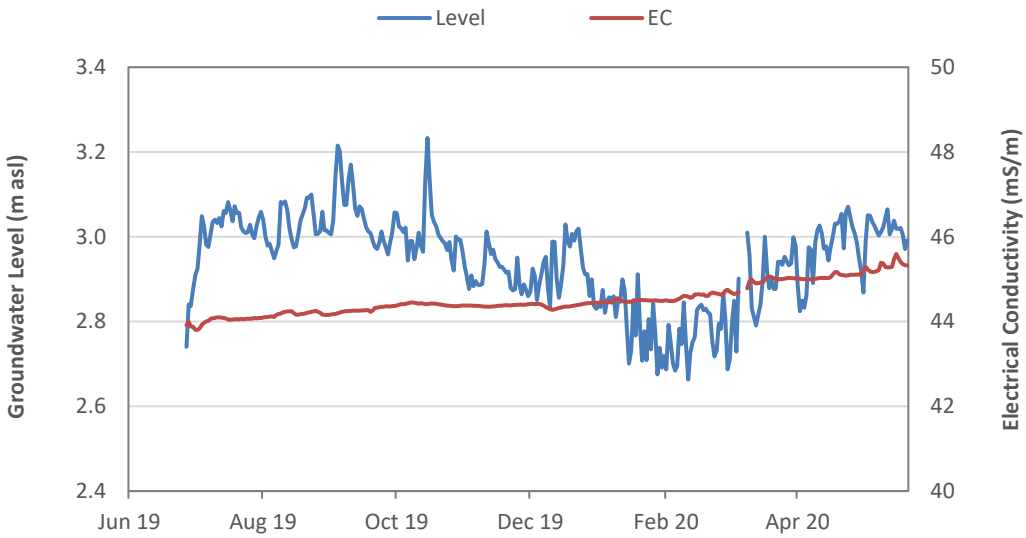

Figure 27. *Groundwater level and EC measured in the Waterfront sentinel bore at Pukenui, June 2019 to June 2020*

5.1 Elevated Salinity at Kaimaumau Settlement

75. In early February 2018 a domestic bore (LOC.317054) drilled in Kaimaumau Settlement was reported to have intercepted saline groundwater in a shellbed layer between 51.0 and 54.5 m bgl. Due to the salinity of the water, the driller backfilled the bore and installed a second bore immediately adjacent, targeting a grey sand layer between 33 to 36 m bgl. This second bore also intercepted saline water and was backfilled, and a third bore (intercepting fresh water) installed and screened between 7 and 10 m bgl. Reported static water levels in the bores ranged from 3.2 m bgl in the two deeper bores to 2.5 m bgl in the shallower bore. Electrical Conductivity (EC) values measured by NRC in samples collected by the driller from the two deeper bores ranged between 4,834 mS/m in the deeper bore to 4,115 mS/m in the intermediate depth bore, indicating significantly elevated salinity.

76. Following the reported interception of saline water NRC undertook a survey of groundwater quality in a total of 15 bores ranging in depth from 10 to 85 metres located in the vicinity of Kaimaumau Settlement in late February 2018[19]. Results of this survey indicated EC values ranging from 27 to 55.5 mS/m and Chloride concentrations between 45 to 76 g/m³. These values were consistent with water quality observed elsewhere on the Aupōuri Peninsula, indicating results from the deep bores in Kaimaumau settlement were somewhat anomalous.

77. In August 2019 a water quality compliance monitoring bore (LOC.324250) for the MWWUG consents was installed in Kaimaumau Settlement. This bore was screened in a thin shellbed layer between 44.7 to 45.7 m bgl, immediately overlying basement rock. Table 8 summarises water quality monitoring results from this bore which show exhibit EC, Chloride, Sodium and Total Dissolved Solids (TDS) concentrations all close to, or slightly, above those typically observed in seawater.

