WATER PERMIT
RESOURCE CONSENT

FEASIBILITY STUDY

765 MUHUNOA WEST ROAD
OHAU
LEVIN

PROJECT NO. J20043-REP-01

PREPARED FOR
GRENADIER DEVELOPMENTS LIMITED

PREPARED BY
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EXECUTIVE SUMMARY

This report provides a review of the feasibility of obtaining a resource consent for an irrigation water permit at 765 Muhunoa West Road, Ohau, Levin. The use is for the irrigation of a new golf course and associated facilities, located at the coast to the southwest of Levin and on the northern bank of the Ohau River mouth. This application requires consideration of the Resource Management Act (RMA) (1991) and the Horizons Regional Council (HRC) - One Plan.

The current rate estimate for abstraction is 1,500m³/d to 2,000m³/d. The irrigation demand was calculated using the SPASMO irrigation demand calculator. This estimates a subsequent irrigable area of 38.76Ha to 51.68Ha with an annual requirement estimated as 168,606m³ to 224,806m³. Ultimately, the abstraction potential may be dictated by the ground conditions encountered at the site.

The property is within the Horowhenua GWMZ, there is allocation available within this zone. It is also within SWMZ Ohau (Ohau_1) and the sub-catchment Lower Ohau (Ohau_1b), applications are with HRC for this allocatable surface water, i.e. no further surface water allocation is available.

The area is in the south Wanganui Basin, groundwater recharge is predominantly from rainfall infiltration. The coastal site is dominated by sand dunes and inland are alluvial deposits. Underlying the surficial dunes are beach deposits consisting of alternating marginal marine gravel with sand, mud, and beach ridges. These marine sediments form a hydraulic barrier where groundwater is forced upwards into the main river channels.

There are no surrounding wells located within 1km of the centre of the Muhunoa West Rd property. There is a well, bore #361063, located a similar distance inland as the Muhunoa West Road property, but it is on the southern bank of the Ohau River. This well holds a substantial irrigation consent, indicating that there is the potential to encounter gravel units at depths in this area that can supply irrigation water. This well is used as an analogue to assess the potential surrounding effects for a similar well at Muhunoa West Road.

State of the Environment (SOE) water quality monitoring in the area indicates concentrations of some determinants may exceed the NZ Drinking Water Guideline values. Further consideration is required in relation to the quality of the water that may be encountered and the ultimate use of that water.

A review of the aquifer test data from bore #361063 showed that the original analysis could be replicated and confirmed that the aquifer is a highly transmissive leaky confined aquifer, but the value for leakage is low.

Preliminary prediction of well interference indicates the magnitude of drawdown may be small. If the assessment is based on a roughly central location at the site, then given the general absence of nearby wells, it is considered likely that the potential for adverse impacts on surrounding wells will be "less than minor".

Connection to the nearby stream for bore #361063 was assessed at 5% of the pumped volume after 100 days, placing it in the low category for stream depletion. This level of impact was considered minor, with management based on river flows not required.

In terms of coastal impact and the potential for the proposed abstraction to induce saline intrusion the risk is also considered as low.

There is available allocation within the Horowhenua GWMZ. So long as the irrigation abstraction is considered as groundwater and not surface water.

It is recommended to construct a small diameter exploration bore at the site, to confirm aquifer presence and test water quality. This well should be drilled to at least 50m in total depth. If suitable, a larger diameter production bore should then be constructed, with aquifer pump testing carried out on it. The exploratory bore will be used as an observation well location during testing. If water quality is not suitable for potable supply further consideration of well options may be required to ensure suitable quality water can obtained, this may require a third well that is shallower and closer to the river that can abstract as a separate permitted take.

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1.0 INTRODUCTION

Grenadier Developments Limited (Grenadier) are currently seeking to develop a golf course (Douglas Links) on a property at 765 Muhunoa West Road, Ohau, Levin. As part of this development proposal they want to understand the risks associated with obtaining the required resource consents, in particular obtaining a water permit consent for the abstraction of groundwater to irrigate and maintain the proposed golf course.

There are no existing groundwater bores at the site and no water permit consents. The property borders the main channel of the Ohau River, extending along to the river mouth, and a section of the coastal zone. The area of the property is 107Ha it is presently undeveloped and used for grazing.

In order to apply for a resource consent water permit at this property it is necessary to understand what the water requirements are and what the surrounding environmental impact might be as a result of abstracting from this water resource. This includes consideration of impacts on surface water resources, other existing water users, sustainability of the aquifer resource and potential for saline intrusion.

Lattey Group (Lattey) were engaged by Grenadier to prepare a Feasibility Assessment that will review the water requirements for the site and identify potential issues that may arise in terms of the Assessment of Environmental Effects (AEE) required for the water permit application. The scope of works and information provided by this report includes:

- A summary of the proposed development;
- Legislative Assessment;
- Review of Water requirements;
- Review of local and site-specific geology / hydrogeology;
- Assessment of existing aquifer pump test data;
- Preliminary forward modelling of the proposed abstraction; and
- Provisional Assessment of Environmental Effects:
    - Potential neighbouring well effects;
    - Potential impacts on surface water bodies;
    - Consideration of Saline intrusion potential; and
    - Aquifer sustainability.

1.1 PROPOSED DEVELOPMENT

Grenadier is planning to construct an 18-hole championship length (5000m – 7000m) golf course and associated club house and accommodation facilities. This will comprise 18 greens, 36 tees and a practice tee. The clubhouse and accommodation facilities will include the clubhouse, a cart shed, carparking, accommodation and ancillary buildings, greens shed and outside green storage and driveways. A provisional indication of water requirements provided by Grenadier is 1.5 to 2M L/d (1,500m³/d to 2,000m³/d), equivalent to 17.36L/s to 23.15L/s. A summary of the proposed consent in provided in Table 1.

The total area of the property is 107Ha and the location is shown on the map in Figure 1. The property is formed from beach sands with dunes and alluvial deposits of the Ohau River. It is located within the Horowhenua Groundwater Management Zone (GWMZ). The Surface Water Management Zone (SWMZ) in this area is the Ohau_1. The duration of the consent requested should be 25 years to reflect the scale of the development.

TABLE 1: SUMMARY OF PROPOSED CONSENT DETAILS

Consent No.	Bore #	Area (Ha)	Crop	Max. rate (L/s)	Daily Rate. (m³/d)	Seas. vol. (m³)	Expiry
TBC	TBC	107 (38 -52)	Pasture	50 -60	1,500 – 2,000	168,606 – 224,806	Oct 2045

