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Aupouri Aquifer Groundwater Take Consent Applications

Assessment of Environmental Effects

AUPOURI AQUIFER WATER USER GROUP

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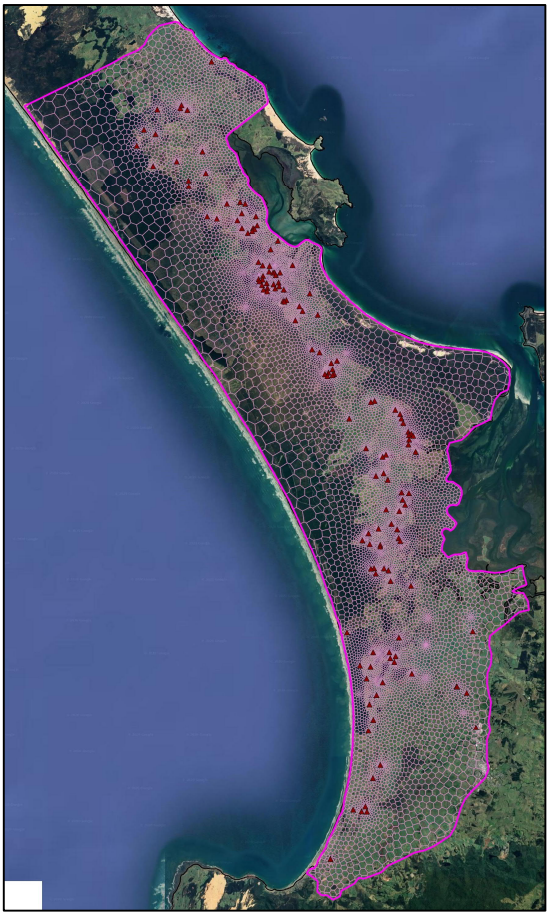
10 February 2020



Aupouri Aquifer Groundwater Take Consent Applications - AEE

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Contents

1. Introduction

This document comprises an assessment of hydrological effects for 24 proposed groundwater takes for which applications are currently pending with NRC. Williamson Water & Land Advisory (WWLA) has provided support for 23 of these applications, which has entailed the development of a transient groundwater flow model that has been used to assess the degree of impact on hydrological systems that is likely to occur if the consents are to be granted. Complete documentation of model development and calibration is provided in a separate report (WWLA, 2020).

A LIDAR survey was commissioned by NRC in 2019 and the resulting data improved resolution of land surface elevation data over the entire model area from ±8 to ±1 m. This improvement propagated to underlying layers of the model because the model base elevation and layer interfaces were generated by an interpolation of data obtained from bore logs distributed over the Aupouri Peninsula. As a result, the elevation data defining the model domain was adjusted based on the LIDAR survey data and model calibration was revised accordingly. This resulted in an improvement in model calibration, reducing RMSE from 1.89 m to 1.31 m.

Following the completion of model calibration, scenarios were run to assess groundwater conditions with current pumping demand, pumping demand with all proposed groundwater takes included, and a naturalised condition where there is no groundwater pumping. This document summarises the findings of this assessment and is intended to supersede model assessments completed prior to the incorporation of LIDAR data into the model design.

1.1 Report Structure

The report comprises:

- **Section 2** – a description of the proposed activity;
- **Section 3** – an assessment of environmental effects;
- **Section 4** – summary and conclusions.

2. Description of Proposed Activity

2.1 Location

Figure 1 provides a map of the project area and shows the locations of the bores proposed to be implemented for the 24 current groundwater take applications.

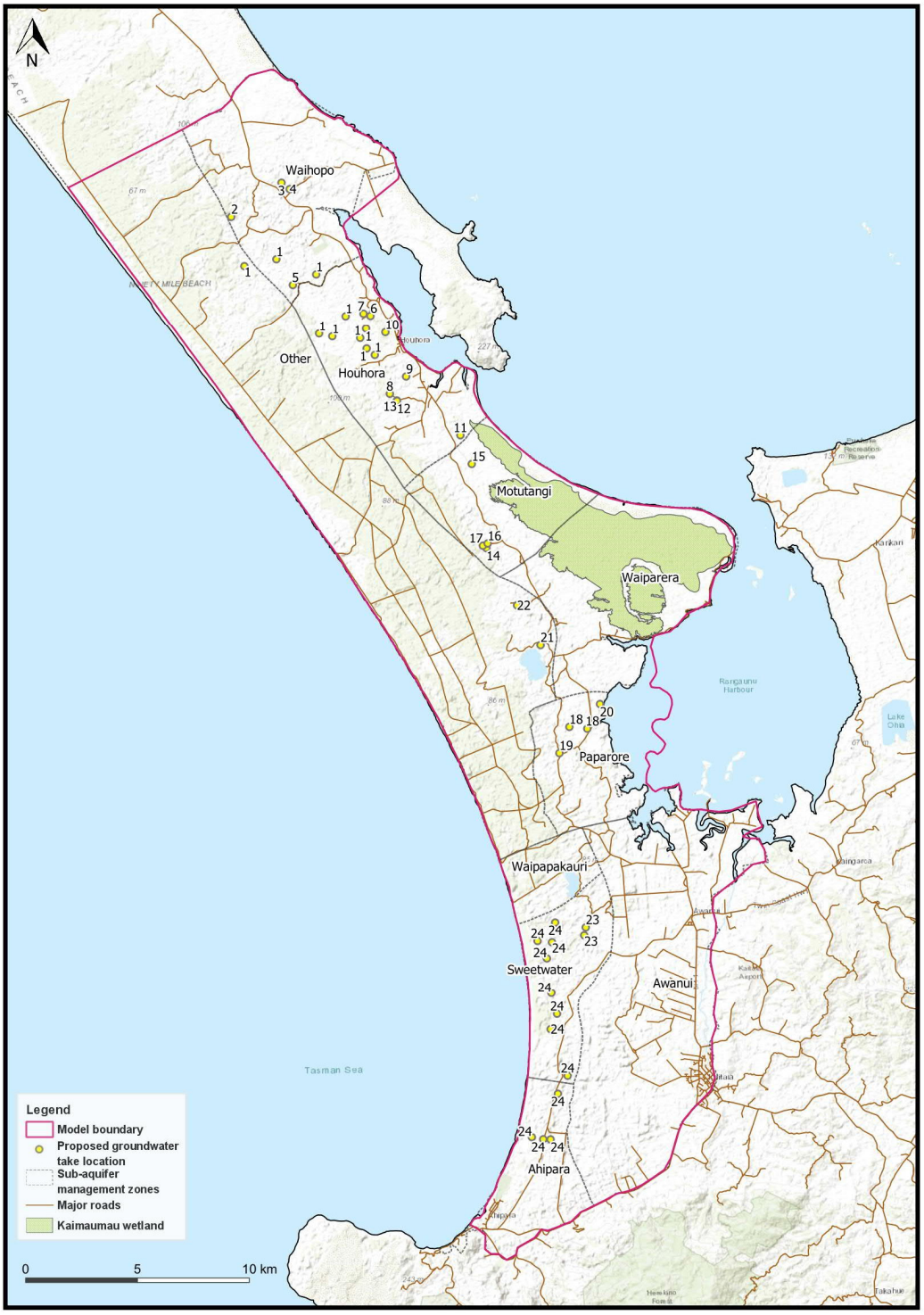

Figure 1. Project location map (numbers labelling proposed groundwater take locations correspond to applicants listed in Table 1).

Locations associated with currently pending groundwater take applications are shown in **Figure 1** and their name and proposed take volumes are provided in **Table 1**.

Table 1. Pending applications for groundwater takes from the Aupouri Aquifer.

Map ID	Application Number	Name (abbreviated)	Daily Volume (m3)	Annual Volume (m3)
1	APP.039859.01.01	Te Aupouri Commercial Development Ltd	10,735	1,170,000
2	APP.040601.01.01	Waikopu Avocados Ltd *	736	83,360
3	APP.017428.02.01	Henderson Bay Avocados Ltd *	178	19,000
4	APP.040600.01.01	Far North Avocados Ltd	240	32,000
5	APP.041211.01.01	P McGlaughlin	700	78,400
6	APP.040121.01.01	NE Evans Trust & WJ Evans & J Evans	1,675	160,000
7	APP.040231.01.01	P&G Enterprises (PJ & GW Marchant)	350	28,000
8	APP.039644.01.01	MP Doody & DM Wedding	2,375	304,000
9	APP.040397.01.01	A. Matthews	95	12,000
10	APP.040652.01.01	SE & LA Blucher	720	96,000
11	APP.040919.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valadares & D Bryan (property 1)	500	80,000
12	APP.040979.01.01	MV Evans (Property No 2)	1,125	126,000
13	APP.040558.01.01	MV Evans (Property No 1)	350	36,400
14	APP.040130.01.01	Tuscany Valley Avocados Ltd (M Bellette)	375	36,000
15	APP.040918.01.01	NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan, Valadares & D Bryan (property 2)	1,000	160,000
16	APP.008647.01.06	Avokaha Ltd (c/- K Paterson & A Nicholson) *	70	5,600
17	APP.039628.01.02	KSL Ltd (C/- S Shine) *	90	3,600
18	APP.040361.01.01	Tiri Avocados Ltd	3,876	581,250
19	APP.040362.01.01	Valic NZ Ltd	1,158	173,700

Map ID	Application Number	Name (abbreviated)	Daily Volume (m3)	Annual Volume (m3)
20	APP.040363.01.01	Green Charteris Family Trust (Wataview Orchards)	225	33,750
21	APP.039841.01.02	Mate Yelavitch & Co Ltd	450	52,000
22	APP.040386.01.01	Robert Paul Campbell Trust	3,350	360,000
23	APP.040364.01.01	Elbury Holdings Ltd (c/-K J & F G King)	1,875	200,000
24	APP.020995.01.04	Te Rarawa Farming Ltd and Te Make Farms Ltd *	10,705	776,000
Total			**42,953**	**4,607,060**

* Indicates application is for increased volumes for an existing take.

2.2 Neighbouring Bore Information

There are 410 bores registered in the NRC database that fall within a 2 km radius of a proposed pumping location (**Figure 2**). Statistics on the bores are as follows:

- 371 are active, 19 are inactive, and 17 are pending;
- Bore depth is provided for 356 bores and ranges from 3 m to 143 m with an average of 65 m;
- 310 bores have information attached in terms of the purpose of the bores; among these bores:
  - 80 are for domestic purposes;
  - 76 are for irrigation;
  - 61 are for stock;
  - 30 are for monitoring;
  - 29 are for domestic and stock use;
  - 11 are for exploration;
  - 10 are for domestic use and irrigation;
  - 6 is for a private water supply;
  - 5 are for stock and irrigation;
  - 2 is for commercial water supply.

