

Memorandum



To Angela Stride & Stuart Saville
(Northland Regional Council);
Brydon Hughes (Land & Water People)

Date 4 April 2019

From Jon Williamson & Jake Scherberg
(Williamson Water & Land Advisory)

Project No WWA0068

Subject **Addendum to Assessment of Effects Reports Pertaining to Aupouri Aquifer Resource Consent Applications Compiled by WWLA**

1. Introduction

Williamson Water & Land Advisory (WWLA) has submitted assessment of environmental effects (AEE) documents associated with resource consent applications for the parties listed in **Table 1**. Initially, AEE's were compiled using either analytical methods or sub-zone groundwater models to evaluate potential impacts from the proposed groundwater extraction. After a number of applications were processed in this manner, it was determined that the number and combined volume of resource consent applications justified the development of a numerical model, which was used for subsequent applications.

The Aupouri Aquifer Groundwater Model (AAGWM), a MODLOW-USG (unstructured grid) based numerical groundwater model for the Aupouri Aquifer, was completed in October 2018 and was used as the basis for the AEE analyses beginning with the S92 submission for Te Raite Station in November 2018. Prior applicants were incorporated into the model as proposed groundwater takes, and are thereby included in the cumulative analysis of potential aquifer impacts in subsequent AEE's, and in this document. Model development and calibration are detailed in WWLA (2019).

Table 1. Pending resource consent applications compiled by WWLA for Aupouri aquifer groundwater takes

Applicant	Volume (m ³ /yr)	Application Date	Aupouri Sub-aquifer Management Zone	Analysis Approach
Te Raite Station	1,152,500	1/05/2018	Houhora; Waihopo; Other	AAGWM ¹
Jeremy Evans	160,000	14/06/2018	Houhora	Houhora Model
Tuscany Avocados	36,000	18/06/2018	Motutangi	F&W Model ²
Elbury Holdings	200,000	3/08/2018	Sweetwater	F&W Model
Tiri Avocados	581,250	3/08/2018	Paparore	Paparore Model
Valic Avocados	173,700	3/08/2018	Paparore	Paparore Model
Wataview Orchards	33,750	3/08/2018	Paparore	Paparore Model
D. Wedding & M. Doody	304,000	10/08/2018	Houhora	F&W Model
Yelavich	52,000	14/08/2018	Other	F&W Model

¹ S92 Response only prepared in November 2018.

² Feather & Williamson, and Theis analytical models.

Applicant	Volume (m ³ /yr)	Application Date	Aupouri Sub-aquifer Management Zone	Analysis Approach
Robert Campbell	360,000	21/08/2018	Other	F&W Model
Anton Matthews	12,000	28/08/2018	Houhora	F&W Model
Mervyn Evans	36,400	9/11/2018	Houhora	AAGWM
Waikopu Avocados	83,360	22/11/2018	Waihopo	AAGWM
Henderson Bay Avocados	19,000	22/11/2018	Waihopo	AAGWM
Far North Avocados	32,000	26/11/2018	Waihopo	AAGWM
S. & L. Blucher	96,000	21/12/2018	Houhora	AAGWM
KSL Limited	3,600	29/03/2019	Motutangi	AAGWM
Sweetwater Station	776,000	In process	Sweetwater; Aupouri; Ahipara	AAGWM
Bryan Estate	240,000	In process	Houhora; Motutangi	AAGWM

Initial review of the assessment of environmental effects by Northland Regional Council (NRC) and their Peer Reviewer Brydon Hughes from Water & Land People has raised several questions relating to:

- simulated pumping volumes;
- the analysis of predicted drawdown in the Aupouri Aquifer; and
- the analysis of potential saline intrusion by the process of lateral migration.

This document is intended to address the questions in a manner that is applicable to all of the applications listed in **Table 1**.

2. Pumping Volume

Review Question

Several groundwater takes in the Waihopo management zone are missing from the AAGWM.

Response

The original database for groundwater takes throughout the Aupouri Aquifer was provided by NRC to WWLA for the MWWUG groundwater model in 2016. However, in checking the query with respect to the Waihopo zone, a new groundwater consent database file was obtained from Susie Osbaldiston of NRC on 8 April 2019.

It was found that there were a number of discrepancies between the two databases, all of which are relatively small annual volumes, as summarised in **Table 2**. This shows the orchards that

were missing and that the scale of abstraction not previously included in the model was minor relative to the overall volume of groundwater abstraction in the various zones.

Table 2. Summary of discrepancies between groundwater take databases - 2016 and 2019.

Consent Holder	Annual Volume (m ³ /ann)	Zone
Landcorp (stock & domestic)	21,900	Ahipara
Fraser	10,000	Ahipara
Walker & MacMillan	40,000	Other
Rarawa Campground	8,036	Waihopo
Thomas & O Connor	98,000	Waihopo
Thomas & O Connor	4,500	Houhora

The groundwater model was subsequently updated to include the latest consented groundwater take information. The location of all groundwater takes are shown in **Figure 1A** through **Figure 1C**, with the corresponding bore owners and annual pumping volumes (consented or proposed, as appropriate) provided in **Appendix A**.

