

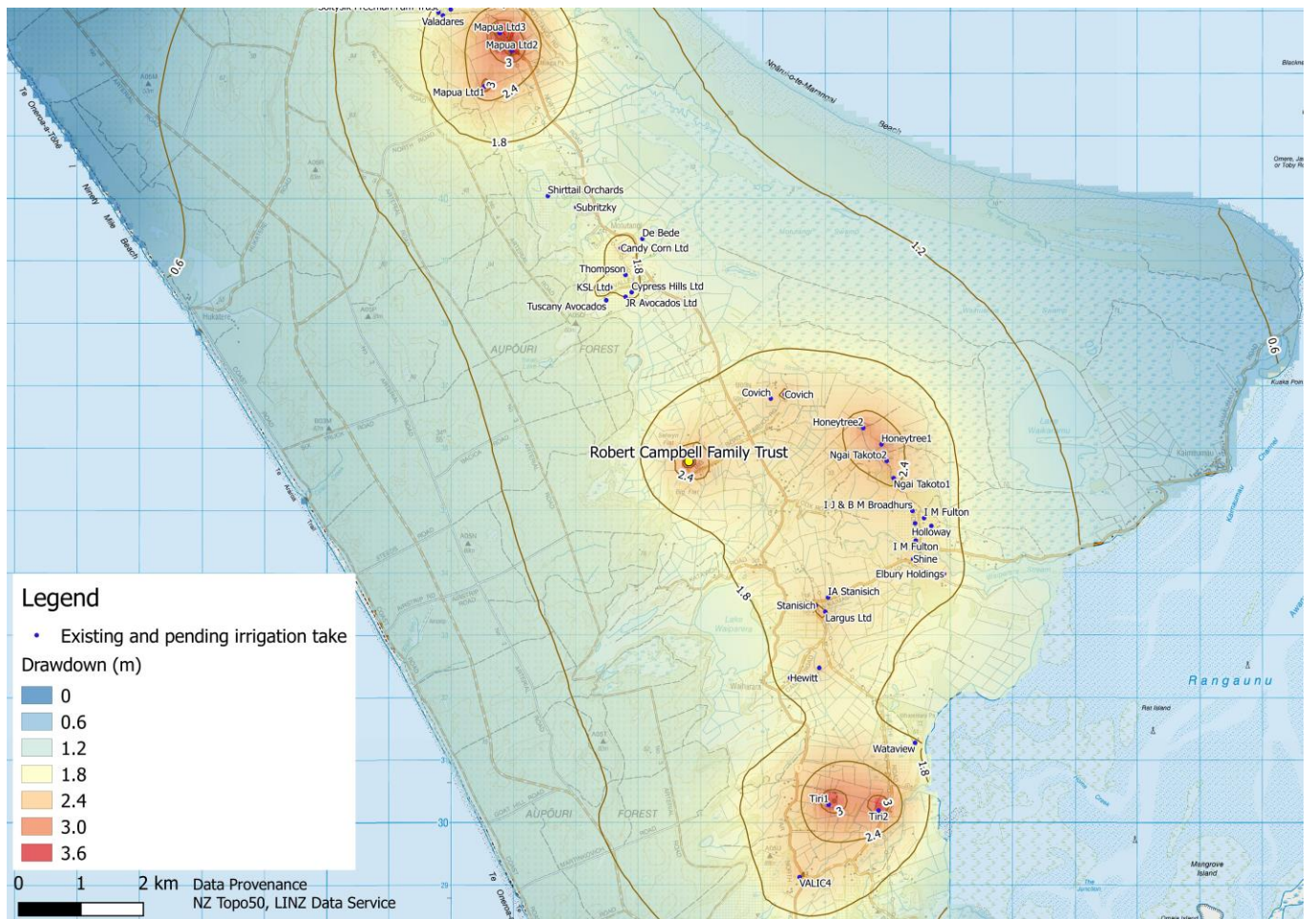
## Irrigation Water Take Consent

### Resource Consent Application & Assessment of Environmental Effects

ROBERT CAMPBELL FAMILY TRUST

WWA0056| Rev. 3

13 August 2018



## Irrigation Water Take Application

Project no: WWA0056  
Document title: Robert Campbell Family Trust  
Revision: 3  
Date: 13 August 2018  
Client name: Robert Campbell Family Trust  
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File name: G:\Team Drives\Projects\Robert Campbell Family Trust\WWA0056\Deliverables\Robert Campbell Family Trust AEE.docx

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## Document history and status

Rev	Date	Description	By	Review	Approved
1	24 July 2018	Internal Draft	Hangjian Zhao	Jon Williamson	
2	21 August 2018	Internal review	Hangjian Zhao	Jon Williamson	Jon Williamson

## Distribution of copies

Rev	Date issued	Issued to	Comments
2	21 August 2018	Northland Regional Council mailroom; Client	Resource consent submission

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# 1. Introduction

This document and attachments comprise a Resource Consent Application and an Assessment of Environmental Effects report associated with a water take permit for irrigation of a 134-hectare Total Orchard Area<sup>1</sup> development at 134 Big Flat Rd, Waiharara, on behalf of The Robert Campbell Family Trust.

The background details of this application using Northland Regional Council's (NRC) "Application for Resource Consent" form is provided in **Appendix A**. Further details of various items where marked on the form are provided in the **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 consideration of consultation; and
- **Section 9** – summary and conclusions.

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<sup>1</sup> Total Orchard Area was selected as the area metric for calculation of the irrigation water daily application volume by the Commissioners at the Hearing of 17 groundwater take applications for the Motutangi-Waiharara Water User Group in June 2017. The volume of water applied to this Total Orchard Area was 25 m<sup>3</sup>/ha/day (see paragraphs 132 and 133 of the Commissioners Decision - June 2018). In the Commissioner's Decision they defined the Total Orchard Area as the area where the canopy occupies 80%.



## 2. Description of Proposed Activity

### 2.1 Location

Figure 1 provides a map of the project area. The subject bore is located at end of 134 Big Flat Rd, Waiharara.

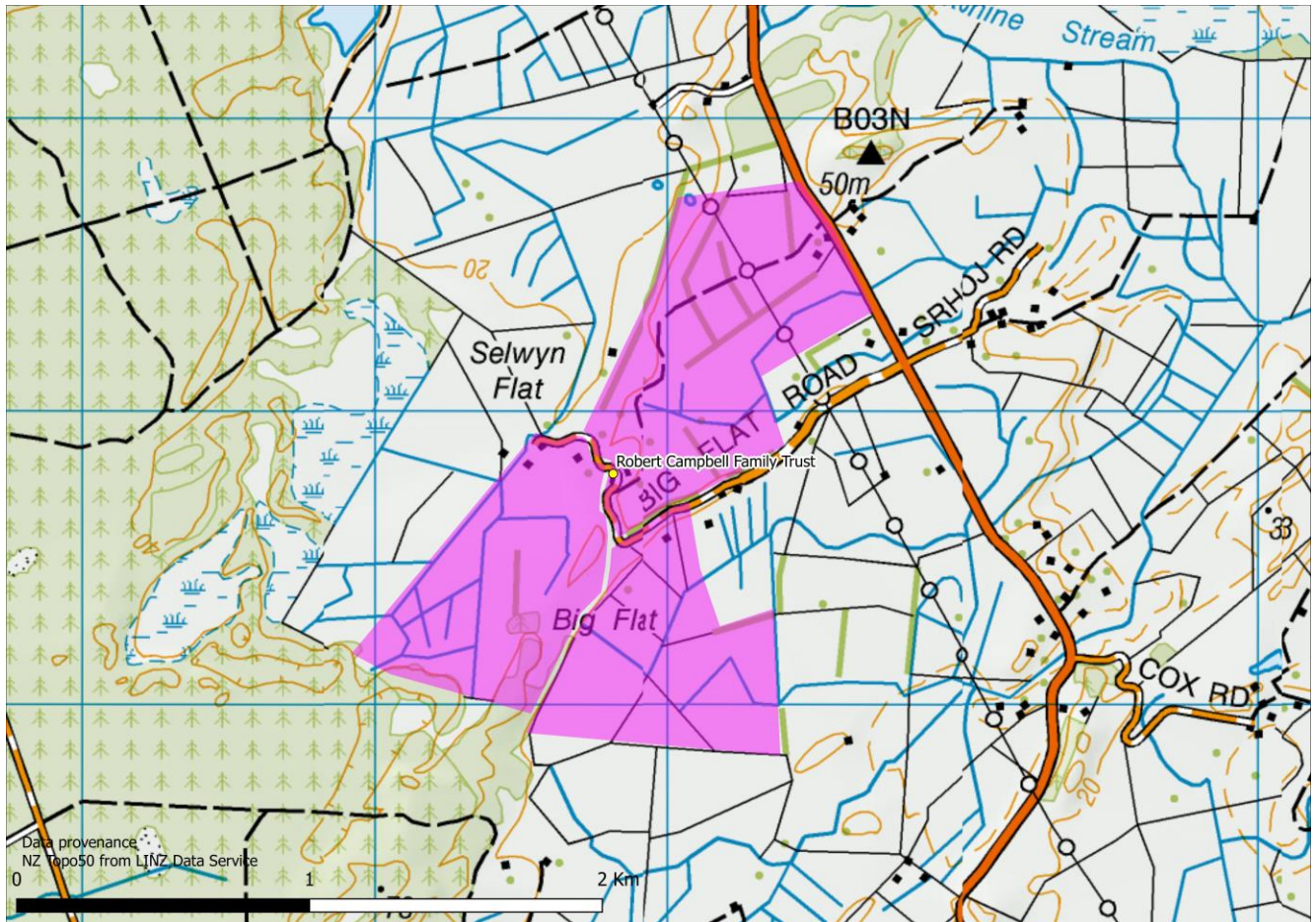


Figure 1. Project locality map.