Figure 2. Neighbouring bores within 2 km radius of proposed groundwater takes.

3. Assessment of Environmental Effects

Aupouri Aquifer Groundwater Model Overview

The proposed 4,607,060 m^3/year groundwater take from the Aupouri Aquifer was evaluated using the Aupouri Aquifer Groundwater Model (AAGWM), which is a numerical model covering the Aupouri shellbed aquifer from Ahipara to Ngataki. The model applied the MODFLOW Unstructured Grid (MODFLOW-USG) developed by the United States Geological Survey (USGS) applied within the GMS10.3 modelling platform to simulate regional groundwater flow.

The model comprises six layers that are used to represent the varying geology of the region with the shellbed aquifer, the primary source of groundwater, represented by the fourth and sixth model layers. **Table 2** provides a brief description of the geological units assigned to the layers in the model.

The development and calibration of the AAGWM is detailed in a standalone report on model development and calibration (WWLA 2020). The model domain and locations of consented and proposed groundwater takes are shown in **Figure 3.**

Table 2. Geological units in the model conceptualisation.

Model Layer	Strat. 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	

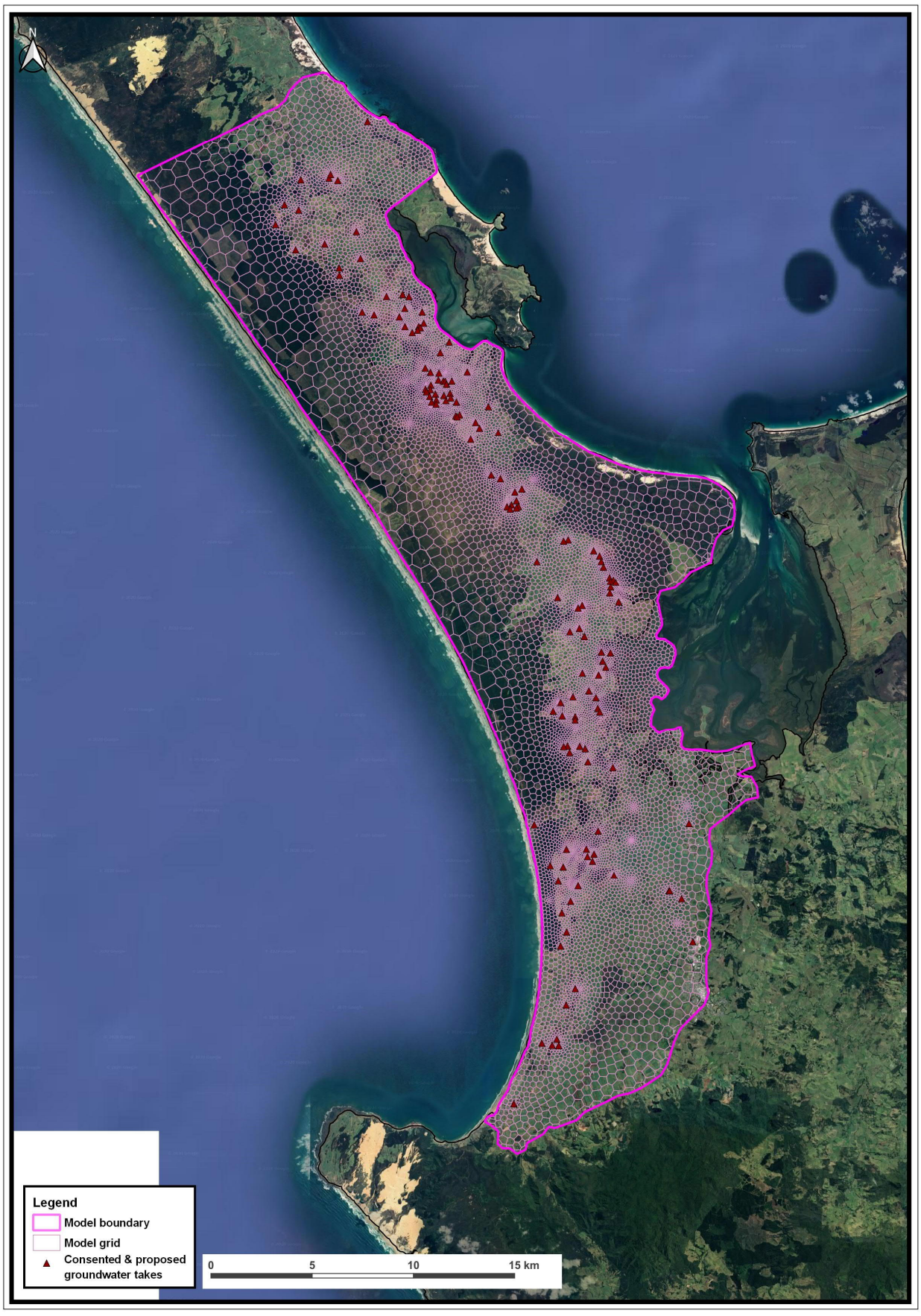

Figure 3. Aupouri Aquifer Groundwater Model domain.

Model Scenario Descriptions

Scenario 1 is the Base Case Scenario used for understanding aquifer water balance and groundwater levels under naturalised conditions where no groundwater abstraction occurred.

Scenario 2 is the Proposed Extraction Scenario, which includes all current groundwater consents, and currently pending take applications.

The results of Scenario 1 and 2 were compared to assess cumulative effect of the proposed groundwater extraction. Simulation results were evaluated to assess potential effects from proposed pumping.

Scenario 3 is a sensitivity analysis, which was undertaken using the methods described in WWA (2017). In the sensitivity analysis, connectivity between the shallow aquifer and the deep aquifer was significantly reduced, while boundary and source/sink conditions remained the same as in the baseline model. The model was not calibrated to the conditions applied in Scenarios 3; therefore Scenario 3 results are only referenced to illustrate relative (rather than absolute) changes in simulated groundwater levels.

The sensitivity analysis was undertaken because the calibrated groundwater model errs on the side of over simulation of vertical leakage. This was deliberately built into the model in the absence of a single well-defined low permeability horizon in the field, but rather a series of multi-layered and discontinuous iron pans and other low permeability horizons within the sedimentary sequence that in combination act as a flow barrier between the deeper groundwater system and the surface drains and wetlands. As a result, the model exaggerates the effects of the proposed abstraction on the groundwater levels in the shallow aquifer and at the surface. Conversely, the model may slightly under-predict the local-scale drawdown in the deeper aquifer.

The numerical simulation was run for a 58-year time period using historic climate records and groundwater pumping data. In effect, the climatic conditions of the last 58-years have been utilised to simulate conditions that may occur in the next 58-years.

The three predictive model scenarios can be summarised as follows:

- ***Scenario 1: Naturalised*** – the calibration model with no groundwater pumping included in the simulation.
- ***Scenario 2: Proposed Extraction*** – includes all current and proposed groundwater totalling 14.4 million m^3/year.
- ***Scenario 3: Low Permeability-Proposed Extraction*** – Groundwater extraction is the same as in Scenario 2 with horizontal hydraulic conductivity of Model Layer 2 decreased to $1x10^{-7}$ m/s to simulate a hard pan extending over the model area.

From an assessment of effects perspective, it is important to focus on annual volumes. However, simulated pumping in the model is premised on peak daily rates (consented or proposed) pumped until the annual volume is reached (cap). Due to variable stress period length ranging from a minimum of 13 days to a maximum of 185 days, the average pumping rate reported from the model is always less than the peak rate due to days within the stress period where pumping was not required. Historical dates where the maximum annual volume (consented or proposed) was simulated included 1974, 1991, and 2010.

3.1 Surface Water Effects

An analysis of the impact on flows including discharge to both farm drains and wetlands was undertaken for low-flow situations. Scenario 2 was selected for this assessment because first and foremost it is the only calibrated model scenario, and of secondary importance, it represents a greater potential impact on surface drains compared to Scenario 3. The annual minima in daily flow was determined from the global flow budget for all combined drain cells within the potential area of impact. Annual minima flows were assessed to calculate the annually recurring minimum flow for each scenario and the resulting data is presented in **Table 3.**

Table 3. Surface water low-flow reduction analysis.

Recurrence Interval	Scenario 1: Naturalised	Scenario 2: Proposed GW Extraction	Relative Difference
(years)	(L/s)	(L/s)	(%)
1	3,436	3,287	-4.3%

A comparison of the proposed groundwater extraction (Scenario 2) against the Naturalised scenario indicates that the mean annual (1-year) low flow as a result of the combined groundwater extraction from all bores in the model area is likely to be 4.3% less than if there was no groundwater pumping. This is well below the NRC threshold for maximum allowable impact on small rivers, specified in Table 23 of the Proposed Regional Plan for Northland which states that minimum flow shall be defined as 90% of the mean annual low flow for Coastal River, which includes all streams within the model area (NRC 2019). However, it should also be noted that some of the streams within the model area are ephemeral streams and are therefore exempt from minimum flow standards based on the NRC Proposed Regional Plan.

However, as stated in WWA (2017) the model errs on the side of exaggerating groundwater level reduction in the shallow aquifer and at the surface because of the lack of hard pans in the model. In this regard, this can be considered a conservative estimate.

3.2 Aquifer Drawdown

The end of the 2010 irrigation season (30 April 2010) was selected for impact analysis as this date represents the end time of the driest period within the historical record, and the greatest simulated seasonal irrigation pumping requirement. Simulation results were evaluated over the model area in order to assess potential effects from proposed pumping in the area most likely to be impacted.

3.2.1 Overall Cumulative Effects

The overall cumulative impact of groundwater extraction on the deep aquifer is shown relative to a naturalised condition for Scenario 2 conditions in **Figure 4** and for Scenario 3 conditions in **Figure 5**.

Available drawdown for shellbed aquifer bores is typically 60 to 100 m, while maximum cumulative drawdown for the NRC registered bores potentially effected by proposed groundwater takes in the model averages 1.30 m in the calibrated model scenario and 3.38 m in the more conservative low permeability scenario.

The maximum drawdown, 14.23 and 19.53 m in the calibrated and low-permeability scenarios, respectively, occur at the currently consented (though not exercised) FNDC-2 groundwater take location. This location represents the maximum pumping in the model area and the majority of the simulated drawdown is due to consented pumping activities that are included in the simulation. Based on bore logs there is 71.3 m of available drawdown at the FNDC-2 bore location, so maximum predicted drawdown in the more conservative scenario amounts to 27% of the available drawdown while predicted drawdown at all other take locations was far less.