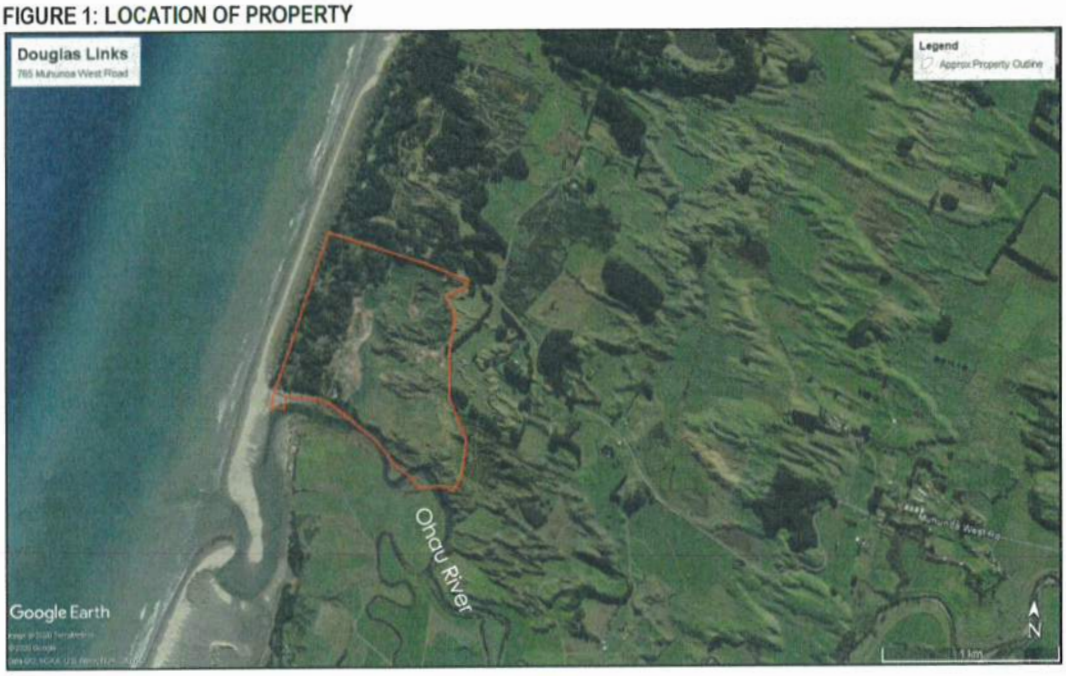
The legal descriptions for the property are as follows:

Location: 765 Muhunoa West Road, Ohau, Levin

Site of take & Use: Lot 1 & Lot 2 DP 51446

Grid reference: (NZMG) E2693286, N6059857 (NZTM) E1783269, N5498144

FIGURE 1: LOCATION OF PROPERTY



1.2 LEGISLATIVE ASSESSMENT

The Resource Management Act (1991) (RMA) is the main piece of legislation that sets out how we should manage our environment. It is based on the principles of sustainable management. This involves considering effects of activities on the environment now and in the future when making resource management decisions. Matters of national importance require consideration. This includes preservation of natural character, protection of natural features, indigenous flora and fauna and culture. There is also a list of other matters for consideration that include stewardship, efficiency of use and maintenance. For reference purposes some excerpts from the RMA are included in Appendix 1 and these are:

- ***Part 2 Purpose and Principles – Section 5, 6 & 7***
- ***Part 6 Decisions -Section 104 Consideration of applications***
- ***Schedule 4: Information required in application for resource consent – Clauses 2, 6 & 7.***

Of relevance to this proposed water permit application are:

Clauses 2 (1)(g): which makes reference to Part 6 Section 104(1)(b) this includes consideration of "*any actual and potential effects on the environment of allowing the activity*" and consideration of any other documents that may apply to the application such as regional plans, national policy statements or environmental standards.

Clause 2 (3): refers to Clauses 6 and 7 and requires that the AEE includes detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

With respect to Schedule 4 and Part 6 Section 104 the "One Plan", notified in 2007, is the Horizons Regional Council (HRC) - Regional Resource Management Plan (RRMP) document. It combines the Regional Policy Statement, Regional Plan and Coastal Plan, defining how the natural and physical resources of the region, including fresh water, air, productive land and natural ecosystems, will be cared for and managed by the council.

Part I provides the Regional Policy Statements (RPS) that set out the issues and outlines the objectives, policies and methods to address the issues.

Part II is the Regional Plan it specifies the controls on natural and physical resource use.

Of relevance to this proposed water permit application are the policies outlined below from Part I Chapter 5 and Part II Chapter 16.

1.2.1 PART I - CHAPTER 5 - WATER

The focus of this application is water quantity. An overview of Chapter 5 identifies the demand on surface water and groundwater resources as one of the most critical issues addressed in the RRMP. However, groundwater monitoring indicates that groundwater levels are stable, and research indicates that there is sufficient water for all users at a regional scale. A recent increase in large groundwater takes along the west coast is noted to have raised the potential for saltwater intrusion.

To manage increasing demand for water permit consents for both public water supply and irrigation HRC have set minimum environmental flows and defined core allocation volumes for water management sub-zones under pressure from surface takes. They have also established groundwater management zones, with respective allocable volumes and active management.

Water use efficiency and accurate measurement are important and monitoring of abstraction rates using telemetered water meters is expected.

The high density of wells in some areas has caused localised problems. Including impacts on other groundwater users and on groundwater-fed streams, lakes and wetlands.

Specific issues, objectives and policies taken from Chapter 5 are identified and comments are provided. Full details, as presented within the plan, for each section are provided in Appendix 1.

Issue 5-2: Water Quantity and Allocation

The use of both surface water and groundwater has increased dramatically during the last decade. The demand for surface water in the Ohau, Oroua and parts of the upper Manawatu catchments already exceeds supply, and other catchments are experiencing marked increases. This increased demand has the potential to adversely affect both instream values and the natural character of rivers, wetlands and lakes, if not managed. The amount of groundwater is generally capable of meeting demand within the Region, although there is a need to actively manage effects between wells at a local level, the effects of groundwater takes on surface water, and to be vigilant about the risk of saltwater intrusion along the west coast.

Objective 5-3: Water Quantity and Allocation

In summary it requires that water quantity is managed to enable people, industry and agriculture to take and use water to meet their reasonable needs. Whilst ensuring that for groundwater the takes do not cause a significant adverse effect. When hydraulically connected to rivers, lakes, or wetlands they are appropriately managed. Significant adverse effects on another groundwater take or surface water take are avoided as is saltwater intrusion to coastal aquifers. For all takes water must be used efficiently.

Policy 5-12: Reasonable and Justifiable Need for Water

Essentially the water user must be able to reasonably justify the amount of water used for the specified purpose. For irrigation this test relates to the maximum daily rate, irrigation return period and seasonal or annual volume. For domestic use, stock drinking and dairy washdown values are specified. Industrial use must follow best management practices. There are a series of specified checks to determine the reasonable use of public water supplies.

Policy 5-13 Efficient Use of Water

Water audits and budgets are required for leak checking. Infrastructure upgrades are required to ensure serviceable standards are maintained. Water permit transfers and storage are available options. Installation of water metering and telemetry is required.

Policy 5-20: Overall approach for bore management and groundwater allocation

Bores must be suitably constructed and managed. Groundwater Management Zones (GWMZ) are applied with allocable volumes set. The measured or modelled effects of a proposed groundwater take on other groundwater users, surface water bodies and saltwater intrusion must be managed in accordance with Policies 16-1, 16-5,16-6 and 16-7.

Policy 5-21: Groundwater Management Zones

The total amount of groundwater allocated should not exceed the annual allocable volume for the GWMZ.

1.2.2 PART II - CHAPTER 16 - TAKES, USES AND DIVERSIONS OF WATER, AND WELLS

Objective 16-1 provides for the regulation of takes in recognition of Schedule B and provides for objectives and policies of Chapter 5.

Policy 16-5: Effects of groundwater takes on other groundwater takes

Consent application to take groundwater must include pump testing and hydrogeological assessments to determine impact on surrounding wells. Consent conditions may be required to avoid significant impact on existing users.