Table 8. *Groundwater quality monitoring results from the MWWUG Kaimaumau Settlement deep piezometer, 2019-20.*

	Units	3/10/19	12/11/19	16/12/19	6/2/20	18/3/20	29/4/20	8/6/20
Temperature	°C	18.8	19.3	19.6	19.7	19.3	19.4	18.9
Groundwater Depth	m	2.685	2.919	2.685	3.297	3.172	2.958	3.000
Chloride	g/m³	18,700	14,700	28,100	17,800	18,200	18,700	18,700
EC	mS/m	5,034	4,526	4,886	4,825	4,558	4,664	4,625
Sodium	g/m³	9,000	8,800	8,900	10,000	10,000	10,000	9,500
Total dissolved solids	g/m³	37,000	37,000	39,000	38,000	36,000	39,000	36,000

78. The nearest monitoring site to Kaimaumau Settlement at which reduced groundwater levels are available is the NRC Kaimaumau Road monitoring site located approximately 2.3 kilometres to the south-west. Groundwater levels recorded at this site over the 2019-20 year ranged between 1.9 to 2.5 m asl in the shellbed aquifer and between 1.3 to 1.8 m asl in the shallow aquifer (i.e., indicating an upward hydraulic gradient of around 0.6 metres).

[19] NRC, 2018; Update on results of groundwater monitoring undertaken by the Northland Regional Council - Paparore to Pukenui. Report prepared for the MWWUG Hearing Panel, March 2018.

79. Extrapolation of the hydraulic gradient observed in the shellbed aquifer between the Kaimaumau Road sentinel and the MWWUG Norton Road monitoring site during summer 2020 to Kaimaumau Settlement indicates a groundwater level of the order of 0.7 m asl in the shellbed aquifer at Kaimaumau Settlement[20]. This level is similar to the groundwater level of 0.6 m asl at Kaimaumau Settlement predicted by the AAGM 'naturalised' scenario.

80. Assuming a groundwater level of 0.6 m asl, the Ghyben-Herzberg relation indicates the saline interface would occur at a depth of approximately 25 m bgl at Kaimaumau Settlement. While this estimate is consistent with the observed increase in salinity in deeper groundwater, some aspects of observed salinity remain somewhat anomalous. These include:

- The observed salinity of groundwater >30 m bgl is close to that of sea water. Typically, a gradual transition would be expected between fresh water in the shallow aquifer and increasingly brackish water at depth, rather than an abrupt change from fresh to essentially sea water over a narrow depth range.
- Given the highly elevated salinity observed at Kaimaumau Settlement it would be reasonable to expect water quality in the shellbed aquifer to transition from brackish to fresh with distance inland. However, the nearest shellbed bore to Kaimaumau Settlement for which water quality information is available (LOC.201602, located approximately 1 kilometre west) exhibits EC values and Chloride concentrations similar to those measured in inland areas of the Aupōuri Peninsula and in excess of two orders of magnitude than observed at Kaimaumau Settlement (EC 35 mS/m and Chloride 53 g/m^3).
- Groundwater quality measured in February 2018 in a 31 metre deep bore (LOC.309384) located approximately 1 kilometre north-east of Kaimaumau Settlement (i.e., toward the mouth of the Rangaunu Harbour) indicated fresh water (EC 46 mS/m and Chloride 60 g/m^3). Logically, given the salinity observed at Kaimaumau Settlement, groundwater in this area could be expected to also exhibit brackish characteristics.
- Static water levels reported in the two deep bores in Kaimaumau township (~3 m bgl) are lower than those observed in the shallow aquifer (~2.5 m bgl) indicating a downward hydraulic gradient. Other areas around the coastal margin of the Aupōuri Peninsula typically exhibit an upward hydraulic gradient (e.g., an upward hydraulic gradient of approximately 0.6 m is observed at the NRC Kaimaumau Road sentinel site approximately 2.5 kilometres south-west of Kaimaumau Settlement).

81. Overall, the occurrence of saline water at depth >30 m bgl in the Kaimaumau Settlement area appears to be a natural phenomenon and may indicate the presence of saline water in the shellbed aquifer under an large area extending from Kaimaumau Settlement toward the southern end of East Beach. However, given observed groundwater levels and quality across the surrounding area, both the potential location and geometry of the saline interface is not well constrained.

[20] This assumes a constant hydraulic gradient north-east of the Kaimaumau Road sentinel bore. However, in reality the hydraulic gradient is likely to flatten toward East Beach so the reduce groundwater level may be higher than that estimated.

82. A major consideration regarding aquifer salinity in the Kaimaumau Settlement area arising from the proposed AAWUG abstraction is the potential effect on groundwater levels and consequent influence on the position of the saline interface. Kaimaumau Settlement is located over 6 kilometres from the nearest AAWUG abstraction point. Consequently, drawdown resulting from the proposed abstraction is likely to be minor. Scenario modelling undertaken using the AAGM indicates a drawdown of less than 50 mm in the vicinity of Kaimaumau Settlement in response to the proposed abstraction even under the low leakage scenario (Scenario 3). A drawdown of this magnitude is likely to be within the range of natural seasonal variability and unlikely to materially influence the current position of the saline interface in this area.