### 2.2 Description of Proposed Activity

The resource consent application for Robert Campbell Family Trust is to take and use groundwater for a new 134-ha orchard development.

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

- Maximum daily volume of 3,350 m<sup>3</sup>/day; and
- Maximum annual volume of 360,000 m<sup>3</sup>/yr.

Two to three new shell bed bores each producing a maximum of approximately 50 L/s will be constructed to enable exercise of the consent.

The maximum daily volume has been calculated from 25 m<sup>3</sup>/ha/day over the Total Orchard Area, in accordance with the decision made in the Motutangi-Waiharara Water User Group (MWWUG) decision<sup>2</sup>.

The maximum annual volume has been calculated from the canopy area, which for this orchard (given the topographic and existing building constraints) is 67% of the Total Orchard Area or 90 ha<sup>3</sup>. The maximum annual volume has been calculated on the basis of 400 mm/annum, which is consistent with the Council Officers' recommendation in the MWWUG Hearing. This irrigation requirement is adequate to meet up to a 1 in 10 years drought requirement (**Section 3.1.4**).

### 2.2.1 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 2.3**.

## 2.3 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 3,350 m<sup>3</sup>/day (being any 24 consecutive hours); and
  - (b) Maximum annual volume of 360,000 m<sup>3</sup>/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.

<sup>2</sup> The maximum daily volume can also be calculated on the basis of 41.6 m<sup>3</sup>/day per canopy hectare (4.16 mm irrigation system capacity) on the basis of a peak daily soil requirement of 3.74 mm/day per canopy hectare and allowing for 10% system losses in delivery and application.

<sup>3</sup> The maximum annual volume can also be calculated on the basis of approximately 96 days at full daily volume, which is equivalent to approximately 400 mm/year. In practice the maximum daily rate will only be required on consecutive days during the peak of summer and when this coincides with drought.

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](http://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. there 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 soil around the property as typic sandy brown soils<sup>4</sup> occurring in areas without regular summer drought periods, nor winter waterlogging; and acidic medic organic soils<sup>5</sup>, occurring in wetlands or under acidic forest leaf litter. These soils display the following properties:

- **Physical properties** – Brown soils are relatively stable topsoils with a well-developed structure. Mesic organic soils occur in areas of wetlands or under forests which produce acidic litter, with low bulk density, bearing strength and thermal conductivity but high total available – water capacity.
- **Chemical properties** – Brown soils have low to moderate base saturation. Part of Mesic organic soils have mineral material but is dominated by organic matter.
- **Biological properties** – Brown soils are associated with high biological activity (earthworms are prominent). Organic soils have restricted biological activity of organisms due to the anaerobic conditions, leading to a slow decomposition rate..

#### 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.

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 shellbed is the aquifer targeted by avocado orchardists and typically is found between 70 - 140 m below ground surface. The shellbed typically comprises two distinct upper and lower zones, which are separated by a fine sand deposit.

The lower shellbed aquifer typically forms the basal unit and is underlain by volcanic basement rocks that outcrop in the east 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.

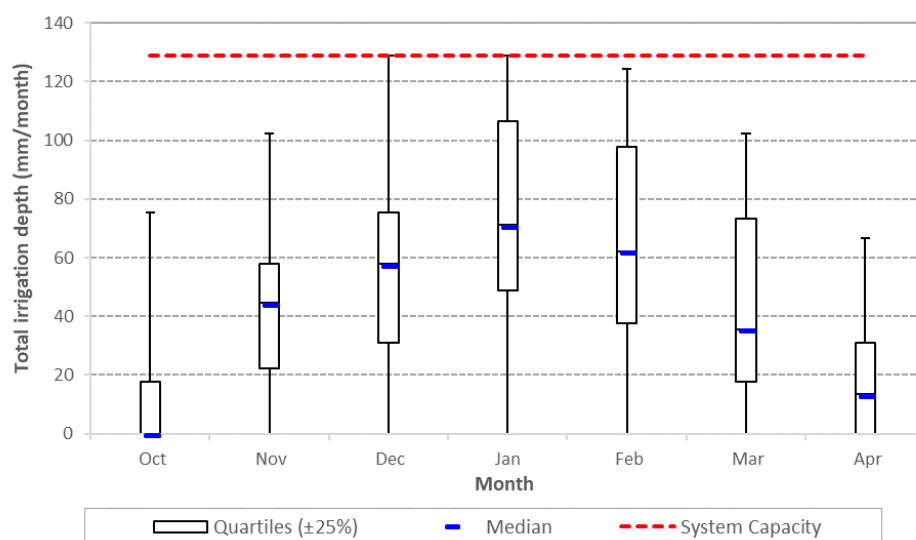
All the basement rocks in the area are known to be low permeability.

<sup>4</sup> <https://soils.landcareresearch.co.nz/describing-soils/nzsc/soil-order/brown-soils/>

<sup>5</sup> <https://soils.landcareresearch.co.nz/describing-soils/nzsc/soil-order/organic-soils/>

### 3.1.4 Irrigation Requirements

The peak water requirement is 41.6 m<sup>3</sup>/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 2**, which is a box and whisker plot showing the monthly median, lower quartile (25<sup>th</sup> percentile), upper quartile (75<sup>th</sup> 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. typically in spring and autumn), which is exemplified in the monthly statistics shown in **Figure 2**.

**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]

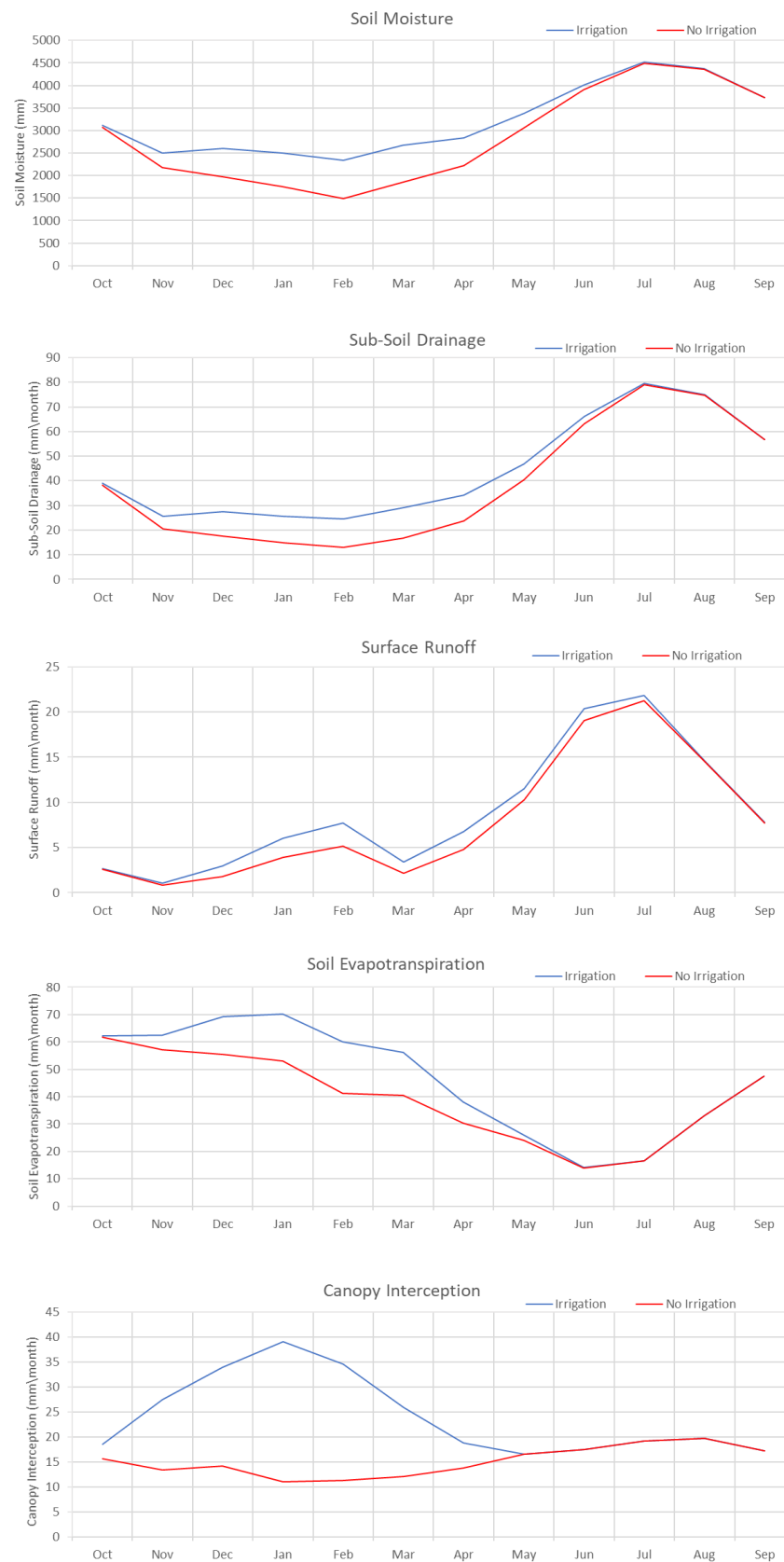
4 yr	18 [4]	58 [14]	76 [18]	107 [26]	98 [24]	74 [18]	31 [7]	369 [89]
5 yr	18 [4]	62 [15]	76 [18]	107 [26]	98 [24]	80 [19]	40 [10]	382 [92]
10 yr	31 [7]	76 [18]	104 [25]	117 [28]	116 [28]	84 [20]	50 [12]	401 [96]
100 yr	53 [13]	102 [25]	124 [30]	129 [31]	124 [30]	100 [24]	64 [15]	545 [131]

**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

Borelogs for three bores located on the property were provided by Robert Campbell. The exact location of the borelogs has not been confirmed. However, the logs are consistent (in so far as drillers information can be) in that each bore was screened and terminated in shellbed ranging in depths from 82 m to 110 m. These three bores are all 100 mm stock bores, hence will require replacement with larger diameter production bores for supplying orchard irrigation water.