The cumulative impact of all groundwater pumping relative to a naturalised condition is shown for the shallow aquifer for Scenario 2 conditions in **Figure 6**, where it is apparent that cumulative drawdown is influenced by the locations of agricultural drains but not impacted by the proposed groundwater take.

Figure 4. Cumulative drawdown (Scenario 2) in the deep aquifer relative to a naturalised condition for all consented and proposed bores.

Figure 5. Cumulative drawdown (Scenario 3) in the deep aquifer relative to a naturalised condition for all consented and proposed bores.

Figure 6. Cumulative drawdown (Scenario 2) in the shallow aquifer relative to a naturalised condition for all consented and proposed bores.

3.2.2 Cumulative Impact on Neighbouring Bores

The drawdown induced by the proposed groundwater take applied with calibrated and low-permeability hydrological conditions was calculated and plotted at the 410 existing bores within 2 km of the proposed groundwater takes (**Figure 2**) as a boxplot, with the maximum and minimum drawdown shown in **Figure 7**. Some of the most heavily effected bores are the proposed pumping bores themselves in cases where effects are cumulative with other proposed bores.

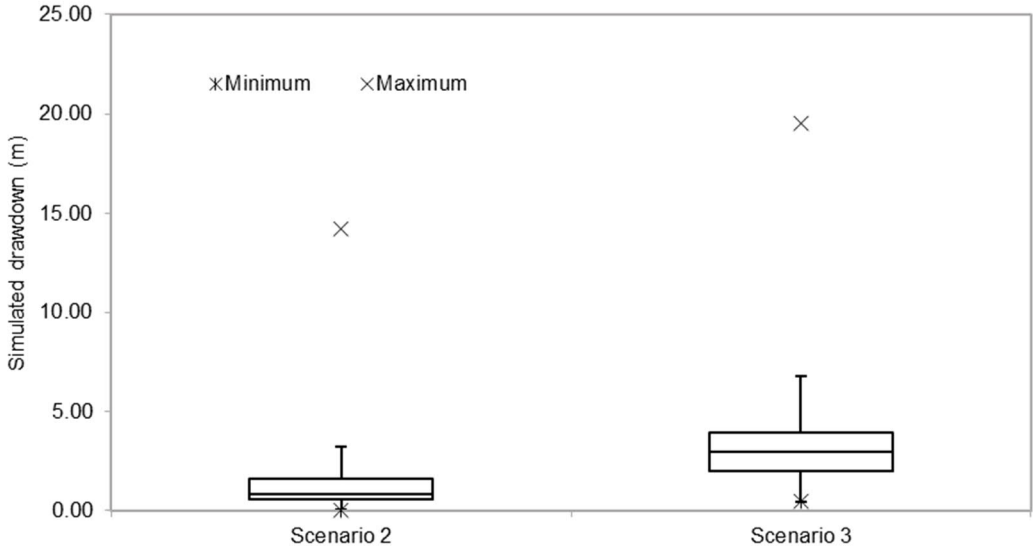

Figure 7. Drawdown observed at existing bores at the observation time step for each scenario.

Figure 8 shows predicted drawdown under Calibrated model (Scenario 2) conditions for bores registered in the NRC database. As is shown in the inset map, the greatest drawdown is predicted to occur at and around the FNDC bores where there is a consented groundwater take for Kaitaia water supply that is yet to be exercised.

Appendix B provides a table specifying predicted drawdown at all NRC registered bores within 2 km of the proposed groundwater takes.

Figure 8. Predicted drawdown at NRC registered bores under S2 conditions.

3.2.3 Drawdown Relative to the Permitted Baseline

Deep aquifer

To assess the likely effects of the proposed groundwater extraction relative to current consent profile or permitted bassline, Scenario 2 and Scenario 3 results were compared to a scenario where the pumping was only applied at currently consented groundwater takes.

The predicted drawdown in the deep aquifer for Scenario 2 is shown in **Figure 9**. In Scenario 2 the maximum predicted drawdown was 3.9 m at the proposed Sweetwater-3 bore location. Significant drawdown is typically considered to be the 0.6 m. By this definition, only a limited portion of the model area was predicted to be impacted by significant drawdown on account of the proposed groundwater takes.

In Scenario 3, the low permeability of model Layer 2 limited leakage from the overlying layers thereby magnifying the impact of pumping on groundwater levels (**Figure 10**). The maximum drawdown predicted in Scenario 3 was 6.3 m at the Te Raite Station-Other pumping location. In Scenario 3 the area within the 0.6 m drawdown contour was greater, however additional drawdown resulting from proposed groundwater takes was still well within the limits of available drawdown for production bores.

Figure 9. Simulated drawdown of deep aquifer resulting from proposed groundwater takes (Scenario 2).

Figure 10. Simulated drawdown of deep aquifer resulting from proposed groundwater takes (Scenario 3).

Shallow aquifer

The proposed groundwater take was predicted to cause a maximum of 1.3 m of drawdown in the shallow aquifer under Scenario 2 conditions at one of the proposed Te Raite Statioin bores in the Houhora sub-aquifer management zone (**Figure 11**). On the whole, minimal Layer 1 drawdown was predicted to occur on account of the proposed groundwater pumping. In Scenario 3, no shallow aquifer drawdown was predicted due to increased groundwater pumping because of the disconnection of the upper and lower portions of the aquifer.

Figure 11. Simulated drawdown of shallow aquifer resulting from proposed pumping (Scenario 2).

3.3 Saline Intrusion

Potential saltwater intrusion into the shellbed aquifer has been evaluated using the method of *Lateral Migration Analysis*, used for the MWWUG applications as defined in WWA (2017).

Lateral migration along the aquifer/bedrock interface considers the material under the aquifer impermeable where inland migration of salinity occurs via the permeable sediments along the lower boundary of the aquifer. This mechanism assumes that the pressure at the coastal margin is relevant to maintaining an offshore position of the saline interface.

The shellbed aquifer in the groundwater assessment area is underlain by relatively impermeable basement rock and is well represented by this conceptual approach. Results from model Scenario 1 (Naturalised conditions) and Scenario 2 (Proposed Extraction) were used for this analysis because these scenarios apply parameters from the calibrated AAGWM. The difference between predicted groundwater pressure at the coast can be attributed to the cumulative impact of groundwater extraction.

3.3.1 Lateral Migration Analysis

Based on the estimated depth to the basement rock at the coastal margins, the Ghyben-Herzberg relation was used to back-calculate the minimum hydraulic head required to maintain the saline interface below the shellbed aquifer, known as the lateral migration “Trigger Level” (TL). This calculation was performed at approximately 200 m intervals along the coastal margin of the eastern model boundary and 500 m intervals along the western model boundary, increasing to 1,000 m intervals toward the northern extent of the west coast. The point locations used for lateral migration analysis are shown in **Figure 12**. Simulated Layer 6 groundwater levels from the Naturalised and Proposed Extraction scenarios were extracted at these points for analysis.

Saltwater intrusion is not an instantaneous response to changes in groundwater pressure, rather it is a gradual process requiring prolonged reduction in groundwater level below a critical level to initiate the landward migration of the saline interface. A 90-day rolling average (RA) was calculated from the simulated groundwater level to reflect this slow process. Lateral migration analysis was done at the time of peak drawdown impact from groundwater pumping by using simulated groundwater levels at the model time 30 April 2010.

Figure 12. Location of the selected points for lateral migration analysis.

Figure 13 to **Figure 16** present map tiles progressing from north to south of the saline intrusion results (head residuals in meters) at regularly spaced analysis points around the coastline.

Positive residuals indicate that simulated head is greater than the TL, whereas a negative value indicates potential saline intrusion. The residual from the Proposed Extraction Scenario is shown as the primary label for each point, with the Naturalised Scenario residuals in parentheses.

The results are summarised for each figure in **Table 4**.

Table 4. Summary of saline intrusion results.

Fig.	Location	West Coast	East Coast
12	Northern Tile – Ngataki to Pukenui	In the north, heads reside below the TL, which may signal localised saline intrusion potential. However, this is i) an area of limited groundwater and geological data (basement is inferred to be shallow), ii) limited groundwater utilisation with forestry as the primary land use; and iii) not impacted by the proposed pumping (i.e. both scenarios are similarly negative).	In the area north of Henderson Bay, simulated groundwater heads are below the TL at most analysis locations, however shellbed aquifer is very thin or absent in this area and there is limited groundwater use. Simulated heads are the same for the naturalised and proposed extraction scenarios indicating that groundwater heads are not impacted by the proposed pumping. Potential saline intrusion is also indicated at the top of the Houhora Harbour due to shallow basement rock in the area. Groundwater heads are above the TL along the majority of the inlet. Pumping has negligible impact in the area of potential concern.
13	Mid-East Tile – Houhora to Motutangi	Potential saline intrusion is not indicated in this area. Simulated groundwater head ranges from 1.5 to 6 m above the TL.	The margin of Houhora Heads is an area that is potentially vulnerable to saline intrusion largely due to shallow basement rock. The proposed pumping has a minimal impact on the simulated groundwater levels. South of Houhora Heads groundwater levels are below the TL along the coastal margin adjacent to Kaimaumau wetland, however pumping has minimal impact.
14	Southeast Tile – Kaimaumau Wetland to Awanui	No west coast points are shown in this tile.	Groundwater levels are below the TL along the coast adjacent to Kaimaumau Wetland though proposed pumping has a negligible impact on groundwater levels. In the Paparore and Waipapakauri areas groundwater levels remain above the TL, however the wetlands in the southeast portion of the tile may have potential for saline intrusion. Groundwater use, and pumping effects are minimal in this area.
15	South Tile – Awanui to Ahipara	Groundwater levels in this tile remains above the TL at all points on this tile. Pumping impacts are predicted adjacent to the Sweetwater and FNDC bores, however sufficient groundwater pressure remains to avert saline intrusion.	The only east coast points shown in this tile are included in the discussion of Tile 3.