83. However, given the significantly elevated salinity, it is recommended that existing monitoring in the Kaimaumau Settlement area is continued and, if possible, reconfigured to include regular monitoring of reduced groundwater levels and relocation of the current groundwater quality monitoring site to an area inland of the zone of elevated salinity. Along with additional monitoring of groundwater levels and saline intrusion indicators, this will be addressed in more detail in the proposed GCMP for the AAWUG application.

6. Management of the Proposed Groundwater Abstraction

84. Given the scale of the proposed abstraction it is recommended that Council develop a Groundwater Monitoring and Contingency Plan (GCMP) for the proposed AAWUG abstraction which is similar in form and content and, if possible, integrated with the GCMP for the MWWUG consents. At a minimum the GCMP should:

- Specify a framework for implementation of the consents whereby abstraction is authorised in incremental stages, with progression between each stage being contingent on the results of environmental monitoring.
- Identify requirements for monitoring of groundwater levels and quality, with a particular focus on ‘key’ locations where anticipated effects are anticipated to be most significant, or where environmental sensitivity is highest. This monitoring should be integrated with existing monitoring undertaken for the MWWUG consents.
- Specify groundwater level and groundwater quality triggers that initiate mitigation actions (including a reduction in the rate and volume of abstraction). Trigger levels and associated mitigation actions should be established to ensure the reliability of supply for existing groundwater users is not derogated by the proposed abstraction.
- Specify a framework for application of trigger levels and/or mitigation actions on a sub-area basis that recognises the geographic distribution of the proposed abstraction as well as the magnitude of potential effects and potential sensitivity of the local hydrological and hydrogeological environment.

7. Summary

85. The proposed abstraction by the Aupōuri Aquifer Water Users Group (AAWUG) seeks authorisation to enable abstraction of groundwater a cumulative maximum rate of 42,953 m^3/day, up to a seasonal volume of 4,606,260 m^3/year. The proposed abstraction includes 24 separate water permits split between 48 individual production bores distributed across 7 sub-areas of the Aupōuri Aquifer management unit, between Ngataki and Ahipara.

86. Based on the geographic location of the proposed abstraction, cumulative allocation including the proposed abstraction will remain within the allocation limits specified in Policy H.4.4 of the Proposed Regional Plan for Northland (pRPN) except in the Sweetwater sub-area where allocation will total 101.1 percent of the allocation limit. However, given the interconnected nature of individual management units (sub-areas), application of a methodology for calculating allocation to account for cross-boundary effects developed by NRC indicates allocation within all sub-areas will remain within the Regional Plan limits. Subject to minor amendments, the proposed rates and volumes of groundwater abstraction for individual water permits are consistent with guidelines for reasonable and efficient use.

87. Individual and cumulative effects of the proposed groundwater abstraction were assessed using a numerical groundwater model. Comparison of modelled groundwater levels with data collected by NRC and resource consent compliance monitoring indicates:

- The model as a reasonability to simulate the spatial distribution of relative groundwater levels across the Aupōuri Aquifer (subject to relatively minor uncertainty).
- Temporal variation in measured groundwater levels is not universally well replicated in model simulations. At least in part, this variance represents potential variations in groundwater recharge associated with landcover changes associated with plantation forestry rotation that are not included in the recharge model.
- Comparison of measured and modelled drawdown in response to groundwater abstraction suggests that, as acknowledged in model documentation, Scenario 2 may tend to under-estimate the magnitude of localised drawdown in some areas of the model domain.

88. Monitoring of water levels in the Kaimaumau Wetland do not appear to indicate any significant hydraulic connection between the wetland and the underlying groundwater system. While appreciable spatial differences in relative water levels are observed in the wetland, monitoring sites exhibit a relatively consistent temporal response. The wetland appears to function as an (almost) linear storage, with recharge derived from rainfall and discharge occurring via evapotranspiration and discharge to drains.