There are 31 bores registered within the NRC database within a 2 km radius of the Robert Campbell Family Trust site (**Figure 4**). Statistics on the 31 bores are as follows:

- 26 are active and five are pending.
- The bores range in depth from 0 m to 117 m with an average of 49.9 m.
- 21 bores have information available in terms of the purpose of the bores:
  - one is for domestic purposes;
  - one is for irrigation;
  - three are for stock and irrigation;
  - four are for domestic and stock; and
  - twelve are for stock use (only).

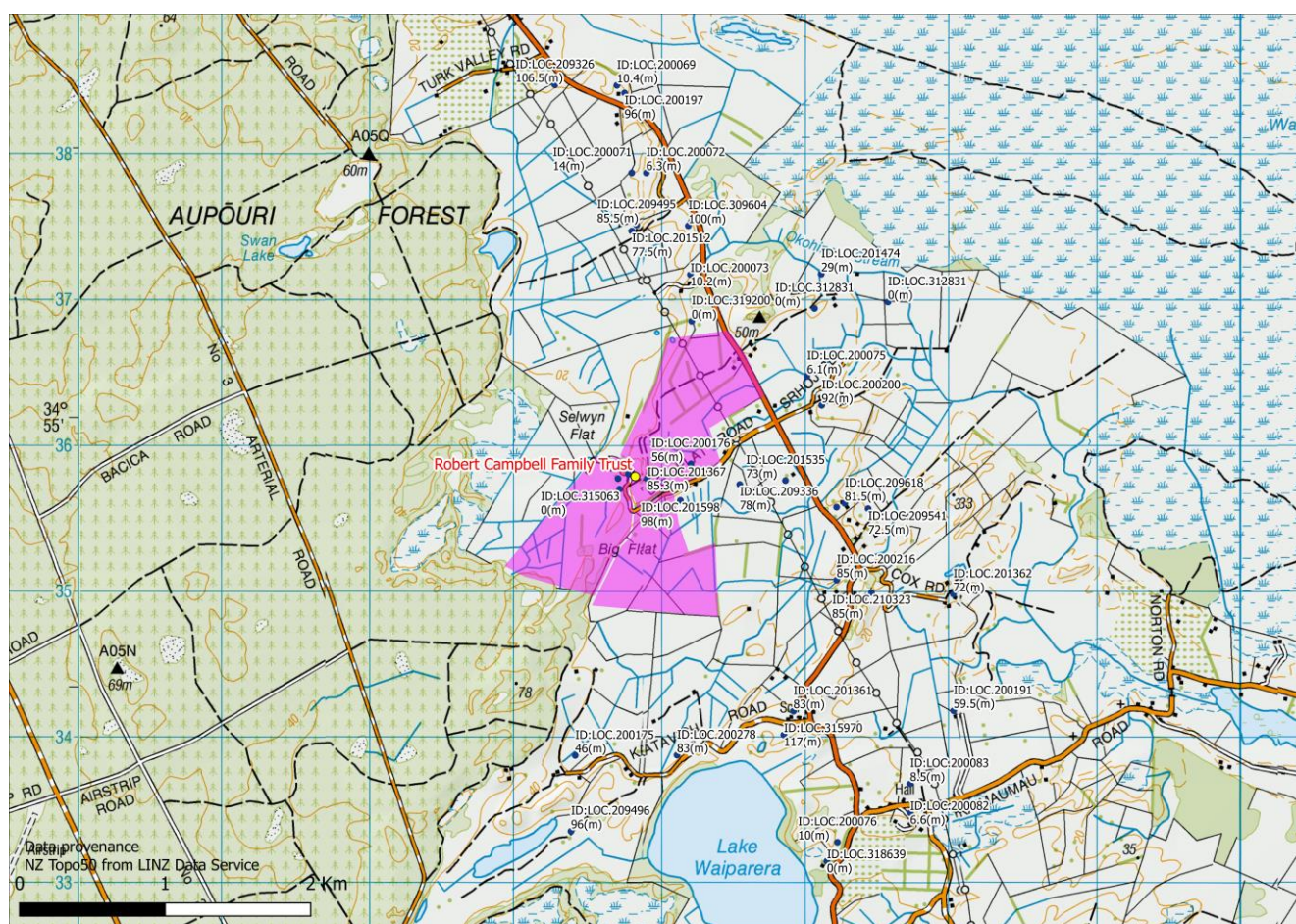


Figure 4. Neighbouring bores within a 2 km radius of the Robert Campbell Family Trust property.



### 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 6** provides an assessment against the relevant documents.

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

- a national environmental standard;
- other regulations;
- a national policy statement;
- a New Zealand coastal policy statement;
- a regional policy statement or proposed regional policy statement;
- 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 3**.

**Table 3. Summary of relevance of Section 104 statutes.**

Statute	Relevance	Requirement of Statute
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 $\pm 5\%$ of the actual volume taken if from a full pipe (e.g. bore)).
National Policy Statement for Freshwater Management 2014	<p>The following objectives and policies of the NPS are relevant to this proposal:</p> <p><i>Water Quality</i></p> <ul style="list-style-type: none"> <li>• Objectives A1, A2, and A4.</li> <li>• Policies A2, A3, and A7.</li> </ul> <p><i>Water Quantity</i></p> <ul style="list-style-type: none"> <li>• Objective B2, B3 and B5.</li> <li>• Policies B2 to B6.</li> </ul> <p><i>Integrated Management</i></p> <ul style="list-style-type: none"> <li>• Objective C1.</li> <li>• Policies C1 and C2.</li> </ul>	<p><i>Water Quality</i></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> </ul>

Statute	Relevance	Requirement of Statute
		<ul style="list-style-type: none"> <li>Objective A4 seeks to enable communities to provide for their economic well-being, including productive economic opportunities.</li> <li>Policies A2, A3, and A7 are considered relevant to this application and give effect to Objectives A1, A2, A4.</li> </ul> <p><i>Water Quantity</i></p> <ul style="list-style-type: none"> <li>Objective B2 seeks to avoid any further over-allocation of fresh water and phase out existing over-allocation.</li> <li>Objective B3 seeks to improve and maximise the efficient allocation and efficient use of water.</li> <li>Objective B5 seeks to provide for communities' economic wellbeing within freshwater quantity limits.</li> <li>Policies B2 to B6 are considered relevant to this proposal.</li> </ul> <p><i>Integrated Management</i></p> <ul style="list-style-type: none"> <li>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.</li> <li>Policies C1 and C2 are relevant to this application and give effect to Objective C1.</li> </ul>
Regional Policy Statement for Northland	<p>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.</p> <p>The following Objectives are considered relevant to this proposal:</p> <ul style="list-style-type: none"> <li>Objective 3.2, 3.3, 3.5, and 3.10.</li> </ul> <p>The following Policies give effect to the above Objectives, and therefore are considered relevant to this application:</p> <ul style="list-style-type: none"> <li>Policy 4.3.2, 4.3.3.</li> </ul>	<ul style="list-style-type: none"> <li>Objective 3.2 seeks to maintain and improve water quality for human use and ecological health.</li> <li>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.</li> <li>Objective 3.5 requires that the region's resources are sustainably managed in a way that is attractive for business and investment that will improve the economic wellbeing of the region and its communities.</li> <li>Objective 3.10 requires efficient use and allocation of common natural resources with a particular focus on maximising the security and reliability of supply for users.</li> <li>Policy 4.3.2 requires regulatory methods to avoid over-allocation of region-wide ecological flows and water levels.</li> <li>Policy 4.3.3 requires the allocation and use of water efficiently within allocation limits.</li> </ul>
Regional Plans	<p>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 September 2017 and closed for submissions on 26 March 2018. The pRPN will replace the Regional</p>	<p>From the pRPN:</p> <ul style="list-style-type: none"> <li>Objective F.0.1 seeks to manage the use, development, and protection of Northland's natural and physical resources which enables people and</li> </ul>