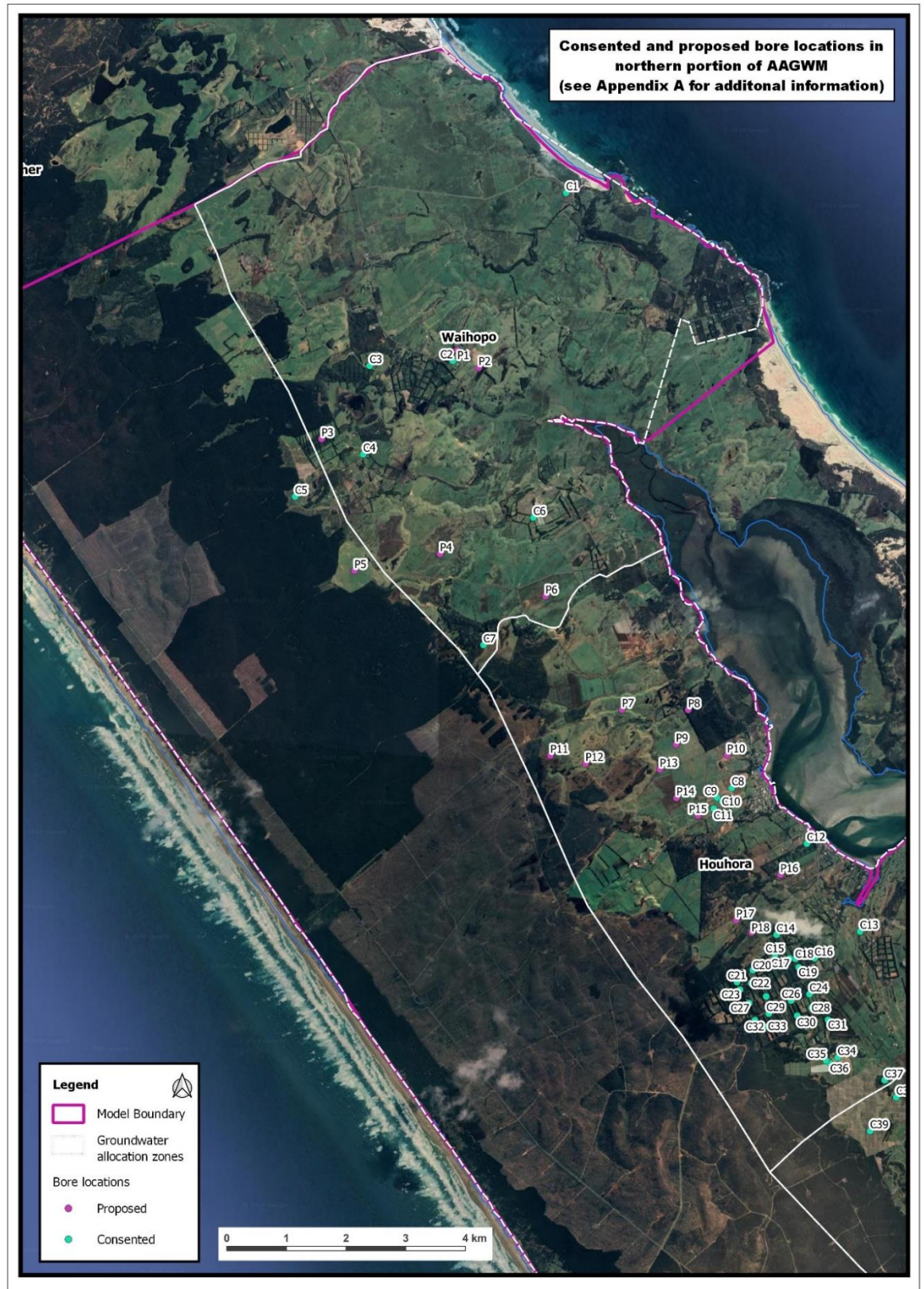


Figure 1A. Consented and proposed bore location in northern portion of AAGWM.

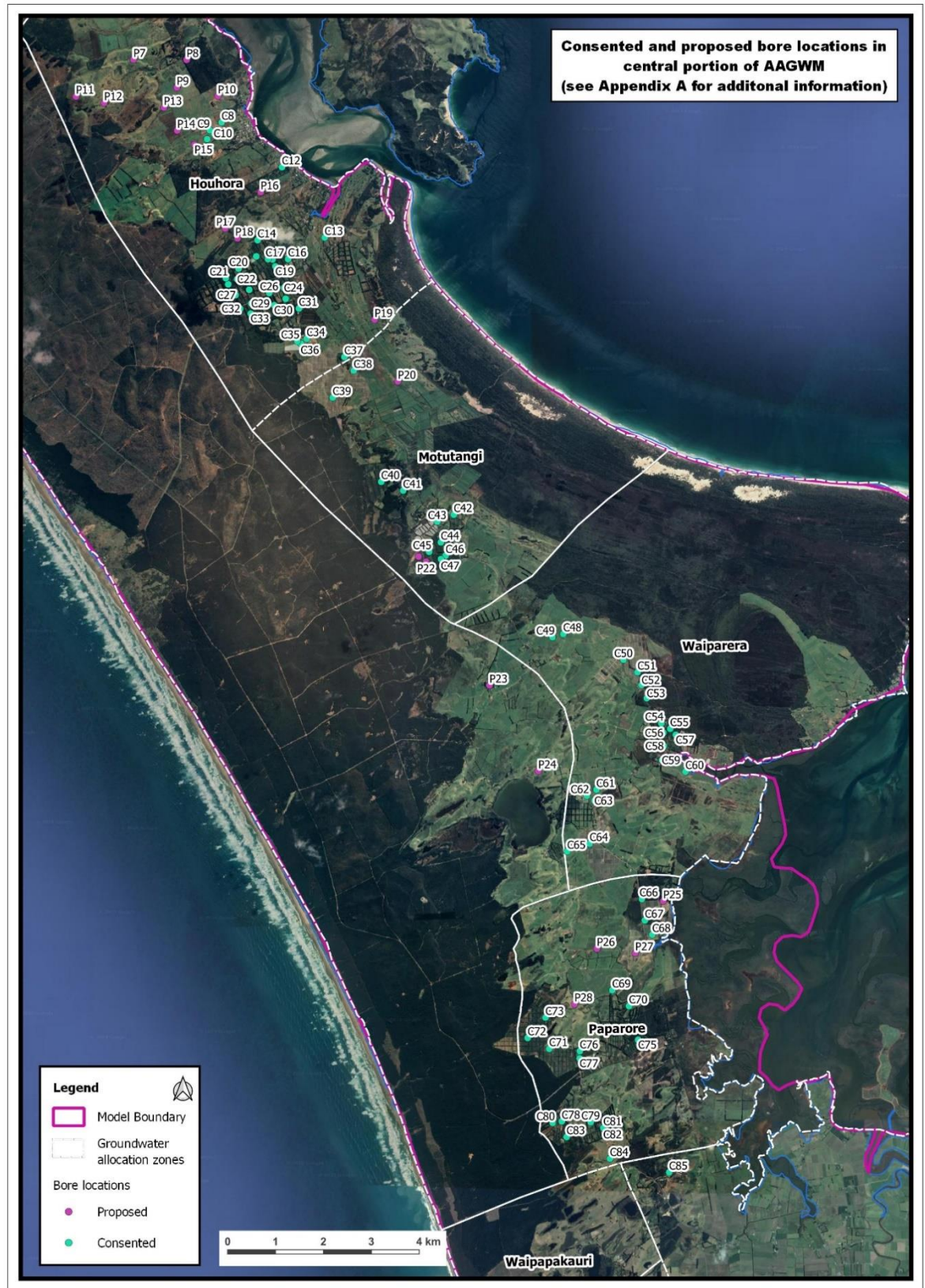


Figure 1B. Consented and proposed bore location in central portion of AAGWM (see A3 attachment at rear).