89. Groundwater quality across the Aupōuri Aquifer is generally high. Groundwater contains dilute concentrations of dissolved ions reflecting rainout of marine aerosols with no indications of elevated salinity. The exception to this pattern is the significantly elevated salinity observed in two deeper bores (>30 m bgl) Kaimaumau Settlement which exhibit a salinity close to that of seawater. This elevated salinity appears to reflect the natural condition of the aquifer, possibly reflecting the low groundwater head toward the southern end of East Beach. However, some aspects of the elevated salinity are anomalous, particularly given the 'fresh' nature of groundwater observed across the wider Kaimaumau Settlement area (both spatially and with depth), and it is reasonable to observe the geometry of the saline interface is not well constrained in this area

90. It recommended that Council develop a Groundwater Monitoring and Contingency Plan for the proposed AAWUG abstraction. It is suggested that document follow a similar format to the GCMP for the MWWUG consents, with a similar focus on 'adaptive management' following a staged approach supported by requirements for monitoring and mitigation that is specified on a sub-area basis.

Yours Sincerely

Brydon Hughes
Hydrogeologist

ATTACHMENT 6

ATTACHMENT 6 Relevant objectives and policies

National Policy Statement for Freshwater Management 2014 (Updated August 2017)	New Zealand Coastal Policy Statement 2010	Regional Policy Statement for Northland 2016 (Updated May 2018)	Water and Soil Plan for Northland 2014 (Updated 2016)	Proposed Regional Plan – Appeals Version June 2020
Te Mana o te Wai / Tangata whenua				
Objective AA1 Objective D1	Objective 3 Policy 2 The Treaty of Waitangi, tangata whenua and Maori heritage Policy 4 Integration		Objective 6.3.1 Policy 6.4.1 Policy 6.4.3 Policy 7.5.7	Objective F.1.8
Purpose: Acknowledgement and recognition of Te Mana o te Wai (NPSFS), and tangata whenua as kaitiaki of traditional taonga. NZPCS and RPS suggest tangata whenua involvement in sustainable resource management.				
Water Quality				
Objective A1 Objective A2 (relevant to freshwater management units) Objective A3 (relevant to freshwater management units) Objective A4	Objective 1	Objective 3.2 Region-wide Water Quality	Objective 7.4.1 Objective 10.4.1 Policy 7.5.1	Objective F.1.2 Water Quality Policy D.4.1 Maintaining overall water quality
Purpose: Maintenance and when possible improvement of the quality of fresh water. The maintenance of water quality is intended for protection of the integrity, form and functioning of the ecosystems in the coastal environments, particularly its life-supporting capacity, ecosystem processes and indigenous species.				
Water Quantity				
Objective B1 Objective B2 Objective B3 Objective B4 (applies to wetland and outstanding freshwater bodies) Objective B5		Objective 3.3 Ecological flows and water levels	Objective 10.4.3	Objective F1.1 Freshwater quantity
Purpose: Support the efficient allocation and use of water (and avoid over-allocation) intended to maintain life-supporting capacity, ecosystem processes and indigenous species. Aim to a sustainable management of freshwater quantity to enable the economic wellbeing of the communities and to avoid saline intrusion and land subsidence (associated adverse effect).				
Integrated Management				
Objective C1		Objective 3.1 Integrated catchment management Objective 3.10 Use and allocation of common resources	Objective 10.4.2 Objective 13.3.1 Policy 13.4.4	

National Policy Statement for Freshwater Management 2014 (Updated August 2017)	New Zealand Coastal Policy Statement 2010	Regional Policy Statement for Northland 2016 (Updated May 2018)	Water and Soil Plan for Northland 2014 (Updated 2016)	Proposed Regional Plan – Appeals Version June 2020
Purpose: Support use and management of freshwater that considers the interaction between freshwater, land and associated ecosystems. Support catchment-base management and taking into consideration all the activities that may impact water quality and quantity.				
Social economic, and cultural wellbeing				
	Objective 6 Activities in the coastal environment	Objective 3.5 Enabling economic wellbeing		F1.4 Enabling economic well-being
Purpose: Aim to a sustainable management of the natural resources that is attractive for business and can lead to the improvement of the economic wellbeing of the Northland communities.				

National Policy Statement for Freshwater Management 2014 (Updated 2017)

AA. Te Mana o te Wai

Objective AA1 *To consider and recognise Te Mana o te Wai in the management of fresh water.*

A. Water quality

Objective A1 *To safeguard:*

a) *The life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, or fresh water; and*
b) *The health of people and communities, as affected by contact with fresh water;*

in sustainably managing the use and development of land, and of discharges of contaminants.