Statute	Relevance	Requirement of Statute
	<p>Water and Soil Plan for Northland (RWSPN), which has been operative since 28 August 2004.</p> <p>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.</p> <p>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.</p> <p>The following objectives and policies of the pRPN are considered relevant to this proposal:</p> <ul style="list-style-type: none"> <li>• Objective F.0.1.</li> <li>• Policy D.2.2.</li> <li>• Policy D.2.5.</li> <li>• Policy D.4.5.</li> <li>• Policy D.4.13.</li> <li>• Policy D.4.17.</li> <li>• Policy D.4.18.</li> <li>• Policy D.4.20.</li> <li>• Policy D.4.23.</li> </ul> <p>The following objectives and policies of the RWSPN are considered relevant to this proposal:</p> <ul style="list-style-type: none"> <li>• Objective 7.4.</li> <li>• Objective 10.4.1.</li> <li>• Policy 10.5.1.</li> <li>• Policy 10.5.2.</li> <li>• Policy 10.5.4.</li> <li>• Policy 10.5.7.</li> <li>• Policy 10.5.9</li> </ul>	<p>communities to provide for their social, economic and cultural well-being while</p> <ol style="list-style-type: none"> <li>1. sustaining the natural resources to meet the reasonable foreseeable needs of future generations,</li> <li>2. safeguarding life-supporting capacities of water, and</li> <li>3. avoiding, remedying, or mitigating adverse effects on the environment.</li> </ol> <ul style="list-style-type: none"> <li>• Policy D.2.2 requires that regard is had to the social, cultural, and economic benefits of the proposed activity when considering resource consents.</li> <li>• Policy D.2.5 requires an authority to have regard to community and tangata whenua values</li> <li>• Policy D.4.5 seeks to maintain overall water quality.</li> <li>• 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).</li> <li>• Policy D.4.17 considers allocation limits for aquifers and requires rules and applications to meet allocation limits</li> <li>• Policy D.4.18 concerns conjunctive surface water and groundwater management.</li> <li>• 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.</li> <li>• Policy D.4.23</li> </ul> <p>From the RWSPN:</p> <ul style="list-style-type: none"> <li>• Objective 7.4 requires the maintenance or enhancement of water quality of natural water bodies.</li> <li>• 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.</li> <li>• 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.</li> </ul>

Statute	Relevance	Requirement of Statute
		<ul style="list-style-type: none"> <li>Policy 10.5.2 recognises that aquifers are at risk in certain circumstances and that adverse effects on water quality should be avoided.</li> <li>Policy 10.5.4 seeks that groundwater allocations take into account reduction in recharge that may occur in time.</li> <li>Policy 10.5.7 requires the Northland Regional Council to consider effects of a groundwater take and use on surface water bodies.</li> <li>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.</li> </ul>

### 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 4**.

**Table 4. Summary of activity status against Regional Plan Provisions.**

Plan	Relevant Rules	Comment
RWSPN	<p>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.”</p> <p>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 m<sup>3</sup>/d and instantaneous rate of 5 L/s per bore.</p>	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	<p>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:</p> <ol style="list-style-type: none"> <li>1) a permitted activity under C.5.1.1 'Minor takes – permitted activity', or</li> <li>2) a permitted activity under C.5.1.2 'Temporary take for road construction or maintenance – permitted activity', or</li> <li>3) a permitted activity under C.5.1.3 'Water take from an off-stream dam – permitted activity', or</li> <li>4) a permitted activity under C.5.1.4 'Water take from an artificial watercourse – permitted activity', or</li> <li>5) a permitted activity under C.5.1.5 'Water take associated with bore development, bore testing or dewatering – permitted activity', or</li> <li>6) a controlled activity under C.5.1.6 'Replacement water permits for registered drinking water supplies - controlled activity', or</li> <li>7) a controlled activity under C.5.1.7 'Takes existing at the notification date of the plan - controlled activity', or</li> </ol>	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 <b>Section 3.3.3</b> does not exceed an allocation limit, therefore the proposed activity constitutes a Discretionary Activity under the pRPN.

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

The Aupouri Peninsula Aquifer is divided into different allocation zones for management purposes. The Robert Campbell Family Trust sits within the Aupouri- Other allocation zone. The allocation limit, current level of allocation and the level of allocation should this consent be granted are shown in **Table 5**.

**Table 5** also considers other applications pending and shows that the granting of this consent and that of Yelavich and Te Raite Station, will increase the allocation status to 2.8% of full allocation.

The proposed take will not exceed the allocation limit, hence under the pNRP this consent maintains Discretionary Activity status.

**Table 5. Aupouri Aquifer Limits<sup>6</sup> and Allocation Status.**

Sub-aquifer	Allocation Limit		Allocation Status (Current)		Allocation Status	
					If Granted: Te Raite Station (157,500), Robert Campbell (360,000) Yelavich (52,000)	
	m <sup>3</sup> /year	% mean annual recharge	m <sup>3</sup> /year	%	m <sup>3</sup> /year	%
Aupouri - Other	21,991,289	15	53,184	0.2 %	622,684	2.8

<sup>6</sup> According to NRC's allocation maps at <http://gis.nrc.govt.nz/LocalMaps-Viewer/?map=895e0785f7054d47b10a72edc38022dc>



## 4. Assessment of Environmental Effects

The proposed Robert Campbell Family trust (360,000 m<sup>3</sup>/year), and three other pending applications including Yelavich take (52,000 m<sup>3</sup>/year), Anton Mathews (12,000 m<sup>3</sup>/year), and Wedding & Doody (304,000 m<sup>3</sup>/year) are located in the Motutangi-Waiharara Groundwater Model (MWGW) domain (WWA, 2017). A further three pending applications including Tiri Avocados Limited (581,250 m<sup>3</sup>/year), Valic NZ Limited (173,700 m<sup>3</sup>/year) and Wataview Orchards (33,750 m<sup>3</sup>/year) are located in the Waiharara-Paparore Model domain (WWA, 2018b).

The cumulative drawdown of all current and pending applications has been evaluated using analytical methods superimposed on the drawdown profile from Tuscany Avocados (WWA, 2018a) and Waiharara-Paparore Groundwater Model (WPGW, WWA, 2018b) - noting that this included the existing takes and newly granted MWWUG (Motutangi – Waiharara Water User Group) takes.

The methodology and results of the groundwater and surface water impact analysis are detailed in **Appendix B**.

### 4.1 Pumping Interference Effects

Drawdown due to proposed take was analysed using Theis (1935) and Feather & Williamson Solution (Unpublished)<sup>7</sup>. A maximum additional drawdown from Robert Campbell Family Trust ranging between 10.0 m (Feather & Williamson) and 13.4 m (Theis) was estimated in the deep aquifer adjacent to the pumping bore location. A drawdown of 0.18 m was calculated in the shallow aquifer near the pumping bore with the Feather & Williamson Solution.

The superimposition of the Feather & Williamson Solution onto the conservative drawdown from Tuscany (WWA, 2018a) and WPGW (WWA, 2018b) shows that the proposed take induced an additional drawdown of up to 0.1 m for two bores in the Covich property. For bores within 5 km radius, the cumulative drawdown ranged from 1.6 m to 3.0 m.

The interference effects on existing groundwater uses considering the available drawdown of the aquifer is considered less than minor.

### 4.2 Surface Water Effects

As discussed in **Appendix B**, the potential surface water features that may be impacted by the proposed take including:

- Selwyn drain to northwest (0.3 km);
- Unnamed swamp to northwest (0.7 km);
- Unnamed drain to south (1.4 km);
- Okohine stream to northeast (1.8 km);
- Lake Waiparera to southeast (2.0 km);
- Kaimaumau wetland to northeast (2.3 km); and
- Lake Waikaramu to east (5.2 km).

The maximum additional drawdown in the shallow aquifer is less than 0.2 m. The drawdown in the shallow aquifer ranged between 0.3 m to 0.4 m in this area. This drawdown in porous media would translate to an insignificant impact within the standing or flowing water body.

The findings of the MWGM were accepted with respect to impacts on the wetland (and by inference surface waters) with the Commissioners indicating in paragraph 153, “our view is that there are many influences on the

<sup>7</sup> Feather & Williamson solution a multi-layer model based on Hemker and Mass (1987) and Hunt and Scott (2007).

wetland that are far greater than the MWWUG abstractions". Given that the additional impacts predicted from this bore are similarly negligible, the same conclusion can be drawn.

Considering that the additional impact predicted from the proposed take is negligible, the same conclusion can be drawn.

The impact on surface water due to proposed abstract in deep aquifer will be less than minor.

#### 4.3 Saline Intrusion

The risk of saltwater/freshwater interface upconning and lateral migration was in **Appendix B.3.1** based on the analysis conducted in MWGW report (Section 5.2.6, WWA, 2017).

Due to the existence of low permeable bedrock underlying the deep shellbed aquifer, saltwater lateral migration along the base of the shellbed is a more likely mechanism of saltwater intrusion. The proposed take is located in the central sand area. As detailed in **Appendix B**, the additional drawdown is unlikely to change the potential saltwater lateral migration profile at the sentinel locations assessed from MWGW report (WWA, 2017)

The impact on saltwater intrusion due to proposed take will be less than minor.

#### 4.4 Ground Settlement

The potential maximum ground settlement was estimated from the cumulative drawdown in **Appendix B**.

Within 1.5 km of proposed take, the estimated cumulative subsidence is 0.03 m, with a maximum drawdown of 0.38 m and 3.53 m in shallow and deep aquifer, respectively. 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 Northland Regional planning framework. With reference to the effects from horticultural sprays the Commissioners for the MWWUG 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**

Northland Regional Council have an internal procedure where they circulate all applications to local Iwi and Maori Groups that have registered with the Council as having an interest in the area. If a local Iwi or Maori Group is considered to be affected by the effects of the proposed activity the Group must be notified as part of the consultation process.