Policy 16-6: Effects of groundwater takes on surface water bodies

The effects of groundwater takes on surface water bodies must be managed through the use of an appropriate scientific method to calculate the likely degree of connection between the groundwater and surface water. Management of this effect must be in accordance with Table 16.1 which provides a classification regime for depletion effects based on magnitude of effect and outlines an appropriate management approach to be adopted based on the different levels of effect.

Policy 16-7: Saltwater intrusion

Saltwater intrusion along the coastal margins must be managed and this includes a requirement for pump testing and hydrogeological assessments within 5km of the coastal mean high water spring line to determine the level of drawdown at the coast and the likelihood of inducing saltwater intrusion.

1.3 WATER REQUIREMENTS & AVAILABLE ALLOCATION

In accordance with the RMA Part 2 Section 7 and HRC "One Plan" Objective (OBJ) 5-3 and Policy (POL) 5-12, 5-13 and 16-1 consideration is given to the reasonable and justifiable need for water and its efficient use. The availability of allocation to meet these needs is then considered in accordance with the RMA Part 2 and the plan Issues 5-2, OBJ 5-3, POL 5-20 and 5-21 and POL 16-1.

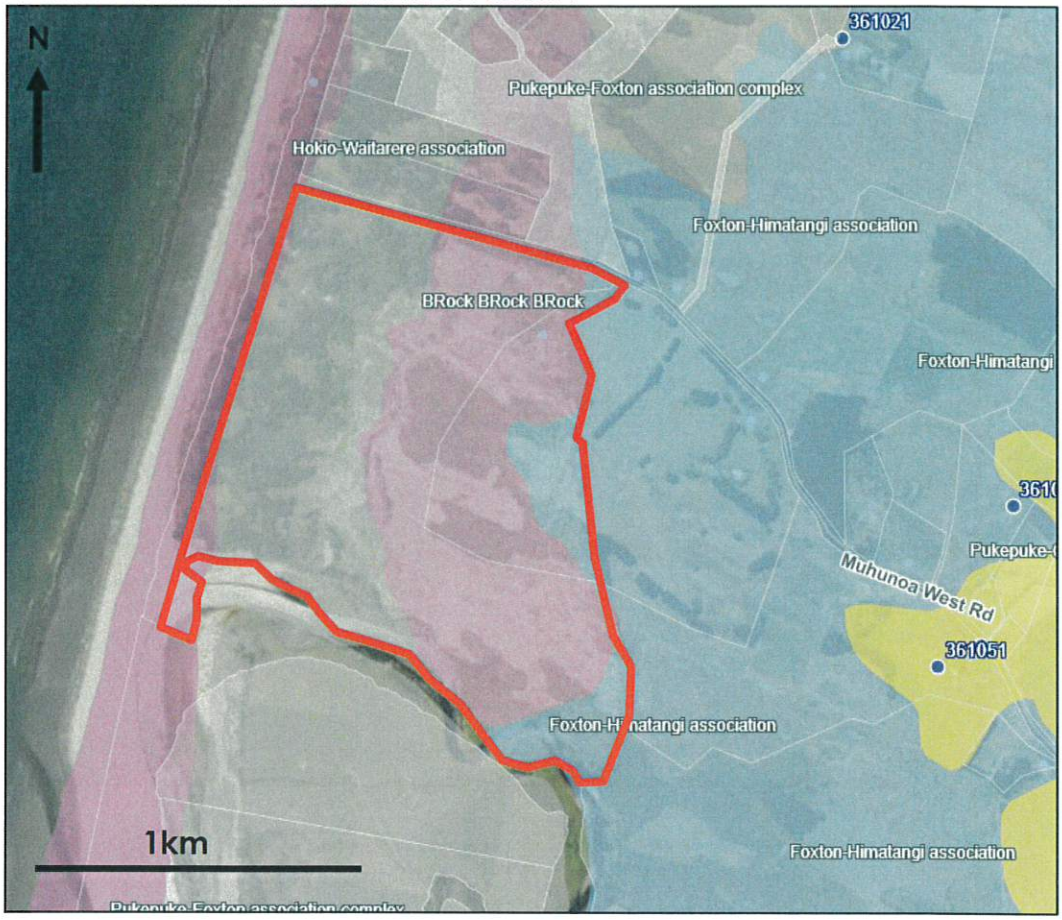
1.3.1 IRRIGATION DEMAND

Information provided by Grenadier indicated a provisional water requirement of 1.5 to 2M L/d (1,500m³/d to 2,000m³/d), equivalent to 17.36L/s to 23.15L/s.

The Irricalc irrigation demand calculator, produced by Aqualinc, is used to assess the daily demand and annual volume requirements. The calculated demand is based on the location 765 Muhunoa West Road, the selected crop is pasture, the most likely plant available water (PAW) of 140mm is selected along with an 80% efficient irrigator for a total area of 107Ha. The resultant daily volume per Ha of irrigation is 53m³ (5,671m³) and the annual volume is 5,040m³ (539,280m³). The results of the Irricalc modelling are provided in Appendix 2.

Following discussions with HRC they have confirmed that it is their preference to determine irrigation demand using the Soil Plant and Atmosphere Model (SPASMO) as developed by Plant and Food Research Limited. This model is not available for open source use so was run for this site in conjunction with HRC. The SPASMO model datasheets are provided in Appendix 2. The climate station was selected based on the property location and is Levin 3275, the crop type selected is pasture and the security of supply is 1:10 year or 90% as is appropriate for groundwater consents. The soil classifications for the site are shown in Figure 2 and were identified using the HRC map viewer.

FIGURE 2: SOIL TYPES AT THE MUHUNOA WEST PROPERTY



There are two soil types that relate to this site that are supported by the SPASMO model and these are Himatangi sand and Foxton black sand. It is estimated that the site comprises 50% of each. The annual irrigation rate for the Foxton black sand is 350mm and the peak monthly rate for January is 100mm. For the Himatangi sand the annual value is 375mm and the peak monthly is 100mm. HRC make an allowance of +20% on the modelled rates for distribution inefficiencies. The volumes calculated for the property are provided in Table 2. The peak monthly is for January, which has 31 days, so it is converted to a daily rate and 28-day rate for volume calculations.

Based on the SPASMO modelling the peak daily volume requirement for 107Ha is estimated as 4,140m³/d (47.92L/s) and the annual volume is 465,450m³. This is less than indicated by the Irricalc model.

However, it is noted that the total area under irrigation is likely to be less than the total area of the property. As the irrigated area will determined by the design of the fairways. The daily volume based on 1Ha is 38.7m³ and the annual volume is 4,350m³. These values can be scaled based on the total area of irrigation required i.e. the 1500m³/d to 2,000m³/d will potentially be sufficient to irrigate 38.76Ha to 51.68Ha of pasture. The annual volume in this instance would be 168,606m³ to 224,806m³.

If the daily volume is 1,500m³/d to 2,000m³/d, this is equivalent to 17.36L/s to 23.15L/s. The maximum rate would need to be higher depending on the daily target for duration of irrigation i.e if the irrigator is running for 8 hours then it will need to pump at 4,500m³/d or 6,000m³/d, equivalent to 52L/s to 69.4L/s to use the full daily volume.

