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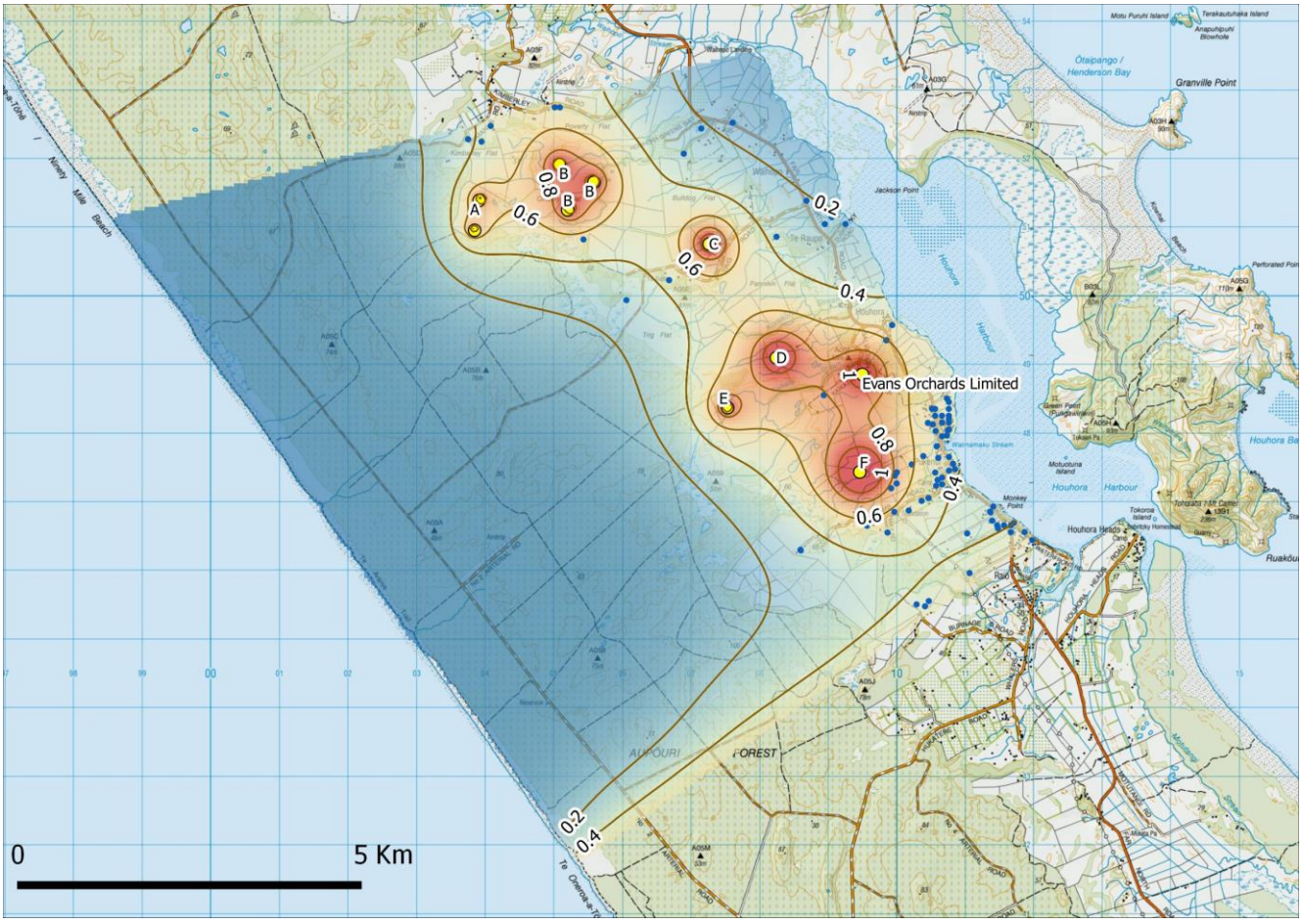
Irrigation Water Take Consent

Resource Consent Application & Assessment of Environmental Effects

NE EVANS TRUST

WWA0044 | Rev. 5

13 June 2018



Irrigation Water Take Application

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4	11 May 2018	Draft for client review	Hangjian Zhao, Jessie Loft and Jon Williamson		Jon Williamson
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4	11 May 2018	Jeremy Evans	Draft for client review
5	13 June 2018	Northland Regional Council	Submission of consent application.

Contents

1. Introduction

This document and attachments comprise a Resource Consent Application and an Assessment of Environmental Effects associated with a water take permit for irrigation of a 40-canopy hectare avocado orchard development at Salvation Road Houhora on behalf of NE Evans Trust (NEET).

Appendix A provides background details of this application using Northland Regional Council's(NRC) "Application for Resource Consent" form. Further details of various items where marked on the form are provided in **Section 2**.

1.1 Report Structure

The report comprises:

- **Section 2** – a description of the proposed activity and suggested consent conditions;
- **Section 3** - background details of the application;
- **Section 4** – an assessment of environmental effects;
- **Section 5** – an assessment of cultural effects;
- **Section 6** - an assessment of statutory considerations;
- **Section 7** – a discussion of the notification process;
- **Section 8** – a discussion of consultation.

2. Description of Proposed Activity

2.1 Location

Figure 1 provides a map of the project area. The property is located at 4355 Far North Road Houhora and is approximately 176 hectares in total area. The proposed production bore is located on Salvation Road Houhora (see **Appendix A**).

Figure 1. Project locality map.

2.2 Description of Proposed Activity

The resource consent application for NEET is to take and use groundwater from a new bore to irrigate a proposed avocado orchard with a Total Orchard Area[1] of 67 hectares. The total property area, as shown in purple in **Figure 1**, is 176.4 hectares and currently comprises dry stock farming and plantation forestry land uses.

[1] Total Orchard Area was selected as the metric for application of irrigation water. The volume of water selected to be applied to this area was 25 m^3/ha/day. See paragraphs 132 and 133 of the Commissioners Decision (June 2018) on the 17 groundwater take applications for the Motutangi-Waiharara Water User Group. In that report they defined the Total Orchard Area as the area where the canopy occupies 80%, however in this property the canopy will represent 60% of the Total Orchard Area.

The groundwater take will be exercised from October to April, in accordance with the following volumes:

- Maximum daily volume of 1,675 m^3/day; and
- Maximum annual volume of 160,000 m^3/yr.

The maximum daily volume has been calculated at 25 m^3/ha/day over the Total Orchard Area.

The maximum annual volume has been calculated from the canopy area, which for this orchard (given the topographic constraints) is 60% of the Total Orchard Area or 40 hectares. The maximum annual volume has been calculated on the basis of approximately 400 mm/annum, which is consistent with the Council Officers' recommendation in the MWWUG Hearing.

2.3 Consent Duration, Lapse and Review

A consent duration of 30 years is sought subject to a lapse period of 5 years from commencement of consent, and review conditions have been proposed for the purposes laid out in **Section 2.4**.

2.4 Proposed Consent Conditions

This section contains the proposed conditions for the water permit sought by the Applicant.

Water Extraction Volumes

1. The rate of take shall not exceed the limits set out as follows:
   (a) Maximum daily volume of 1,675 m^3/day (being any 24 consecutive hours); and
   (b) Maximum annual volume of 160,000 m^3/annum (being 1 July to 30 June).

Notification of Irrigation

2. 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 days beforehand.

Metering and Abstraction Reporting

3. The Consent Holder shall install a meter 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 the purposes of undertaking visual inspections and water take measurements.
4. The Consent Holder shall verify that the meter required by Condition 3 is accurate. This verification shall be undertaken prior to 30 June:
   (a) Following the first taking of water from each production bore; 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 by 31 July following the date of each verification.

5. The Consent Holder shall, using the meter required by Condition 3, keep a record of the daily volume of water taken from each production bore in cubic metres, including all nil abstractions.
6. If the instantaneous rate of taking is equal to or greater than 10 litres per second, then the water meter required by Condition 3 shall have an electronic datalogger for automatic logging of meter data. A copy of the electronic data records shall be forwarded to Council's assigned Monitoring Officer by the 7th of the following month, and immediately on written request from the assigned monitoring officer.
7. The Consent Holder shall measure, and keep a record of, the static water level in each production bore at least once each month. This measurement shall be taken at least eight hours after cessation of pumping. The Consent Holder shall also monitor electrical conductivity at least once a month during any irrigation season when the bore is in use.
8. A copy of the records required to be kept by Conditions 5, 6 and 7 for the period 1 July to 30 June (inclusive) shall be forwarded each year to the Council's assigned Monitoring Officer by the following 31 July. In addition, a copy of these records shall be forwarded immediately to the Council's Compliance Manager 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 the period 1 July to 30 June (inclusive) 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.
9. Easy access for a water level probe shall be provided and maintained at the production bore wellhead to enable the measurement of static water levels in the bore.

Water Use Efficiency

10. The Consent Holder shall prepare an Irrigation Scheduling Plan (ISP) that outlines how irrigation decisions will be made. The ISP shall be prepared by a suitably qualified and experienced person and submitted to the Council's Compliance Manager for written approval. 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 requirement for each irrigation cycle is calculated;
    (b) Method(s) for assessing current soil moisture levels;
    (c) Method(s) for assessing potential evapotranspiration (PET) and rainfall to date;
    (d) Assessment of other inputs such as effluent irrigation and effect on irrigation requirement;
    (e) Soil moisture target to be maintained in each zone by irrigation;
    (f) How measured data will be used to assess irrigation requirements over the next irrigation cycle; and
    (g) A description of proposed method(s) for remaining within consent limits at each borehole or group of boreholes.

    Advice Note: The ISP seeks to ensure that an irrigation efficiency of a minimum 80% is achieved.
11. The Consent Holder shall not exercise this consent until the ISP required by Condition 10 has been certified by the Council's Compliance Manager.
12. The ISP certified in accordance with Condition 11 shall be implemented prior to the first irrigation season, unless a later date has been approved in writing by the Council's Compliance Manager.

13. The Consent Holder shall, within six months of the first exercise of this consent, undertake an audit of the irrigation system and the ISP described in Condition 10 using 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), including recommendations on any improvements that should be made to the system to increase water efficiencies. 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. A follow-up audit shall occur at five yearly intervals throughout the term of this consent, with a focus on the efficiency of water use.
14. 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 13.
15. The reticulation system and components shall be maintained in good working order to minimise leakage and wastage of water.
16. here shall be no significant ponding of irrigated water within any irrigated area, or significant runoff from either surface or subsurface drainage to a water body, as a result of the exercise of this consent.

Review Condition

17. 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 June 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 review the allocation of the resource.

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

Lapsing Condition

18. This consent shall lapse on the **30 June 2023**, unless before this date the consent has been given effect to.

    Advice Note: An application can be made to the Council in accordance with Section 125 of the Act to extend the date after which the consent lapses. Such an application must be made before the consent lapses.

EXPIRY DATE: 30 June 2048

3. Background Information

3.1 Site Conditions

3.1.1 Soils

There is no Landcare Research S-map soil data available for this site, however there is Fundamental Soil Layer information, pre-dating S-Map, which describes the soils around the property as having slow permeability densipan podzol[2], high groundwater table gley soils[3], and brown soils[4]. These soils display the following properties:

- ***Physical properties*** – Densipan podzol are commonly cemented or compacted B horizons which relates to the slow permeability of the soil and its limited root depth, there is extreme limitations for arable use. Gley soils have high groundwater-tables and shallow potential rooting depth (drainage in these soils is necessary for most agricultural developments). Brown soils are relatively stable topsoils with a well-developed structure.
- ***Chemical properties*** - Densipan podzol are highly acidic which secondary clays and minerals strongly differentiating with depth. Densipan podzol and gley soils have generally of very low natural fertility. Gley soils are associated with high organic matter. While brown soils have low to moderate base saturation.
- ***Biological properties*** – Densipan podzol have generally low biological activity, Gley soils organisms are restricted due to the anaerobic conditions and result in slow decomposition rates. Brown soils are associated with high biological activity (earthworms are prominent).