The proposed groundwater abstraction lies within the rohe of Te Aupōuri, Ngāti Kurī, and Ngāi Takoto iwi. Consultation with these iwi has not been carried out stage based on the understanding that if physical effects of an application are less than minor, then any meta-physical (cultural and spiritual) effects would commensurately also be less than minor.

In this rohe we are aware that at least two of the three iwi groups have recently lodged applications for water takes, and we are aware of a third planning to do so. That signals that the taking of water itself is not an activity that iwi are adverse too.

Therefore, given the less than minor impact of this proposal, we do not consider iwi consultation is necessary for this application.

## 6. Assessment Of Statutory Considerations

**Table 6 to Table 9** 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 6. Assessment against relevant objectives and policies for the National Policy Statement for Freshwater Management 2014.**

No.	Objective / Policy	Assessment
Water Quality		
Objective A1	<ul style="list-style-type: none"><li>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.</li></ul>	This proposal is consistent with these objectives and policies and either supports them or at the least maintains them.
Objective A2	<ul style="list-style-type: none"><li>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.</li></ul>	
Objective A4	<ul style="list-style-type: none"><li>Seeks to enable communities to provide for their economic well-being, including productive economic opportunities.</li></ul>	
Policies A2, A3, and A7	<ul style="list-style-type: none"><li>Give effect to Objectives A1, A2, A4</li></ul>	
Water Quality		
Objective B2	<ul style="list-style-type: none"><li>Seeks to avoid any further over-allocation of fresh water and phase out existing over-allocation.</li></ul>	This proposal is consistent with these objectives and policies.
Objective B3	<ul style="list-style-type: none"><li>Seeks to improve and maximise the efficient allocation and efficient use of water.</li></ul>	
Objective B5	<ul style="list-style-type: none"><li>Seeks to provide for communities' economic wellbeing within freshwater quantity limits.</li></ul>	
Policies B2 to B6	<ul style="list-style-type: none"><li>Give effect to Objectives B2 to B5.</li></ul>	
Integrated Management		





No.	Objective / Policy	Assessment
Objective C1	<ul style="list-style-type: none"> <li>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.</li> </ul>	This proposal is consistent with these objective and policies.
Policies C1 and C2	<ul style="list-style-type: none"> <li>Give effect to Objective C1.</li> </ul>	

**Table 7. Assessment against relevant objectives and policies for the Regional Policy Statement for Northland.**

No.	Objective / Policy	Comment
Objective 3.2	<ul style="list-style-type: none"> <li>Seeks to maintain and improve water quality for human use and ecological health.</li> </ul>	This proposal is consistent with this objective as it will at the least maintain water quality.
Objective 3.3	<ul style="list-style-type: none"> <li>Seeks to safeguard the flows and flow variability required to maintain water's life-supporting capacity, for ecological processes, and to support indigenous species.</li> </ul>	The proposal is consistent with this objective as it will have a no more than minor impact on surface water resources.
Objective 3.5	<ul style="list-style-type: none"> <li>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.</li> </ul>	The proposal is consistent with this objective as it will efficiently utilise a natural resource to facilitate development of economic wellbeing.
Objective 3.10	<ul style="list-style-type: none"> <li>Requires efficient use and allocation of common natural resources with a particular focus on maximising the security and reliability of supply for users.</li> </ul>	The proposal is consistent with this objective.
Policy 4.3.2	<ul style="list-style-type: none"> <li>Requires regulatory methods to avoid over-allocation of region-wide ecological flows and water levels.</li> </ul>	The proposal does not exceed allocation limits, hence is consistent with this policy.
Policy 4.3.3	<ul style="list-style-type: none"> <li>Requires the allocation and use of water efficiently within allocation limits.</li> </ul>	The proposal will use water efficiently and will not exceed allocation limits, hence is consistent with this policy.



**Table 8. Assessment against relevant objectives and policies for the Proposed Regional Plan for Northland.**

No.	Objective / Policy	Comment
Objective F.0.1	<ul style="list-style-type: none"> <li>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               <ol style="list-style-type: none"> <li>sustaining the natural resources to meet the reasonable foreseeable needs of future generations,</li> <li>safeguarding life-supporting capacities of water, and</li> <li>avoiding, remedying, or mitigating adverse effects on the environment.</li> </ol> </li> </ul>	The proposal is consistent with this objective.
Policy D.2.2	<ul style="list-style-type: none"> <li>Requires that regard is had to the social, cultural, and economic benefits of the proposed activity when considering resource consents.</li> </ul>	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	<ul style="list-style-type: none"> <li>Requires an authority to have regard to community and tangata whenua values</li> </ul>	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	<ul style="list-style-type: none"> <li>Seeks to maintain overall water quality</li> </ul>	This proposal is consistent with this policy as it will not impact water quality.
Policy D.4.13	<ul style="list-style-type: none"> <li>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).</li> </ul>	This proposal is consistent with this policy as it will avoid the saline intrusion and subsidence impacts, as discussed in <b>Section 4.3 and 4.4.</b>
Policy D.4.17	<ul style="list-style-type: none"> <li>Considers allocation limits for aquifers and requires rules and applications to meet allocation limits.</li> </ul>	This proposal is consistent with this policy as the proposed take will not exceed allocation limits within the Aupouri-Motutangi zone.
Policy D.4.18	<ul style="list-style-type: none"> <li>Concerns conjunctive surface water and groundwater management.</li> </ul>	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	<ul style="list-style-type: none"> <li>Requires the reasonable and efficient use of water for irrigation and sets requirements for a resource consent application to take water for irrigation purposes.</li> </ul>	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	<ul style="list-style-type: none"> <li>Requires conditions on water permits that               <ol style="list-style-type: none"> <li>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</li> <li>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</li> <li>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</li> <li>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</li> <li>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</li> <li>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.</li> </ol> </li> </ul>	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 9. Assessment against relevant objectives and policies for the Regional Water and Soil Plan for Northland.**

No.	Objective / Policy	Comment
Objective 7.4	<ul style="list-style-type: none"> <li>Requires the maintenance or enhancement of water quality of natural water bodies.</li> </ul>	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 <b>Section 4.2</b> .
Objective 10.4.1	<ul style="list-style-type: none"> <li>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.</li> </ul>	Ditto above.
Policy 10.5.1	<ul style="list-style-type: none"> <li>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.</li> </ul>	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	<ul style="list-style-type: none"> <li>Recognises that aquifers are at risk in certain circumstances and that adverse effects on water quality should be avoided.</li> </ul>	This proposal is consistent with this policy in that current water quality will be maintained.
Policy 10.5.4	<ul style="list-style-type: none"> <li>Seeks that groundwater allocations take into account reduction in recharge that may occur in time.</li> </ul>	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	<ul style="list-style-type: none"> <li>Requires the Northland Regional Council to consider effects of a groundwater take and use on surface water bodies.</li> </ul>	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 <b>Section 4.2</b> .
Policy 10.5.9	<ul style="list-style-type: none"> <li>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.</li> </ul>	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 <b>Section 4.4</b> .

## **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.

## **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 and occupiers of the land 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 4.1** concludes that no other groundwater users are considered to be adversely affected by the granting of this application.



## **9. Summary and Conclusions**

Robert Campbell Family Trust own an orchard at 134 Big Flat Rd, Waiharara and are seeking a groundwater take to facilitate the development of the orchard with a total area of 134 ha

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

- Maximum daily volume of 3,350 m<sup>3</sup>/day; and
- Maximum annual volume of 360,000 m<sup>3</sup>/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 approximately 2.8% 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 MWWUG consent applications, the consent should proceed without public notification and be granted on a non-notified basis.

## **10. References**

Feather and Williamson (currently unpublished). An Analytical Tool for Drawdown Analysis in Multi-Layered Aquifer Systems. (App soon to be publicly available on [www.wwa.kiwi](http://www.wwa.kiwi))

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## **Appendix A. Form A - Application For Resource Consent**

## Appendix B. Environmental Impact Analysis

### B.1 Drawdown analysis

The drawdown analysis was conducted based on the peak daily groundwater take of 3,350 m<sup>3</sup>/day, which will be applied to Total Orchard Area development of 134 ha. The drawdown was evaluated after 108-days of pumping at the maximum rate, which equates to a total volume of 361,800 m<sup>3</sup> at the end of the irrigation season. The drawdown impact was analysed using:

- **Theis Solution:** Analytical solution to compute drawdown in abstraction layer with a confined non-leaky condition.
- **Feather & Williamson Solution:** Analytical solution to compute drawdown in a multi-layer aquifer system considering elastic storage within layers.

The hydrogeological parameters of the abstraction layer were sourced from relevant pumping test data in the region, shown in **Table B1**.