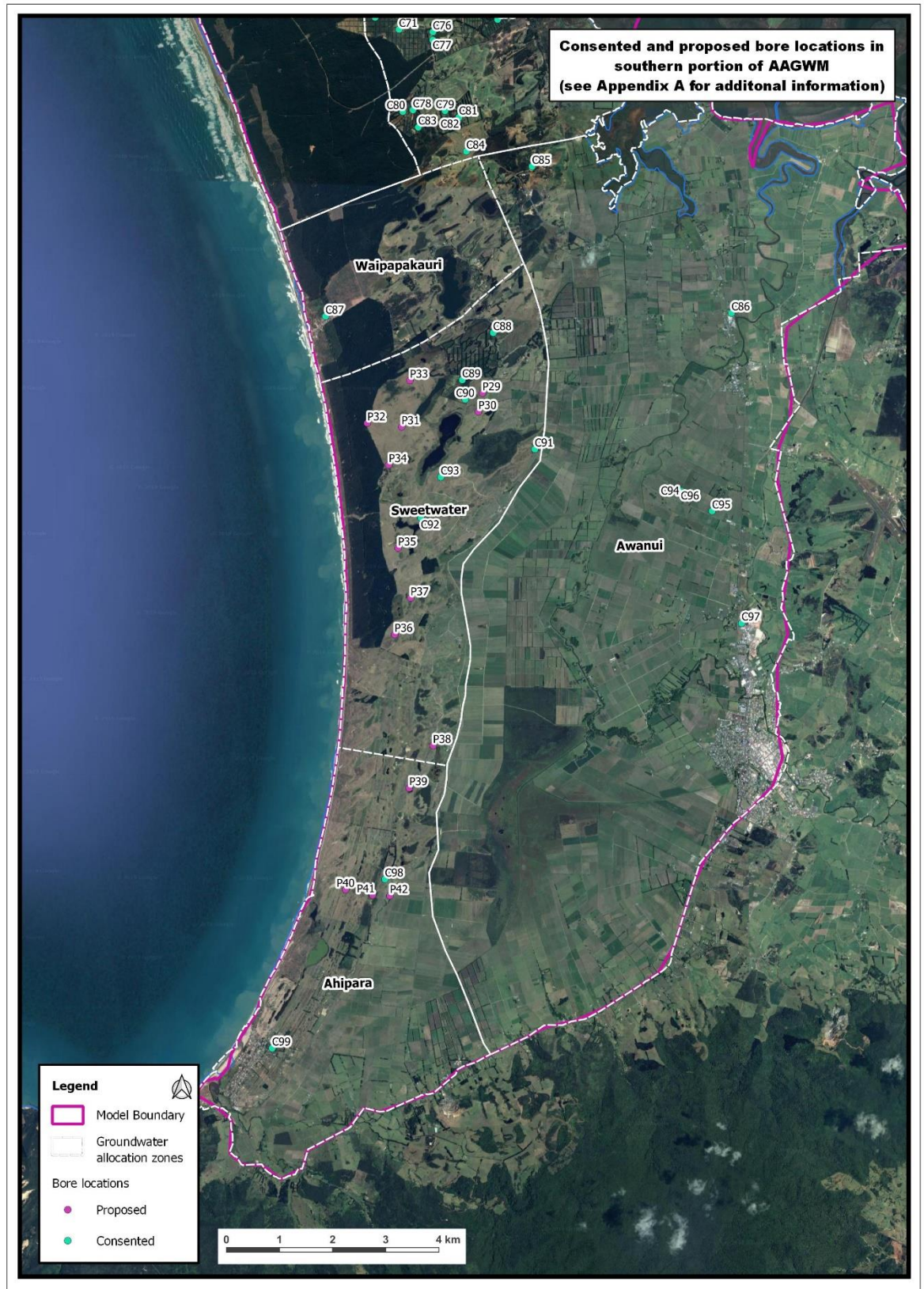


Figure 1C. Consented and proposed bore location in southern portion of AAGWM (see A3 attachment at rear).

3. Model Scenario Setup

Review Question

Total daily pumping in the AAGWM does not appear to match the daily volume sought in several of the AEE's.

Response

The models were setup with the maximum annual groundwater allocation being sought by the applicant as the basis for the pumping applied in the model, rather than the maximum daily rate.

In some of the AEE's that used the AAGWM, the scenarios *Base Case* and *Proposed Extraction* scenarios were defined, in part, with a statement of the total pumping volume in m³/day. While this accurately reflects model inputs, it may have been conceptually misleading with regard to how the model scenarios were developed.

Resource consent applications for groundwater in this area have been based on an annual pumping volume of 400 mm/yr for canopy area and a daily pumping volume of 25 m³/ha/day for total orchard area. Pumping volumes for the model scenarios are based on the proposed annual allocation for the following reasons:

- Annual rates are more fundamental to long term aquifer sustainability than daily pumping, given the time scales of groundwater flow.
- For modelling purposes daily pumping incorporates an input that is averaged over a given stress period (13 to 185 days) where irrigation, in practice, is not applied every day. The final pumping volumes are limited by annual rates (proposed or consented). Daily irrigation rates are, therefore, a function of annual allocation limit and irrigation days required under 10-year drought conditions.
- Though an orchardist may sometimes pump at their maximum rate, if they were to do so regularly, they would reach their annual allocation limit far before the end of irrigation season and be forced to shut off irrigation (bad farming practice).
- Simulated irrigation rates do not vary during a given stress period so using the proposed maximum daily rate, in many cases, would over-simulate the average pumping rate during that period of time.

In light of these considerations, the maximum annual groundwater allocation being sought by the applicant was the basis for the pumping volume applied in the model, hence no change to the model was needed.

To overcome any future confusion, in more recent and any future AEE's, the maximum annual pumping volume for the *Base Case* and *Proposed Extraction* scenarios will be stated in the scenario descriptions.

4. Aquifer Drawdown

Review Question

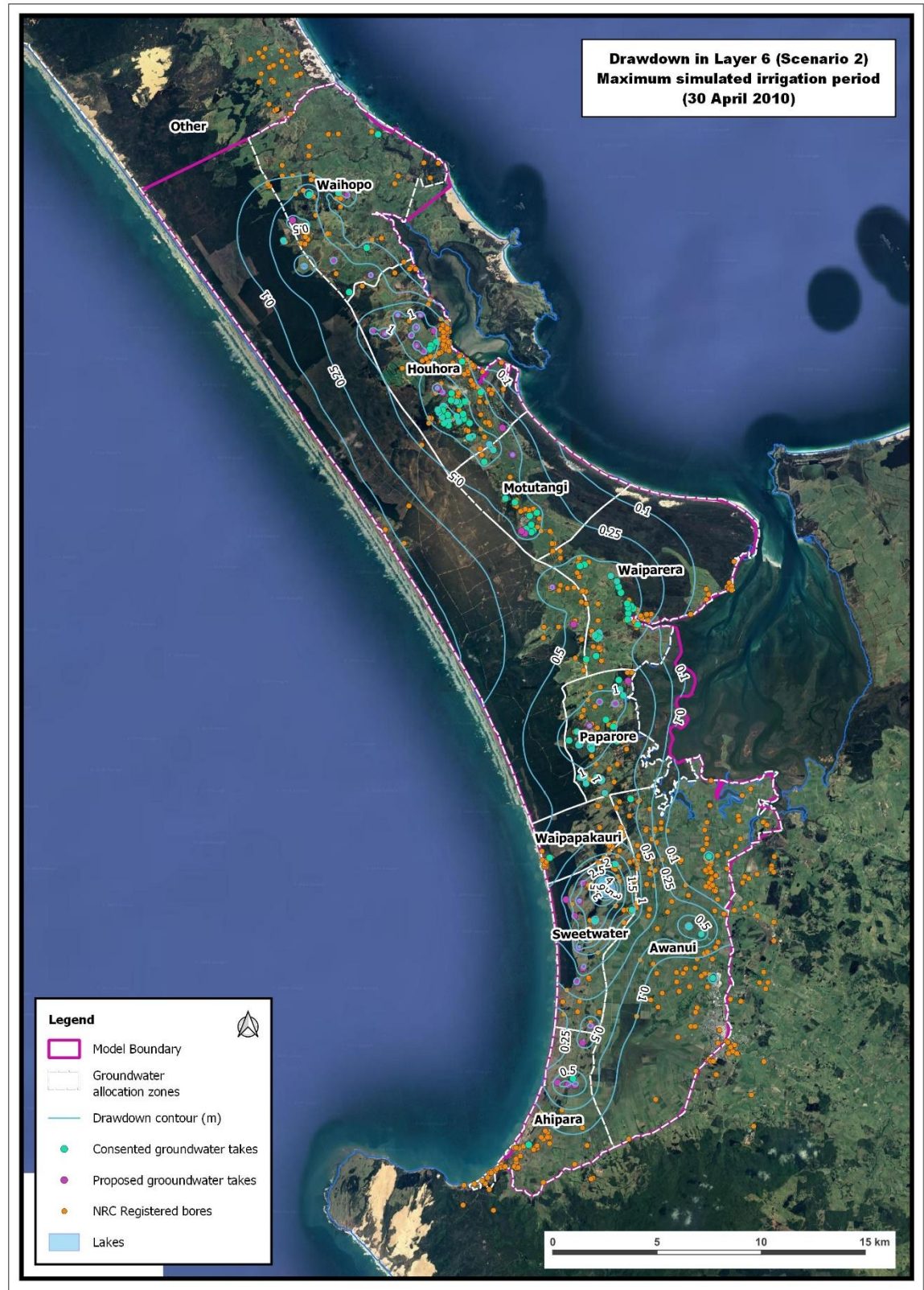
The reported drawdown does not appear to consider cumulative effects, but rather is limited to the effects of the specific groundwater take proposed in the given AEE.

Response

The previous work did consider cumulative effects from a baseline of existing consented takes plus previous applications assuming they were granted.