It is important to note that the ground conditions may ultimately control the maximum rate of irrigation, but if a higher rate is required than can be achieved by a single well then options could include construction of multiple wells or the use of buffering tanks or ponds.

There are no existing wells at the site so the productivity of the aquifer at this location is unproven.

TABLE 2: IRRIGATION DEMAND CALCULATIONS

Soil Type	Land Area (Ha)	Peak Monthly Rate (mm)	+20% for Distribution inefficiencies	Peak Daily Rate (mm)	Peak Daily volume (m3)	28-day Rate	28-day Volume (m3)
Foxton Black sand	53.5	100	120	3.87	2,070	108	57,780
Himatangi Sand	53.5	100	120	3.87	2,070	108	57,780
Totals	107				**4,140**		**115,560**
Soil Type	**Land Area (Ha)**	**Annual Rate (mm)**	**+20% for Distribution inefficiencies**	**Annual Volume (m3)**			
Foxton Black sand	53.5	350	420	224,700			
Himatangi Sand	53.5	375	450	240,750			
Totals	107			**465,450**			

There is a One Plan permitted take rule for groundwater (16-2 minor takes and uses of groundwater). This states that the rate of take must not exceed 50m³/day per property. The take must not be located within 50m of any other bore on any other property. The take must not be located within 100m of any river or lake or within 200m of any wetland that is a rare habitat or threatened habitat. If it is artesian the rate of take must be controlled. The water must be used on the property and the council must be notified of the take, the maximum instantaneous rate of take and the intended use of water.

1.3.2 WATER MANAGEMENT ZONES

To assist with the management of groundwater allocation HRC provide, within their One Plan, Schedule D: Groundwater Quantity this document has a table of management zones, allocation volumes and a map. The Grenadier property is located within the Horowhenua Groundwater Management Zone (GWMZ) this zone has an annual allocable volume of **27Mm³/yr**. The annual allocable volumes specified are based on 5% of the average annual rainfall for each GWMZ. Communication with HRC in April 2020 confirmed the current daily allocation from this zone 20,487m³ and the annual is 3,627,101m³ or 13% of the allocable volume.

There are five surface water management zones (SWMZ) within this GWMZ these are: Lake Horowhenua (Hoki_1), Ohau (Ohau_1), Waitarere (West_7), Lake Papaitonga (West_8) and Waikawa (West_9). This property is within SWMZ Ohau (Ohau_1) and the sub-catchment Lower Ohau (Ohau_1b). The water allocation status map for all catchments within the region dated October 2019 and accessed via the HRC website confirms that there is water available for allocation from this SWMZ. However, direct contact with HRC indicates that all of the available allocation is included within existing applications.

Therefore, there is additional allocation available only within the GWMZ at this location. If the consent is identified as being stream depleting then in line with the "One Plan" Section 16-6 Effects of groundwater takes on surface water bodies, the level of classification will be important with regard to the likelihood of this consent being granted or not.

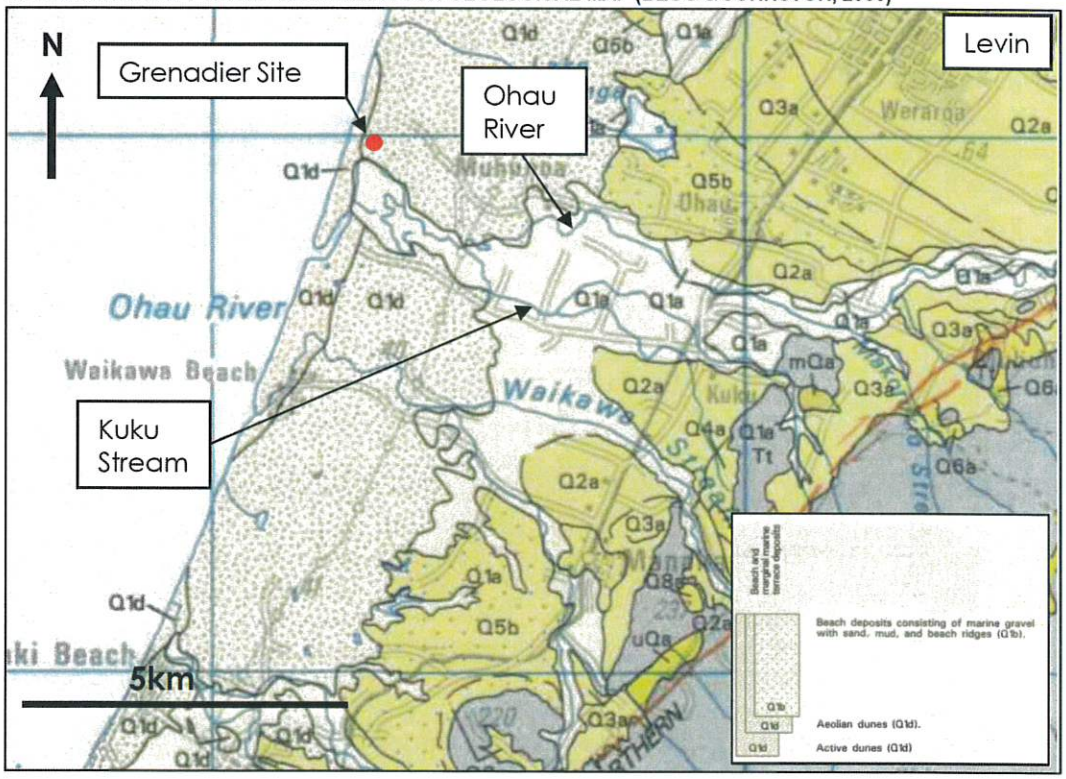
2.0 SURROUNDING ENVIRONMENT

2.1 LOCAL GEOLOGY AND HYDROGEOLOGY

The well is in the Horowhenua District and is approximately 7km southwest of the town of Levin. This area represents the south-western margin of the south Wanganui Basin. There is approx. 10km here between the Tararua Range recharge area to the east and the west coast (White & Rosen, 2001). Groundwater recharge is from rainfall infiltration over the Tararua Range and flow is west to northwest and approximates the surface water drainage patterns.

The Horowhenua lowlands extend from north of Paekakariki as a triangular area that reaches a width of 40km in the northeast. The area is dominated by fixed dunes and mobile sand dunes. Initially transported southwards by longshore drift, the sand has been blown inland to form dune ridges aligned northwest/southeast. Inland from the dunes rivers draining the Tararua Range have formed an alluvial plain with a gentle gradient in the northeast and steeper to the south, where the Ohau and Otaki and Waikanae Rivers flow only short distances from the range to the coast (Begg & Johnston, 2000). The surficial sediments comprise Holocene beach and marginal marine terrace deposits dominated at this site by aeolian dunes (Q1d), as identified in the local area geological map (Begg & Johnston, 2000), an excerpt of which is provided as Figure 3. Underlying the surficial aeolian dune deposits are beach deposits consisting of alternating marginal marine gravel with sand, mud, and beach ridges.

FIGURE 3: EXCERPT FROM THE WELLINGTON GEOLOGICAL MAP (BEGG & JOHNSTON, 2000)



2.2 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

To further develop a conceptual hydrogeological model to aid understanding of the aquifer in this area the site-specific geology was reviewed. This involved obtaining available geological information from HRC bore logs accessed from their database. A request was made for the details of all wells within a 4km radius of the co-ordinate E2693615, N6060156 located within the Muhunoa West property. The locations of the surrounding wells within this radius are shown in Figure 4.