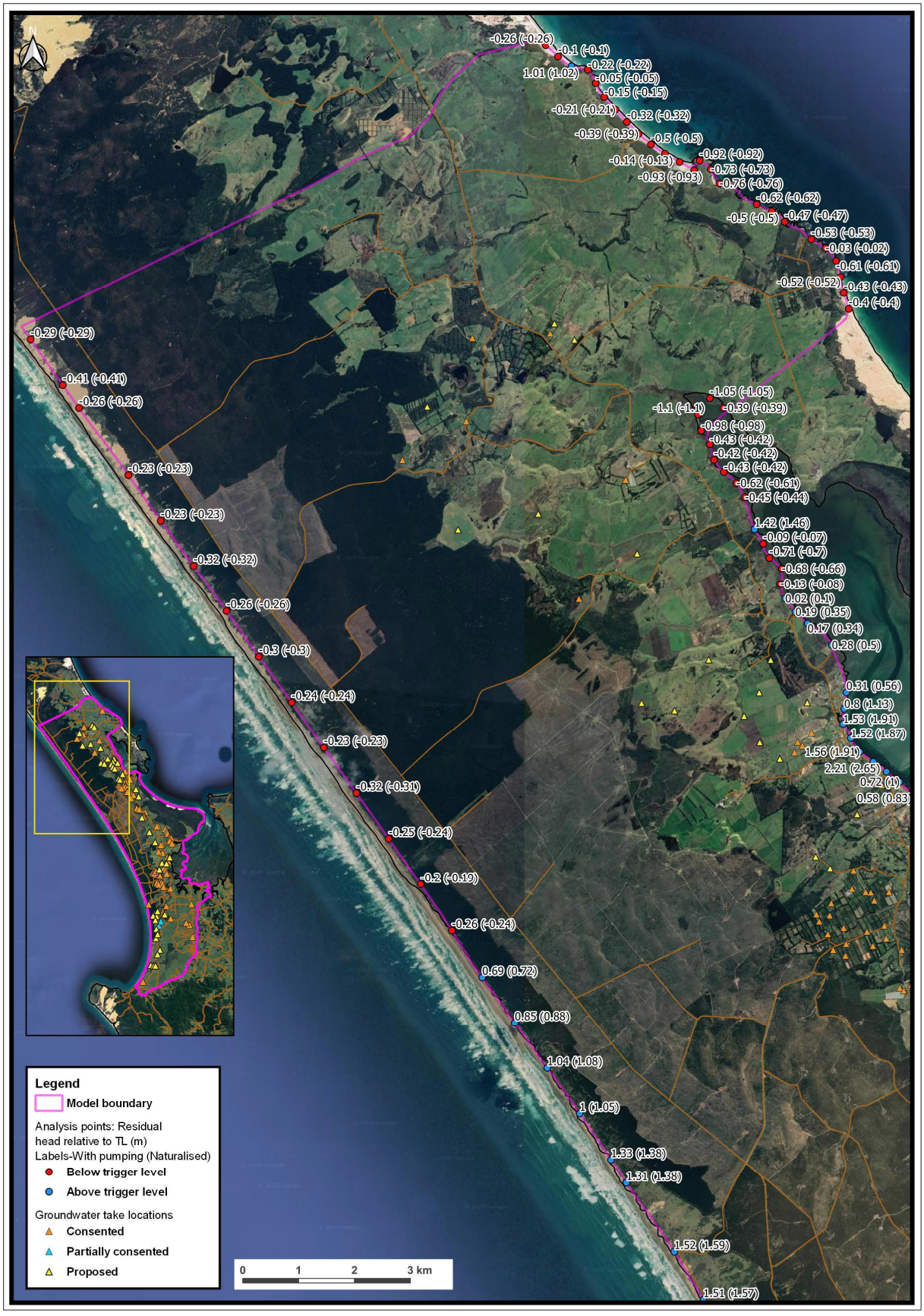

Figure 13. Saline Intrusion potential – residual head (Ngataki to Pukenui).

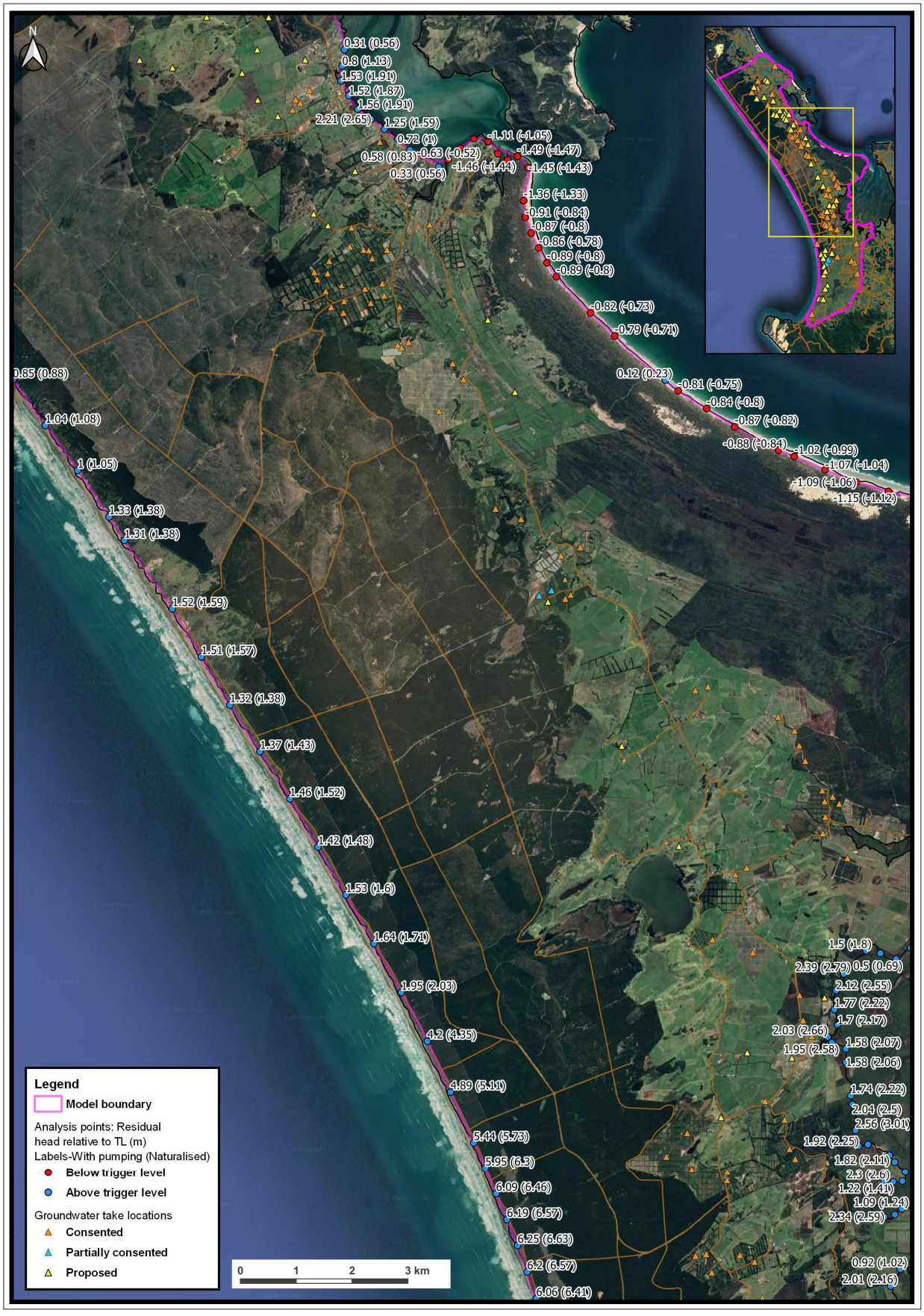

Figure 14. Saline Intrusion potential – residual head (Houhora to Motutangi).

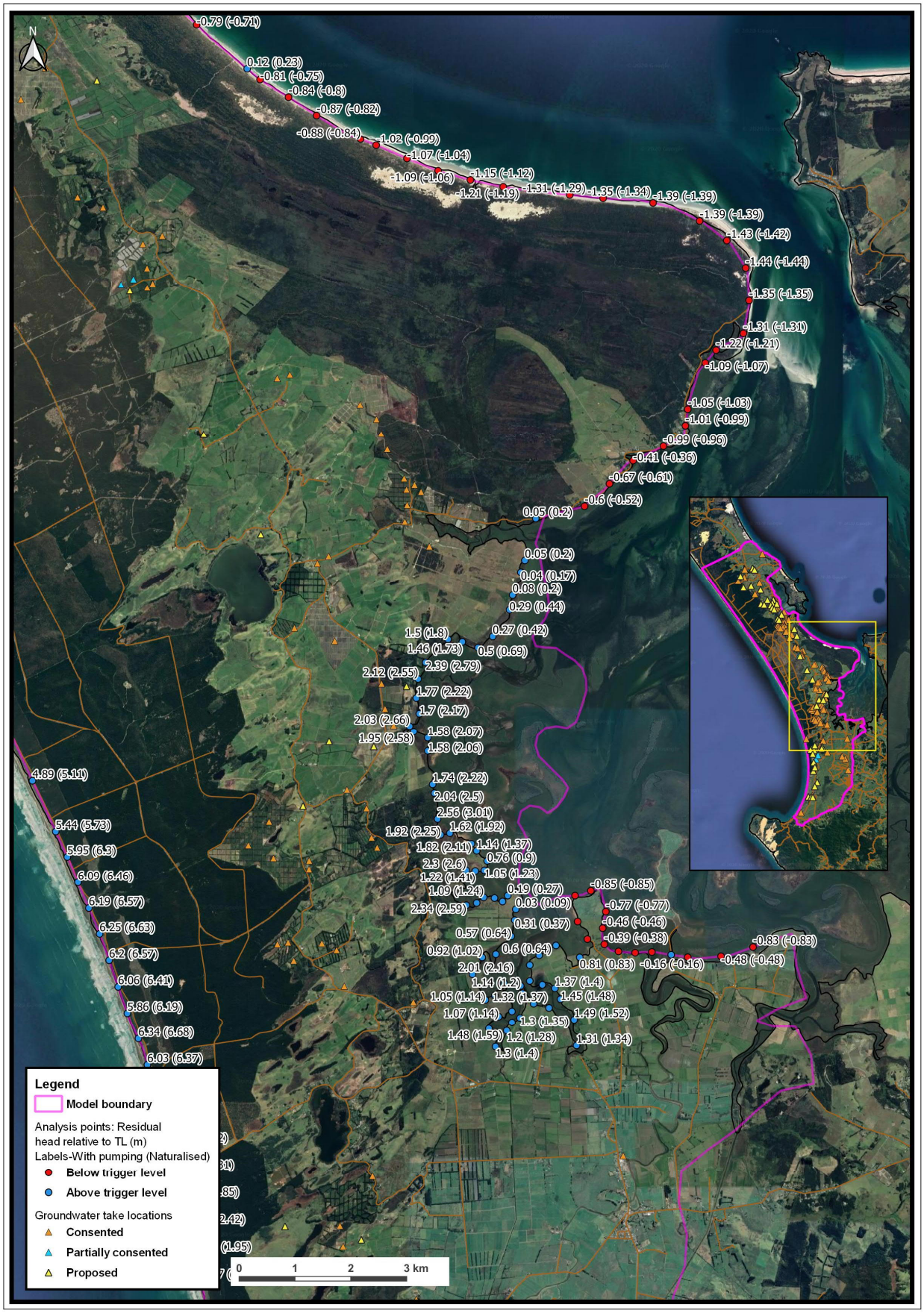

Figure 15. Saline Intrusion potential – residual head (Kaimaumau Wetland to Awanui).