However, to provide visibility of the cumulative impact compared to an undeveloped state, we have developed a naturalised groundwater scenario where all pumping has been eliminated from the model. This scenario was developed for both the calibrated and low permeability versions of the model.

Groundwater levels were compiled for the end of the 2010 irrigation season (30/4/2010), which represents the peak of irrigation over the 58-year simulation with all consents exercised to their annual limit and thereby the maximum impact on groundwater levels. The results were compared to the naturalised scenario to determine the maximum drawdown under the calibrated model and low permeability model conditions. Maximum predicted drawdown in the deep aquifer is shown in **Figure 2** for calibrated model conditions and in **Figure 3** for low permeability model conditions.



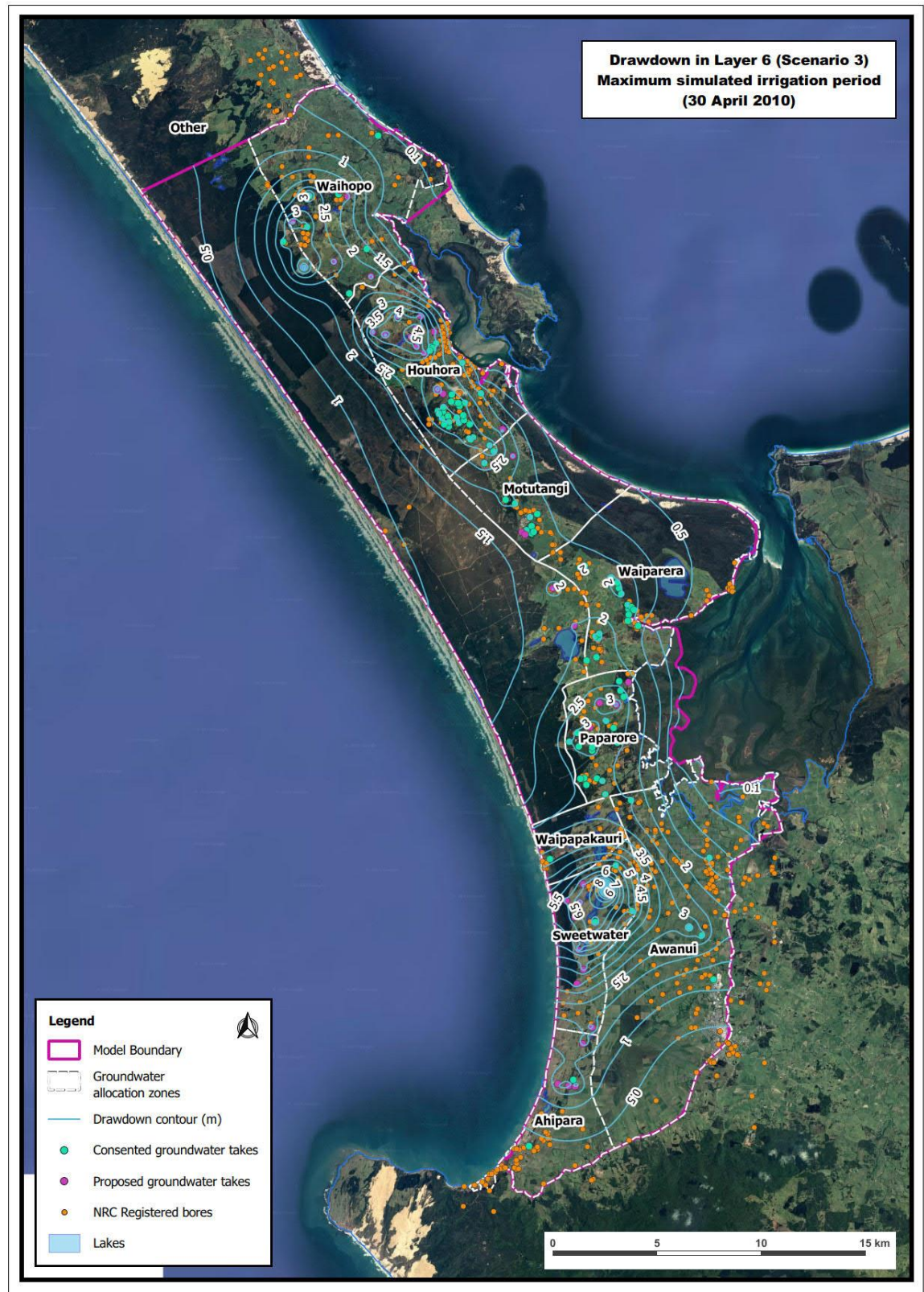


Figure 3. Simulated drawdown of deep aquifer (Scenario 3).

In the deep aquifer, the maximum drawdown from a naturalised condition was 8.6 m under calibrated model conditions. This was predicted to occur in the area around the two FNDC bore takes proposed for Kaitaia (Consent AUT.025683.01.03 that is currently unexercised).

The maximum drawdown predicted in the deep aquifer in the low permeability scenario was 12.6 m, predicted to occur in the same location. This represents 19% of the available drawdown³.

Maximum predicted drawdown in the shallow aquifer over the model area using calibrated model conditions is shown in **Figure 4**, and is predicted to be 1.9 m adjacent to the FNDC bores. In the low permeability scenario drawdown is not predicted in the shallow aquifer because of the disconnection between the upper and lower portion of the aquifer.

³ Available drawdown for each bore has been calculated from the average groundwater level taken from the naturalised scenario and the top of the deep shellbed aquifer minus 5 m for pump installation.