3.1.2 Geology

The property is underlain by the Aupouri Aquifer – an extensive sequence of sand, peat and shellbed that covers an area of approximately 79,000 ha extending from Ahipara in the south to Ngataki in the north. The aquifer is underlain by older low permeability Cenozoic and Mesozoic age basement rocks.

Fine sand is the dominant sediment within the Aupouri Aquifer, which vary in thickness from a few meters near the hard rock boundaries to over 100 m in some places. The sand sequence is interspersed with multiple discontinuous layers of alternating iron pan (sand stone), clay and peat, which reside across the entire peninsula typically in the upper portion of the aquifer. These deposits are associated with ancient wetlands.

The aquifer is underlain to the east by volcanic basement rocks that outcrop forming Mount Camel. These rocks most likely extend at some depth across the subsurface of the Aupouri Peninsula together with greywacke, argillite and indurated conglomerate deposits of the same age.

3.1.3 Hydrogeological Interpretation

The surficial sand deposits generally become progressively younger, unconsolidated and mobile towards the west. These younger sands have higher permeability than the sands in the east, which tend to be more weathered and contain cemented iron pans close to the surface.

With increasing depth, the presence of shell-rich sands increases, which is important from a water yield perspective as the shellbeds typically have significantly higher hydraulic conductivity (ability to transmit water) than the finer sands. The shellbed is the target aquifer for orchard irrigation water and typically resides at depths from 70 – 140 m below ground level.

All the basement rocks in the area are known to be low permeability.

[2] https://soils.landcareresearch.co.nz/describing-soils/nzsc/soil-order/podzol-soils/
[3] https://soils.landcareresearch.co.nz/describing-soils/nzsc/soil-order/gley-soils/
[4] https://soils.landcareresearch.co.nz/describing-soils/nzsc/soil-order/brown-soils/

3.1.4 Irrigation Requirements

The peak water requirement is 41.6 m^3/day per canopy hectare, which is equivalent to 4.16 mm per day. The irrigation requirement was simulated on a daily basis with the Soil Moisture Water Balance Model (SMWBM) using historical rainfall and evaporation data from 1957 to 2016. The simulation results are portrayed statistically on a monthly basis in **Figure 3**, which is a box and whisker plot showing the monthly median, lower quartile (25th percentile), upper quartile (75th percentile) and minimum and maximum recorded monthly values. The graph shows the seasonal irrigation profile and likelihood of water requirements each month.

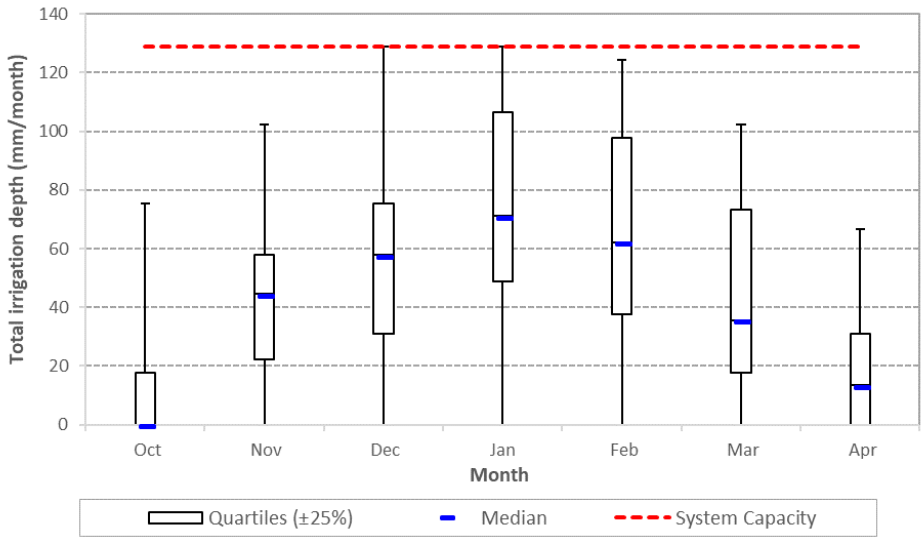

Figure 2. Simulated monthly statistical irrigation profile.

During the irrigation season, the rate of application will remain the same, but the number of days between irrigation events will increase during the shoulders of the season (i.e. the frequency of irrigation events are typically less in spring and autumn), which is exemplified in the monthly statistics shown in **Figure 3**.

Table 2 provides information on the frequency of monthly irrigation requirements and the number of days irrigation is likely required. The 1-year recurrence interval represents the typical monthly requirements and indicates that on average irrigation will not be required in October and April, and between November and March will vary from 18 mm to 47 mm per month.

In a 10-year drought year, the irrigation requirement for the season is likely to approximately 400 mm, with peak monthly totals up to approximately 120 mm, hence the amount of water being applied for is adequate to fully meet the requirements up to the 10-year drought.

Table 1. Frequency of monthly and annual irrigation requirements (mm) and days of irrigation [days].

Average Recurrence Interval	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Annual
1 yr	0 [0]	23 [6]	31 [7]	47 [11]	40 [10]	18 [4]	0 [0]	250 [60]
2 yr	0 [0]	44 [11]	58 [14]	69 [17]	62 [15]	36 [9]	16 [4]	307 [74]
4 yr	18 [4]	58 [14]	76 [18]	107 [26]	98 [24]	74 [18]	31 [7]	369 [89]
5 yr	18 [4]	62 [15]	76 [18]	107 [26]	98 [24]	80 [19]	40 [10]	382 [92]
10 yr	31 [7]	76 [18]	104 [25]	117 [28]	116 [28]	84 [20]	50 [12]	401 [96]
100 yr	53 [13]	102 [25]	124 [30]	129 [31]	124 [30]	100 [24]	64 [15]	545 [131]

Table 2 provides the orchard water balance under dryland and irrigated conditions and **Figure 3** shows the mean monthly seasonal breakdown of this data. The data represents the mean annual water balance components from the 59-year simulation. It is evident that under the irrigated orchard profile, soil moisture content typically resides at a higher status (which is the intention) during summer, and surface runoff, sub-soil drainage, soil evaporation and canopy interception all increase.

However, avoidable losses due to surface runoff have not change appreciably, and the additional runoff that has occurred is due to rainfall excess rather than too much irrigation, demonstrating that the irrigation applications of 4.16 mm/day are efficient.

Table 2. Summary of average annual water balance components under irrigated and unirrigated profiles (mm/yr unless specified otherwise).

Annual Average	Dryland	Irrigated
Average Soil Moisture Content (mm)	92	104
Sub-Soil Drainage	452	522
Surface Runoff	93	105
Soil ET	467	547
Canopy Interception	179	284
TOTAL	1,191	1,458

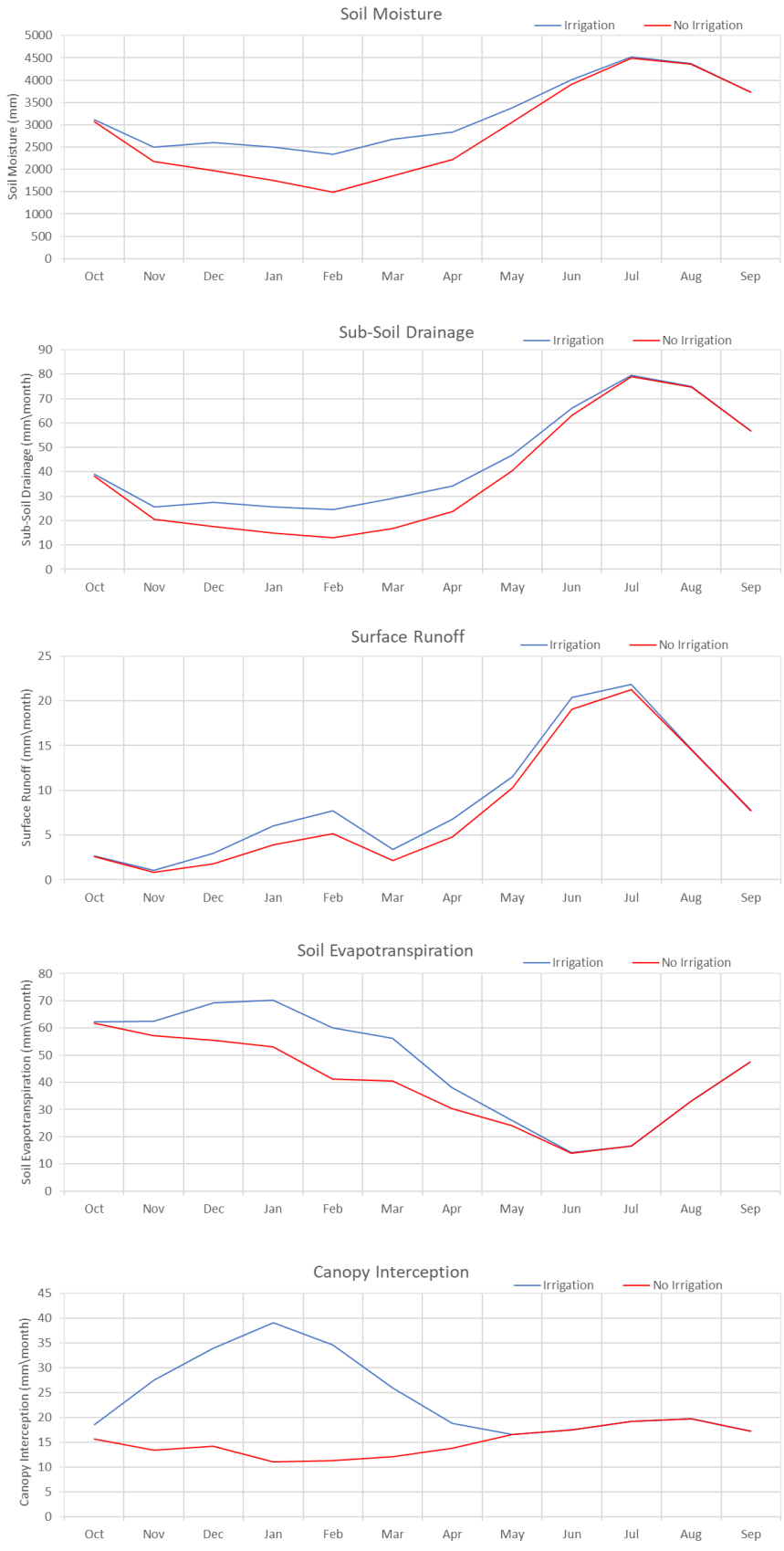

Figure 3. Comparison of water balance components.

3.2 Neighbouring Bore Information

There are 51 bores registered within the NRC database within a 2 km radius of the Evans Orchard site (**Figure 4**). Statistics on the 51 bores are as follows:

- 48 are active, 3 are pending and one has no information attached.
- The bores range in depth from 0 m to 116 m with an average of 46.7 m.
- There is only one bore over 100 m in depth.
- 35 bores have information attached in terms of the purpose of the bores:
    - 28 are for domestic purposes;
    - two are for private water supply;
    - two are for stock use;
    - two for irrigation; and
    - one for commercial use.

There are nine proposed bores within Te Raite Station, which neighbours Evans Orchard to the west of the proposed bore (**Figure 5**). These proposed bores have been allocated into proposed irrigation zones, which correspond to the proposed irrigation amounts listed in **Table 3**. Three of these bores are located within a 2 km radius of the Evans Orchard bore (Zone D, E and F).