Figure 16. Saline Intrusion potential – residual head (Awanui to Ahipara).

3.3.2 Areas Sensitive to Saline Intrusion

There are areas where simulated groundwater levels are below the TLs for potential saline intrusion, indicated by negative residuals, which are marked with red symbols in **Figure 13** to **Figure 16**. However, in all cases these occur under both the Naturalised and Proposed Extraction scenarios. This indicates that the potential saline intrusion is related to factors other than pumping, for example:

- In the area around Houhora Heads the negative residuals are a result of shallow basement rock and associated low TLs for potential saline intrusion.
- In the northwest portion of the model there is minimal borelog information due to the low levels of current development to inform the physical representation of geologic layers in the model and hence relatively high uncertainty in this area. However, the consequence of this uncertainty is negligible given that there is minimal, if any, groundwater demand in this area, which is reflected in the head residual simulation results of 0.01 m or less.

The area of potential greatest impact is the Sweetwater area, where predicted drawdown along the coast is slightly over 1 m. This is primarily due to a large groundwater takes associated with Sweetwater Farms existing and proposed takes, in combination with the FNDC bores for Kaitaia, and Elbury Holding's proposed take. However, groundwater levels are still maintained above the TL for the driest time in the 58-year simulation with the proposed extractions.

It is apparent when comparing residuals from the two scenarios that pumping has less impact in the most sensitive areas, because these tend to be in estuaries and areas likely to be saline under natural conditions and therefore not targeted for development.

3.4 Ground Settlement

Land subsidence due to groundwater extraction was calculated using the Bouwer (1977)[1] 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 = 0.30
- 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 (http://structx.com/Soil_Properties_002.html), 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 were based on Bouwer (1977).

The potential maximum ground settlement was estimated at the proposed groundwater take locations based on the maximum simulated drawdown in Scenario 2 and Scenario 3 relative to a naturalised condition. Results are summarised in **Table 5**.

The maximum predicted settlement at the Sweetwater 1 bore location, amounting to 10 cm under calibrated model parameters (Scenario 2) and 25 cm for under the low permeability scenario conditions (Scenario 3). It should be noted that settlement at the Sweetwater 1 & 2 bores is attribute to ongoing pumping under currently permitted pumping activities. The proposed increase in groundwater take for Sweetwater Farms would affect the other Sweetwater bores where new pumping would be initiated while pumping at the current Sweetwater bores would be reduced under current management plans.

Predicted settlement at many of the proposed bores is largely due to the effects of cumulative pumping which includes the effects of current consents. Settlement that can be attributed to new groundwater takes is significantly less, as shown in the second pair of columns in **Table 5.**

In all cases land settlement is predicted to be greatest at pumping sites. These sites are located in rural settings where settlement effects at the scale predicted to occur, and even in the worse-case scenario, will not cause damage to structures or other infrastructure. Irrigation systems, for example, are generally constructed with flexible HDPE type pipe which will not be damaged by settlement of the magnitude predicted. For context, tractors or other farm machinery are likely to cause more settlement by compaction than would be caused by groundwater pumping.

Table 5. Predicted settlement at groundwater take locations relative to naturalised conditions.

Applicant	Total Settlement (m)		Settlement due to proposed takes (m)	
	Proposed pumping-Calibrated	Proposed pumping-Low permeability	Proposed pumping-Calibrated	Proposed pumping-Low permeability
A. Matthews	0.02	0.03	0.01	0.01
Avokaha Ltd	0.02	0.04	0.00	0.01
Bryan Esate-1	0.02	0.03	0.01	0.01
Bryan Esate-2	0.02	0.04	0.02	0.02
D. Wedding & Doody	0.05	0.07	0.04	0.04
Ellbury Holdings-1	0.10	0.24	0.02	0.03
Ellbury Holdings-2	0.09	0.23	0.02	0.03
Far North Avocados (Blake Powell)	0.01	0.02	0.01	0.02
Henderson Bay Avocados	0.00	0.02	0.00	0.01
J Evans	0.03	0.04	0.03	0.04
KSL Ltd	0.02	0.03	0.01	0.01
M Evans-Total	0.04	0.06	0.01	0.02
P McGlaughlin	0.02	0.04	0.02	0.04
P&G Enterprises	0.02	0.04	0.02	0.04
Robert Campbell	0.03	0.05	0.03	0.03
S. & L. Blucher	0.02	0.04	0.02	0.03
Sweetwater-1	0.10	0.25	0.00	0.00
Sweetwater-2	0.07	0.18	0.00	0.00
Sweetwater-3	0.09	0.22	0.05	0.08
Sweetwater-4	0.04	0.13	0.03	0.04
Sweetwater-5	0.07	0.18	0.04	0.06
Sweetwater-6	0.05	0.15	0.02	0.03
Sweetwater-7	0.04	0.13	0.04	0.05
Sweetwater-8	0.02	0.06	0.02	0.03
Sweetwater-9	0.03	0.09	0.02	0.03
Sweetwater-10	0.02	0.05	0.02	0.04
Sweetwater-11	0.01	0.03	0.01	0.03
Sweetwater-12	0.01	0.02	0.01	0.02
Sweetwater-13	0.02	0.03	0.02	0.03
Sweetwater-14	0.02	0.03	0.02	0.03
Te Raite Station other	0.04	0.09	0.04	0.09
Te Raite Station-Houhora-1	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-2	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-3	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-4	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-5	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-6	0.04	0.06	0.04	0.06
Te Raite Station-Houhora-7	0.04	0.06	0.04	0.06
Te Raite Station-Waihopo-1	0.01	0.03	0.01	0.03
Te Raite Station-Waihopo-2	0.01	0.03	0.01	0.03
Tiri-1	0.04	0.09	0.04	0.08
Tiri-2	0.04	0.09	0.04	0.08

Applicant	Total Settlement (m)		Settlement due to proposed takes (m)	
	Proposed pumping-Calibrated	Proposed pumping-Low permeability	Proposed pumping-Calibrated	Proposed pumping-Low permeability
Tuscany Avocados	0.02	0.04	0.01	0.01
Valic	0.04	0.07	0.02	0.03
Waikopu Avocados	0.02	0.04	0.02	0.04
Wataview	0.01	0.04	0.01	0.02
Yelavich	0.02	0.04	0.01	0.02

4. Summary and Conclusions

WWLA has completed an assessment of groundwater effects within the Aupouri Aquifer associated with the 24 applicants with pending groundwater take applications. This assessment was undertaken to update predicted effects as reported in the individual applications previously submitted by WWLA, as these were based on outputs of the AAGWM, a groundwater model calibrated to groundwater conditions within the Aupouri Aquifer. The AAGWM was updated in January 2020, following a 2019 LIDAR survey that improved the information available for model input, resulting in improved resolution and improved model calibration.

For analytical purposes the model was run with calibrated hydraulic parameters and in a low-permeability scenario to generate a conservative estimate of conditions that may arise in areas where there are low-leakage layers (iron-pans) that reduce connectivity to recharge sources.

The proposed groundwater takes collectively amount to a maximum volume of 4,607,060 m^3/year. This level of abstraction is predicted to bring about a maximum potential reduction of 4.3% in annual low-flow in streams. Surface water usage in the area is very low due to the reliability issues associated with intermittent flows and water quality, practically in the small streams in sand country catchments. The PNRP allows for 10% reduction in mean annual low flows for coastal streams.

The maximum drawdown predicted in the model occurs at the FNDC-2 bore, a consented groundwater take that is not currently exercised, however is included in the model. Cumulative drawdown at this bore is 14.2 and 19.5 m in the calibrated and low-permeability versions of the model, respectively, though the drawdown is primarily due to pumping at the bore itself rather than the effect of additional proposed groundwater extraction.

Drawdown was assessed throughout the model area and used to predict areas that may be sensitive to saline intrusion or land settlement with groundwater pumping. It was found that the west coast is not likely to be sensitive to saline intrusion other than an area to the northwest where there is no development and minimal available information. The east coast is potentially sensitive to saline intrusion, however this occurs under naturalised conditions and is minimally impacted by the proposed pumping activities. It is also notable that potential saline intrusion is not predicted to propagate inland under naturalised or proposed pumping conditions.

A maximum of 0.10 and 0.25 m of land settlement is predicted at the Sweetwater 1 & 2 bores in the calibrated and low-permeability scenarios, respectively, however this is entirely due to ongoing pumping. Proposed groundwater takes are predicted to have minimal settlement impacts that would be difficult to measure in the field.

In conclusion, cumulative impacts of the proposed groundwater abstraction on the Aupouri Aquifer are predicted to be no more than minor and do not pose significant risk in terms of surface water depletion, lowering groundwater levels at existing bores, potential saline intrusion, or land settlement.