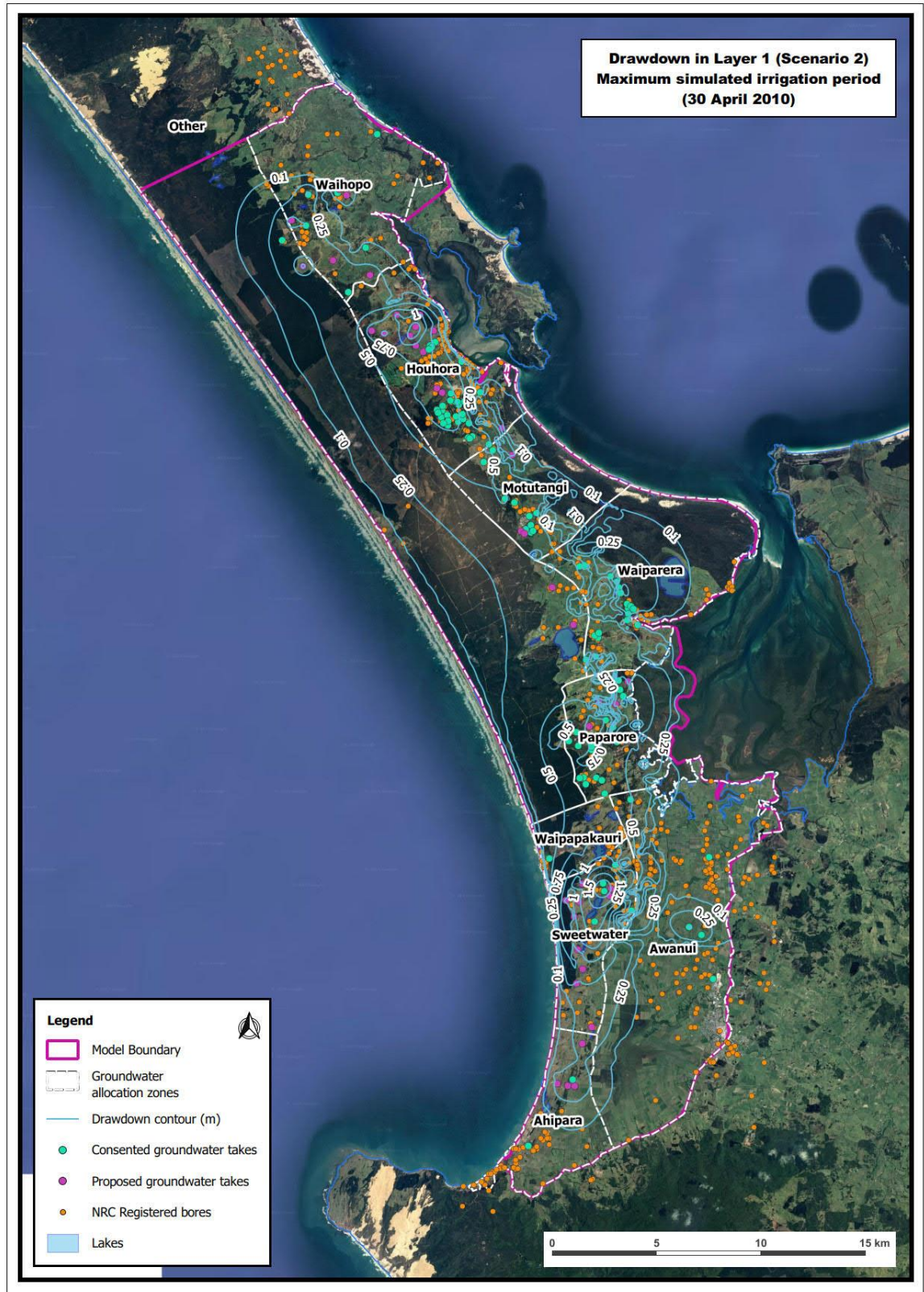


Figure 4. Simulated drawdown of shallow aquifer (Scenario 2).

Predicted drawdown from a naturalised condition under both the calibrated model conditions and for the low permeability scenario, as well as available drawdown, is shown for every bore included in the model in **Appendix B**.

The specific level of interference propagated for each proposed bore in the AEE's prepared by WWLA, based on the AAGWM results are included in the AEE documents themselves.

5. Lateral Migration Analysis

Review Question

The AEE's indicate potential saline intrusion near Houhora Heads and along the west coast. It is also unclear if the analysis of potential saline intrusion is cumulative in that it accounts for all proposed groundwater extraction.

Response

The analysis of potential saline intrusion did account for cumulative drawdown from all groundwater pumping in the model.

Potential saltwater intrusion was assessed in each of the AEE documents using the method of Lateral Migration Analysis based on the Ghyben-Herzberg relationship. Points along the east or west coast were selected for analysis based on the proposed bore location for the given AEE. The Lateral Migration Analysis entailed an assessment of the groundwater pressure required to avoid saline intrusion relative to the groundwater pressure predicted by the model for the given analysis location. The specifics for Lateral Migration Analysis calculations are provided in the appropriate section for each AEE.

In each case, the model was used to assess saline intrusion potential from cumulative pumping with and without the proposed take for the given consent application. Any potential increase in saline intrusion due to the proposed groundwater take was then noted in the AEE.

Figure 2 shows maximum drawdown in the deep aquifer from the calibrated model and can therefore be considered indicative of areas with potential saline intrusion resulting from groundwater pumping. The figure shows that drawdown along the coast is under 0.1 m over most of the model area.

The greatest drawdown on the west coast is adjacent to the Sweetwater Station bores. Water levels in this area were assessed in the Sweetwater Station AEE and shown to be above the level needed to avert saline intrusion with maximum pumping applied. On the east coast the greatest drawdown is in the Houhora area and was assessed in the Te Raite Station AEE. Groundwater pressure in this region was also sufficient to avert saline intrusion.

In some cases, saline intrusion may occur under natural conditions, most commonly at headlands or estuarine areas. In these cases, it is appropriate to assess potential saline intrusion at an

inland location where groundwater is not saline to begin with to determine if pumping is likely to cause adverse effects. In the cases of Te Raite Station and Bryan Estate potential lateral migration was evaluated inland from Houhora Heads for that reason. It was found that while there may be saline intrusion along the coast at Houhora Heads, the proposed groundwater extraction will not impact the level of salinity in the groundwater.

Though there were areas where there appeared to be potential saline intrusion along the west coast, this was the case under natural conditions and was not affected by groundwater extraction.

6. Conclusion

This memorandum is intended to clarify questions that have arisen in regard to the nineteen AEE documents that have been submitted by WWLA to support resource consent applications for groundwater takes from the Aupouri Aquifer.

Explanation was provided for the calculation of pumping in the AAGWM based on proposed annual groundwater extraction.

To supplement the resource consent applications an analysis of cumulative simulated drawdown in the Aupouri aquifer for the all groundwater extraction, consented and proposed, relative to naturalised conditions where no groundwater extraction occurs. It was found that while drawdown is inevitable, the maximum expected drawdown is a far less than the available drawdown in each registered borehole or take consent.

Additional explanation of the analysis methods used to evaluate potential saline intrusion from the proposed groundwater takes was also provided.

Please do not hesitate to contact us should you require further clarification.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'Jon Williamson'.

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References

Williamson Water & Land Advisory (2019). Aupouri Aquifer Groundwater Model-Factual Technical Report. Consultancy report prepared for interested parties and the public.

Appendix A. Consented and Proposed Allocation Volumes in AAGWM

Figure Reference	Bore Owner	X Coordinate	Y Coordinate	NRC Authorization/ Application Number	Annual Volume (m3/year)
C1	Rarawa campground	1607445	6157509	AUT.007669.01.02	8,036
C2	Henderson Bay Avocados-Consented	1605547	6154694	AUT.017428.01.02	13,000
C3	Thomas & OConnor-Waihopo	1604154	6154613	AUT.015147.01.03	98,000
C4	Waikopu Avocados-Consented	1604046	6153129		44,640
C5	Walker & MacMillan	1602904	6152422	AUT.037987.01.01	40,000
C6	G J & D J Price	1606898	6152070	AUT.029091.01.01	7,500
C7	L & P Trust	1606061	6149936	AUT.003768.01.04	6,000
C8	Kelvin Thomas*	1610222	6147542	APP.039244.01.01	59,600
C9	Fullam GW take	1609975	6147378	AUT.037292.01.01	14,000
C10	Brien Lamb*	1610058	6147313	APP.039381.01.01	14,900
C11	Thomas & OConnor-Houhora	1609919	6147193	AUT.040369.01.01	4,500
P1	Henderson Bay Avocados	1605623	6154872		19,000
P2	Far North Avocados (Blake Powell)	1605981	6154581		32,000
P3	Waikopu Avocados	1603347	6153388		83,360
P4	Te Raite Station-Waihopo	1605333	6151462		60,000
P5	Te Raite Station_other	1603898	6151179		175,000
P6	Te Raite Station-Waihopo	1607102	6150752		60,000
P7	Te Raite Station-Houhora	1608383	6148854		175,000
P8	J Evans	1609492	6148850		160,000
P9	Te Raite Station-Houhora	1609287	6148271		180,000
P10	S. & L. Blucher	1610145	6148091	APP.040652.01.01	96,000
P11	Te Raite Station-Houhora	1607182	6148084		110,000
P12	Te Raite Station-Houhora	1607771	6147949		110,000
P13	Te Raite Station-Houhora	1609016	6147852		100,000
P14	Te Raite Station-Houhora	1609296	6147373		100,000
P15	Te Raite Station-Houhora	1609655	6147078		100,000
C12	LL & DF Rasmussen	1611481	6146609	AUT.002890.01.02	43,200
C13	Wagener Houhora Heads Properties Ltd	1612372	6145137	AUT.004543.01.03	45,000
C14	Longbeach Trust	1610973	6145083	AUT.003883.01.03	26,400
C15	Tomo Orchard Ltd	1610945	6144743	AUT.003841.01.02	14,800
C16	Ongare Trust-2	1611610	6144688	AUT.008203.01.02	37,200
C17	Alligator Pear Partnership	1611191	6144687	AUT.026611.01.01	49,752
C18	McLarnon-Ongare trust*	1611284	6144679	APP.039345.01.01	23,520
C19	Ongare Trust-1	1611345	6144535	AUT.012472.01.01	17,856
C20	B C Smith	1610575	6144488	AUT.009808.01.02	51,200