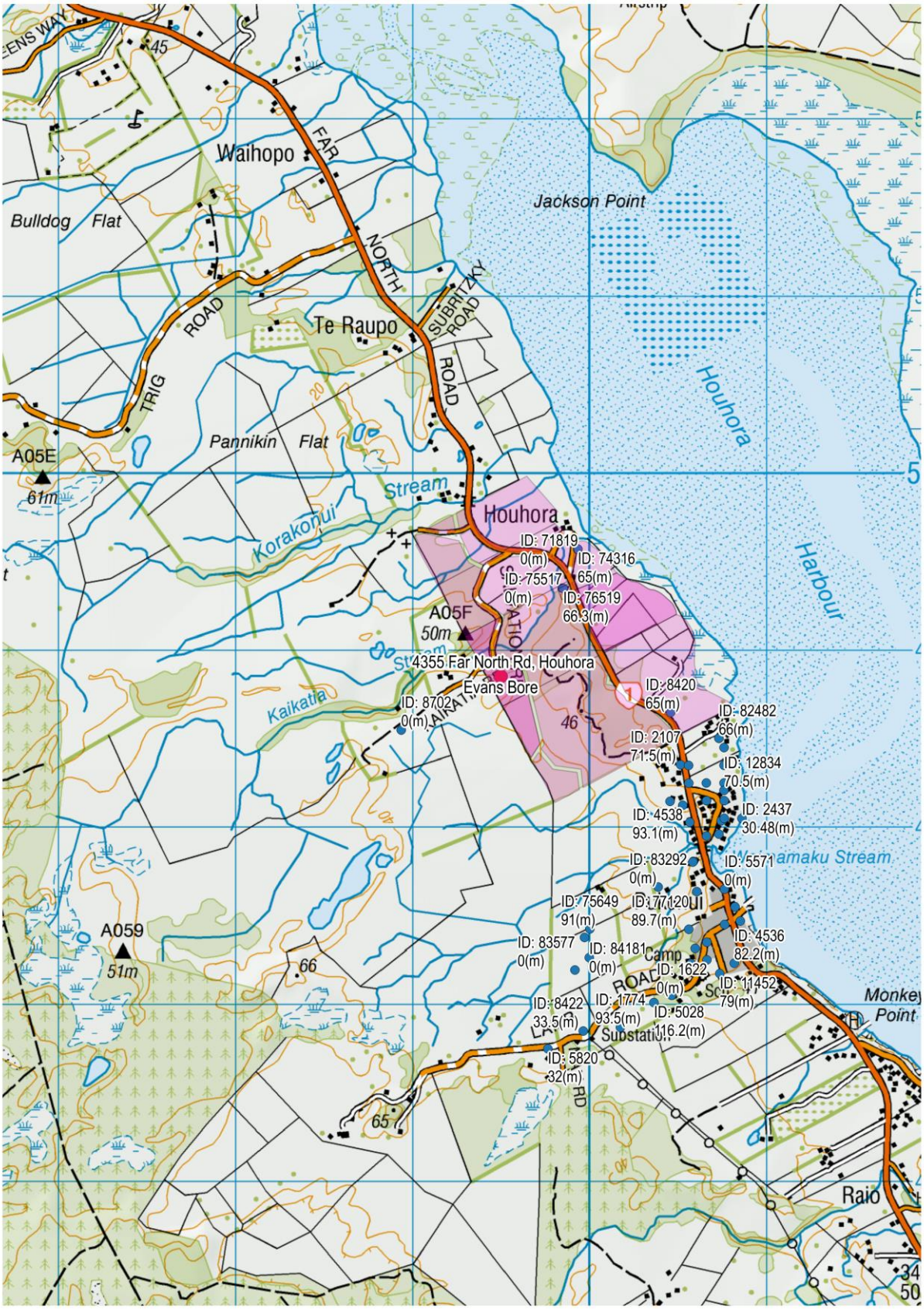

Figure 4. Neighbouring bores map.

Figure 5. Proposed bores and NRC Aupouri Sub-Aquifer allocation zones.

Table 3. Te Raite Station Proposed Bores (taken from OPUS, February 2018. Assessment of Environmental Effects; Application for Water Permit to take and use groundwater).

Zone	Locality	Gross Area (h)	Intended Irrigable area (ha)	Intended Use	Per hectare rate (m^3/ha/yr)	Nominal Rate of Take (m^3/year)	Peak daily Rate (mm/day)
A	Kimberly Flat	38	35	Horticulture	4,500	157,500	4
B	Cendery Flat	93	60	Cropping / Horticulture	4,500	270,000	4
C	Trig-Bulldog Flat	54	40	Cropping / Horticulture	4,500	180,000	4
D	Korakonui Str.	60	40	Cropping / Horticulture	4,500	180,000	4
E	Kaikatia Stream	29	25	Horticulture	4,500	112,500	4
F	Lamb Road	103	60	Cropping / Horticulture	4,500	270,000	4
Total		**377**	**260**			**1,170,000**	

3.3 Relevant Statutory Documents

3.3.1 Section 104(1)(b) of the RMA

Schedule 4 of the RMA requires that when applying for a resource consent for any activity an assessment of activities against the matters in any relevant provisions of a statutory document referred to in s104(1)(b) of the RMA must be provided. These matters are described below and **Section** Error! Reference source not found. provides an assessment against the relevant documents.

The documents referred to in Section 104(1)(b) of the RMA are:

19. a national environmental standard;
20. other regulations;
21. a national policy statement;
22. a New Zealand coastal policy statement;
23. a regional policy statement or proposed regional policy statement;
24. a plan or proposed plan;

The following section provides details of the relevant Regional Planning provisions, while assessment of which documents listed is above are relevant is provided in **Table 14**.

Table 4. Summary of relevance of Section 104 statutes.

Statute	Relevance	Requirement of Statue
National Environmental Standards	There are no national environmental standards that are applicable to the proposed activity.	None
Resource Management (Measurement and Reporting of Water Takes) Regulations 2010	This regulation applies to a water permit that allows fresh water to be taken at a rate of 5 litres/second or more and is consumptive. Therefore, this regulation is relevant for this water take consent.	In summary, the regulations require permit holders to keep records that provide continuous measurement of the water taken under a water permit, including water taken in excess of what the permit allows. These records are to comprise measurements of the volume of water taken each day (in cubic metres) or each week (if approved by the Regional Council), and must be in an appropriate format for auditing, and in a form suitable for electronic storage. The regulations also specify the required accuracy of any metering device (to within ±5% of the actual volume taken if from a full pipe (e.g. bore)).
National Policy Statement for Freshwater Management 2014	The following objectives and policies of the NPS are relevant to this proposal: *Water Quality* • Objectives A1, A2, andA4. • Policies A2, A3, and A7. *Water Quantity* • Objective B2, B3 and B5. • Policies B2 to B6. *Integrated Management* • Objective C1. • Policies C1 and C2.	*Water Quality* • Objective A1 seeks to safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the use and development of land, and of discharges of contaminants. • Objective A2 required that the overall quality of fresh water within a region is maintained or improved while improving the quality of fresh water in water bodies that have been degraded by

Statute	Relevance	Requirement of Statue
		human activities to the point of being over-allocated. • Objective A4 seeks to enable communities to provide for their economic well-being, including productive economic opportunities. • Policies A2, A3, and A7 are considered relevant to this application and give effect to Objectives A1, A2, A4. *Water Quantity* • Objective B2 seeks to avoid any further over-allocation of fresh water and phase out existing over-allocation. • Objective B3 seeks to improve and maximise the efficient allocation and efficient use of water. • Objective B5 seeks to provide for communities' economic wellbeing within freshwater quantity limits. • Policies B2 to B6 are considered relevant to this proposal. *Integrated Management* • Objective C1 seeks 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. • Policies C1 and C2 are relevant to this application and give effect to Objective C1.
Regional Policy Statement for Northland	The Regional Policy Statement (RPS) was made operative on 9 May 2016. The RPS provides a broad direction and framework for managing Northland's natural and physical resources. These include land, water, air, soil, minerals, plants, animals and all built structures. The following Objectives are considered relevant to this proposal: • Objective 3.2, 3.3, 3.5, and 3.10. The following Policies give effect to the above Objectives, and therefore are considered relevant to this application: • Policy 4.3.2, 4.3.3.	• Objective 3.2 seeks to maintain and improve water quality for human use and ecological health. • Objective 3.3 seeks to safeguard the flows and flow variability required to maintain water's life-supporting capacity, for ecological processes, and to support indigenous species. • Objective 3.5 requires that the region's resources are sustainable managed in a way that is attractive for business and investment that will improve the economic wellbeing of the region and its communities. • Objective 3.10 requires efficient use and allocation of common natural resources with a particular focus on maximising the security and reliability of supple for users. • Policy 4.3.2 requires regulatory methods to avoid over-allocation of region-wide ecological flows and water levels. • Policy 4.3.3 requires the allocation and use of water efficiently within allocation limits.
Regional Plans	The Proposed Regional Plan for Northland (pRPN) sets out policies and rules for how Northland's water, soil, air and coast are used and was publicly notified on 6	From the pRPN: • Objective F.0.1 seeks to manage the use, development, and protection of Northland's natural

Statute	Relevance	Requirement of Statue
	September 2017 and closed for submissions on 26 March 2018. The pRPN will replace the Regional Water and Soil Plan for Northland (RWSPN), which has been operative since 28 August 2004. At present, the rules in both these plans have legal effect, with weight given to whichever plan has the more restrictive rule for the same activity if there is a conflict between the two plans, or the later plan if no submissions were received on certain aspects. Both plans address groundwater abstractions that have the potential to adversely affect the environment. However, there are no specific aquifer allocation limits set in the RWSP. The following objectives and policies of the pRPN are considered relevant to this proposal: • Objective F.0.1. • Policy D.2.2. • Policy D.2.5. • Policy D.4.5. • Policy D.4.13. • Policy D.4.17. • Policy D.4.18. • Policy D.4.20. • Policy D.4.23. The following objectives and policies of the RWSPN are considered relevant to this proposal: • Objective 7.4. • Objective 10.4.1. • Policy 10.5.1. • Policy 10.5.2. • Policy 10.5.4. • Policy 10.5.7. • Policy 10.5.9	and physical resources which enables people and communities to provide for their social, economic and cultural well-being while 1. sustaining the natural resources to meet the reasonable foreseeable needs of future generations, 2. safeguarding life-supporting capacities of water, and 3. avoiding, remedying, or mitigating adverse effects on the environment. • Policy D.2.2 requires that regard is had to the social, cultural, and economic benefits of the proposed activity when considering resource consents. • Policy D.2.5 requires an authority to have regard to community and tangata whenua values • Policy D.4.5 seeks to maintain overall water quality. • Policy D.4.13 seeks to achieving freshwater quantity related outcomes and inn particular manage the taking, use, damming, and diversion of fresh water so that (with relevance to this application) saline intrusion in, and land subsidence above, aquifers is avoided (amongst other things). • Policy D.4.17 considers allocation limits for aquifers and requires rules and applications to meet allocation limits • Policy D.4.18 concerns conjunctive surface water and groundwater management. • Policy D.4.20 requires the reasonable and efficient use of water for irrigation and sets requirements for a resource consent application to take water for irrigation purposes. • Policy D.4.23 From the RWSPN: • Objective 7.4 requires the maintenance or enhancement of water quality of natural water bodies. • Objective 10.4.1 maintains the sustainable use and development of the region's groundwater resources while avoiding, remedying, or mitigating actual and potential adverse effects on groundwater quantity and quality. • Policy 10.5.1 seeks to ensure the sustainable use of resources by avoiding takes that exceed recharge. Saltwater intrusion, reduced groundwater quality, significant drawdown, and adverse effects on surface water resources can arise where takes exceed recharge.

Statute	Relevance	Requirement of Statue
		• Policy 10.5.2 recognises that aquifers are at risk in certain circumstances and that adverse effects on water quality should be avoided. • Policy 10.5.4 seeks that groundwater allocations take into account reduction in recharge that may occur in time. • Policy 10.5.7 requires the Northland Regional Council to consider effects of a groundwater take and use on surface water bodies. • Policy 10.5.9 seeks to avoid, remedy or mitigate any ground subsidence as a result of groundwater takes, use or diversion, where this is likely to cause adverse flooding, drainage problems, or building damage.

3.3.2 Activity Status

The activity status of the proposed activity under both the RWSPN and pRPN is considered a discretionary activity – details of this conclusion are summarised in **Table 14**.