5. References

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Appendix A. Impact on Neighbouring Bores

Predicted drawdown on bores that are included in the NRC database within 2 km of the Evans bore:

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.210515	1618308	6121233	Monitoring	100.3	14.23	19.53
LOC.210432	1618225	6121604	Not specified	97.5	12.11	17.18
LOC.210433	1618225	6121604	Exploration	99.0	12.11	17.18
LOC.210513	1618159	6121280	Not specified	95.6	10.37	15.65
LOC.314089	1617450	6119000	Irrigation	95.0	8.40	13.05
LOC.210514	1617927	6121289	Monitoring	101.0	6.54	11.74
LOC.210504	1618677	6121528	Exploration	31.2	6.26	11.34
LOC.210530	1617843	6119772	Monitoring	15.0	5.28	10.23
LOC.210522	1617851	6119772	Irrigation	91.0	5.12	10.05
LOC.200228	1617682	6121552	Not specified	29.0	5.03	10.00
LOC.200226	1617605	6121325	Not specified	105.5	4.93	10.05
LOC.200227	1617528	6121482	Exploration	29.5	4.44	9.42
LOC.209689	1619022	6121671	Domestic and Stock	13.0	4.28	9.15
LOC.200199	1618935	6121888	Domestic	27.0	4.27	9.05
LOC.201606	1619617	6120296	Stock	64.5	4.03	8.56
LOC.209755	1617597	6119793	Monitoring	98.0	3.98	8.96
LOC.210505	1618820	6122238	Exploration	28.0	3.93	8.55
LOC.201424	1618734	6122288	Irrigation	82.0	3.91	8.47
LOC.201010	1618839	6120489	Not specified	Not specified	3.79	8.92
LOC.209756	1617594	6119410	Monitoring	93.0	3.64	8.44
LOC.209757	1617067	6118436	Monitoring	89.0	3.60	8.06
LOC.313516	1617620	6118810	Not specified	Not specified	3.59	8.09
LOC.209710	1619026	6122344	Domestic	78.0	3.48	7.99
LOC.209511	1618033	6122535	Domestic	101.0	3.10	7.42
LOC.209754	1616759	6120571	Monitoring	99.0	2.87	8.09
LOC.201581	1619560	6120189	Domestic	65.0	2.82	7.30
LOC.201607	1619560	6120189	Stock	65.5	2.82	7.30
LOC.201011	1619239	6120290	Not specified	Not specified	2.79	7.61
LOC.210507	1619440	6120307	Exploration	38.7	2.75	7.44
LOC.201012	1619539	6120191	Not specified	Not specified	2.70	7.26
LOC.201558	1618283	6122816	Domestic	40.0	2.68	6.79
LOC.201580	1618343	6119088	Exploration	72.5	2.60	7.05
LOC.201583	1618343	6119088	Not specified	44.5	2.60	7.05
LOC.201584	1618343	6119088	Not specified	32.0	2.60	7.05
LOC.209499	1617696	6127997	Irrigation	107.0	2.54	4.78

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.209586	1612784	6142645	Domestic	92.8	2.44	4.14
LOC.201472	1618932	6122888	Stock	14.3	2.41	6.46
LOC.311405	1618539	6123040	Domestic	101.5	2.34	6.30
LOC.209587	1617118	6128179	Exploration	117.0	2.30	4.37
LOC.200332	1612979	6142360	Stock	89.0	2.23	3.86
LOC.201390	1619839	6120392	Stock	6.5	2.21	6.59
LOC.306709	1611801	6142975	Not specified	Not specified	2.13	4.04
LOC.308495	1611801	6142975	Not specified	Not specified	2.13	4.04
LOC.308749	1611801	6142975	Irrigation	114.0	2.13	4.04
LOC.200060	1610771	6144056	Irrigation	68.0	2.12	4.15
LOC.210508	1610310	6144290	Irrigation	118.2	2.09	4.10
LOC.209323	1610591	6144271	Irrigation	106.0	2.08	4.10
LOC.200208	1610722	6144033	Not specified	64.9	2.07	4.10
LOC.200312	1611216	6143980	Irrigation	88.5	2.05	4.07
LOC.209608	1617567	6129061	Irrigation	93.7	2.05	4.30
LOC.312724	1617571	6129063	Monitoring	94.0	2.05	4.30
LOC.201013	1619838	6120592	Not specified	Not specified	2.05	6.48
LOC.209606	1616633	6128443	Irrigation	124.8	2.04	3.99
LOC.312720	1616628	6128445	Monitoring	122.0	2.04	3.99
LOC.209605	1617092	6128147	Irrigation	103.7	2.03	4.10
LOC.312715	1617096	6128144	Monitoring	100.0	2.03	4.10
LOC.209186	1619513	6122588	Stock	32.2	2.03	6.17
LOC.311427	1610411	6144157	Irrigation	109.0	2.02	4.04
LOC.200050	1610576	6144053	Domestic	39.0	2.02	4.05
LOC.200255	1610514	6143937	Irrigation	109.6	2.01	4.01
LOC.200061	1610675	6144453	Irrigation	50.0	2.00	4.02
LOC.200147	1610775	6144153	Not specified	60.6	2.00	4.03
LOC.209241	1610876	6143953	Irrigation	48.0	1.98	4.01
LOC.209562	1610945	6144743	Irrigation	105.0	1.97	3.95
LOC.210501	1619782	6121219	Exploration	4Not specified6	1.97	6.45
LOC.201510	1619755	6121701	Domestic and Stock	28.7	1.96	6.34
LOC.201389	1619241	6119690	Stock	12.0	1.95	6.47
LOC.308834	1611997	6143025	Irrigation	108.0	1.95	3.85
LOC.200174	1610974	6144653	Domestic and Irrigation	45.0	1.94	3.91
LOC.201522	1619031	6123138	Domestic and Stock	88.3	1.94	5.80
LOC.314182	1610293	6145502	Not specified	Not specified	1.94	3.82
LOC.209607	1616878	6128841	Irrigation	124.8	1.92	3.95
LOC.312723	1616870	6128835	Monitoring	124.0	1.92	3.95

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.200059	1610823	6143757	Irrigation	55.0	1.92	3.93
LOC.200184	1610215	6145090	Not specified	110.0	1.92	3.87
LOC.200151	1611026	6144893	Irrigation	66.0	1.90	3.82
LOC.315067	1610416	6145474	Domestic	90.5	1.90	3.77
LOC.200335	1610275	6144351	Irrigation	105.5	1.87	3.88
LOC.209600	1617709	6129216	Stock	83.3	1.85	4.14
LOC.209245	1611262	6143751	Irrigation	92.6	1.84	3.86
LOC.200148	1611277	6143655	Stock	67.0	1.84	3.85
LOC.200044	1611320	6143725	Not specified	40.7	1.84	3.85
LOC.209264	1611345	6144535	Irrigation	86.0	1.83	3.79
LOC.307989	1611796.739	6142884.828	Not specified	Not specified	1.83	3.72
LOC.200233	1611028	6143838	Irrigation	48.0	1.82	3.85
LOC.201478	1618003	6133379	Stock	7.0	1.82	3.60
LOC.315389	1612998	6142496	Not specified	Not specified	1.80	3.43
LOC.317160	1613023	6142453	Irrigation	94.0	1.80	3.43
LOC.209780	1618687	6123328	Domestic	105.0	1.79	5.48
LOC.210166	1611339	6144277	Irrigation	68.0	1.79	3.78
LOC.200237	1610477	6143752	Stock	50.0	1.78	3.77
LOC.201548	1617991	6118248	Stock	18.0	1.77	5.78
LOC.200149	1610610	6143652	Irrigation	55.0	1.76	3.75
LOC.315389	1612506	6141783	Not specified	Not specified	1.75	3.39
LOC.201540	1611236	6144864	Not specified	6.0	1.75	3.64
LOC.200303	1611475	6144155	Irrigation	102.0	1.69	3.67
LOC.200215	1617853	6130056	Stock	76.0	1.68	4.06
LOC.209670	1611559	6143858	Commercial Water Supply	88.0	1.66	3.66
LOC.200150	1611610	6143937	Irrigation	67.0	1.66	3.66
LOC.209172	1611566	6143905	Domestic and Stock	87.5	1.66	3.66
LOC.200189	1610471	6145551	Domestic	54.0	1.66	3.48
LOC.200317	1610803	6143530	Irrigation	92.0	1.64	3.62
LOC.210528	1617811	6114690	Irrigation	6.0	1.63	3.21
LOC.201479	1619841	6122499	Domestic	26.0	1.58	5.59
LOC.209637	1611272	6144952	Domestic and Stock	95.6	1.58	3.42
LOC.200320	1611273	6144954	Domestic and Irrigation	86.0	1.58	3.42
LOC.317728	1611772	6143277	Not specified	Not specified	1.58	3.53
LOC.201480	1611776	6143656	Domestic and Irrigation	11.0	1.57	3.54
LOC.200334	1611776	6143656	Irrigation	95.1	1.57	3.54
LOC.209227	1611673	6143325	Domestic and Irrigation	106.0	1.56	3.53
LOC.210499	1619903	6122293	Exploration	35.6	1.53	5.57

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.200209	1611323	6145092	Not specified	100.3	1.51	3.32
LOC.209534	1617970	6129035	Stock	82.5	1.50	3.89
LOC.200066	1611776	6143756	Domestic and Irrigation	11.0	1.49	3.45
LOC.315398	1609921	6147194	Not specified	Not specified	1.49	3.33
LOC.200081	1617702	6127677	Not specified	68.6	1.48	3.74
LOC.209581	1617696	6127678	Monitoring	33.0	1.48	3.74
LOC.200324	1611573	6144755	Irrigation	74.1	1.48	3.30
LOC.313697	1612552	6142994	Not specified	Not specified	1.45	3.24
LOC.306105	1618376	6129421	Irrigation	95.0	1.44	3.97
LOC.200063	1611272	6145154	Not specified	6.7	1.44	3.21
LOC.210268	1617991	6133256	Stock	94.5	1.43	3.23
LOC.200217	1617214	6129579	Stock	85.3	1.42	3.54
LOC.209033	1619754	6122661	Domestic	75.1	1.41	5.28
LOC.201014	1619933	6122491	Not specified	8.5	1.40	5.32
LOC.210276	1619882	6122486	Stock	60.1	1.40	5.32
LOC.316126	1610002	6147264	Not specified	Not specified	1.40	3.13
LOC.304125	1609975	6147378	Not specified	Not specified	1.40	3.13
LOC.305545	1610005	6147426	Domestic and stock	91.0	1.40	3.13
LOC.315389	1612346	6142423	Not specified	Not specified	1.39	3.16
LOC.317161	1612622	6141745	Irrigation	108.0	1.38	2.99
LOC.209774	1610005	6143884	Domestic	108.0	1.37	3.30
LOC.200288	1611372	6145154	Irrigation	86.0	1.35	3.09
LOC.313307	1612425	6142123	Irrigation	109.0	1.35	3.05
LOC.209575	1616796	6112205	Stock	51.5	1.32	2.19
LOC.310308	1617846	6133480	Irrigation	101.0	1.32	3.08
LOC.210404	1611786	6144633	Domestic	79.0	1.32	3.14
LOC.200249	1609768	6146749	Domestic	32.0	1.29	3.22
LOC.200177	1617803	6133379	Stock	37.0	1.28	3.06
LOC.200045	1617313	6129879	Domestic	15.0	1.28	3.43
LOC.200289	1617313	6129879	Stock	105.0	1.28	3.43
LOC.200078	1617313	6129879	Stock	45.0	1.28	3.43
LOC.201507	1618514	6129183	Irrigation	62.3	1.28	3.78
LOC.210161	1608940	6148550	Not specified	Not specified	1.27	4.50
LOC.311745	1609890	6143900	Not specified	Not specified	1.27	3.18
LOC.200231	1612377	6143358	Domestic and Stock	46.5	1.26	3.12
LOC.200213	1609569	6146648	Stock	110.0	1.26	3.35
LOC.201546	1619902	6122666	Domestic and Irrigation	Not specified	1.26	5.03
LOC.201537	1618726	6129089	Irrigation	62.3	1.25	3.74
LOC.200167	1618614	6129183	Irrigation	60.0	1.24	3.75