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Figure Reference	Bore Owner	X Coordinate	Y Coordinate	NRC Authorization/ Application Number	Annual Volume (m3/year)
C21	E J Williams	1610309	6144289	AUT.020726.02.02	33,000
C22	Far North Avos Limited	1610547	6144269	AUT.028511.01.02	32,000
C23	Honeytree Farms Ltd	1610360	6144161	AUT.020727.02.02	33,000
C24	Whispering Pines Ltd	1611525	6144087	AUT.023557.01.02	46,000
C25	Hine & Associates current	1610798	6144048	AUT.003726.01.02	74,400
C26	Trebcombe Limited-1	1611216	6143980	AUT.008605.01.02	52,080
C27	S127 GW take	1610514	6143937	AUT.007735.01.04	66,000
C28	McQuarrie	1611559	6143858	AUT.038075.01.01	12,000
C29	Trebcombe Limited-2	1610842	6143760	AUT.003527.01.02	26,040
C30	RB Freeman-1	1611320	6143725	AUT.003888.01.02	34,560
C31	EJ Wagener	1611836	6143656	AUT.008586.02.01	30,000
C32	Matalaka Trust	1610610	6143652	AUT.007108.01.02	16,740
C33	RB Freeman-2	1610829	6143550	AUT.003372.01.02	25,920
C34	Whalers Rd Houhora	1611997	6143025	AUT.037274.01.01	74,500
C35	Soltysik-Freeman Fam Trust	1611801	6142975	AUT.036910.01.02	135,000
C36	Valadares*	1611872	6142927	APP.038732.01.01	22,350
C37	Mapua Avocados-1	1612784	6142645	AUT.040174.01.01	209,000
C38	Mapua Avocados-2	1612979	6142360	AUT.040174.01.01	209,000
C39	Mapua_Avocados-3	1612541	6141795	AUT.040174.01.01	209,000
C40	Shirrtail Orchards	1613554	6140038	AUT.008340.01.03	158,520
C41	Subritzky	1614010	6139855	AUT.003964.01.03	67,106
C42	De Bede	1615069	6139351	AUT.038379.01.01	70,000
C43	Candy Corn Ltd*	1614723	6139203	APP.039332.01.01	78,400
C44	Thompson*	1614798	6138773	APP.038589.01.01	35,280
C45	Avokaha Ltd	1614554	6138575	AUT.008647.01.03	26,400
C46	Cypress Hills Ltd1*	1614898	6138495	APP.038591.01.01	35,280
C47	JR Avocados Ltd	1614800	6138422	AUT.028834.01.01	20,000
C48	GT&MT Covich-1*	1617353	6136859	APP.038410.01.00	111,750
C49	GT&MT Covich-2*	1617128	6136793	APP.038410.01.01	111,750
C50	Honeytree2	1618611	6136321	APP.038471.01.02	173,213
C51	Honeytree1*	1618903	6136060	APP.038471.01.01	173,213
C52	Ngai Takakto1*	1618987	6135795	APP.038513.01.01	96,850
C53	Ngai Takakto2*	1619097	6135520	APP.038513.01.01	96,850
C54	IJ & BM Broadhurst	1619399	6134994	AUT.017559.02.01	105,000
C55	I M Fulton-2	1619585	6134880	AUT.016914.02.01	40,000
C56	J P Broadhurst	1619442	6134796	AUT.029171.01.01	24,000

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Figure Reference	Bore Owner	X Coordinate	Y Coordinate	NRC Authorization/ Application Number	Annual Volume (m3/year)
C57	Holloway*	1619702	6134754	APP.038380.01.01	14,900
C58	I M Fulton-1	1619452	6134520	AUT.029109.01.01	20,000
C59	KB&SD Shine*	1619411	6134224	APP.038328.01.01	39,200
C60	Elbury Holdings-King*	1619904	6133984	APP.038454.01.01	113,700
C61	Stanisich1	1618046	6133608	AUT.027391.01.01	120,000
C62	Stanisich-proposed*	1617846	6133480	APP.027391.01.02	64,070
C63	Largus-2*	1618003	6133379	APP.038420.01.01	96,850
C64	Largus-1*	1617905	6132480	APP.038420.01.01	96,850
C65	Hewitt*	1617436	6132318	APP.038650.01.01	39,200
C66	Broadhurst	1618994	6131326	AUT.038339.01.01	50,000
C67	Luca Vista	1619057	6130879	AUT.020533.02.01	24,200
C68	Bell	1619211	6130581	AUT.038402.01.01	35,000
C69	Stanisich2	1618376	6129421	AUT.036868.01.01	60,000
C70	Rangaunu	1618726	6129089	AUT.003580.01.03	35,000
C71	VALIC1	1617061	6128196	AUT.017045.01.02	186,000
C72	VALIC2	1616610	6128425	AUT.017045.01.02	186,000
C73	VALIC3	1616982	6128849	AUT.017045.01.02	186,000
C74	Far North Farms Ltd	1618816	6128564	AUT.004564.01.04	80,000
C75	DG&HA Inglis	1618916	6128385	AUT.003968.01.03	25,000
C76	Millpara	1617699	6128150	AUT.014520.02.01	91,960
C77	Millpara	1617696	6127997	AUT.014520.01.02	91,960
C78	Avocado Investments Ltd	1617322	6126681	AUT.002459.01.03	18,600
C79	RA&LS Huddart	1617926	6126666	AUT.008589.01.02	11,040
C80	Javo	1617131	6126650	AUT.003788.01.03	18,600
C81	Hayward	1618191	6126546	AUT.004350.01.03	24,000
C82	JB & GM Clark	1618190	6126545	AUT.008177.01.02	24,000
C83	NG Rouse	1617423	6126357	AUT.003798.01.04	16,500
C84	J Jones	1618328	6125903	AUT.028476.01.01	60,000
C85	DC&MA Olsen	1619564	6125618	AUT.004571.01.03	45,000
P16	A. Matthews	1611038	6146087	APP.040397.01.01	12,000
P17	D. Wedding & Doody	1610297	6145328	APP.039644.01.01	304,000
P18	M Evans	1610554	6145121		36,400
P19	Bryan Esate-1	1613415	6143424		80,000
P20	Bryan Esate-2	1613901	6142132		160,000
P21	KSL Ltd	1614333	6138477	AUT.039628.01.02	30,000
P22	Tuscany Avocados	1614490	6138367		36,000