Table 5. Summary of activity status against Regional Plan Provisions.

Plan	Relevant Rules	Comment
RWSPN	Rule 25.03.01 of the plan states that "The taking, use or diversion of groundwater from an aquifer, and any associated discharge of groundwater onto or into land or into water, which does not meet the requirements of the permitted, controlled or non-complying activity rules is a discretionary activity." In essence, the discretionary activity rule is for takes that are not for domestic or stock watering purposes (Rule 25(A)) and exceed the permitted activity thresholds (Rule 25.01.01) of a daily volume of 10 m3/d and instantaneous rate of 5 L/s per bore.	Under this plan and until such time as the equivalent provisions within the Proposed Regional Plan for Northland (pRPN) are no longer contested, the proposed activity would be considered Discretionary Activity.
pRPN	Rule C.5.1.10 states that the taking and use of fresh water is a discretionary activity unless it is one of the following: 1) a permitted activity under C.5.1.1 'Minor takes – permitted activity', or 2) a permitted activity under C.5.1.2 'Temporary take for road construction or maintenance – permitted activity', or 3) a permitted activity under C.5.1.3 'Water take from an off-stream dam – permitted activity', or 4) a permitted activity under C.5.1.4 'Water take from an artificial watercourse – permitted activity', or 5) a permitted activity underC.5.1.5'Water take associated with bore development, bore testing or dewatering – permitted activity', or 6) a controlled activity under C.5.1.6 'Replacement water permits for registered drinking water supplies - controlled activity', or 7) a controlled activity under C.5.1.7 'Takes existing at the notification date of the plan - controlled activity', or	The proposed groundwater take does not conform to any of the activities in listed in 1) to 10) above, and as indicated in the following Section **3.3.3** does not exceed an allocation limit, therefore the proposed activity constitutes a Discretionary Activity under the pRPN.

	8) a restricted discretionary activity under C.5.1.8 'Supplementary allocation – restricted discretionary activity', or 9) a discretionary activity under C.5.1.9 'Takes existing at the notification date of this plan – discretionary activity', or 10) a non-complying activity under C.5.1.11 'Water take below a minimum flow or water level-non-complying activity', or 11) a non-complying activity under C.5.1.12 'Water take that will exceed an allocation limit - non-complying activity', or 12) a prohibited activity under C.5.1.13 'Water takes that will exceed an allocation limit - prohibited activity'.	

3.3.3 Allocation Zones

Under the pRPN, the Aupouri Peninsula Aquifer is divided into allocation zones for management purposes. NEET sits within the Aupouri-Houhora allocation zone (**Figure 5**) and **Error! Reference source not found.** summarises the allocation status for this zone. As indicated above, there are three proposed bores from Te Raite Station that also fall within the Aupouri-Houhora allocation zone (Zone D, E, and F).

The NEET proposed take of 160,000 m^3/year represents 7.5% of the allocation limit. The proposed Te Raite Station takes that are within the Aupouri-Houhora allocation zone comprise 562,500 m^3/year or 26% of the annual allocation limit. Collectively, these takes equate to 33.5% of the allocation limit and if granted would take the allocation status up to almost 100% of full allocation.

However, it is also understood the allocation limit has been contested in submissions on the pRPN on the basis that the current level of allocation is only approximately 11% of annual recharge, which is too low in the context that default allocation limits for aquifers are typically 35% of mean annual rainfall. WWA understand that there have been no submissions that seek to lower the allocation limits, hence any justified changes to the pRPN would only increase the allocation limit.

Table 6. Aupouri-Houhora Water Management Zone Aquifer Limits[5] and Allocation Status (according to the proposed Regional Plan for Northland (pRPN)).

Sub-aquifer	Allocation Limit		Current Allocation	Consents in Process[6]	Allocation Potentially Available	
	m^3/year	% ann. ave. recharge	m^3/year			%
Aupouri-Houhora	2,141,300	11	1,045,494	374,983	720,823	34

[5] According to NRC's allocation maps at http://gis.nrc.govt.nz/LocalMaps-Viewer/?map=895e0785f7054d47b10a72edc38022dc
[6] From Table 1 in Northland Regional Council Staff Report Application No. REQ-581172 for Motutangi-Waiharara Water Users Group.

4. Assessment of Environmental Effects

The impact on groundwater and surface water baseflow was assessed based on the simulation results from a groundwater flow model, which is detailed in **Appendix B.** The assessment of environmental effects has considered the effects that materialise at the end of a period of 96 days without rainfall and with the maximum allowable abstractions for the following:

- existing consents and domestic takes (1,424 m^3/day; 149,935 m^3/annum); and
- ongoing consent applications in the zone, including the Te Raite station (12,187 m^3/day; 1,170,000 m^3/annum) and NEET (1,675 m^3/day, 160,000 m^3/annum).

The environmental effects discussed below are considered conservative for the proposed groundwater take.

4.1 Pumping Interference Effects

Pumping interference effects were assessed by analysing the drawdown after 96-days of continuous pumping at the maximum rate under a low leakage scenario. The effects were assessed at 88 bores that are located in the model domain. The potential drawdown at these neighbouring bore locations due to the additional pumping ranges from 0.2 m to 0.8 m, as shown in **Appendix B.**

The magnitude of impact is not significant and unlikely to affect the ability of existing groundwater users to continue withdrawing water (assuming the bores are currently operational). The interference effects on existing groundwater users in the context of available drawdown of the aquifer is considered less than minor.

4.2 Surface Water Effects

The impact on surface water was assess by comparing the model water budget after 96-days of continuous pumping under a leaky aquifer scenario, which for assessment of surface water effects purposes, is the more conservative of the two model scenarios simulated. As discussed in **Appendix B,** the reduction in surface drain flow component is less than 1% due with a pumping rate of 15,275 m^3/day.

In conclusion, the surface water effects from the additional pumping will be less than minor.

4.3 Saline Intrusion

Saltwater upconing and potential lateral migration were analysed using the Ghyben-Herzberg relationship (**Appendix B**). The maximum drawdown in the shellbed aquifer under low-leakage (Scenario B) was 0.9 m, which equates to a 36 m potential rise of the saltwater/fresh water interface. However, the position of the saline interface is approximately >400 m below mean sea level, which means that the potential rise is insignificant because the position of the interface will remain below the base of the shellbed aquifer.

The potential lateral migration of the saline interface was discussed in detail in **Appendix B**, the elevation of Aupouri aquifer base ranges between -90 mAMSL and -30 mAMSL from south to north along the east coastline, and the minimum pressure required to prevent the saline water migrating laterally inland ("Trigger Level") was calculated at between 0.75 mAMSL to 2.25 mAMSL. Under a low-leakage scenario, the simulated pressure along the east coastline ranged between 9 mAMSL to 12 mAMSL, which is significantly high enough to prevent the saline water lateral migration along the base of the shellbed. The impact on saline/freshwater interface and risk of saline water lateral migration will be less than minor.

4.4 Ground Settlement

Groundwater settlement was calculated using the Bouwer (1977)[7] equation:

$$S_u = (P_{i2} - P_{i1})\frac{Z_1}{E}$$

where S_u = vertical subsidence (m)
$P_{i2} - P_{i1}$ = Increase in intergranular pressure due to drop of the water table
Z_1 = layer thickness
E = modulus of elasticity of the soil

The following characteristics were assumed for the aquifer:

- Porosity = 0.25
- Unsaturated water content = 0.08
- Specific weight of aquifer material (consolidated silty sand) = 20 kN/m^3 (Silty sand density ranges between 1,410 kg/m^3 and 2,275 kg/m^3[8], corresponding to specific weight of 14 kN/m^3 and 22 kN/m^3)
- Specific weight of water = 9.81 kN/m^3.

The deep shellbed material is denser and less compressible compared to the mixture of sand, silt and peat overlying above. The subsidence analysis was conducted using three separate layers representing the conceptual hydrogeological units of the sub-surface environment, and the parameter values used are shown in **Table 7.**

Table 7. Elasticity and depth of each zone for subsidence estimate.

Stratigraphy	Total depth	Modulus of elasticity (kPa)*
Silty sand (unsaturated zone)	25	10,000
Silty sand (saturated zone)	50	20,000
Shellbed (saturated zone)	25	50,000

* Modulus of elasticity (E) was sourced from Bouwer,1977

Table 8. Modulus of elasticity [E] for unconsolidated materials (Bouwer, 1977).

Material	E (kg/cm^2)	E (kPa)
Peat	1 – 5	98 – 490
Loose clay	10 – 50	981 – 4,903
Medium clay and silt	50 – 100	4,903 – 9,807
Dense clay and silt	100 – 1,000	9,807 – 98,067
Loose sand	100 – 200	9,808 – 19,613
Dense sand	500 – 2,000	49,033 – 196,133
Dense gravel and sand	2,000 – 10,000	196,133 – 980,665

[7] Bouwer, H., 1977. Land Subsidence and Cracking Due to Ground-Water Depletion. Ground Water 15, 358–364. doi:10.1111/j.1745-6584.1977.tb03180.
[8] Density ranges for different soil types: http://structx.com/Soil_Properties_002.html

Based on the low-leakage scenario (Scenario B), a maximum drawdown of 2 m was simulated at the NEET bore location. The subsidence was estimated based on different magnitudes of drawdown with distance from the NEET pumping bore, shown in **Table 9.** Calculated subsidence with various radius from the pumping bore. This same magnitude of drawdown was applied to silty sand saturated zone. However, this is a conservative estimate due to 1) shallow aquifer will be less affected by pumping, and 2) pumping season is over summer only and the intermittent pumping schedule is more practical.

Table 9. Calculated subsidence with various radius from the pumping bore.

	Radius of impact (m)		
	0.1	**100**	**200**
Drawdown (m)	2.0	1.2	1.0
Silty sand unsaturated zone	3.3E-03	1.2E-03	8.1E-04
Silty sand saturated zone	5.5E-02	3.4E-02	2.8E-02
Shellbed saturated zone	7.5E-03	4.7E-03	3.9E-03
Total	0.066	0.039	0.033

The estimated subsidence ranges between 0.03 m to 0.07 m, with a drawdown of 1.0 m and 2.0 m. Under the low leakage scenario, the subsidence of majority of the model domain will be less than 0.05 m. In a rural setting, settlement effects of this magnitude (or less as would be more realistic) are less than minor for the following reasons:

- There is no sensitive urban infrastructure like water or wastewater mains or high-rise buildings to rupture or crack; and
- The changes in land surface due to farm machinery (e.g. rotary hoeing) would likely mask impacts of this magnitude (<0.3 m) if materialised.

In summary, the potential settlement effects are considered less than minor

4.5 Water Quality

The potential risk to water quality from the leaching of fertilisers and pesticides that may be associated with horticulture is not a relevant consideration for a water take application under the current planning framework. With reference to the effects from horticultural sprays the Commissioners sitting on the Motutangi-Waiharara Water Users Group water take applications stated in their Hearing Decision Report (June 2018) that:

“such are not matters that are directly engaged by the present applications for water abstraction. Accordingly, we have no present jurisdiction to consider those putative effects. If resource (or other) consent is subsequently required, then such will need to be applied for and considered at the appropriate time”.

Nevertheless, there are a range of factors that make the leaching of fertiliser and pesticides unlikely to impact water quality:

- In practice orchardists in this area tend to apply fertiliser efficiently via fertigation as part of their irrigation water using a small dosage regularly, which is driven by both the soil conditions (i.e. high permeability and lacking in nutrients) and economic considerations.
- Inefficient irrigation practice will lead to root rot, thus because orchardists will actively avoid this, excessive leaching of nutrients is unlikely.

- Both fertiliser and approved pesticides are applied in accordance with permitted activity rules within the pRPN and rules needing to be met to become certified under the AvoGreen Assured program by the Avocado Industry Council Ltd. One of the key aims is “environmental sustainability by only using sprays when required”.
- Due to the presence of significant amounts of organic matter within the shallow sand deposits, shallow groundwater is likely to be reducing. Under such conditions, nitrate concentrations are likely to be low in groundwater (consistent with available groundwater quality data) due to denitrification within the aquifer system. The presence of organic matter is also likely to substantially decrease the mobility of any pesticide compounds prone to leaching.