Objective A2 *The overall quality of fresh water within a freshwater management unit is maintained or improved while:*

a) *protecting the significant values of outstanding freshwater bodies;*
b) *protecting the significant values of wetlands; and*
c) *improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over-allocated.*

Objective A3 *The quality of fresh water within a freshwater management unit is improved so it is suitable for primary contact more often, unless:*

a) *regional targets established under Policy A6(b) have been achieved; or*
b) *naturally occurring processes mean further improvement is not possible.*

Objective A4 *To enable communities to provide for their economic well-being, including productive economic opportunities, in sustainably managing freshwater quality, within limits.*

B. Water quantity

Objective B1 *To safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the taking, using, damming, or diverting of fresh water.*

Objective B2 *To avoid any further over-allocation of fresh water and phase out existing over-allocation.*

Objective B3 *To improve and maximise the efficient allocation and efficient use of water.*

Objective B5 *To enable communities to provide for their economic well-being, including productive economic opportunities, in sustainably managing fresh water quantity, within limits.*

C. Integrated management

Objective C1 *To improve integrated management of fresh water and the use and development of land in whole catchments, including the interactions between fresh water, land, associated ecosystems and the coastal environment.*

D. Tangata Whenua roles and interests

Objective D1 *To provide for the involvement of iwi and hapū, and to ensure that tangata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding freshwater planning, including on how all other objectives of this national policy statement are given effect to.*

New Zealand Coastal Policy Statement 2010

Objective 1 *To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land, by:*

- *maintaining or enhancing natural biological and physical processes in the coastal environment and recognising their dynamic, complex and interdependent nature;*
- *protecting representative or significant natural ecosystems and sites of biological importance and maintaining the diversity of New Zealand's indigenous coastal flora and fauna; and*
- *maintaining coastal water quality and enhancing it where it has deteriorated from what would otherwise be its natural condition, with significant adverse effects on ecology and habitat, because of discharges associated with human activity.*

Objective 3 *To take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment by:*

- *recognising the ongoing and enduring relationship of tangata whenua over their lands, rohe and resources;*
- *promoting meaningful relationships and interactions between tangata whenua and persons exercising functions and powers under the Act;*
- *incorporating mātauranga Māori into sustainable management practices; and*
- *recognising and protecting characteristics of the coastal environment that are of special value to tangata whenua*

Objective 6 *To enable people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through subdivision, use, and development, recognising that:*

- *the protection of the values of the coastal environment does not preclude use and development in appropriate places and forms, and within appropriate limits;*
- *some uses and developments which depend upon the use of natural and physical resources in the coastal environment are important to the social, economic and cultural wellbeing of people and communities;*
- *functionally some uses and developments can only be located on the coast or in the coastal marine area;*

- *the coastal environment contains renewable energy resources of significant value; • the protection of habitats of living marine resources contributes to the social, economic and cultural wellbeing of people and communities;*
- *the potential to protect, use, and develop natural and physical resources in the coastal marine area should not be compromised by activities on land;*
- *the proportion of the coastal marine area under any formal protection is small and therefore management under the Act is an important means by which the natural resources of the coastal marine area can be protected; and*
- *historic heritage in the coastal environment is extensive but not fully known, and vulnerable to loss or damage from inappropriate subdivision, use, and development.*

Policy 3 Precautionary approach

(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.

(2) In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, so that:

(a) avoidable social and economic loss and harm to communities does not occur;

(b) natural adjustments for coastal processes, natural defences, ecosystems, habitat and species are allowed to occur; and

(c) the natural character, public access, amenity and other values of the coastal environment meet the needs of future generations.

Policy 4 Integration

Provide for the integrated management of natural and physical resources in the coastal environment, and activities that affect the coastal environment. This requires:

(a) co-ordinated management or control of activities within the coastal environment, and which could cross administrative boundaries, particularly:

(i) the local authority boundary between the coastal marine

(ii) local authority boundaries within the coastal environment, both within the coastal marine area and on land; and

(iii) where hapū or iwi boundaries or rohe cross local authority boundaries;

(b) working collaboratively with other bodies and agencies with responsibilities and functions relevant to resource management, such as where land or waters are held or managed for conservation purposes; and

(c) particular consideration of situations where:

(i) subdivision, use, or development and its effects above or below the line of mean high water springs will require, or is likely to result in, associated use or development that crosses the line of mean high water springs; or

(ii) public use and enjoyment of public space in the coastal environment is affected, or is likely to be affected; or

(iii) development or land management practices may be affected by physical changes to the coastal environment or potential inundation from coastal hazards, including as a result of climate change; or

(iv) land use activities affect, or are likely to affect, water quality in the coastal environment and marine ecosystems through increasing sedimentation; or

(v) significant adverse cumulative effects are occurring or can be anticipated.