To assist with understanding the potential aquifer units in the Muhunoa West Road area six nearby well locations within 2kms were identified. They are Bore #361021, #361060, #361051, #361041, #361003 and #361012. These bores range in total depth from 10m to 45.8m and

their locations are identified in Figure 4, circled in red. There is no lithology information available for #361060 and #361003. The other wells indicate a surficial brown fine to medium sand variably silty or with peat to less than 4m. Underlying the brown sand is blue medium to fine sand that extends into alternating layers of blue sand, clay or gravel, some of which is water bearing. The deepest well #361051 has peat and brown sand at its base from 39.2m to 45.8m, within this deeper brown gravel the log notes an iron concentration of 0.5ppm and manganese of 0.3ppm. The selected well lithology logs are provided in Appendix 3. Where SWL information is available these wells are not flowing artesian, the levels range from 0.6m to 3.0m below top of casing (toc). However, it is expected that wells further to the west would exhibit flowing conditions. Transmissivity values are recorded for #361021, #361051 and #361041 of 23m²/d, 86m²/d and 41m²/d, respectively, these values are low.

This information corresponds with the local geology information described in the previous section of surficial aeolian dune sands overlying marginal marine sediments.

FIGURE 4: LOCATIONS OF WELLS WITHIN A 4KM RADIUS OF E2693615, N6060156

2.3 SURROUNDING WELL DETAILS

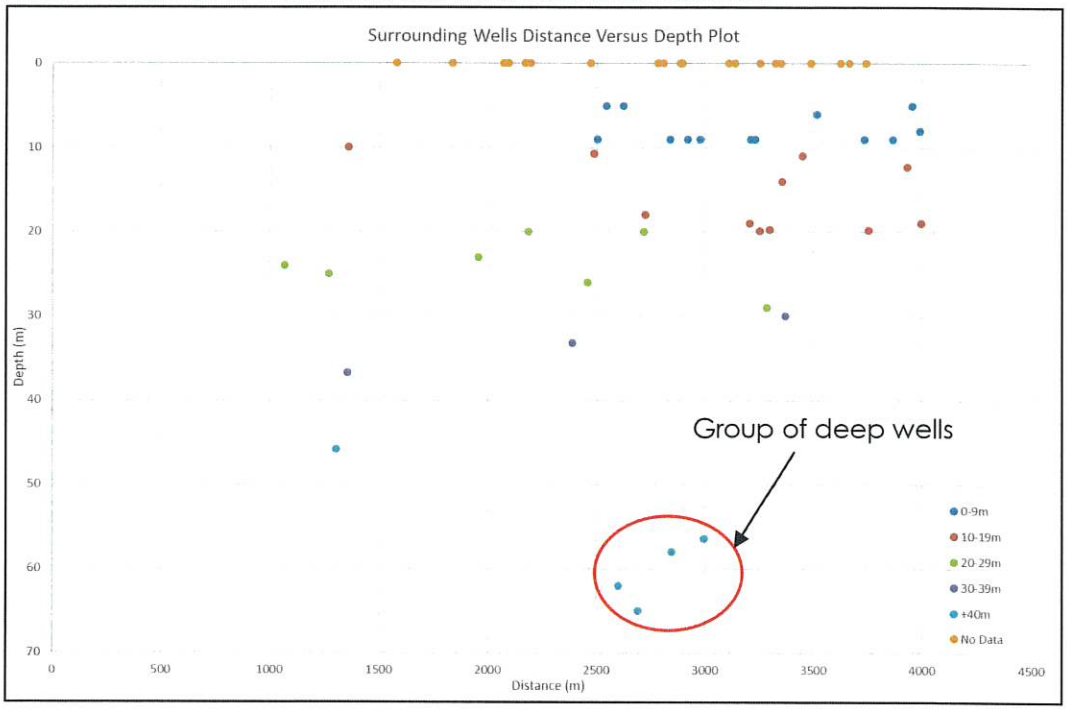
Abstraction can affect surrounding well users through a reduction of water levels that can impact that user's ability to draw water. The depths and locations of surrounding wells can also indicate the most productive or heavily used aquifer intervals. It is a useful way to identify wells of particular interest and to better understand the potential for adverse effects.

The information provided by the surrounding well search was used to create a graph of the surrounding wells depth and distance distribution, Figure 5. A total of 59 wells are within 4km of the central area of the Muhunoa site, 8 within 2kms. Of the 8 wells within 2kms 5 are greater than 20m depth, 1 is 10m deep and the other two have no depth data. Of these

only #361012 has an identified purpose as a monitoring well. The others are therefore likely only used for stock/domestic purposes or are unused. This means the volume of abstraction from them is likely relatively low. Reducing the likelihood of significant adverse well interference.

The graph in Figure 5 identifies a group of deep wells all located a similar distance from the Muhunoa West Road site. With the exception of #361051, all 4 of the deeper wells (+40m) are over 2.5kms away, there spatial locations are illustrated in Figure 4, as the orange circles. Lithology logs are available for two of these wells, #362131 and #361011, brown sand and peat are more evident to greater depths in this area, as would be expected given the more inland location. Water bearing blue gravel is noted in #362131 at greater than 54.6m depth.

FIGURE 5: WELLS DEPTH VS DISTANCE FROM THE MUHUNOA WEST ROAD SITE



There is one well #361063 that is identified as an irrigation supply well, it is located 2,390m from the Muhunoa West site and is 33.21m in total depth, screened across gravel from 28.71m to the base. The location of this well is shown in Figure 4, circled in purple. The maximum daily irrigation rate from this well is 4,098m³ and the annual volume is 410,770m³ Wilson (2011). This indicates that there are gravel units at depth in this area that have the potential to supply at these sorts of rates and volumes. The pump test and analysis carried out at this well is discussed in more detail in Section 3.0.

Wells that are most susceptible to well interference effects are those that are nearby, are relatively shallow or are large users. This is because the greatest magnitude of effects will occur closest to the abstraction well and shallow wells, or those with existing high use, will have less available head to accommodate the effects of well interference. This site has few nearby wells, they are low magnitude users and relatively deep, this reduces the likelihood of adverse impact on them.

2.4 STATE OF THE ENVIRONMENT MONITORING

Water quality monitoring on the LAWA site (www.lawa.org.nz) shows the nearest well registered is #362001, this well is 100mm in diameter and directly due east of the Muhunoa property. It is relatively shallow at 16.3m in total depth with a top screen height of 12.3m and a SWL of 4.9m below measuring point. The water quality parameters measured are chloride, dissolved reactive phosphorus (DRP), E.coli, Electrical conductivity and nitrate nitrogen. The 5-year median for chloride is 24m/L, for DRP is 0.07mg/L and for Nitrate-Nitrogen is 6.5mg/L. E.coli has been detected and Electrical conductivity is 332µs/cm. This well is shallow and more likely to be impacted by activities at the surface with regards nutrient concentrations and E.coli., than would be anticipated for a new deeper well at Muhunoa West.