4.6 Consideration of Alternatives

An AEE must include a description of alternative locations or methods for undertaking an activity, if it is likely that the activity will result in any significant adverse effect on the environment.

The effects of the proposed taking and using of groundwater were assessed above as being no more than minor on the environment and less than minor on other groundwater users. As such, no alternatives have been considered for this proposal.

5. Assessment of Cultural Effects

The proposed groundwater abstraction lies within the rohe of Te Aupōuri, Ngāti Kurī, and Ngāi Takoto iwi.

According to the Te Raite Station groundwater take consent application (OPUS, 2018), the proposed take is not located within, or in close proximity to an area sensitive to the respective iwi. This has been confirmed via the 'Sites and Areas of Significance to Tangata Whenua' GIS layer on the Northland Regional Council Proposed Regional Plan planning maps, and by Te Aupōuri.

6. Assessment Of Statutory Considerations

Table 10 to **Table 13** provide assessments of the relevant statutory documents as were identified in **Section 3.3**.

Overall, this resource consent application is consistent with the objectives and policies of the National Policy Statement for Freshwater Management 2014, incumbent regional plan (RWSPN) and proposed regional plan (pRPN).

Table 10. Assessment against relevant objectives and policies for the National Policy Statement for Freshwater Management 2014.

No.	Objective / Policy	Assessment
Water Quality		
Objective A1	• Seeks to safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the use and development of land, and of discharges of contaminants.	This proposal is consistent with these objectives and policies and either supports them or at the least maintains them.
Objective A2	• Required that the overall quality of fresh water within a region is maintained or improved while improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over-allocated.	
Objective A4	• Seeks to enable communities to provide for their economic well-being, including productive economic opportunities.	
Policies A2, A3, and A7	• Give effect to Objectives A1, A2, A4	
Water Quality		
Objective B2	• Seeks to avoid any further over-allocation of fresh water and phase out existing over-allocation.	This proposal is consistent with these objectives and policies.
Objective B3	• Seeks to improve and maximise the efficient allocation and efficient use of water.	
Objective B5	• Seeks to provide for communities' economic wellbeing within freshwater quantity limits.	
Policies B2 to B6	• Give effect to Objectives B2 to B5.	
Integrated Management		

No.	Objective / Policy	Assessment
Objective C1	• Seeks 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.	This proposal is consistent with these objective and policies.
Policies C1 and C2	• Give effect to Objective C1.	

Table 11. Assessment against relevant objectives and policies for the Regional Policy Statement for Northland.

No.	Objective / Policy	Comment
Objective 3.2	• Seeks to maintain and improve water quality for human use and ecological health.	This proposal is consistent with this objective as it will at the least maintain water quality.
Objective 3.3	• Seeks to safeguard the flows and flow variability required to maintain water's life-supporting capacity, for ecological processes, and to support indigenous species.	The proposal is consistent with this objective as it will have a no more than minor impact on surface water resources.
Objective 3.5	• Requires that the region's resources are sustainable managed in a way that is attractive for business and investment that will improve the economic wellbeing of the region and its communities.	The proposal is consistent with this objective as it will efficiently utilise a natural resource to facilitate development of economic wellbeing.
Objective 3.10	• Requires efficient use and allocation of common natural resources with a particular focus on maximising the security and reliability of supple for users.	The proposal is consistent with this objective.
Policy 4.3.2	• Requires regulatory methods to avoid over-allocation of region-wide ecological flows and water levels.	The proposal does not exceed allocation limits, hence is consistent with this policy.
Policy 4.3.3	• Requires the allocation and use of water efficiently within allocation limits.	The proposal will use water efficiently and will not exceed allocation limits, hence is consistent with this policy.

Table 12. Assessment against relevant objectives and policies for the Proposed Regional Plan for Northland.

No.	Objective / Policy	Comment
Objective F.0.1	• Seeks to manage the use, development, and protection of Northland's natural and physical resources which enables people and communities to provide for their social, economic and cultural well-being while 1. sustaining the natural resources to meet the reasonable foreseeable needs of future generations, 2. safeguarding life-supporting capacities of water, and 3. avoiding, remedying, or mitigating adverse effects on the environment.	The proposal is consistent with this objective.
Policy D.2.2	• Requires that regard is had to the social, cultural, and economic benefits of the proposed activity when considering resource consents.	As discussed in Section 6, proposal will facilitate the economic and social benefits of both the landowner, their employees and the wider community through flow on effects of purchases made to operate and maintain the orchard.
Policy D.2.5	• Requires an authority to have regard to community and tangata whenua values	The proposal is not inconsistent with either community values, as there has been conversion to market gardening and horticulture in the area that has benefitted the community and tangata whenua through employment opportunities.
Policies D.4.5	• Seeks to maintain overall water quality	This proposal is consistent with this policy as it will not impact water quality.
Policy D.4.13	• Seeks to achieve freshwater quantity related outcomes and in particular manage the taking, use, damming, and diversion of fresh water so that (with relevance to this application) saline intrusion in, and land subsidence above, aquifers is avoided (amongst other things).	This proposal is consistent with this policy as it will avoid the saline intrusion and subsidence impacts, as discussed in **Section 4.3** and **4.4**.
Policy D.4.17	• Considers allocation limits for aquifers and requires rules and applications to meet allocation limits.	This proposal is consistent with this policy as the proposed take will not exceed allocation limits within the Aupouri-Houhora zone.
Policy D.4.18	• Concerns conjunctive surface water and groundwater management.	This application is not inconsistent with this policy, in that the groundwater take will not adversely impact on surface water through stream depletion.
Policy D.4.20	• Requires the reasonable and efficient use of water for irrigation and sets requirements for a resource consent application to take water for irrigation purposes.	This proposal is consistent with this policy as the daily irrigation rate and annual volume are considered efficient and just meet 10-year drought requirements, but provide reduced reliability for more severe droughts.

No.	Objective / Policy	Comment
Policy D.4.23	• Requires conditions on water permits that 1) 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 2) 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 3) 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 4) 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 5) 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 6) 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.	The proposal is only partially consistent with this policy, as the applicants are arguing that so long as pumping data is recorded electronically and available for the council upon request, telemetry is not required. All other provisions will be met.

Table 13. Assessment against relevant objectives and policies for the Regional Water and Soil Plan for Northland.

No.	Objective / Policy	Comment
Objective 7.4	• Requires the maintenance or enhancement of water quality of natural water bodies.	This proposal is consistent with this objective as the effects of the take and use of the water will have no more than minor impacts on the shallow aquifer and other surface water bodies, as discussed in **Section 4.2**.
Objective 10.4.1	• Seeks to maintain the sustainable use and development of the region's groundwater resources while avoiding, remedying, or mitigating actual and potential adverse effects on groundwater quantity and quality.	Ditto above.
Policy 10.5.1	• Seeks to ensure the sustainable use of resources by avoiding takes that exceed recharge. Saltwater intrusion, reduced groundwater quality, significant drawdown, and adverse effects on surface water resources can arise where takes exceed recharge.	This proposal is consistent with this policy as the cumulative allocation in this aquifer management zone is only 11% of mean annual recharge, which is a low limit on a national scale.

No.	Objective / Policy	Comment
Policy 10.5.2	• Recognises that aquifers are at risk in certain circumstances and that adverse effects on water quality should be avoided.	This proposal is consistent with this policy in that current water quality will be maintained.
Policy 10.5.4	• Seeks that groundwater allocations take into account reduction in recharge that may occur in time.	This proposal is consistent with this policy in that the analysis assumed no rainfall for the entire 96 days of pumping.
Policy 10.5.7	• Requires the Northland Regional Council to consider effects of a groundwater take and use on surface water bodies.	This proposal is consistent with this policy as the effects of the take and use of the water will have no more than minor impacts on the shallow aquifer and other surface water bodies, as discussed in **Section 4.2**.
Policy 10.5.9	• Seeks to avoid, remedy or mitigate any ground subsidence as a result of groundwater takes, use or diversion, where this is likely to cause adverse flooding, drainage problems, or building damage.	This proposal is consistent with this policy as subsidence effects will be no more than minor in the context of a rural setting, as discussed in **Section 4.4**.

7. Notification

Section 95 sets out the decision-making steps for the determining of public notification and limited notification of applications and the timeframe Councils have for making the notification decision.

A notification assessment has been carried out in accordance with the stepped process as documented in **Table 14**.

Table 14. RMA Section 95A public notification of consent applications assessment.

Step	Question	Assessment
Step 1: mandatory public notification in certain circumstances	a) The applicant has requested that the application be publicly notified	NO
	b) Public notification is required under section 95C	NO
	c) The application is made jointly with an application to exchange recreation reserve land under section 15AA of the Reserves Act 1977	NO
Step 2: if not required by step 1, public notification precluded in certain circumstances	a) The application is for a resource consent for 1 or more activities, and each activity is subject to a rule or national environmental standard that precludes public notification.	NO
	b) The application is for a resource consent for 1 or more of the following, but no other, activities: (i) a controlled activity; (ii) a restricted discretionary or discretionary activity, but only if the activity is a subdivision of land or a residential activity; (iii) a restricted discretionary, discretionary, or non-complying activity, but only if the activity is a boundary activity; (iv) a prescribed activity (see section 360H(1)(a)(i)).	NO
Step 3: if not precluded by step 2, public notification required in certain circumstances	a) The application is for a resource consent for 1 or more activities, and any of those activities is subject to a rule or national environmental standard that requires public notification.	NO
	b) The consent authority decides, in accordance with section 95D, that the activity will have or is likely to have adverse effects on the environment that are more than minor.	NO
Step 4: public notification in special circumstances	Determine whether special circumstances exist in relation to the application that warrant the application being publicly notified.	NO

Therefore, in accordance with s95A(9)(b) RMA, the consent authority should not publicly notify this application but may determine whether to give limited notification under s95B.

8. Consultation

Schedule 4 of the RMA requires that an AEE should identify (amongst other things) the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted.

Potentially affected parties in relation to this application could include other groundwater users within the pumping induced groundwater cone of depression.

However, it should also be noted that while it is considered good practice and “neighbourly” to undertake consultation, under Section 36A of the RMA there is no requirement for an applicant or council to undertake any consultation with any person in regard to an application.

In this case, no consultation has been undertaken with other water users and landowners because the assessment of effects and in particular the bore interference assessment provided in **Section 0** concludes that no other groundwater users are considered to be adversely affected by the granting of this application.

9. Conclusion

NE Evans Trust (NEET) own a 176.4-hectare dry stock and plantation forestry property at Salvation Road Houhora and are seeking a groundwater take to facilitate the development of a 40-canopy hectare avocado orchard development.

The groundwater take will be exercised from October to April, in accordance with the following volumes:

- Maximum daily volume of 1,675 m^3/day; and
- Maximum annual volume of 160,000 m^3/yr.

A consent duration of 30 years is sought, subject to a lapse period of 5 years.

If granted, this consent taken with another application we are aware of, will take the allocation status for the Aupouri-Houhora allocation zone to just under 100% of full allocation. The activity status thus remains Discretionary.

The AEE has demonstrated that the potential adverse effects of the proposed water take and use on the environment will be less than minor, and the effects on persons will also be less than minor.

The proposal is also considered to be consistent with the relevant objectives and policies of the NPS, the RPS, the PRP, the RWSPN, and Part 2 of the RMA. The applicant considers that in light of the less than minor effects of the application, the decision made following the recent hearing for the Motutangi-Waiharara Water User Group consent applications, the consent should proceed without public notification and be granted on a non-notified basis.

Appendix A. Form A - Application For Resource Consent

The Northland Regional council application for resource consent is attached as an accompanying document.