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.200248	1609968	6146849	Stock	33.5	1.22	2.97
LOC.209501	1604203	6154553	Irrigation	33.0	1.22	4.23
LOC.315166	1604198	6154560	Irrigation	40.0	1.22	4.23
LOC.200211	1618829	6128509	Not specified	90.0	1.21	3.61
LOC.200049	1609869	6146549	Not specified	Not specified	1.20	3.05
LOC.209753	1616404	6119040	Monitoring	92.0	1.19	6.22
LOC.210527	1616386	6119031	Monitoring	25.0	1.19	6.22
LOC.303413	1619200	6130630	Not specified	Not specified	1.17	3.59
LOC.307661	1619211	6130581	Domestic and stock	93.5	1.17	3.59
LOC.200236	1609877	6143651	Domestic	43.0	1.16	3.04
LOC.200079	1617512	6130380	Domestic	8.5	1.16	3.34
LOC.201549	1617544	6117042	Not specified	14.3	1.15	4.21
LOC.200229	1618859	6128533	Irrigation	79.0	1.14	3.52
LOC.201550	1620335	6121526	Domestic	36.5	1.13	5.13
LOC.209561	1617889	6127299	Domestic and Stock	105.0	1.13	3.45
LOC.210322	1618806	6129256	Domestic	75.5	1.13	3.64
LOC.307751	1604094	6154583	Irrigation	37.5	1.11	4.10
LOC.209230	1610178	6146870	Domestic	93.5	1.10	2.67
LOC.201367	1615897	6135772	Stock	85.3	1.10	2.52
LOC.201267	1617431	6123583	Domestic	60.0	1.10	4.34
LOC.209758	1617576	6116979	Monitoring	76.0	1.09	4.12
LOC.316695	1611066	6145958	Domestic	80.7	1.05	2.49
LOC.200080	1617611	6130680	Not specified	7.6	1.04	3.22
LOC.200154	1617611	6130680	Stock	Not specified	1.04	3.22
LOC.200082	1617703	6133479	Not specified	6.6	1.03	2.78
LOC.201426	1617703	6133479	Domestic	36.0	1.03	2.78
LOC.200070	1615697	6135772	Not specified	7.0	1.02	2.42
LOC.209340	1612600	6143684	Domestic	78.0	1.01	2.75
LOC.200240	1617905	6132480	Stock	96.0	1.01	2.98
LOC.209971	1619050	6130821	Irrigation	79.0	1.00	3.40
LOC.200292	1613486	6139963	Not specified	117.3	1.00	2.40
LOC.209759	1617644	6114898	Monitoring	61.0	0.99	2.62
LOC.315063	1615707	6135699	Not specified	Not specified	0.98	2.38
LOC.200311	1610367	6147010	Irrigation	116.2	0.98	2.36
LOC.200319	1612375	6144058	Irrigation	88.5	0.97	2.71
LOC.209232	1612816	6143569	Domestic and Stock	70.6	0.97	2.64
LOC.312491	1618994	6131326	Not specified	Not specified	0.96	3.21
LOC.200192	1617702	6133678	Stock	80.0	0.93	2.66
LOC.200083	1617702	6133678	Not specified	8.5	0.93	2.66

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.315061	1610391	6147663	Not specified	Not specified	0.92	2.15
LOC.311385	1612759	6143681	Domestic and stock	72.8	0.91	2.56
LOC.201500	1619142	6128372	Irrigation	79.6	0.91	3.24
LOC.317202	1612321	6144685	Domestic	68.5	0.91	2.51
LOC.200274	1610467	6147051	Domestic and Irrigation	50.0	0.90	2.18
LOC.210378	1614723	6139203	Domestic	89.7	0.90	2.16
LOC.201363	1618110	6130981	Stock	78.5	0.90	3.19
LOC.200321	1613986	6139865	Not specified	117.0	0.87	2.20
LOC.209611	1617767	6132926	Monitoring	85.0	0.86	2.74
LOC.314427	1618027	6132874	Domestic and stock	108.0	0.86	2.75
LOC.209887	1608602	6146282	Domestic	83.0	0.85	3.14
LOC.209933	1608602	6146282	Stock	110.5	0.85	3.14
LOC.311386	1611031	6146536	Domestic	86.0	0.84	2.06
LOC.200214	1612355	6144972	Stock	76.2	0.84	2.26
LOC.200201	1618104	6132880	Stock	83.0	0.83	2.73
LOC.209078	1611934	6145513	Monitoring	3.9	0.83	2.20
LOC.209078	1611947	6145501	Monitoring	3.9	0.83	2.20
LOC.200339	1611948	6145499	Monitoring	6.2	0.83	2.20
LOC.210445	1611943	6145493	Domestic	67.8	0.83	2.20
LOC.315970	1616835	6134014	Not specified	Not specified	0.83	2.43
LOC.201366	1617436	6132318	Domestic	48.8	0.82	2.74
LOC.200038	1603952	6153128	Not specified	5.8	0.82	4.01
LOC.200275	1603952	6153128	Exploration	63.0	0.82	4.01
LOC.209290	1604015	6153225	Irrigation	60.0	0.82	4.01
LOC.209231	1610577	6147231	Commercial Water Supply	86.6	0.82	1.99
LOC.201025	1620470	6122039	Not specified	33.8	0.81	4.48
LOC.200168	1619205	6128425	Irrigation	47.0	0.81	3.12
LOC.209510	1610600	6147316	Domestic	75.5	0.81	1.95
LOC.201598	1616125	6135622	Irrigation	98.0	0.80	2.23
LOC.308897	1610564	6147424	Domestic	89.7	0.79	1.91
LOC.200158	1618104	6132780	Stock	24.0	0.79	2.72
LOC.209280	1614798	6138773	Irrigation	88.5	0.79	2.05
LOC.201579	1618054	6115390	Exploration	56.0	0.78	2.34
LOC.200338	1611971	6145456	Monitoring	5.6	0.78	2.10
LOC.209078	1611954	6145502	Monitoring	3.9	0.78	2.10
LOC.209078	1611974	6145471	Monitoring	3.9	0.78	2.10
LOC.209078	1611975	6145490	Monitoring	3.9	0.78	2.10
LOC.209078	1611979	6145503	Monitoring	3.9	0.78	2.10
LOC.209078	1611958	6145513	Monitoring	3.9	0.78	2.10

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.209078	1611964	6145491	Monitoring	3.9	0.78	2.10
LOC.209078	1611966	6145506	Monitoring	3.9	0.78	2.10
LOC.209078	1611967	6145518	Monitoring	3.9	0.78	2.10
LOC.200246	1611971	6145456	Domestic	72.2	0.78	2.10
LOC.009561.01.02	1611965	6145472	Not specified	Not specified	0.78	2.10
LOC.210337	1612021	6145496	Monitoring	6.0	0.78	2.10
LOC.200341	1614490	6138367	Irrigation	89.0	0.78	2.09
LOC.210452	1612100	6145411	Domestic	76.0	0.78	2.12
LOC.209173	1611590	6146004	Domestic and Stock	72.0	0.77	1.97
LOC.200176	1616197	6135873	Stock	56.0	0.77	2.19
LOC.200191	1618000	6134179	Stock	59.5	0.77	2.43
LOC.201364	1617406	6132178	Stock	93.0	0.77	2.69
LOC.209678	1604083	6153122	Stock	61.2	0.77	3.93
LOC.210016	1610739	6147174	Domestic	79.0	0.75	1.83
LOC.200326	1614554	6138575	Irrigation	116.2	0.75	2.04
LOC.209599	1610609	6147637	Domestic	89.0	0.74	1.76
LOC.312831	1617046	6136940	Not specified	Not specified	0.74	2.03
LOC.209585	1614328	6138468	Irrigation	114.0	0.73	2.04
LOC.200051	1610666	6147251	Not specified	Not specified	0.73	1.77
LOC.312665	1615069	6139351	Not specified	Not specified	0.73	1.92
LOC.308025	1611889	6145692	Not specified	Not specified	0.73	1.96
LOC.308730	1611903	6145698	Irrigation	72.0	0.73	1.96
LOC.209291	1611960	6145633	Domestic	72.0	0.73	1.97
LOC.210270	1616501	6116438	Domestic and stock	65.0	0.72	3.19
LOC.209284	1614800	6138422	Irrigation	90.0	0.72	2.01
LOC.200075	1616994	6136475	Not specified	6.1	0.71	2.07
LOC.200055	1610666	6147351	Not specified	Not specified	0.71	1.71
LOC.201362	1617998	6134979	Stock	72.0	0.70	2.24
LOC.201034	1614000	6139700	Irrigation	26.0	0.70	2.03
LOC.312299	1612256	6145355	Domestic	75.0	0.70	1.94
LOC.200039	1604148	6154528	Not specified	6.7	0.70	3.66
LOC.209500	1617306	6131788	Stock and Irrigation	93.0	0.69	2.65
LOC.315384	1618165	6132248	Irrigation	95.0	0.69	2.73
LOC.200190	1614086	6139965	Stock	76.0	0.69	2.01
LOC.200076	1617203	6133277	Not specified	10.0	0.69	2.42
LOC.209644	1610530	6148125	Domestic	93.1	0.69	1.71
LOC.209885	1610458	6148147	Domestic	98.5	0.69	1.71
LOC.200200	1617095	6136275	Stock	92.0	0.69	2.07
LOC.200328	1614087	6139665	Irrigation	88.0	0.68	2.00