There is another groundwater level monitoring bore located near the Muhunoa property and registered on the LAWA site it is #361003 it is 1357m due east. This bore is 10m in total depth with no reported screen depths. The initial water depth was 2.8m below measuring point and 5.896m amsl. The water level in February reported on the LAWA site was 5.596m above datum (amsl) and this was considered within the normal range. The median level is 5.64m and the average minimum level is 5.291m. The lowest recorded level was 4.506m in January 2003.

It is anticipated that a new well at a location west of this well will have a flowing artesian condition, with a SWL higher than that reported in bore #361003. Particularly, if it is drilled to greater depths.

Another nearby bore #361012, located 1955m to the north-west is owned by Horowhenua District Council it is 23m in total depth with a SWL of 3.0m below measuring point. There are some water chemistry results for this bore that were collected during the period July 1984 and October 1996. Primarily for pH, Iron, Ammonium (NH_4) and some Nitrate (NO_3). The pH is stable between 6 and 7. The iron ranges from 1.25 to 32mg/L, the NH_4 is from 0.18 to 2.057mg/L and the NO_3 from 0.089 to 9.74mg/L.

The value ranges for the water quality testing are compared against the New Zealand Drinking Water Standards (NZDWS):

The Maximum Acceptable Value (MAV) for inorganic determinands of health significance for Nitrate (NO_3) is 50mg/L. The result range is below this value.

The guideline values for aesthetic determinands include Iron with a value of 0.2mg/L for the staining of laundry and sanitary ware. The iron values reported exceed this guideline. For Ammonia (NH_4) the guideline value is 1.5mg/L as an odour threshold in alkaline conditions. The reported values suggest this may be exceeded on occasion. A pH guideline range of 7 – 8.5 is published and it is further recommended that this should be between 7 and 8. Most waters with a low pH have a high plumbosolvency (ability to dissolve lead in the pipe network). Waters with a high pH have a soapy taste and feel. A pH less than 8 is preferable for effective disinfection with chlorine. In this instance the reported pH range of 6 – 7 suggests it may be a little on the low side.

These results indicate that further consideration is required in relation to the quality of the water that may be encountered at this site and the ultimate use of that water. Water quality sampling is recommended as part of the drilling process.

3.0 AQUIFER TESTING

Aquifer testing provides an understanding of the potential for interactions with surrounding wells and connections to surface water, and this information is required in line with the "One Plan" POL 16-5 and 16-6. An aquifer pump test was carried out for a nearby irrigation consent application. The existing information for this consent was reviewed to assess the potential outcome of a similar assessment on a well of equivalent depth at the Muhunoa West Road site. The results of this analysis are then used to predict potential effects associated with the abstraction regime and assess their impacts.

3.1 EXISTING NEARBY TEST DATA

The consented irrigation bore #361063 is located on the southern side of the Ohau River and is circled in purple in Figure 4. The bore is 35.1m in total depth, the top 22m are cemented sand and silt, there is a layer of peat and clay from 22m to 26.7m and then good water bearing gravels from 26.7m to 33.9m. The bore is flowing artesian with a static water level 2.46m above top of casing (toc).

The constant discharge pump test started on 26 January 2011 and lasted for two days, the pumping rate was 43.6L/s (3,679m^3/d). Two nearby observation wells were monitored along with the water level in the Ohau Loop. One of the observation wells located about 400m away had a clear response to the pumping of the test well. The other well was adversely affected by intermittent pumping and the measurements from the Ohau Loop were of limited analytical use.

The flowing artesian conditions indicate that the aquifer is confined. Tidal fluctuations evident in the data also suggest relatively extensive confinement. The drawdown data from the observation well indicates the interception of a recharge boundary after approximately 13 hours of pumping. Drawdown modelling of the observation well data using the Boulton solution, as provided in the consultant's report, are Transmissivity (T) of 5,200m²/d, a Storativity (S) of 1.1E-4 and a leakage coefficient (K'/B') 1.3E-4. These values indicate a highly transmissive leaky confined aquifer, but it is noted the value for leakage is relatively low.

At the time of this consent application there was some debate about the level of connection with the river, the applicant's consultant and an independent peer reviewer both stated that the well was confined, and the river was not impacted. This view was based primarily on the artesian conditions and that the water level in the aquifer was higher than in the stream so there was no induced flow.

HRC groundwater scientist at the time disagreed and thought there was potential for a high level of connection to the river. HRC sought a further independent review from Pattle Delamore Partners (PDP) who pointed out that you do not need to induce flow from the stream for depletion to occur and that a reduction in discharge to the stream is also considered as stream depletion. They used the Hunt (2003) solution (Hunt 2012) to quantify the potential for stream depletion based on the values determined from the pump test. It was concluded by them that, even when using a high value of stream leakage (higher than would be expected in this setting) the stream leakage was equivalent to about 5% of the pumped volume after 100 days of pumping. When this level of predicted effect was considered in line with the One Plan Policy 16-6 then the impact was considered minor and below the threshold where it would require management based on river flows or surface water allocation.

3.2 AQUIFER PARAMETER CALCULATION

The corrected water level response data from the observation well is included in the AEE report provided by the applicant for the irrigation consent for bore #361063. Only the drawdown data was analysed at the time using the Boulton solution. This data was re-analysed by Lattey using both the drawdown and recovery portions of the dataset with the Aqtesolv Pro Version 4.5 software and the Cooley-Case (1973) solution. This solution is analogous to the Boulton solution and provides a solution for a pumping test in a confined aquifer overlain by a water table aquitard, which matches the setting in this instance. The assumptions that relate to this modelling are:

- aquifer has infinite areal extent;
- aquifer is homogeneous and of uniform thickness;
- aquifer potentiometric surface is initially horizontal;
- pumping well is fully or partially penetrating;
- aquifer is unconfined with delayed gravity response;
- flow is unsteady; and
- diameter of pumping well is very small so that storage in the well can be neglected.

These assumptions are made to enable reasonable aquifer parameter calculations, but the actual conditions will be more complex. The aquifer is not infinite, and it is not homogeneous, isotropic or of uniform thickness.

For the purposes of this assessment the aquifer characteristics are based on the well details and the lithology log for the pumped well and other surrounding wells. The saturated aquifer thickness is 7.2m, equivalent to the screened water bearing gravels.

The Cooley-Case solution curve matching provides a good match to the data from the observation bore Seymour Well, Figure 6. The results are similar to those presented previously with a Transmissivity (T) value is 3,784m²/d, the Storativity (S) is 8.6E-5 and leakage (K'/B') is 6.25E-4, these values are summarised in Table 3 with the full model datasheet in Appendix 4.