APPLICATION FORM FOR RESOURCE CONSENT

NORTHLAND REGIONAL COUNCIL

Putting Northland first

Whāngārei Office	Phone:	(09) 470 1200
	Fax:	(09) 470 1202
Kaitāia Office	Phone:	(09) 408 6600
Ōpua Office	Phone:	(09) 402 7516
Dargaville Office	Phone:	(09) 439 3300
Free Phone		0800 002 004
E-mail		mailroom@nrc.govt.nz
Website		www.nrc.govt.nz

This application is made under Section 88/127 of the Resource Management Act 1991

To: Consents Department
Northland Regional Council
Private Bag 9021
Whāngārei Mail Centre
Whāngārei 0148

IMPORTANT NOTES TO APPLICANTS

(a) Please read fully the notes below and the Information Brochures and Explanatory Notes available from the Council, before preparing your application and any supporting information.

(b) The Resource Management Act 1991 sets out the information you must provide with your application for a resource consent. If you do not provide adequate information, your application cannot be received nor processed by the Council and will be returned to you. If you are unsure of what information should be included with your application, please contact the Council before submitting the application.

(c) Applications require notification (public advertising calling for submissions) unless the Council is satisfied that the adverse effects on the environment of the activity for which consent is sought will be minor; and written approval has been obtained from every person who the Council is satisfied may be adversely affected by the granting of the consent. The Council also has available a form "Form 8A – Affected Person's Written Approval", to help you record such approvals for applications that may be processed without public notification.

PART A – GENERAL

APPLICANT	Full Names
(1) Full Name of Applicant(s): (in full e.g. Albert William Jones and Mary Anne Jones. For Companies, Trusts and other Organisations, commonly used name)	Jeremy Evans
	NE Evans Trust
Phone Number – Business:	Fax:
Home:	09-435-2050 Mobile: 027-225-0132
E-mail:	

For applications by a company, private trusts or other entity/organisations, the Directors; Trustees and Officers' full names must be supplied and Section (12) completed and signed.

(2) Postal Address: (in full)	324 Three Mile Bush Road
	Kamo
	~~Whangarei, 0112~~

(3) Residential Address: (if different from postal address)	

Application Form continued on next page

(4) Address for Service of Documents: (if different from postal address e.g. Consultant)	Jon Williamson (jon.williamson@wwa.kiwi) c/o Williamson Water Advisory PO Box 314 Kumeu, 0812 Auckland

(5) Owner/Occupier of Land/ Water Body: (if different from the Applicant)	N/a

(6) Type(s) of Resource Consent sought from the Regional Council:

You will need to fill in a separate Assessment of Environmental Effects Form for each activity.
These forms can be obtained from the Northland Regional Council.

Coastal Permit

☐ Mooring ☐ Marine Farm ☐ Structure ☐ Pipeline/Cable

☐ Other (specify)_____

Land Use Consent

☐ Vegetation Clearance ☐ Quarry ☐ Structure in/over Watercourse

☐ Earthworks ☐ Construct/Alter a Bore ☐ Dam Structure

☐ Other (specify)_____

Water Permit

☐ Stream/Surface Take ☐ Damming ☒ Groundwater Take ☐ Diverting Water

☐ Other (specify)_____

Discharge Permit

☐ Domestic Effluent to Land ☐ General Discharge to Land ☐ Farm Dairy Effluent to Land/Water

☐ Air ☐ Water

☐ Other (specify)_____

(7) Other Resource Consents required from the District Council:

Where other Resource Consents are required for the same activity, they must be applied for at the same time.
Not doing so will delay the processing of this application.

What other Resource Consents are required from the District Council?

☐ None ☐ Land Use Consent ☐ Subdivision Consent

Have the applications been made? ☐ Yes ☐ No

(8) Description of the Activity:

Please briefly describe the activities and duration for which Consent(s) are being sought. It is important you fill this out correctly, as the Council cannot grant Consent for any activity you do not apply for.

Groundwater take consent to enable development of up to 67 hectares Total Orchard Area of avocados. The details of the take are as follows:

Daily rate - 1,675 m3/day (25 m3/day per Total Orchard Area)

Annual volume - 160,000 m3/annum (based on a maximum of 400 mm per annum over 40 ha canopy area.

Application Form continued on next page

(9) Location of Property/Waterbody to which Application relates:

Describe the location in a manner which will allow it to be readily identified, e.g. street address, legal description, harbour, bay, map reference etc. Attach appropriate plans and/or diagrams.

Property Address: 4355 Far North Road, Houhora (see rate demand) Locality: _____

Legal Description: Lot 1, DP 127802 Blk: Blk X Houhaora East SD: NA 78D/376

Other Location Information: _____

PART B – ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

You must include an assessment of the effects of your activity on the environment as part of your application.

The Resource Management Act 1991 requires that each application include an assessment of the actual and potential effects of the activity on the environment in accordance with the Fourth Schedule.

To assist you to supply this assessment of effects, the Council has prepared specific forms for various consent activities. For minor activities, all that will be required is for you to complete the specific form. Where the potential effects of the activity are more significant, we recommend you undertake a full assessment of effects, with professional assistance if necessary.

If you are unsure of what information to include with you application and the assessment of effects, please contact the Council before submitting your application. A pre-lodgement meeting with relevant Consent Staff is recommended.

PART C – GENERAL

(10) Renewal of an Existing Resource Consent:

☐ Yes ☒ No ☐ A change in conditions of a current Resource Consent

(11) Fee/Deposit Enclosed with Application(s):

Application to be processed as: ☐ Notified ☐ Limited Notified ☒ Non-notified

☐ Coastal Permit: $ _____ ☐ Land Use Consent: $ _____

☒ Water Permit: $ 3,296.00 ☐ Discharge Permit: $ _____

☐ Bore Permit: $ _____ ☐ Change Conditions: $ _____

(12) Signature of Applicant(s) or Persons authorised to sign on behalf of Applicant(s):

IMPORTANT NOTES TO APPLICANTS

(a) Your application must be accompanied by the minimum fee (deposit) as determined by the Council. A schedule of the fee/deposits for different consent applications is annexed. Please note that applications by private trusts and other group entities require the personal guarantees of the Trustees and/or Officers for the payment of costs to be submitted with the application.

- For complex applications, the Council may require an additional deposit pursuant to Section 36(3) of the Act, based on the estimated costs for processing such complex applications and may require progressive monthly payments during consent processing.
- The final fee is based on actual and reasonable costs including disbursements and where this fee exceeds the fee/deposit, the additional fee is subject to objection and appeal.

(b) All accounts are payable by the 20th of the month following the date of invoice. Any actual and reasonable costs, including but not limited to legal costs, debt collection fees or disbursements incurred as a result of any default in payment, shall be recoverable from the Applicant and is so notified in compliance with the Credit Contracts and Finance Act 2003. Submitting this Application authorises the Council to, if necessary, provide your personal information to a Credit Reporter in order to employ in its debt collection services in compliance with the Credit Reporting Privacy Code 2004, should payment default occur.

(c) Resource Consents usually attract an annual fee to recover the reasonable costs of the Council's monitoring, supervision and administration of the Consent during its term.

(d) The information you provide is official information. It will be used to process the application and, together with other official information, assist the management of the region's natural and physical resources. Access to information held by the Northland Regional Council is administered in accordance with the Local Government Official Information and Meetings Act 1987 and the Privacy Act 1993.

Application Form continued on next page

I/we declare that, to the best of my/our knowledge and belief, the information given in this Application and attached Assessment of Environmental Effects is true and correct. I/we unconditionally guarantee jointly and severally to pay the actual and reasonable costs of processing this Application as and when charges become due and payable. I/we acknowledge that I/we understand the consequences of signing this declaration.

Signature:	**Signature:**
Full Name (print): Jeremy Evans	**Full Name** (print): William J Evans
Date: 5/2/18	**Date:** 5-2-18

Continue with Trustees' and Authorised Officers' signatures below, as necessary.

Personal details and signatures of Trustees*, or Officers authorised to sign on behalf of and to bind Trusts, Societies and Unincorporated Entities.
*** Private and Family Trusts only**

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

CHECKLIST – Have you remembered to...

- ☐ Complete all details set out in this Application Form
- ☐ Include an Assessment of Effects of the activity on the environment, set out in the attached form
- ☐ Sign and date the Application Form
- ☐ Include a Site Plan
- ☐ Include the appropriate fee/deposit as set out in the "Schedule of Fees"
- ☐ Complete details of Trustees and/or Authorised Officers on this page

Appendix B. Groundwater Model Development

To assist in the assessment of pumping effects of the proposed water take on groundwater levels in neighbouring bores and on stream baseflows, a numerical groundwater model was developed using the model code MODFLOW (Harbaugh, 2005).

B.1 Model Setup and Parameterisation

B.1.1 Model structure

The model domain was selected based on the regional coastlines and neighbouring bores that are within 2 km radius. The model structure was set up consistently with the Motutangi-Waiharara Groundwater Model (WWA, 2017), in that the model was vertically discretised into 6 model layers to represent four geologic layers. The model consists of 206,076 model cells with a horizontal cell size of 50×50 m, as shown in **Figure B1**. The geological units assigned to each model layer is shown in **Table B1.**

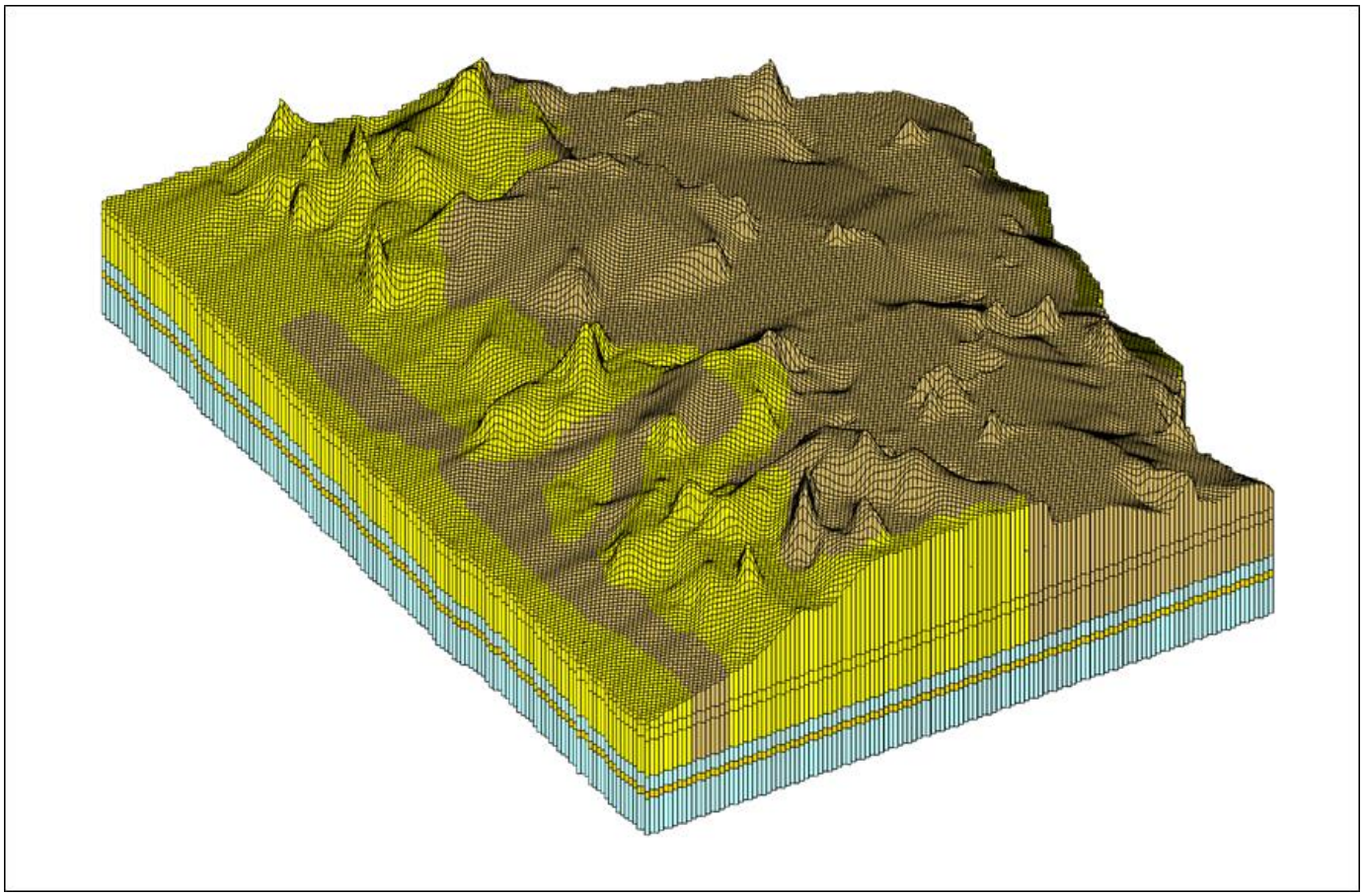

Figure B1. Groundwater model discretisation.