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Figure Reference	Bore Owner	X Coordinate	Y Coordinate	NRC Authorization/ Application Number	Annual Volume (m3/year)
P23	Robert Campbell	1615813	6135787		360,000
P24	Yelavich	1616833	6133996		52,000
P25	Wataview	1619441	6131282	APP.040363.01.01	33,750
P26	Tiri	1618056	6130290	APP.040361.01.01	290,625
P27	Tiri	1618856	6130196	APP.040361.01.01	290,625
P28	Valic	1617589	6129130	APP.040362.01.01	173,700
C86	Te Urungi O Ngati Kuri LTD	1623319	6122860	AUT.007618.01.03	18,250
C87	Far North Holiday Park-Non irrigation	1615677	6122797	AUT.003606.01.04	10,920
C88	J A Trussler	1618833	6122488	AUT.008391.01.02	148,800
C89	FNDC: GW take for Kaitaia-1	1618250	6121600	AUT.025683.01.03	730,000
C90	FNDC: _GW_take_for_Kaitaia-2	1618307	6121233	AUT.025683.01.03	730,000
C91	Landcorp Farming Limited	1619617	6120296	AUT.010649.01.03	200,000
C92	Sweetwater-1	1617473	6119002	AUT.020995.01.03	632,000
C93	Sweetwater-2	1617846	6119771	AUT.020995.01.03	436,000
C94	KJ & FG King : GW for Awanui Straight-1	1622335	6119515	AUT.007148.01.02	92,754
C95	KJ & FG King : GW for Awanui Straight-2	1622954	6119131	AUT.007148.01.02	92,754
C96	KJ & FG King : GW for Awanui Straight-3	1622365	6119515	AUT.007148.01.02	92,754
C97	RF & MH Barber-Tudorwood Orchard	1623509	6117021	AUT.007429.01.03	23,760
C98	Landcorp-domestic	1616796	6112202	AUT.016645.01.02	21,900
C99	Fraser-Ahipara	1614673	6109021	AUT.002898.01.03	10,000
P29	Ellbury Holdings-Sweetwater-1	1618632	6121353		100,000
P30	Ellbury Holdings-Sweetwater-2	1618554	6121002		100,000
P31	Sweetwater-3	1617109	6120717		385,000
P32	Sweetwater-4	1616465	6120787		180,000
P33	Sweetwater-5	1617267	6121591		180,000
P34	Sweetwater-6	1616868	6120002		180,000
P35	Sweetwater-7	1617043	6118433		180,000
P36	Sweetwater-8	1616978	6116808		180,000
P37	Sweetwater-9	1617279	6117495		180,000
P38	Sweetwater-10	1617702	6114717		105,000
P39	Sweetwater-11	1617254	6113920		105,000
P40	Sweetwater-12	1616055	6112008		116,667
P41	Sweetwater-13	1616563	6111903		116,667
P42	Sweetwater-14	1616889	6111890		116,667

Appendix B. Model drawdown and available drawdown at AAGWM pumping bores

Figure Reference	Bore Owner	Available Drawdown (m)	Maximum Drawdown as % of Available Drawdown	Calibrated Model		Low Permeability Model
				Upper Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)
C1	Rarawa campground	39.0	0.8%	0.0	0.1	0.3
C2	Henderson Bay Avocados-Consented	48.3	4.6%	0.2	0.2	2.2
C3	Thomas & OConnor-Waihopo	53.5	6.6%	0.5	0.7	3.5
C4	Waikopu Avocados-Consented	57.5	6.4%	0.5	0.7	3.7
C5	Walker & MacMillan	62.3	5.1%	0.4	0.5	3.2
C6	G J & D J Price	57.2	3.0%	0.1	0.2	1.7
C7	L & P Trust	71.7	3.3%	0.3	0.4	2.4
C8	Kelvin Thomas*	77.1	4.2%	0.7	1.3	3.2
C9	Fullam GW take	71.8	4.7%	0.8	1.3	3.4
C10	Brien Lamb*	75.2	4.2%	0.7	1.2	3.2
C11	Thomas & OConnor-Houhora	73.6	4.7%	0.8	1.3	3.5
P1	Henderson Bay Avocados	48.2	4.6%	0.2	0.3	2.2
P2	Far North Avocados (Blake Powell)	48.5	4.4%	0.2	0.3	2.1
P3	Waikopu Avocados	58.9	6.5%	0.6	0.8	3.8
P4	Te Raite Station-Waihopo	66.5	4.9%	0.4	0.8	3.3
P5	Te Raite Station_other	68.4	7.7%	0.8	2.0	5.3
P6	Te Raite Station-Waihopo	66.0	4.3%	0.4	0.9	2.8
P7	Te Raite Station-Houhora	62.3	8.8%	1.0	2.1	5.5
P8	J Evans	59.5	7.3%	1.1	1.7	4.3
P9	Te Raite Station-Houhora	64.2	8.1%	1.4	2.1	5.2
P10	S. & L. Blucher	74.9	4.5%	0.7	1.3	3.4
P11	Te Raite Station-Houhora	67.2	6.9%	0.9	1.5	4.6
P12	Te Raite Station-Houhora	65.0	8.0%	1.0	1.8	5.2
P13	Te Raite Station-Houhora	65.4	8.1%	1.3	2.0	5.3
P14	Te Raite Station-Houhora	65.8	7.4%	1.0	2.1	4.9
P15	Te Raite Station-Houhora	68.9	5.8%	0.9	1.7	4.0
C12	LL & DF Rasmussen	74.8	2.7%	0.3	0.8	2.1
C13	Wagener Houhora Heads Properties Ltd	73.0	2.9%	0.2	0.8	2.1
C14	Longbeach Trust	81.8	3.9%	0.8	1.3	3.2

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Figure Reference	Bore Owner	Available Drawdown (m)	Maximum Drawdown as % of Available Drawdown	Calibrated Model		Low Permeability Model
				Upper Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)
C15	Tomo Orchard Ltd	79.5	4.3%	0.9	1.5	3.4
C16	Ongare Trust-2	84.0	3.7%	0.5	1.2	3.1
C17	Alligator Pear Partnership	82.4	4.2%	0.8	1.5	3.5
C18	McLarnon-Ongare trust*	83.7	4.1%	0.7	1.5	3.4
C19	Ongare Trust-1	86.8	3.9%	0.7	1.4	3.4
C20	B C Smith	82.9	4.3%	0.9	1.6	3.6
C21	E J Williams	87.9	4.0%	0.9	1.6	3.5
C22	Far North Avos Limited	83.0	4.4%	0.9	1.7	3.6
C23	Honeytree Farms Ltd	88.8	4.0%	0.9	1.6	3.6
C24	Whispering Pines Ltd	88.1	3.9%	0.7	1.5	3.4
C25	Hine & Associates current	86.8	4.5%	0.9	1.9	3.9
C26	Trebcombe Limited-1	88.7	4.2%	0.8	1.7	3.7
C27	S127 GW take	89.3	4.3%	0.9	1.8	3.8
C28	McQuarrie	87.6	3.8%	0.7	1.3	3.3
C29	Trebcombe Limited-2	88.4	4.0%	0.8	1.6	3.5
C30	RB Freeman-1	88.3	4.1%	0.8	1.6	3.6
C31	EJ Wagener	84.7	3.9%	0.6	1.3	3.3
C32	Matalaka Trust	89.4	3.8%	0.8	1.4	3.4
C33	RB Freeman-2	89.2	3.8%	0.8	1.4	3.4
C34	Whalers Rd Houhora	85.1	4.3%	0.7	1.7	3.6
C35	Soltysik-Freeman Fam Trust	85.6	4.3%	0.7	1.8	3.7
C36	Valadares*	85.9	4.1%	0.7	1.6	3.5
C37	Mapua Avocados-1	82.4	5.5%	0.5	2.7	4.5
C38	Mapua Avocados-2	83.0	4.4%	0.5	1.9	3.7
C39	Mapua_Avocados-3	88.6	3.6%	0.6	1.5	3.2
C40	Shirttail Orchards	99.7	2.4%	0.5	1.0	2.4
C41	Subritzky	99.1	2.2%	0.4	0.9	2.2
C42	De Bede	101.9	1.9%	0.3	0.7	1.9
C43	Candy Corn Ltd*	106.3	2.0%	0.4	0.9	2.1
C44	Thompson*	107.5	1.8%	0.3	0.7	2.0
C45	Avokaha Ltd	107.0	1.9%	0.4	0.7	2.0
C46	Cypress Hills Ltd1*	106.2	1.8%	0.3	0.7	1.9
C47	JR Avocados Ltd	106.4	1.8%	0.3	0.7	2.0