FIGURE 6: RE-ANALYSIS OF SEYMOUR BORE DATA

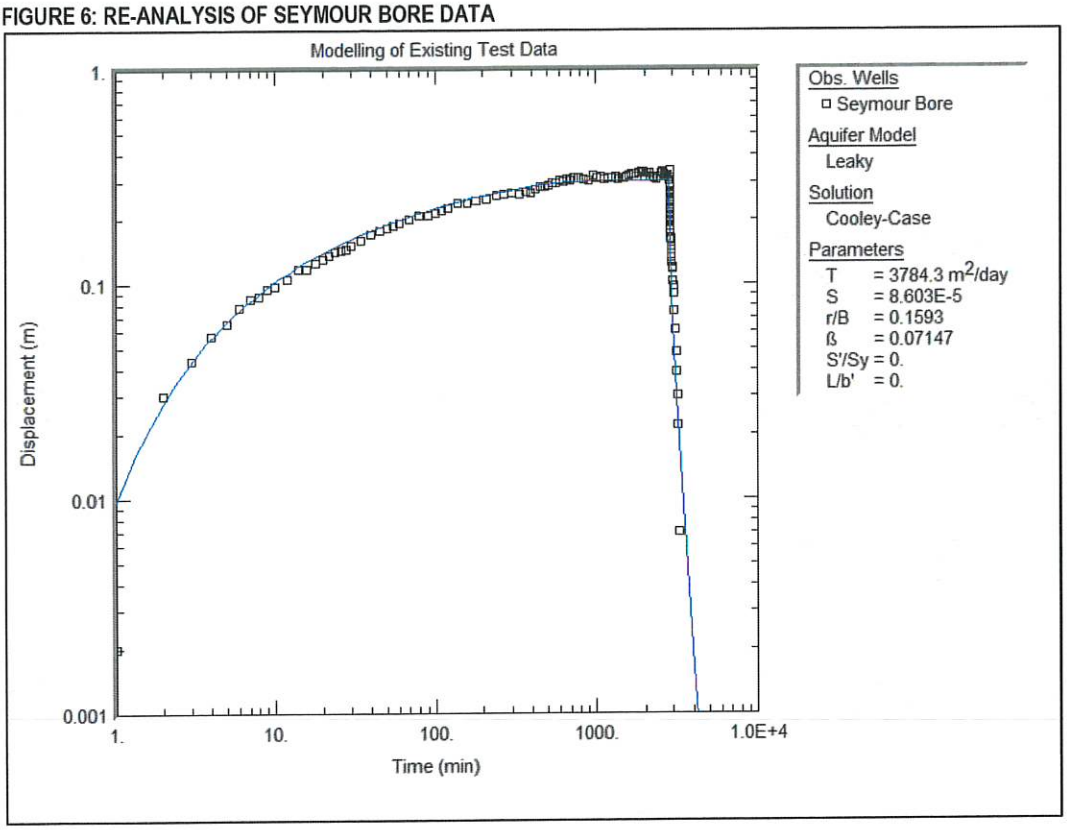


TABLE 3: SUMMARY OF MODELLING RESULTS

Model Solution	T (m^2/d)	S	K'/b'
Boulton	5,200	1.1E-4	1.3E-4
Cooley-Case	3,784	8.6E-5	6.25E-4

If the assumption is made that the sedimentary sequence at the Muhunoa West Road is similar to that at the location of #361063, then this analysis can be used to provide a basis for preliminary prediction of effects. Given that the well is a similar distance inland and that it is also similarly distance from the main channel of the Ohau River, albeit on the southern rather than northern flank, lithological similarities are expected. However, there do remain uncertainties and this assessment is provisional.

4.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

This AEE considers the potential effects associated with the proposed consent for the new bore. It specifically considers the potential of the abstraction to affect the ability of surrounding well users to access their existing water supplies (POL 16-5), the impacts on surface water resources (POL 16-6), potential for saline intrusion (POL 16-7) and aquifer sustainability (POL 5-21).

4.1 SURROUNDING WELL INTERFERENCE

Preliminary predictions of surrounding well effects were made using the values determined from the existing pump test on Bore #361063. This is achieved in this instance by using the model solution and making predictions of drawdown at fixed distances from an imagined new well located at the Muhunoa site. The distances are 500m, 750m, 1000m, 1250m and 1500m. The rate of abstraction is based on the requirements indicated in Section 1.1.3 of this report. If the estimated requirement is 2000m^3/d then this rate can be considered over a season of irrigation along with a higher rate (6000m^3/d) shorter duration pumping event that

would allow the daily volume to be abstracted over an 8 hour period. The predicted drawdowns under these scenarios are shown in Figures 7 & 8 with the results summarised in Table 4. The magnitude of drawdown predicted is small, particularly as it is based on a roughly central location for a new well and there are no surrounding wells located with 1km and only 8 within 2kms.

On the basis of this preliminary assessment it is considered likely that the potential for this level of abstraction to adversely impact surrounding wells is likely "less than minor".

TABLE 4: SUMMARY OF DRAWDOWN PREDICTION RESULTS

Well Distance (m)	Predicted Seasonal DD (m)	Predicted Max Rate DD (m)
500	0.17	0.46
750	0.14	0.35
1000	0.11	0.28
1250	0.09	0.23
1500	0.08	0.19

FIGURE 7: PREDICTED SURROUNDING WELL - SEASONAL DRAWDOWN FORWARD MODEL

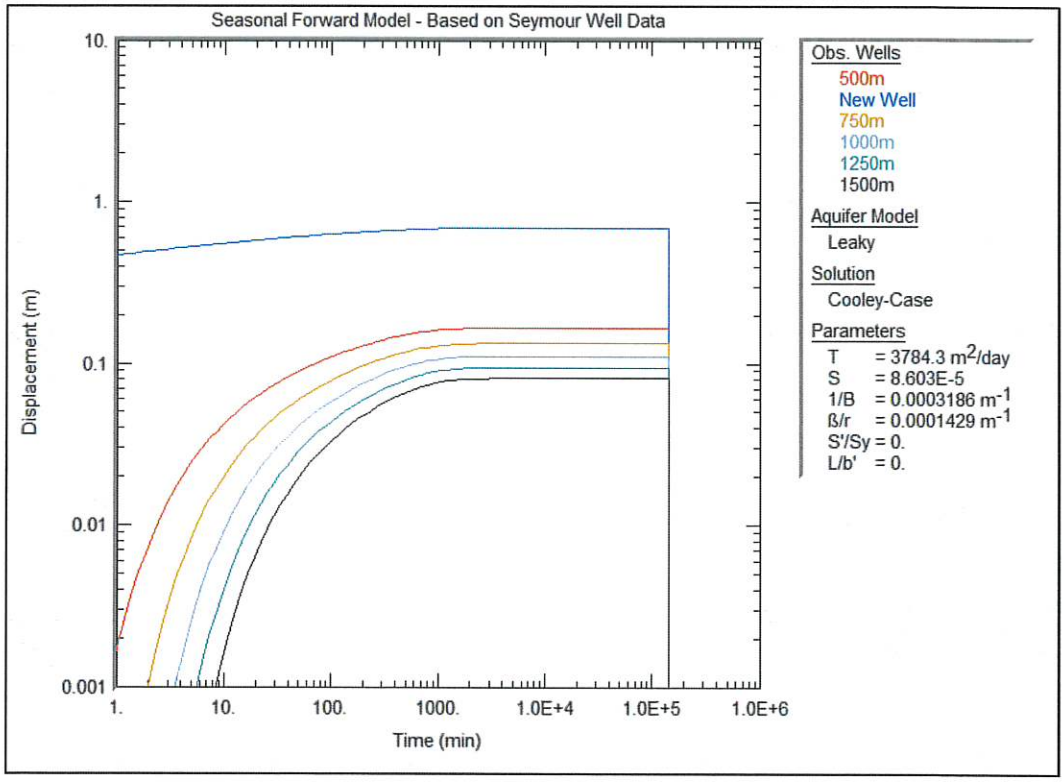
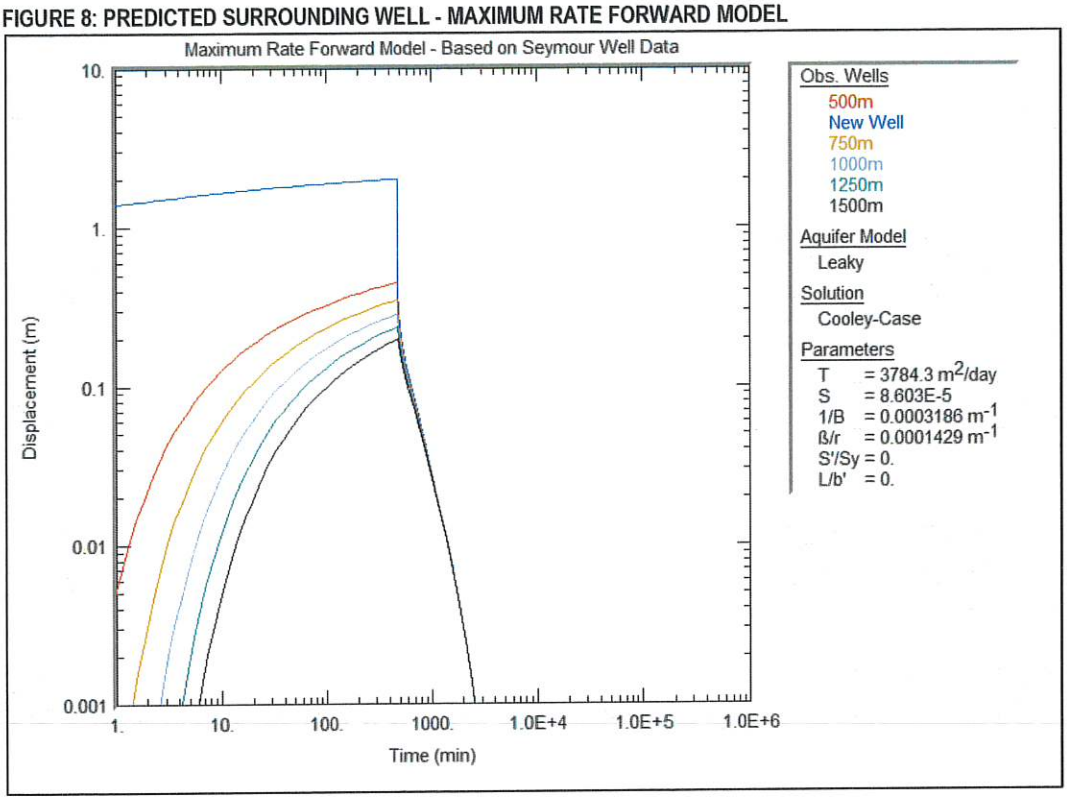