Table B1. Geological units in the model conceptualisation.

Model Layer	Stratigraphic Layer	Name	Description	Locality
1-3	1	Coastal sand	Loose coast sand, highly permeable	Western and eastern coastal strips.
	1	Weathered sand	Weathered dune sand, moderately compacted	Inland hilly or rolling country areas.
	1	Plain zone	Peaty and clayey sediments, low permeability	Inland low-lying plain areas.
4	2	Shellbed	Sand presented with shells, highly permeable	Throughout model, albeit thickness varies.
5	3	Fine sand	Old sand deposits, fine sand, moderately permeable	
6	4	Shellbed	Sand presented with more shells, highly permeable	

The top elevation of Layer 1 was assigned using the 8 m Digital Elevation Model (DEM). The bottom elevation of Layer 3, 4, 5 and 6 was assigned with a constant number, based on the approximate depth inferred from sediments geology. Layer 1,2 and 3 were used to represent a complex stratigraphic unit consisting of alternating sand, silt, peat, clay and iron pan in a bulk sense (not discretely). It is very difficult to define the subdivision of these stratigraphic layers with any degree of accuracy. Thus, the base of model Layer 1 and 2 were assigned with an elevation of -2 mAMSL and -10 mAMSL, respectively. The elevation of each model layer is shown in **Table B2.**

Table B2. Elevation assigned to the model layer

Model Layer	Model Layer	Elevation (mAMSL)	Thickness (m)
1	Top of Layer 1	NZ 8m DEM	Vary across the landscape
	Base of Layer 1	-2	
2	Base of Layer 2	-10	8
3	Base of Layer 3	-35	25
4	Base of Layer 4	-45	10
5	Base of Layer 5	-50	5
6	Base of Layer 6	-75	25

B.1.2 Recharge

Based on the regional soil distribution, three primary recharge zones were identified similarly shown in Motutangi-Waiharara Groundwater Model (WWA, 2017). The water budget of recharge simulation was shown in **Table B3**.

Table B3. The average annual water mass balance for each recharge zone from the SMWBM.

Recharge zone	Groundwater recharge	Evapo-transpiration	Runoff	Description
Coastal sand zone	43%	52%	5%	Loose sand, high infiltration capacity, low surface runoff
Weathered sand zone	38%	54%	8%	Relatively more compacted sand, high infiltration capacity, reduced surface runoff
Plain zone	10%	56%	34%	Low infiltration capacity, medium soil moisture storage, high surface runoff

B.1.3 Boundary conditions

The drain boundary was used to represent the surface stream reaches. Bottom elevation of the drain boundary was assigned 2 m below the DEM.

The constant head boundary was assigned along the east and west coastline for model Layer 1, and general head boundary was assigned along the coastlines for model Layer 2-6 to represent the groundwater outflow toward the ocean.

To address the cumulative impact of groundwater takes from Motutangi-Waiharara Water User Group (MWWUG), the predicted drawdown of 0.6 m in Scenario 4c of WWA (2017) was applied to the simulated groundwater level at southern boundary of the constructed model, where a specific head boundary condition was assigned.

B.1.4 Groundwater takes

There are 86 existing groundwater takes (83 domestic and stock use and 3 horticulture use), 2 pending takes for horticulture. The groundwater allocation information was not available for almost all the domestic bores, and some of the bore are shallow groundwater take bores. For the purpose of modelling and assessment, all the domestic bores were assumed to take water from the deep shellbed aquifer, with a daily rate of 0.3 m^3/day in winter month (Jun-Sep) and 0.75 m^3/day for the rest of the year. In total, 88 bores with a daily take 1,423 m^3/day were incorporated in the base case and scenario models.

Considering the location of 9 pending bores from Te Raite station and their proposed groundwater take, these 9 bores (12,187.5 m^3/day) together with Evan Orchard bore (1,675 m^3/day) with a total daily take of 13,862.5 m^3/day were incorporated in the scenario model.

The transient pumping time series were constructed following:

- ***Domestic and stock use bore:*** 0.30 m^3/day constant take was applied for winter month, and 0.75 m^3/day constant take was applied for the rest of 365 days simulation period
- ***Horticulture:*** On the basis of 96 days pumping and applied annual allocation, daily groundwater take was calculated and applied for 96 days out of 365 days of simulation period.

B.2 Calibration Target

Without available groundwater monitoring data in the model domain, model was calibrated against Motutangi-Waiharara Groundwater Model (WWA, 2017), by cross-comparing the simulated groundwater level and gradient from the central high topographic areas toward the east and west coastlines.

The calibrated base case model parameters are shown in **Table B4**.

Table B4. Hydrogeologic model parameters of the base case model.

Model Geological Units	Model Layer	K_x		Vertical Anisotropy (-)	S_y (-)	S_s (m^{-1})
		(m/d)	(m/s)			
Coastal sand	1	3.5	4.1E-05	10	0.3	-
Weathered sand	1	2.0	2.3E-05	20	0.25	-
Plain zone	1	0.1	1.2E-06	20	0.01	-
Coastal sand	2&3	3.5	4.1E-05	10	-	0.0005
Weathered sand	2&3	2.0	2.3E-05	80	-	0.0005
Shellbed	4&6	30	3.5E-04	1	-	0.0016
Sand	5	1.0	1.2E-05	60	-	0.0005

B.3 Predictive Simulation

In both base case and scenario models, recharge component was turned off during 96 days of pumping period, to represent an extremely drought condition.

Considering the downward confinement and intended purpose of the project, the predictive simulation was constructed by changing the horizontal hydraulic conductivity of model Layer 2 to 0.00864 m/d (1.0×10^{-7} m/s) to represent a low leakage scenario and to assess the maximum impact on the deep shelled aquifer. The base case model and predictive scenario simulations are shown in **Table B5.**

Table B5. Base case model and predictive scenario simulation set-up.

Model	Layer 2 K_h (m/d)	Groundwater takes
Base case	2.0	Existing takes
Scenario A	2.0	Existing takes and additional takes
Scenario B	0.00864	Existing takes and additional takes

B.3.1 Groundwater Level Drawdown

The groundwater level drawdown was calculated between base case scenario and low leakage scenario (Scenario b) at time step of 96-days, shown in **Figure B4**. The cone of depression was developed around each pumping bore. The major groundwater drawdown occurred near the northern model boundary because of the concentration of 5 relatively larger groundwater takes.

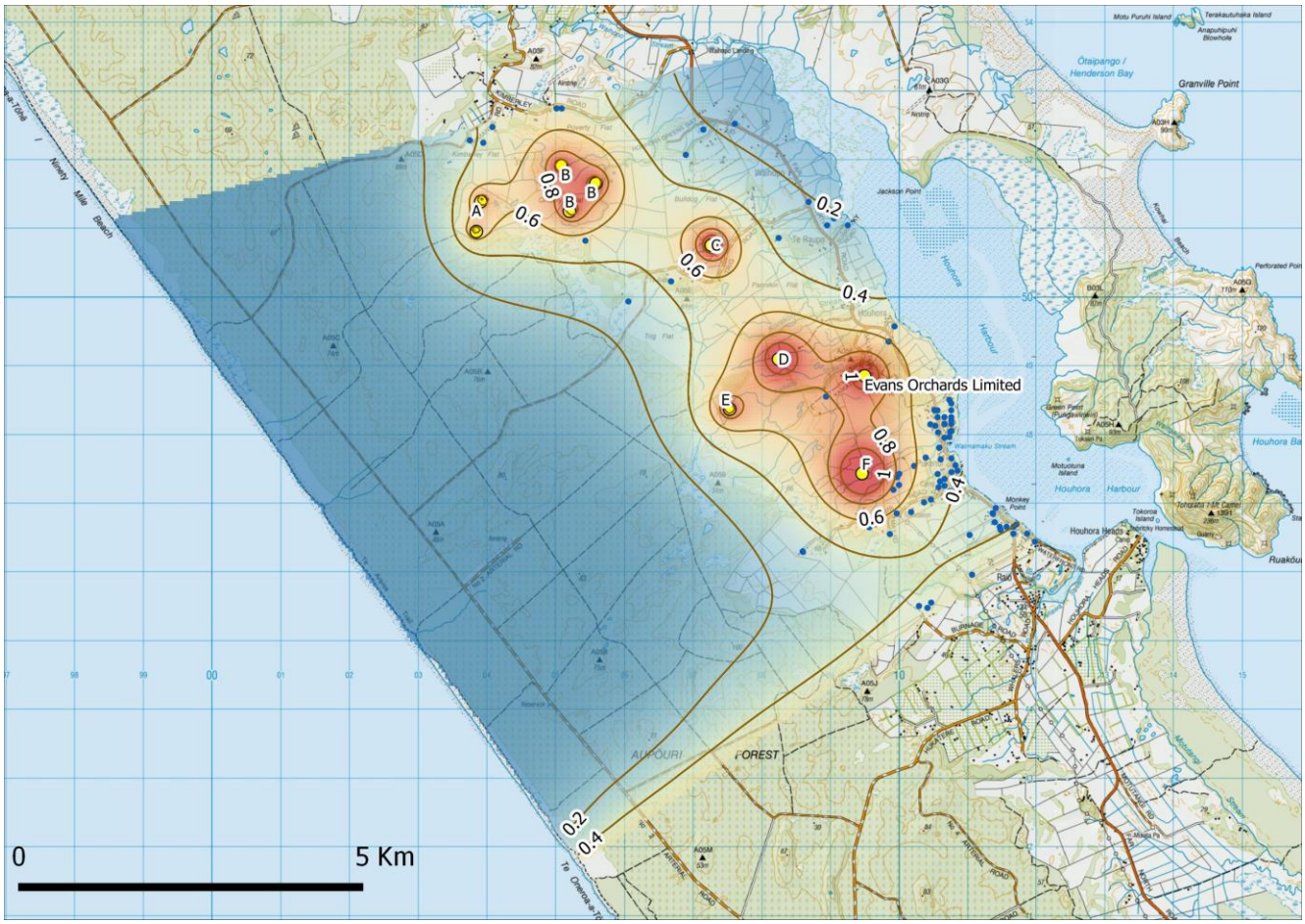

Figure B4. Drawdown after 96 days of continuous pumping.

For the impact on existing bores, a maximum drawdown of 0.8 m was observed at Landcorp Farming Ltd (LOC.210159), Fullam (AUT.037292.01.01) and a pending bore (LOC.315398), a minimum drawdown of 0.5 m was observed. The drawdown impact on existing groundwater bores in the domain is summarised in **Table C6**.

Table C6. Summary of drawdown impact on existing groundwater bores.