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Figure Reference	Bore Owner	Available Drawdown (m)	Maximum Drawdown as % of Available Drawdown	Calibrated Model		Low Permeability Model
				Upper Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)
C48	GT&MT Covich-1*	97.6	2.2%	0.1	0.9	2.1
C49	GT&MT Covich-2*	98.5	2.1%	0.2	0.8	2.1
C50	Honeytree2	94.0	2.6%	0.1	1.2	2.4
C51	Honeytree1*	102.3	2.3%	0.0	1.2	2.3
C52	Ngai Takakto1*	99.5	2.1%	0.4	1.0	2.1
C53	Ngai Takakto2*	96.6	2.2%	0.5	1.0	2.1
C54	IJ & BM Broadhurst	91.9	2.2%	0.4	0.9	2.0
C55	I M Fulton-2	90.0	2.0%	0.3	0.8	1.8
C56	J P Broadhurst	90.3	2.1%	0.3	0.8	1.9
C57	Holloway*	88.1	1.9%	0.3	0.7	1.7
C58	I M Fulton-1	88.8	2.1%	0.2	0.7	1.8
C59	KB&SD Shine*	87.8	2.2%	0.1	0.8	1.9
C60	Elbury Holdings-King*	82.1	2.3%	0.1	0.9	1.9
C61	Stanisich1	91.9	2.9%	0.4	1.3	2.7
C62	Stanisich-proposed*	92.5	2.8%	0.4	1.2	2.6
C63	Largus-2*	92.9	2.9%	0.4	1.3	2.7
C64	Largus-1*	118.4	2.0%	0.1	0.8	2.3
C65	Hewitt*	115.0	1.9%	0.3	0.8	2.2
C66	Broadhurst	81.3	3.0%	0.5	0.9	2.5
C67	Luca Vista	71.5	3.7%	0.6	1.0	2.7
C68	Bell	71.2	3.8%	0.5	1.1	2.7
C69	Stanisich2	81.1	3.7%	0.6	1.2	3.0
C70	Rangaunu	76.4	3.7%	0.1	1.1	2.9
C71	VALIC1	86.4	3.7%	0.6	1.6	3.2
C72	VALIC2	92.8	3.4%	0.5	1.5	3.1
C73	VALIC3	91.9	3.5%	0.6	1.6	3.2
C74	Far North Farms Ltd	73.8	3.9%	0.5	1.1	2.9
C75	DG&HA Inglis	70.1	3.8%	0.6	1.0	2.7
C76	Millpara	77.0	4.5%	0.8	1.7	3.5
C77	Millpara	76.1	4.5%	0.8	1.7	3.4
C78	Avocado Investments Ltd	73.2	4.1%	0.7	1.2	3.0
C79	RA&LS Huddart	73.7	3.9%	0.7	1.1	2.9
C80	Javo	75.0	3.8%	0.7	1.1	2.9

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Figure Reference	Bore Owner	Available Drawdown (m)	Maximum Drawdown as % of Available Drawdown	Calibrated Model		Low Permeability Model
				Upper Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)
C81	Hayward	68.0	4.8%	0.7	1.5	3.3
C82	JB & GM Clark	68.1	4.8%	0.7	1.5	3.3
C83	NG Rouse	73.9	4.0%	0.6	1.1	2.9
C84	J Jones	70.4	4.4%	0.7	1.2	3.1
C85	DC&MA Olsen	58.1	4.5%	0.5	0.8	2.6
P16	A. Matthews	80.5	3.1%	0.6	0.9	2.5
P17	D. Wedding & Doody	85.4	5.3%	0.9	2.6	4.5
P18	M Evans	83.7	4.2%	0.9	1.6	3.5
P19	Bryan Esate-1	71.6	3.4%	0.0	0.9	2.5
P20	Bryan Esate-2	85.2	3.2%	0.1	1.2	2.7
P21	KSL Ltd	105.5	1.9%	0.4	0.7	2.0
P22	Tuscany Avocados	106.0	1.8%	0.4	0.7	1.9
P23	Robert Campbell	103.4	2.5%	0.4	1.2	2.5
P24	Yelavich	87.8	2.3%	0.3	0.6	2.0
P25	Wataview	71.5	3.2%	0.5	0.8	2.3
P26	Tiri	105.7	3.3%	0.0	1.8	3.5
P27	Tiri	89.9	4.1%	0.5	1.9	3.7
P28	Valic	85.8	3.9%	0.8	1.6	3.3
C86	Te Urungi O Ngati Kuri LTD	27.2	6.0%	0.1	0.3	1.6
C87	Far North Holiday Park-Non irrigation	81.0	4.7%	0.4	0.7	3.8
C88	J A Trussler	61.7	9.3%	1.0	2.4	5.8
C89	FNDC: GW take for Kaitaia-1	59.9	19.6%	1.8	7.9	11.7
C90	FNDC: _GW_take_for_Kaitaia-2	65.0	19.4%	1.9	8.6	12.6
C91	Landcorp Farming Limited	58.0	9.7%	0.3	2.0	5.7
C92	Sweetwater-1	75.9	10.6%	1.2	4.2	8.0
C93	Sweetwater-2	66.9	11.3%	1.4	3.5	7.5
C94	KJ & FG King : GW for Awanui Straight-1	34.3	12.7%	0.5	1.8	4.4
C95	KJ & FG King : GW for Awanui Straight-2	31.9	11.3%	0.4	1.3	3.6
C96	KJ & FG King : GW for Awanui Straight-3	34.3	12.7%	0.5	1.8	4.4

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Figure Reference	Bore Owner	Available Drawdown (m)	Maximum Drawdown as % of Available Drawdown	Calibrated Model		Low Permeability Model
				Upper Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)	Lower Shellbed Drawdown (m)
C97	RF & MH Barber-Tudorwood Orchard	26.9	5.6%	0.1	0.3	1.5
C98	Landcorp-domestic	38.2	4.7%	0.4	0.8	1.8
C99	Fraser-Ahipara	38.9	1.1%	0.0	0.1	0.4
P29	Ellbury Holdings-Sweetwater-1	61.8	14.3%	1.8	4.9	8.8
P30	Ellbury Holdings-Sweetwater-2	64.9	13.2%	1.7	4.6	8.6
P31	Sweetwater-3	74.2	10.0%	1.2	3.3	7.4
P32	Sweetwater-4	76.4	8.0%	0.9	1.9	6.1
P33	Sweetwater-5	76.5	8.5%	1.3	2.6	6.5
P34	Sweetwater-6	73.3	9.0%	1.0	2.3	6.6
P35	Sweetwater-7	66.9	9.0%	0.8	2.3	6.0
P36	Sweetwater-8	52.0	7.4%	0.5	1.1	3.8
P37	Sweetwater-9	56.4	7.9%	0.6	1.5	4.5
P38	Sweetwater-10	37.1	6.9%	0.4	1.1	2.5
P39	Sweetwater-11	37.9	5.5%	0.3	0.8	2.1
P40	Sweetwater-12	39.0	4.5%	0.3	0.7	1.7
P41	Sweetwater-13	37.9	5.6%	0.4	1.1	2.1
P42	Sweetwater-14	38.3	5.1%	0.4	1.0	2.0