**Table B1. Summary of hydrogeological parameters of shellbed analysed from pumping test data.**

Bore	Screen depth	Depth	Lithology	Transmissivity	Thickness	Specific storage	Leakance	Analysis method	Source
	mBGL	mBGL		m <sup>2</sup> /day	m	m <sup>-1</sup>	d	-	
King Avo1	110.5	-	Shell	305	26	2.7x10 <sup>-5</sup>	0.0003	-	Aupouri Aquifer Groundwater Model (Lincoln AgriTech, 2015)
King Avo2	110.5	-	Shell	370	17	6.5 x10 <sup>-5</sup>	0.0003	-	
184	101	110	Shelly sand	140-340	-	-	-	-	Aupouri Aquifer Sustainable Yield Groundwater Modelling Study (HydroGeo Solutions, 2000)
SKM101b	84.5-100	100	Sand/shell	496	15.5	-	-	-	King Avocado Orchard Groundwater Take Consent Application (AEE Final) (SKM, 2007b)
SKM102b	112-122	122	Sand/shell	130	10	-	-	-	
SKM103b	114-124	124	Sand/shell	300	10	-	-	-	
SKM104b	82-94	94	Sand/shell	444	12	-	-	-	
Stanisich Pumping bore	87-101	-	Shell	485	14	-	-	Single well Jacob	Motutangi-Waiharara Groundwater Model Factual Technical Report – Modelling. (Williamson Water Advisory, 2017)
				512		-	-	Theis Recovery	
				471		-	-	Single well Jacob leaky solution	
Stanisich Monitoring bore	77-85	-	Shell	356	8	4.4 x10 <sup>-3</sup>	-	Theis (point match)	
				138		1.6 x10 <sup>-4</sup>	0.00183	Hantush-Jacob	
				408		3.0x10 <sup>-4</sup>	0.00135	Hantush-Jacob	
				348		3.1x10 <sup>-4</sup>	0.000736	Hantush-Jacob	

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Bore	Screen depth	Depth	Lithology	Transmissivity	Thickness	Specific storage	Leakance	Analysis method	Source
	mBGL	mBGL		m <sup>2</sup> /day	m	m <sup>-1</sup>	d	-	
Honeytree Pumping bore	62-68,68-71,84-93	-	Shell	618	18	-	-	Single well Jacob	
				511		-	-	Theis Recovery	
Honeytree Monitoring bore	63-69,69-72,86-95	-	Shell	751	18	3.0x10 <sup>-4</sup>	-	Theis (point match)	
				784		3.0x10 <sup>-4</sup>	-	Cooper Jacob	
				579		1.6x10 <sup>-5</sup>	0.00015	Hantush-Jacob	
				484		2.2x10 <sup>-5</sup>	0.000284	Hantush-Jacob	
				707		1.7x10 <sup>-5</sup>	0.0000509	Hantush-Jacob	
De Bede Pumping bore	91-97	-	Shell	377	6	-	-	Single well Jacob	
				363				Theis Recovery	
				273					
Minimum				130	6	1.6 x10 <sup>-5</sup>	5.1x10 <sup>-5</sup>		
Median				444	14	1.6x10 <sup>-5</sup>	3.0x10 <sup>-4</sup>		
Average				444	14	5.4x10 <sup>-4</sup>	6.3x10 <sup>-4</sup>		
Maximum				784	26	4.4x10 <sup>-3</sup>	1.8x10 <sup>-3</sup>		

### B.1.1 Theis Drawdown Solution

The median aquifer hydraulic property values from **Table B1** were used to represent the deep shellbed aquifer. The estimated drawdown after 108-days of pumping at various distance from pumping bore is shown in **Figure B1**. A maximum drawdown of 13.4 m was simulated near the pumping location.

Due to the existence of discrete low-permeable geological materials (e.g. iron pan, silt, peat), the regional aquifer is a leaky confined system, showing a progressive confinement with depth. The confined (non-leaky) condition of the Theis solution will lead to an appropriately conservative overestimation of drawdown in the deep shellbed.

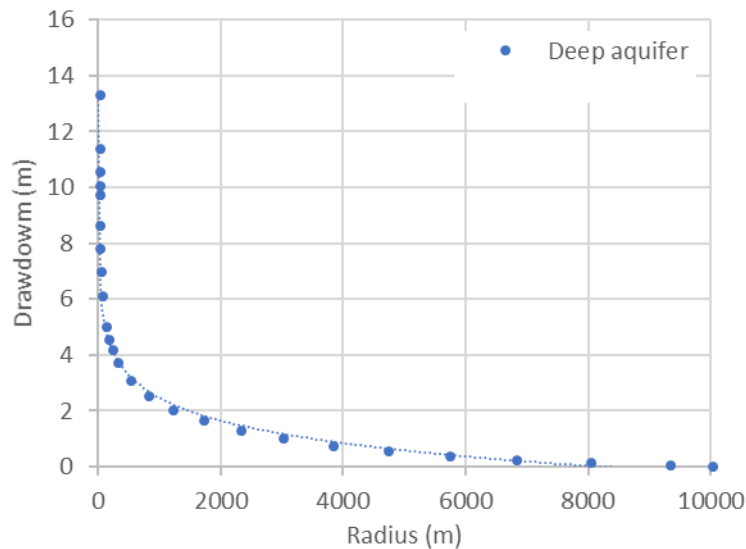


Figure B1. Calculated drawdown of abstraction layer (Theis).

### B.1.2 Feather & Williamson Solution

Feather and Williamson (unpublished) developed a solution for drawdown calculation in a multi-layer aquifer system considering elastic storage, which by coincidence was an extension of the solution by Hemker and Maas (1987) for unsteady flow to well in layered aquifer systems, and an extension of the solution by Hunt and Scott (2007) for two-layered systems. By assigning the hydrogeologic parameters and thicknesses of individual layers, drawdown is calculated for each individual layer using an inversion of Laplace transformation of the groundwater flow equation.

A 6-layer single well pumping model was setup, and the hydrogeologic parameters of Layer 1 to Layer 5 were sourced from the MWGM (WWA,2017), with the hydrogeologic parameters for the shellbed (Layer 6) taken as the median value from **Table B1**, as shown in **Table B2**.

Table B2. Hydrogeologic parameterisation in the Feather and Williamson model.

Layer	Transmissivity (m <sup>2</sup> /day)	Horizontal hydraulic conductivity (m/s)	Vertical anisotropy (-)	Storativity (-)	Layer thickness (m)
1	140	4.05E-05	80	2.50E-01	40
2	75	3.47E-05	80	1.25E-02	25
3	60	3.47E-05	80	1.00E-02	20
4	210	3.47E-04	1	1.12E-02	7
5	18	6.94E-05	30	1.50E-03	3
6	444	3.67E-04	1	2.17E-03	14



The estimated drawdown in the deep and shallow aquifer is shown in **Figure B2**. At a radius of 0.1 m from the pumping bore, drawdown of 10.0 m and 0.18 m were calculated for the deep and shallow aquifer, respectively.

The calculated drawdown extent and magnitude from Feather and Williamson Solution is less than from the Theis Solution, due to the vertical leakance simulated in the model. The drawdown estimated from Feather and Williamson Solution is considered a more realistic solution for leaky-confined aquifer systems, nevertheless the Theis Solution has value as an upper range estimate and therefore conservative approximation.

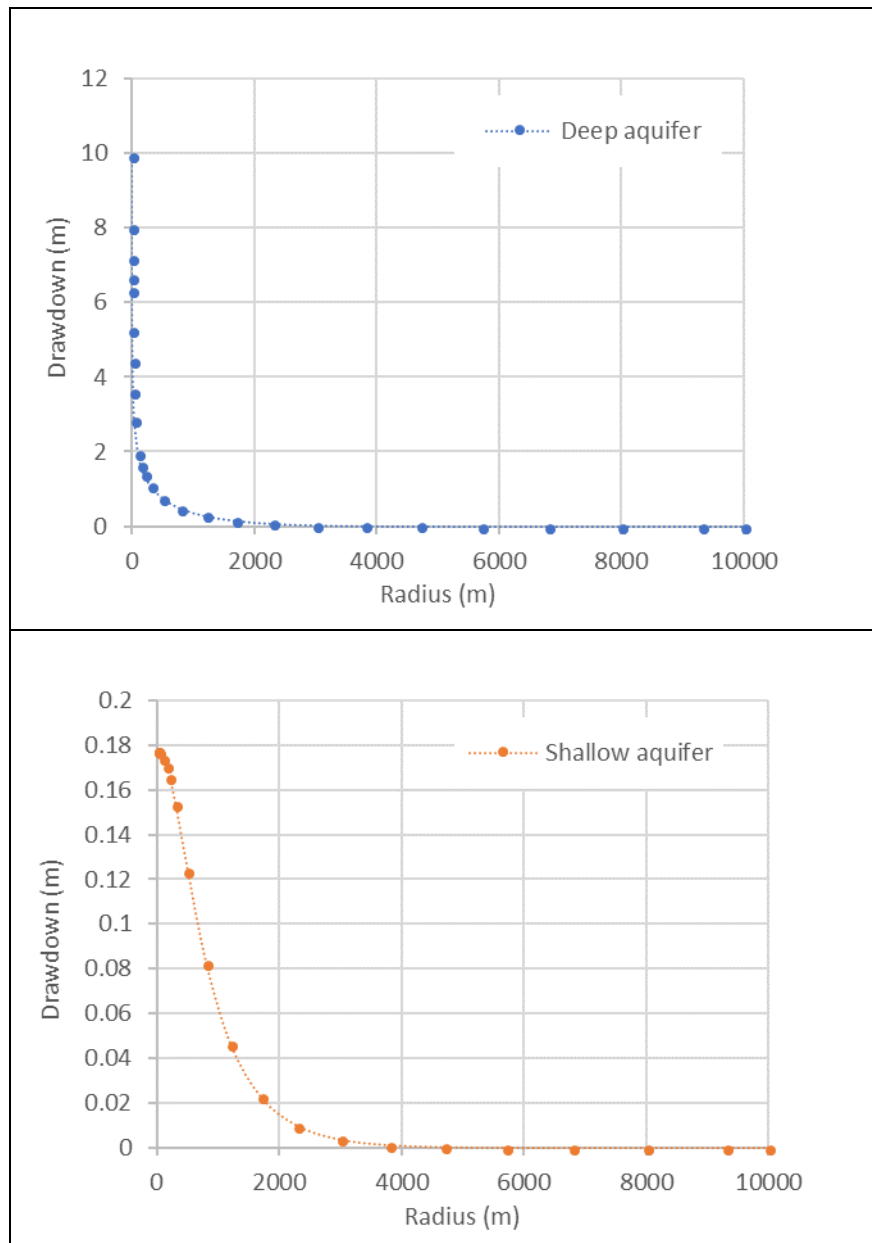


Figure B2. Estimated drawdown in deep aquifer and shallow aquifer (Feather & Williamson).