IRISID	Location ID	Common Name	Location Status	Purpose	Drawdown (m)
LOC.210161	8702	BORE Landcorp Farming Ltd.	Active		0.8
AUT.037292.01.01		Fullam: Groundwater take at Elingamite Drive, Pukenui			0.8
LOC.315398	83577	Bore	Pending		0.8
LOC.305545	75649	Bore - Bruce Fullam, Elangamite drive, off lamb road, Pukenui, Houhora (REG.036608.01)	Active	Domestic and stock	0.7
LOC.316126	84181	Bore construction	Pending		0.7
APP.039244.01.01		Thomas			0.6
LOC.305229	75517	activity location	Active		0.6
LOC.307773	76519	Bore - Bill Evans, 4355 Far North Road, Houhora (REG.036731.01)	Active	Domestic and stock	0.6

IRISID	Location ID	Common Name	Location Status	Purpose	Drawdown (m)
LOC.200249	5820	BORE Lamb Rd, Houhora	Active	Domestic	0.6
LOC.200248	8422	BORE N Lamb	Active	Stock	0.6
LOC.200213	4274	BORE E Clark	Active	Stock	0.6
LOC.210159	8700	BORE Landcorp Farming Ltd	Active		0.5
LOC.315061	83292	Bore construction	Pending		0.5
LOC.313925	82335	Te Aupouri Commercial Development Limited	Active	Stock	0.5
LOC.210160	8701	BORE Landcorp Farming Ltd	Active		0.5
LOC.302455	74316	Bore - Bill Evans, Saleyard Avenue, Houhora	Active	Stock	0.5
LOC.209885	10042	BORE L A & B A Anderson, 4217A,Far North Road, Kaitaia	Active	Domestic	0.5
LOC.209230	1774	BORE Herb Adams, 93 Lamb Rd, Pukenui	Active	Domestic	0.5
LOC.209644	4538	BORE Steve Boyce, 4205 Far North Road, Pukenui	Active	Domestic	0.5
LOC.200245	8420	BORE Gaeley	Active	Domestic	0.5
LOC.209185	2107	BORE V H Hensley, Farnorth Rd, Pukenui	Active	Domestic	0.5
LOC.312872	81450	Bore construction	Pending		0.5
LOC.314929	83173	Bore construction	Active	Domestic	0.5
LOC.315166	83383	Bore construction	Active	Irrigation	0.5
LOC.314181	82555	Bore construction	Active	Domestic	0.5
LOC.200234	5801	BORE C Anderson	Active	Domestic	0.5
LOC.200251	5822	BORE V Hensley	Active	Private Water Supply	0.5
LOC.200311	5028	BORE P Wedding - Lamb Road,Houhora	Active	Irrigation	0.5
LOC.200049	3957	BORE Norman Wagner	Active		0.5
LOC.200244	8419	BORE Ian Stewart	Active	Domestic	0.5
LOC.200052	1623	BORE J Morecroft	Active		0.5
LOC.200053	5569	BORE J Forshind	Active		0.5
LOC.200238	4330	BORE Wilkinson	Active	Domestic	0.5
LOC.209599	2664	BORE Alan Nunns, 4161 Far North Road, Pukenui	Active	Domestic	0.5
LOC.308897	77120	Bore - Stephan Nattras, 32 Lamb Road, Pukenui (REG.037291.01)	Active	Domestic	0.5
LOC.200293	3219	BORE Bob Grange - Harbour View Road, Pukenui	Active	Domestic	0.5
LOC.200274	2452	BORE Pat - Wedding	Active	Domestic and Irrigation	0.5
LOC.314093	82482	Bore construction	Active	Domestic	0.5
LOC.200057	12331	BORE Jack Farham	Active		0.5
LOC.200054	5570	BORE Dr Paton	Active		0.5
LOC.209543	2607	BORE S & M Shearer, 14 Harbour View Road, Houhora	Active	Domestic	0.5
LOC.200058	12332	BORE Brian McDonald	Active		0.5
LOC.200252	2436	BORE D Bellingham	Active	Domestic	0.5

IRISID	Location ID	Common Name	Location Status	Purpose	Drawdown (m)
LOC.209707	12834	BORE P & W Mold, 32B Harbour View Road, Pukenui	Active	Domestic	0.5
LOC.200247	13936	BORE R Wallace	Active	Domestic	0.5
LOC.316695	84655	Bore - Pavlavic, 3933F SH1, Pukenui, Houhora	Active	Domestic	0.5
LOC.315067	83298	Bore construction	Active	Domestic	0.5
LOC.209231	1767	BORE Pukenui Holiday Park, Lamb Rd, Pukenu	Active	Commercial Water Supply	0.5
LOC.200067	12346	BORE W Thornton	Active		0.5
LOC.209510	2595	BORE Hayley McLaine, 28 Lamb Road	Active	Domestic	0.4
LOC.200189	4222	BORE Burnage Rd, Houhora	Active	Domestic	0.4
LOC.209580	11301	BORE L & C Emile, McManus Road, Houhora	Active	Domestic	0.4
LOC.200055	12330	BORE V Hensly	Active		0.4
LOC.210375	10125	BORE Land Corp Farming Ltd., 2 Ragiputa Road RD3 Kaitaia	Active	Stock	0.4
LOC.200056	5571	BORE Pukenui Motels	Active		0.4
LOC.314182	82556	Bore construction	Pending		0.4
LOC.200051	1622	BORE C Barnes	Active		0.4
LOC.209860	15288	BORE P K Foote and A M McGuigan: Bore construction at McManus Road, Ngataki.	Active	Domestic	0.4
LOC.200196	9652	BORE Denison	Active	Private Water Supply	0.4
LOC.209579	11300	BORE Pukenui Lodge Motel, Pukenui, Houhora	Active	Domestic	0.4
LOC.200062	523	BORE B Ballantyne	Active		0.4
LOC.210016	11452	BORE Barry & Kim Kanara, 24 Fitzgerald Road, Pukenui	Active	Domestic	0.4
LOC.200344	7626	BORE Glen Subritzky - Far North Road, Pukenui	Active	Domestic	0.4
LOC.209642	4536	BORE Alan Broadbent ,4115 Far North Road, Pukenui Houhora	Active	Domestic	0.4
LOC.200316	3347	BORE Bruce Malcolm - Main RoadPukenui	Active	Domestic and Stock	0.4
LOC.200210	15017	BORE NCC & RWB	Active		0.4
LOC.200254	2438	BORE R Henson	Active	Domestic	0.4
LOC.209779	12864	BORE B A Wagener, 4101 Far North Road, Pukenui	Active	Domestic	0.4
AUT.002890.01.02		LL & DF Rasmussen:Take groundwater for irrigation at Far North Road, Houhora			0.4
LOC.200043	12311	BORE B Richards	Active	Irrigation	0.4
LOC.311386	80190	Bore - Bruce Askew & Karen Billot, 4037 Far North Road (REG.037851.01)	Active	Domestic	0.4
LOC.209535	15227	BORE Kirk Dension , McManus Road off Kimberly Road, Houhora	Active	Domestic and Stock	0.4
LOC.200318	3357	BORE Houhora Fire Brigade - Main Road Houhora	Active	Private Water Supply	0.4

IRISID	Location ID	Common Name	Location Status	Purpose	Drawdown (m)
LOC.209508	2593	BORE Robbie Dennison, 402 Far North Road	Active	Domestic	0.4
LOC.200295	3206	BORE PS & MJ Byer - Houhora	Active	Domestic and Irrigation	0.4
LOC.304107	75036	ACTIVITY LOCATION	Inactive		0.4
LOC.305551	75652	Bore - Herbert Adam, 4051 Far North Road, Pukenui, Houhora (REG.036604.01)	Active	Domestic	0.4
LOC.200250	5821	BORE Houhora Big Game Sports And Fishing Club	Active	Private Water Supply	0.3
LOC.209887	10044	BORE G & D Price, 4805 D Far North Road, Houhora	Active	Domestic	0.3
LOC.209933	11443	BORE Paul & Brenda Harvey, Lamb Road,Pukenui	Active	Stock	0.3
AUT.029091.01.01		G J & D J Price - Groundwater take for horticultural purposes, Waihopo			0.3
AUT.003768.01.04		L & P Trust: To take from dune lake for irrigation at Houhora			0.3
LOC.201481	9312	BORE D Urlich - Waihopo	Active	Irrigation	0.2
LOC.200157	1859	BORE Urlich	Active	Irrigation	0.2
LOC.210269	7367	BORE George Sucich, Far North Road, Houhora	Active	Stock	0.2
LOC.200156	1858	BORE D Urlich	Active	Irrigation	0.2
LOC.200041	12310	BORE L Wedding	Active		0.2
LOC.209030	1203	BORE Antrim Fields - Far North Road. Houhora	Active	Irrigation	0.2

B.3.2 Stream Baseflow Reduction

Representing a leaky conditon, simulation results from scenario a was used to assess the impact of groundwater pumping on the surface drain flows. The global flow budget at the end 96-days of continuous pumping is shown in **Table B7**.

Table B7. Average flow budget in terms of difference and relative difference compared to the base case.

Scenarios	Base case	Scenario a	Absolute difference	Relative difference
Components	**Flow (m^3/day)**	**Flow (m^3/day)**		
Storage	130,606	143,816	13,210	10%
Recharge	0	0	0	0%
Total inflow	**130,606**	**143,816**	**13,210**	**10%**
Storage	13	5	-8	-62%
Shallow Coastal Discharge (CH)	48,905	48,782	-123	0%
Deep Coastal Discharge (GHB)	60,064	59,719	-345	-1%
Wells	1,423	15,285	13,862	974%
Drains	20,201	20,036	-165	-1%
Total outflow	**130,606**	**143,827**	**13,221**	**10%**

For Scenario a, the additional take will result in less than 1% reduction in the total budget of drain flow, compared with base case.

B.3.3 Saltwater intrusion

The Ghyben-Herzberg analytical solution was used to estimate the depth of freshwater and saltwater interface. Based on the density of freshwater and saltwater, the relation states that there is 40 m of freshwater in the aquifer below sea level, when there is 1 m of freshwater in the aquifer above sea level (Badon-Ghijben and Herzberg, 1901).

To address uncertainty in what constitutes the most plausible mechanism of saline instruction in this hydrogeological setting, two potential mechanisms for saline intrusion potential were assessed

1. ***Upconing*** – assumes the water pressures in the aquifer would translate to a saline interface at some point underneath the aquifer under steady state conditions in accordance with the Ghyben-Herzberg equation and regardless of the material types;
2. ***Lateral migration along the aquifer/bedrock interface*** – considers the material under the aquifer impermeable and the inland migration of salinity would occur via the permeable shellbed sediments along the basement contact. This mechanism assumes that the pressure at the coastal margin is relevant to maintaining an offshore position of the saline interface.

A maximum drawdown of 0.9 m was simulated in Scenario b, representing a conservative drawdown estimated for the deep shellbed aquifer. The magnitude drawdown will potentially lead to 36 m rise of saltwater/freshwater interface. This is insignificant considering the pressure head in deep aquifer which prevents the saltwater intruding into pumping bores through upconing.

Along the east coastline, the elevation of the Aupouri aquifer base ranges between -90 mAMSL and -30 mAMSL from south to north. Using Ghyben-Herzberg relation, the minimum head required (i.e. “Trigger Level”) to maintain the saline interface below the shellbed base ranges between 0.75 mAMSL – 2.25 mAMSL. The saltwater lateral migration along the base of the aquifer is unlikely due to:

- **Regional groundwater flow:** groundwater generally follows the surface topography, moving from the central sand area towards west and east low-lying coastlines. The simulated lowest groundwater level along the east coastline ranges from 9 mAMSL – 12 mAMSL (Scenario b). The predicted lowest groundwater pressures are significantly higher than the trigger level. The nearest Waterfront deep piezometer has an approximately average water level of 5 mAMSL, with a strong upward gradient observed.
- **Stronger horizontal gradient:** at model downstream, the existence of Kaimaumau low-lying wetland drainage reduces the groundwater pressure developed toward the east coastlines to a certain degree in the Waiharara area. In the groundwater model, the non-existence of significant wetland drainage will lead to a stronger horizontal flow gradient towards the east coastlines.

Considering the hydrological and hydrogeological conditions of the model domain, saltwater lateral migration is unlikely to occur.