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.209336	1616532	6135732	Stock	78.0	0.68	2.13
LOC.315166	1610587	6147804	Irrigation	40.0	0.68	1.63
LOC.314929	1610590	6147808	Domestic	86.5	0.68	1.63
LOC.209708	1613781	6141064	Irrigation	79.0	0.67	2.02
LOC.209642	1610821	6147232	Domestic	82.2	0.66	1.63
LOC.200302	1612673	6144658	Irrigation	79.5	0.66	2.05
LOC.201361	1616901	6134176	Not specified	83.0	0.65	2.25
LOC.201535	1616846	6135759	Stock	73.0	0.65	2.10
LOC.209508	1611396	6146722	Domestic	74.5	0.65	1.48
LOC.209541	1617414	6135565	Domestic and Stock	72.5	0.65	2.12
LOC.209170	1611769	6146025	Domestic	77.0	0.65	1.72
LOC.209031	1614902	6139537	Domestic and Stock	115.1	0.64	1.85
LOC.200159	1614687	6139467	Stock	46.0	0.64	1.89
LOC.209618	1617253	6135602	Stock	81.5	0.64	2.12
LOC.200318	1611468	6146654	Private Water Supply	74.4	0.64	1.40
LOC.314463	1614508	6139527	Stock	110.0	0.64	1.91
LOC.200077	1617197	6135576	Not specified	13.0	0.64	2.11
LOC.200239	1614387	6139466	Stock	73.0	0.64	1.92
LOC.200074	1616906	6132377	Not specified	10.0	0.63	2.43
LOC.210374	1614344	6139436	Domestic and stock	113.5	0.63	1.93
LOC.300999	1614283	6139417	Domestic and stock	120.0	0.63	1.93
LOC.210323	1617437	6134989	Domestic	85.0	0.63	2.18
LOC.314181	1610570	6148029	Domestic	82.5	0.62	1.55
LOC.200216	1617198	6135076	Stock	85.0	0.62	2.15
LOC.209779	1610850	6147124	Domestic	94.7	0.61	1.52
LOC.201474	1617092	6137175	Not specified	29.0	0.61	1.86
LOC.201288	1615677	6122797	Private Water Supply	108.0	0.61	3.97
LOC.209620	1617112	6115915	Domestic and Stock	71.0	0.60	2.66
LOC.210299	1615073	6138680	Domestic and Irrigation	90.0	0.60	1.84
LOC.200331	1615089	6138668	Irrigation	87.4	0.60	1.84
LOC.200085	1619407	6131684	Not specified	Not specified	0.60	2.61
LOC.200322	1603853	6153128	Stock	100.0	0.59	3.75
LOC.210233	1615512	6122353	Not specified	Not specified	0.59	4.16
LOC.201005	1615435	6122378	Not specified	10.0	0.58	4.10
LOC.209647	1615180	6139069	Domestic and Irrigation	97.0	0.58	1.78
LOC.210305	1615513.333	6122512	Domestic	84.0	0.58	4.07
LOC.200196	1610766	6147451	Private Water Supply	75.0	0.57	1.39
LOC.304107	1611371	6146843	Not specified	Not specified	0.57	1.32
LOC.200065	1611769	6146155	Not specified	17.0	0.57	1.49

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.200254	1610867	6147152	Domestic	28.7	0.57	1.40
LOC.201006	1615435	6122478	Not specified	6.7	0.57	4.01
LOC.201412	1615535	6122578	Domestic	19.2	0.56	3.98
LOC.210375	1606684	6150227	Stock	93.0	0.56	3.11
LOC.200234	1610564	6148250	Domestic	59.0	0.55	1.43
LOC.209579	1610825	6147551	Domestic	77.0	0.55	1.32
LOC.200325	1614284	6140565	Domestic and Stock	66.0	0.55	1.80
LOC.301443	1604340	6154522	Not specified	Not specified	0.54	3.42
LOC.200086	1619607	6131685	Stock	15.8	0.54	2.49
LOC.200043	1611568	6146654	Irrigation	54.2	0.54	1.21
LOC.200293	1610734	6147962	Domestic	34.4	0.53	1.34
LOC.200244	1610664	6147951	Domestic	55.5	0.53	1.34
LOC.209543	1610747	6148037	Domestic	73.0	0.53	1.34
LOC.200064	1611769	6146255	Not specified	Not specified	0.53	1.37
LOC.209185	1610518	6148354	Domestic	71.5	0.52	1.50
LOC.308345	1603009	6152347	Irrigation	101.0	0.52	3.30
LOC.311280	1603009	6152347	Domestic and stock	101.0	0.52	3.30
LOC.200056	1610765	6147651	Not specified	Not specified	0.52	1.27
LOC.209329	1605981	6154579	Stock	90.0	0.51	2.60
LOC.209326	1615263	6138474	Stock and Irrigation	106.5	0.51	1.75
LOC.210376	1616313	6115888	Domestic and stock	67.0	0.51	2.51
LOC.200073	1616193	6137172	Not specified	10.2	0.50	1.79
LOC.200251	1610563	6148350	Private Water Supply	34.0	0.50	1.36
LOC.210159	1605435	6150820	Not specified	Not specified	0.50	3.20
LOC.209638	1617022	6115406	Stock	62.0	0.50	2.24
LOC.200250	1611411	6146928	Private Water Supply	79.3	0.49	1.16
LOC.305551	1611364	6146854	Domestic	82.0	0.49	1.16
LOC.317737	1603852	6152835	Not specified	Not specified	0.49	3.54
LOC.200062	1611668	6146554	Not specified	Not specified	0.49	1.16
LOC.200278	1616102	6133874	Stock	83.0	0.49	2.01
LOC.210277	1604072	6152792	Domestic	73.0	0.47	3.51
LOC.200053	1610664	6148151	Not specified	Not specified	0.47	1.23
LOC.200052	1610664	6148151	Not specified	14.0	0.47	1.23
LOC.200344	1610855	6147471	Domestic	75.5	0.47	1.14
LOC.209860	1603948	6152245	Domestic	83.8	0.46	3.47
LOC.314465	1611882	6146283	Not specified	Not specified	0.46	1.23
LOC.309604	1616179	6137507	Domestic and stock	100.0	0.46	1.72
LOC.200329	1612771	6145258	Domestic	68.5	0.46	1.49
LOC.209535	1603752	6152281	Domestic and Stock	76.8	0.46	3.44

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.304199	1612877	6145081	Not specified	Not specified	0.46	1.53
LOC.307629	1612882	6145063	Domestic	73.7	0.46	1.53
LOC.209778	1603961	6152588	Domestic	74.0	0.45	3.45
LOC.201512	1615792	6137471	Domestic and Stock	77.5	0.45	1.73
LOC.209495	1615824	6137512	Stock and Irrigation	85.5	0.45	1.73
LOC.209580	1604082	6152474	Domestic	77.0	0.44	3.42
LOC.200058	1610764	6148051	Not specified	12.0	0.43	1.11
LOC.200069	1615689	6138470	Not specified	10.4	0.43	1.62
LOC.200316	1611668	6146654	Domestic and Stock	76.0	0.43	1.00
LOC.200210	1611712	6146689	Not specified	79.6	0.43	1.00
LOC.200197	1615742	6138418	Stock	96.0	0.43	1.63
LOC.200238	1610663	6148251	Domestic	33.5	0.43	1.17
LOC.200071	1615791	6137871	Not specified	14.0	0.43	1.67
LOC.200072	1615891	6137871	Not specified	6.3	0.42	1.66
LOC.200245	1610462	6148650	Domestic	65.0	0.42	1.34
LOC.209168	1612044	6146345	Domestic	77.0	0.41	1.11
LOC.200175	1615403	6133872	Stock	46.0	0.41	1.85
LOC.200247	1610764	6148151	Domestic	33.0	0.40	1.06
LOC.209707	1610763	6148209	Domestic	70.5	0.40	1.06
LOC.209748	1603865	6154810	Irrigation	42.5	0.40	2.96
LOC.209496	1615374	6133352	Stock and Irrigation	96.0	0.39	1.85
LOC.201427	1616355	6115285	Domestic and Stock	38.0	0.39	2.04
LOC.305229	1609849	6149352	Not specified	Not specified	0.37	1.66
LOC.200252	1610763	6148251	Domestic	30.0	0.37	1.01
LOC.200310	1612971	6145259	Domestic	38.5	0.36	1.26
LOC.200315	1612971	6145259	Domestic and Stock	66.0	0.36	1.26
LOC.312872	1611980	6146438	Not specified	Not specified	0.36	0.97
LOC.314093	1610734	6148503	Domestic	66.0	0.35	1.05
LOC.200057	1610763	6148351	Not specified	19.0	0.33	0.95
LOC.200067	1611868	6146555	Not specified	Not specified	0.33	0.84
LOC.307773	1609855	6149351	Domestic and stock	66.3	0.33	1.46
LOC.200170	1604451	6153630	Domestic	84.5	0.32	3.09
LOC.209028	1612076	6146383	Domestic	77.0	0.31	0.86
LOC.200054	1610763	6148451	Not specified	6.0	0.30	0.89
LOC.200340	1605647	6154733	Stock	121.5	0.29	2.55
LOC.313925	1605016	6152745	Stock	46.0	0.29	2.94
LOC.209311	1605547	6154732	Stock	112.0	0.28	2.56
LOC.209171	1612459	6146117	Domestic	79.5	0.28	0.86
LOC.314227	1603484	6154651	Not specified	Not specified	0.28	2.57

IRISID	X	Y	Purpose	Depth of Bore (m)	Scenario 2 Drawdown: Deep Aquifer (m)	Scenario 3 Drawdown: Deep Aquifer (m)
LOC.201597	1616268	6110687	Monitoring	3.3	0.27	0.72
LOC.210160	1605092	6152745	Not specified	Not specified	0.27	2.88
LOC.303423	1604647	6154949	Not specified	Not specified	0.23	2.61
LOC.303423	1604647	6154949	Not specified	Not specified	0.23	2.61
LOC.200295	1608250	6150859	Domestic and Irrigation	5.0	0.22	1.65
LOC.316843	1605635	6154990	Stock and irrigation	90.0	0.20	2.25
LOC.307657	1604716	6154912	Domestic	38.0	0.20	2.54
LOC.200346	1613456	6145285	Domestic	72.2	0.19	0.81
LOC.300133	1609936.924	6149570.4	Not specified	Not specified	0.19	1.01
LOC.301013	1609937	6149573	Not specified	Not specified	0.19	1.01
LOC.302455	1609937	6149573	Stock	65.0	0.19	1.01
LOC.200269	1604246	6155328	Private Water Supply	18.1	0.18	2.25
LOC.209328	1605693	6154483	Stock	131.0	0.18	2.42
LOC.200298	1602248	6155022	Stock	9.0	0.14	1.56
LOC.200256	1605648	6154433	Irrigation	130.0	0.13	2.42
LOC.200040	1604345	6155528	Not specified	14.0	0.13	2.01
LOC.201003	1615269	6110585	Not specified	25.9	0.11	0.52
LOC.200188	1605445	6154430	Irrigation	135.0	0.11	2.48
LOC.200343	1604205	6155588	Domestic	24.0	0.10	1.89
LOC.200041	1607153	6152438	Not specified	17.3	0.10	1.61
LOC.210269	1608687	6151385	Stock	64.0	0.07	0.75
LOC.209029	1607610	6152523	Irrigation	143.0	0.07	1.19
LOC.209030	1607610	6152523	Irrigation	68.3	0.07	1.19
LOC.201481	1608956	6151044	Irrigation	14.6	0.06	0.69
LOC.200181	1605649	6154033	Irrigation	61.0	0.06	2.36
LOC.200156	1609056	6151145	Irrigation	14.0	0.04	0.46