Policy 6 Activities in the coastal environment

(1) In relation to the coastal environment:

(a) *recognise that the provision of infrastructure, the supply and transport of energy including the generation and transmission of electricity, and the extraction of minerals are activities important to the social, economic and cultural well-being of people and communities;*

(b) *consider the rate at which built development and the associated public infrastructure should be enabled to provide for the reasonably foreseeable needs of population growth without compromising the other values of the coastal environment;*

(c) *encourage the consolidation of existing coastal settlements and urban areas where this will contribute to the avoidance or mitigation of sprawling or sporadic patterns of* settlement and *urban growth;*

(d) *recognise tangata whenua needs for papakāinga3, marae and associated developments and make appropriate provision for them;*

(e) *consider where and how built development on land should be controlled so that it does not compromise activities of national or regional importance that have a functional need to locate and operate in the coastal marine area;*

(f) *consider where development that maintains the character of the existing built environment should be encouraged, and where development resulting in a change in character would be acceptable;*

(g) *take into account the potential of renewable resources in the coastal environment, such as energy from wind, waves, currents and tides, to meet the reasonably foreseeable needs of future generations;*

(h) *consider how adverse visual impacts of development can be avoided in areas sensitive to such effects, such as headlands and prominent ridgelines, and as far as practicable and reasonable apply controls or conditions to avoid those effects;*

(i) *set back development from the coastal marine area and other water bodies, where practicable and reasonable, to protect the natural character, open space, public access and amenity values of the coastal environment; and*

(j) *where appropriate, buffer areas and sites of significant indigenous biological diversity, or historic heritage value.*

(2) *Additionally, in relation to the coastal marine area:*

(a) *recognise potential contributions to the social, economic and cultural wellbeing of people and communities from use and development of the coastal marine area, including the potential for renewable marine energy to contribute to meeting the energy needs of future generations;*

(b) *recognise the need to maintain and enhance the public open space and recreation qualities and values of the coastal marine area;*

(c) *recognise that there are activities that have a functional need to be located in the coastal marine area, and provide for those activities in appropriate places;*

(d) *recognise that activities that do not have a functional need for location in the coastal marine area generally should not be located there; and (e) promote the efficient use of occupied space, including by:*

(i) *requiring that structures be made available for public or multiple use wherever reasonable and practicable;*

(ii) *requiring the removal of any abandoned or redundant structure that has no heritage, amenity or reuse value; and*

(iii) *considering whether consent conditions should be applied to ensure that space occupied for an activity is used for that purpose effectively and without unreasonable delay.*

Objective 3.1 Integrated catchment management *Integrate the management of freshwater and the subdivision, use and development of land in catchments to enable catchment-specific objectives for fresh and associated coastal water to be met.*

Objective 3.2 Region-wide Water Quality *Improve the overall quality of Northland's fresh and coastal water with a particular focus on:*

a) Reducing the overall Trophic Level Index status of the region's lakes;
b) Increasing the overall Macroinvertebrate Community Index status of the region's rivers and streams;
c) Reducing sedimentation rates in the region's estuaries and harbours;
d) Improving microbiological water quality at popular contact recreation sites, recreational and cultural shellfish gathering sites, and commercial shellfish growing areas to minimise risk to human health; and
e) Protecting the quality of registered drinking water supplies and the potable quality of other drinking water sources.

Objective 3.3 Ecological flows and water levels *Maintain flows, flow variability and water levels necessary to safeguard the life supporting capacity, ecosystem processes, indigenous species and the associated ecosystems of freshwater.*

Objective 3.5 Enabling economic wellbeing *Northland's natural and physical resources are sustainably managed in a way that is attractive for business and investment that will improve the economic wellbeing of Northland and its communities.*

Objective 3.10 Use and allocation of common resources *Efficiently use and allocate common natural resources, with a particular focus on:*

(a) Situations where demand is greater than supply;
(b) The use of freshwater and coastal water space; and
(c) Maximising the security and reliability of supply of common natural resources for users.