## B.2 Cumulative Impact

The cumulative impact was assessed based on Robert Campbell Family Trust take and other consents that are in different consenting and application stages in the region, and these are shown in **Table B3**

**Table B3. Irrigation takes included in the cumulative impact analysis.**

Category	Irrigation takes	Daily rate (m <sup>3</sup> /day)
Consented irrigation takes	Motutangi - Waiharara Water User Group Consents and other active consents	16,775*
Consent lodged	Tuscany irrigation take	375
	Tiri Avocados Limited	3,876
	Valic NZ Limited	1,158
	Wataview Orchards	225
Consent in application	Anton Matthews	94
	Mate Yelavich Co Ltd	450
	Wedding and Doody	2,375
	<b>Robert Campbell Family Trust</b>	<b>3,350</b>

\*This is retrieved from Scenario 2 MWGW (WWA,2017)

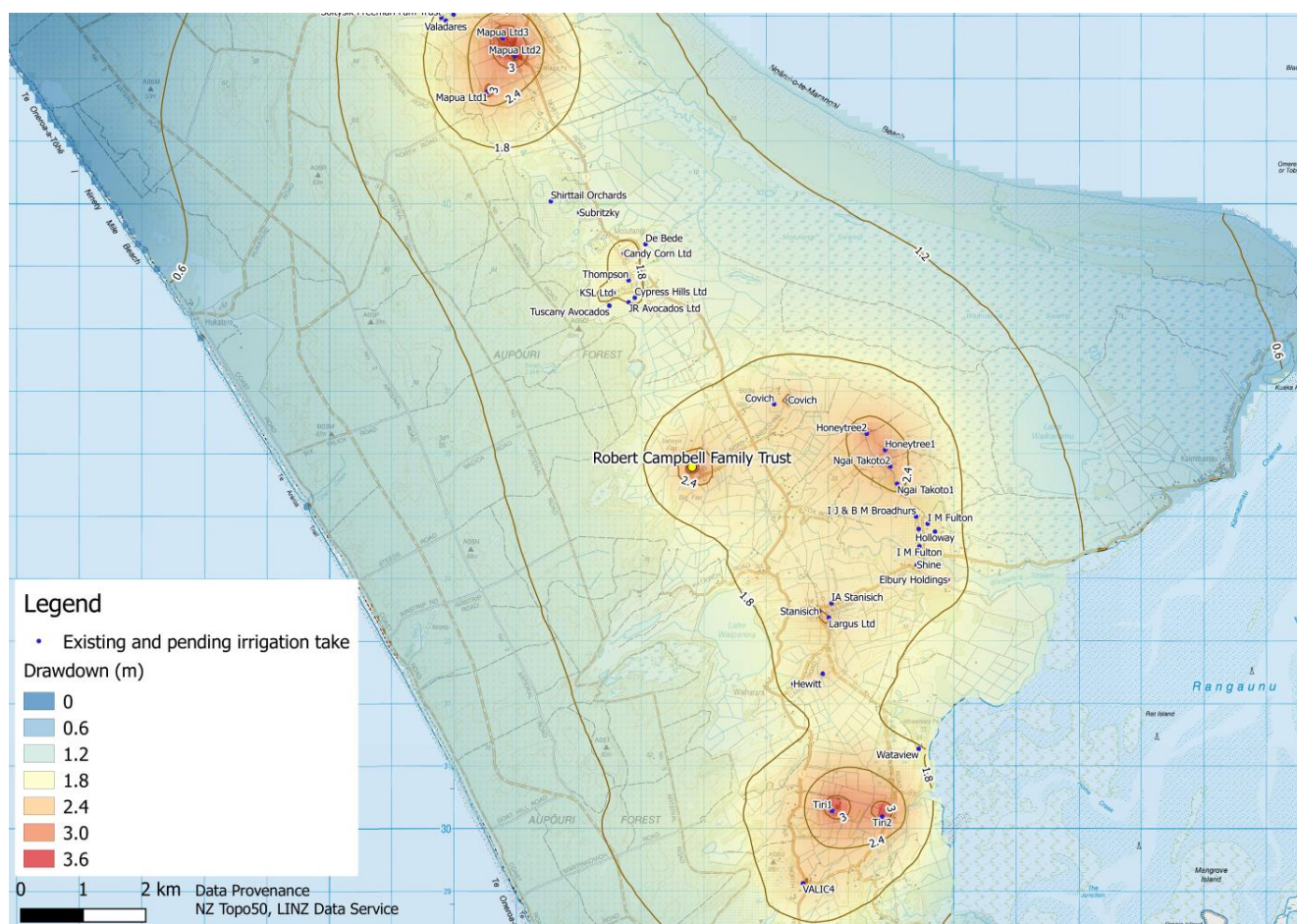
The cumulative impact was assessed by overlying the estimated drawdown from MWGW (WWA,2017), Tuscany (WWA,2018a), WPGW ( WWA, 2018b) and simulated drawdown from the four consents in pending application process shown in **Table B3**. The drawdown profile from MWGW,Tuscany and ,WPGW together is referred as base drawdown below. The drawdown simulation selected are shown in **Table B4**, representing the conservative drawdown assessment with respect to shallow and deep aquifers.

**Table B4. Selected drawdown simulation for cumulative impact assessment.**

Aquifer	Base drawdown simulation	Additional drawdown
Deep aquifer - Feather & Williamson	MWGW Scenario 4c + WPGW Scenario 4c + Tuscany Layer 6 Feather & Williamson drawdown	Feather & Williamson L6 drawdown
Shallow aquifer - Feather & Williamson	MWGW Scenario 2 + WPGW Scenario 2 + Tuscany Layer 1 Feather & Williamson drawdown	Feather & Williamson L1 drawdown

Based on the cumulative drawdown in deep aquifer shown in **Figure B3**, the drawdown was analysed at each neighbouring bore that are within 5 km radius, shown in **Table B5**.

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**Figure B3. Cumulative drawdown of Deep aquifer – Feather & Williamson**

According to the Feather and Williamson analysis, the proposed take will induce additional drawdown of up to 0.1 m for two bores in Covich property. Significant additional drawdown was not observed for other existing bores due to their greater geographic distance from the proposed take. The cumulative drawdown ranging from 1.6 m to 3.0 m was observed for bores that are within 5 km radius.

The cumulative drawdown in the shallow aquifer is shown in **Figure B4**. The maximum additional drawdown in the shallow aquifer is less than 0.2 m near the Campbell proposed take, shown in **Figure B2**. A maximum cumulative drawdown of 0.4 m was simulated in the area close to Campbell bore location.