Water and Soil Plan for Northland 2014 (Updated 2016)

Recognition of and provision for Maori and their culture and tradition

Objective 6.3.1 *The management of the natural and physical resources within the Northland region in a manner that recognises and provides for the traditional and cultural relationships of tangata whenua with the land and water.*

Policy 6.4.1 *To recognise and, as far as practicable provide for the relationship of Maori and their culture and traditions with respect to the use, development and protection of natural and physical resources in the Northland region.*

Policy 6.4.2 *To gain an understanding, and as far as practicable, provide for the concerns and cultural perspectives of tangata whenua in regard to the disposal of waste into water.*

Water Quality Management

Objective 7.4.1 *The maintenance or enhancement of the water quality of natural water bodies in the Northland region to be suitable, in the long-term, and after reasonable mixing of any contaminant with the receiving water and disregarding the effect of any natural events, for such of the purposes listed below as may be appropriate: Groundwater, potentially usable: water supply, protection of uses of receiving water body.*

Groundwater Management

Objective 10.4.1 *The sustainable use and development of Northland's groundwater resources while avoiding, remedying or mitigating actual and potential adverse effects on groundwater quantity and quality.*

Objective 10.4.2 *The sustainable management of groundwater resources in conjunction with the sustainable management of surface water resources.*

Objective 10.4.3 *The management of groundwater resources so that the potential adverse effects of land subsidence are avoided.*

Integrated Catchment Management

Objective 13.3.1 *Integrated catchment management to achieve the sustainable use of all resources and the minimisation of conflicts*

Policy 13.4.4 *To integrate the findings of research and monitoring of land use effects on water quantity into water resource management.*

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Objective F1.1 Freshwater quantity *Manage the taking, use, damming and diversion of fresh water so that:*

1) *the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water are safeguarded and the health of freshwater ecosystems is maintained, and*
2) *the significant values, including hydrological variation in outstanding freshwater bodies and natural wetlands are protected, and*
3) *the extent of littoral zones in lakes are maintained, and*
4) *rivers have sufficient flows and flowvariability to maintain habitat quality, including to flush rivers of deposited sediment and nuisance algae and macrophytes and support the natural movement of indigenous fish and valued introduced species such as trout, and*
5) *flows and water levels support sustainable mahinga kai, recreational, amenity and other social and cultural values associated with freshwater bodies, and*
6) *adverse effects associated with saline intrusion and land subsidence above are avoided (except where the taking, use, damming or diversion is for groundwater management at the Marsden Point refinery, in which case this clause does not apply), and*
7) *it is a reliable resource for consumptive and non-consumptive uses.*

Objective F.1.2 Water quality *Manage the use of land and discharges of contaminants to land and water so that:*

1) *existing water quality is at least maintained, and improved where it has been degraded below the river, lake or coastal water quality standards set out in H.3 Water quality standards and guidelines, and*

2) *the sedimentation of continually or intermittently flowing rivers, lakes and coastal water is minimised, and*
3) *the life-supporting capacity, ecosystem processes and indigenous species, including their associated ecosystems, of fresh and coastal water are safeguarded, and the health of freshwater ecosystems is maintained, and*
4) *the health of people and communities, as affected by contact with fresh and coastal water, is safeguarded, and*
5) *the health and safety of people and communities, as affected by discharges of sewage from vessels, is safeguarded, and*
6) *the quality of potable drinking water sources, including aquifers used for potable supplies, is protected, and*
7) *the significant values of outstanding freshwater bodies and natural wetlands are protected, and*
8) *kai is safe to harvest and eat, and recreational, amenity and other social and cultural values are provided for.*

Objective F.1.4 Enabling economic well-being *Northland's natural and physical resources are managed in a way that is attractive for business and investment that will improve the economic well-being of Northland and its communities.*

Objective F.1.8 Tangata whenua role in decision-making *Tangata whenua's kaitiaki role is recognised and provided for in decision-making over natural and physical resources.*

Policy D.4.1 Maintaining overall water quality *When considering an application for a resource consent to discharge a contaminant into water:*

1) *have regard to the need to maintain the overall quality of water including the receiving water's physical, chemical and biological attributes and associated water quality dependent values, and*
2) *have regard to the coastal sediment quality guidelines in H.3 Water quality standards and guidelines, and*
3) *generally not grant a proposal if it will, or is likely to, exceed or further exceed a water quality standard in H.3 Water quality standards and guidelines.*