**Table B5. Drawdown estimated for existing groundwater take locations.**

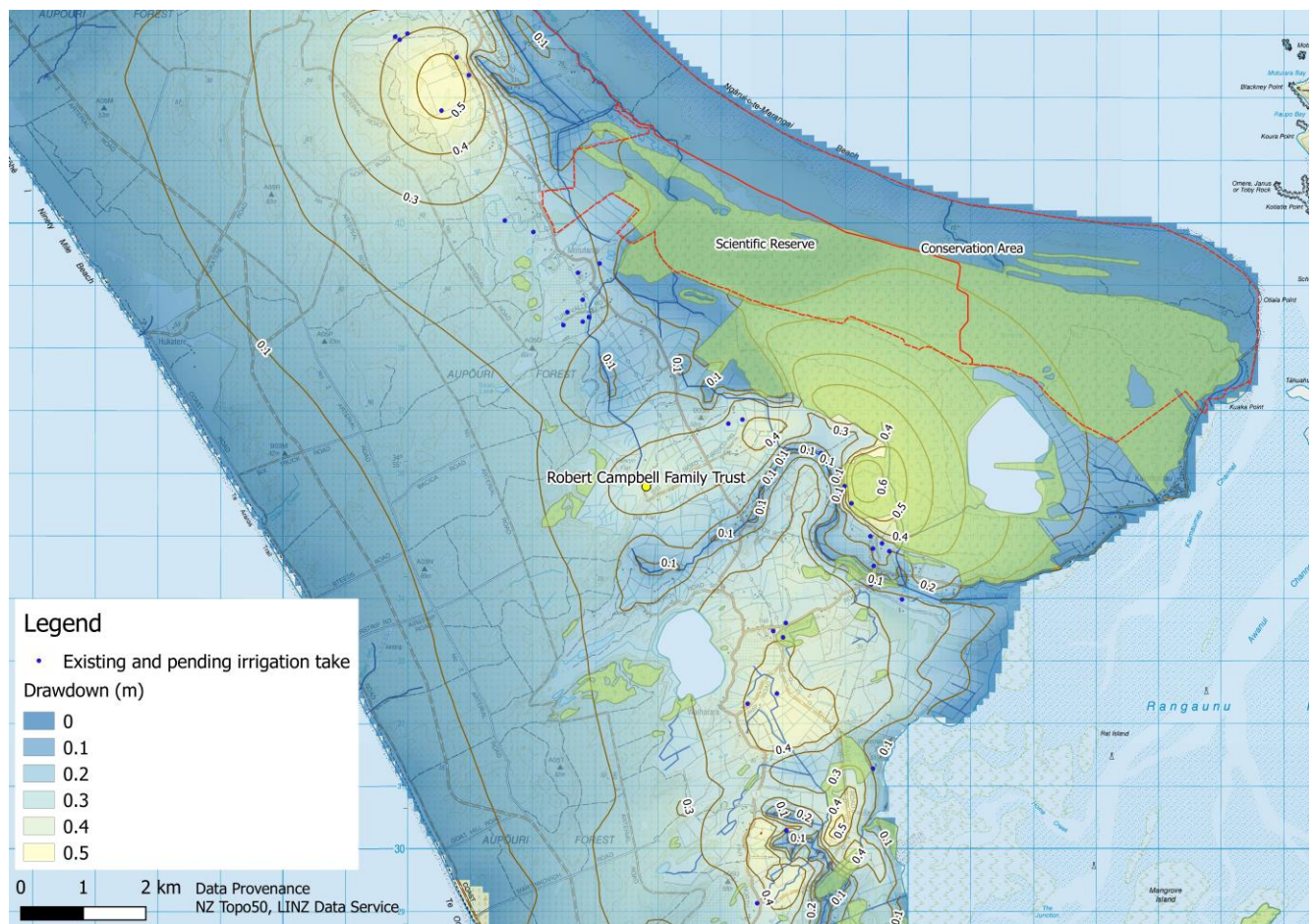
Neighbouring Bore	Distance from Campbell Bore (km)	Base drawdown	Cumulative drawdown	Additional drawdown
		MWGW Scenario 4c + WPGW Scenario 4c + Tuscany Layer 6 Feather & Williamson drawdown	Deep aquifer - Feather & Williamson	Feather & Williamson
Covich1	1.7	2.2	2.4	0.1
Covich2	1.9	2.8	2.9	0.1

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Neighbouring Bore	Distance from Campbell Bore (km)	Base drawdown	Cumulative drawdown	Additional drawdown
		MWGW Scenario 4c + WPGW Scenario 4c + Tuscany Layer 6 Feather & Williamson drawdown	Deep aquifer - Feather & Williamson	Feather & Williamson
JR Avocados Ltd	2.8	1.9	1.9	0.0
Honeytree2	2.8	3.0	3.0	0.0
Cypress Hills Ltd	2.9	1.8	1.9	0.0
KSL Ltd	3.1	1.8	1.8	0.0
Tuscany	3.1	1.7	1.8	0.0
Stanisich	3.1	2.2	2.3	0.0
Honeytree1	3.1	3.0	3.0	0.0
IA Stanisich	3.1	2.0	2.1	0.0
Thompson	3.2	1.9	1.9	0.0
Ngai Takoto2	3.2	2.8	2.8	0.0
Largus Ltd	3.3	2.2	2.2	0.0
Ngai Takoto1	3.3	2.5	2.5	0.0
Candy Corn Ltd	3.6	2.0	2.0	0.0
De Bede	3.6	1.7	1.7	0.0
I J & B M Broadhurs	3.7	2.1	2.1	0.0
J P Broadhurst	3.8	2.0	2.1	0.0
Hewitt	3.8	2.1	2.1	0.0
I M Fulton	3.9	2.0	2.0	0.0
I M Fulton	3.9	2.0	2.0	0.0
Shine	3.9	2.2	2.2	0.0
Holloway	4.0	2.0	2.0	0.0
Subritzky	4.5	1.6	1.6	0.0
Elbury Holdings	4.5	2.0	2.0	0.0
Shirttail Orchards	4.8	1.6	1.6	0.0



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**Figure B4. Cumulative drawdown of shallow aquifer - Feather & Williamson**

### **B.3 Surface Water Impact**

The surface water features in the area adjacent to Robert Campbell Family Trust are shown on **Figure B4** and include:

- Selwyn drain to northwest (0.3 km);
- Unnamed swamp to northwest (0.7 km);
- Unnamed drain to south (1.4 km);
- Okohine stream to northeast (1.8 km);
- Lake Waiparera to southeast (2.0 km);
- Kaimaumau wetland to northeast (2.3 km); and
- Lake Waikaramu to east (5.2 km).

The maximum additional drawdown near the proposed take in the shallow aquifer is less than 0.2 m. The drawdown in this area ranged between 0.3 m to 0.4 m. This magnitude of drawdown in the porous media would translate to a even smaller impact within the standing or flowing water body.

As a lake perching above the regional aquifer, Lake Waiparera is hydrological disconnected with the regional aquifer. The groundwater take in the deep aquifer is unlikely to induce any change in the hydrologic functionality of the lake.

The findings of the MWGM were accepted with respect to impacts on the wetland (and by inference surface waters) with the Commissioners indicating in paragraph 153, “our view is that there are many influences on the wetland that are far greater than the MWWUG abstractions”. Given that the additional impacts predicted from this bore are similarly negligible, the same conclusion can be drawn.

Therefore, the proposed take for the deep aquifer is unlikely to pose significant impact on the surficial hydrological features.

### **B.3.1 Saltwater intrusion**

Saltwater potential upconing and lateral migration were analysed in MWGW report (Section 5.2.6, WWA,2017) using Ghyben-Herzberg analytical solution. Due to the existence of low permeable bedrock underlying the deep shellbed aquifer, saltwater lateral migration along the base of the shellbed is a more likely mechanism of saltwater intrusion.

The proposed take is located in the central sand area. The nearest coastline is approximate 4.3 km away that is located southeast of the proposed take. The simulated groundwater level at coastal sentinel location of 63 – 65 shown in Figure 42 and Figure 43 in MWGW report (Section 5.2.6, WWA, 2017) indicated an average pressure of 7 mAMSL, which is above the minimum pressure (2 mAMSL) to prevent the saltwater lateral migration inland. The conservative non-leaky solution, shown in **Figure B3**, indicated a cumulative drawdown of less than 2 m at the nearest coastal locations under the extremely dry condition. The proposed take is unlikely to change the potential saltwater lateral migration profile from that assessed in MWGW report (WWA,2017).

### **B.3.2 Ground Settlement**

Groundwater settlement was calculated using the Bouwer (1977)<sup>8</sup> 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<sup>3</sup> (Silty sand density ranges between 1,410 kg/m<sup>3</sup> and 2,275 kg/m<sup>3</sup><sup>9</sup>, corresponding to specific weight of 14 kN/m<sup>3</sup> and 22 kN/m<sup>3</sup>)
- Specific weight of water = 9.81 kN/m<sup>3</sup>.

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

<sup>8</sup> 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.

<sup>9</sup> Density ranges for different soil types: [http://structx.com/Soil\\_Properties\\_002.html](http://structx.com/Soil_Properties_002.html)



conceptual hydrogeological units of the sub-surface environment, and the parameter values used are shown in **Table B5**, which were selected from the elasticity values referenced in **Table B6**.

**Table B5. Elasticity and depth of each zone for subsidence estimate.**

Stratigraphy	Total depth	Modulus of elasticity (kPa)*
Silty sand (unsaturated zone)	5	10,000
Silty sand (saturated zone)	70	20,000
Shellbed (saturated zone)	25	50,000

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

**Table B6. Modulus of elasticity [E] for unconsolidated materials (Bouwer, 1977).**

Material	E (kg/cm <sup>2</sup> )	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

The cumulative drawdown profile is an overlap of cone of depressions from proposed take and adjacent MWWUG takes. The drawdown magnitude around the proposed take will not attenuate as a circular pattern. Therefore, maximum cumulative drawdown was extracted within a 1.5 km radius of the proposed take, and the estimated maximum subsidence was calculated by combining the Feather and Williamson analysis for the shallow aquifer with the Theis analysis for the deep aquifer, as shown in **Table B7**.

**Table B7. Calculated subsidence (m) within 1.5 km of the pumping bore.**

Scenario	Shallow aquifer - Feather and Williamson	Deep aquifer - Feather and Williamson-
<b>Drawdown (m)</b>	0.38	3.53
Unit 1. Sand (unsaturated)	$1.2 \times 10^{-4}$	
Unit 2. Sand (saturated)	$1.1 \times 10^{-2}$	
Unit 3. Shellbed (saturated)		$1.4 \times 10^{-2}$
Maximum Cumulative	0.03	

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Within 1.5 km of proposed take, the estimated cumulative subsidence is 0.03 m, with a maximum drawdown of 0.38 m and 3.53 m in shallow and deep aquifer, respectively. 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.