FIGURE 8: PREDICTED SURROUNDING WELL - MAXIMUM RATE FORWARD MODEL



4.2 SURFACE WATER INTERACTION

The Ohau River is the nearest surface water body in the area, it forms the southern boundary of the site. Given the proximity of the site to the river consideration of the potential for any abstraction to adversely impact the river flow will be an important consideration for the consent application. The width of the site is approximately 1000m so it will not be possible to site a bore any further than this from the river. The information from surrounding wells indicates that a viable aquifer may sit between 30m and 50m depth.

Some consideration was given to the potential for stream depletion from bore #361063 located to the south of the Ohau River, adjacent to the Ohau River Loop. This well is similarly distance, but on the south of the river, to the likely new well location. The consultant's report for the consent application identified the well as confined from the river based on the SWL in the bore being above that of the river loop. The peer reviewer at the time analysed the drawdown data from the Seymour bore using the Hunt (2003) solution and the values provided. They then used that information to quantify the stream depletion potential. Lattey reviewed this data to see if it was possible to replicate this assessment. A good match was obtained with the Hunt (2003) solution, Figure 9, using the values reported in the original AEE document of T = 5200m²/d, S = 1E-4 and K'/B' = 1.3E-4/day. The distance to the stream was set at 100m, and the specific yield (σ) at 0.1, which is considered reasonable in this setting. To obtain the match the streambed conductance (λ) was 0.1m/d. Using these values to calculate the rate of stream depletion provided a value of 6% of the total rate after 100 days of pumping, Figure 10. More detailed datasheets for this analysis are provided in Appendix 4. This is consistent with the values obtained historically by the peer reviewer and used as justification to not include within the surface water allocation regime or impose surface water-based restrictions on the take.

The HRC "One Plan" Policy 16-6 is provided as Figure 11 and in Appendix 1. This states that an appropriate scientific method must be used to calculate the degree of connection between the groundwater and surface water and that management is in accordance with the table presented. The surface water associated with the previous consent for well #361063 at 5-6% is classified as LOW.

FIGURE 9: HUNT (2003) MODELLING OF THE SEYMOUR WELL DATA

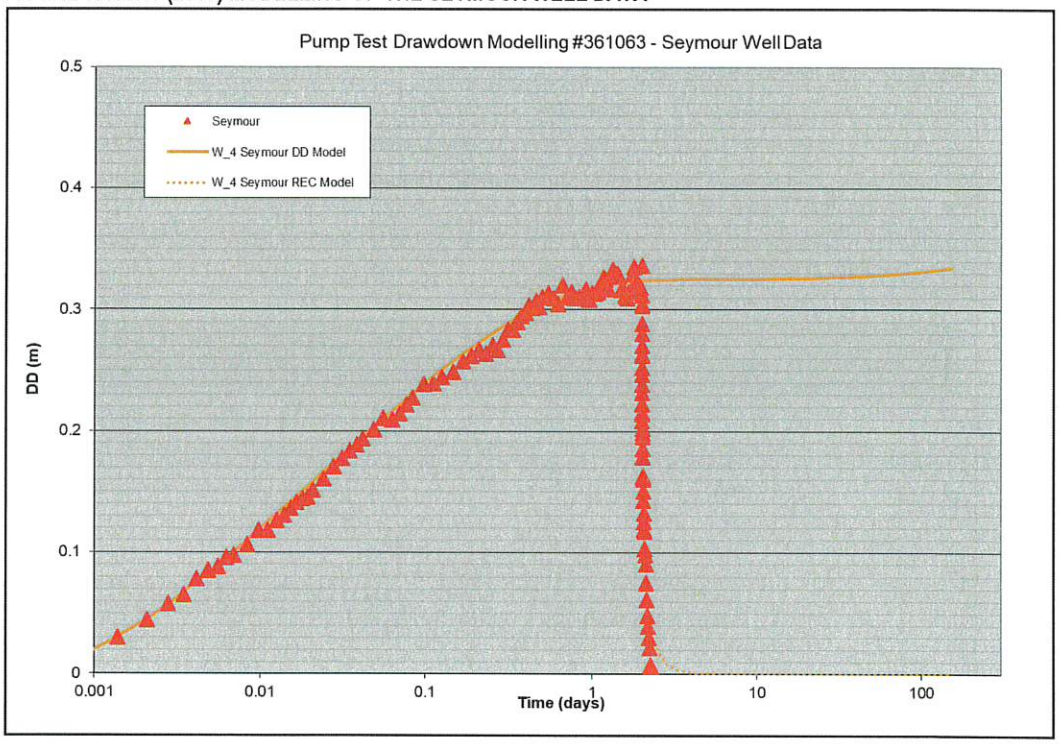
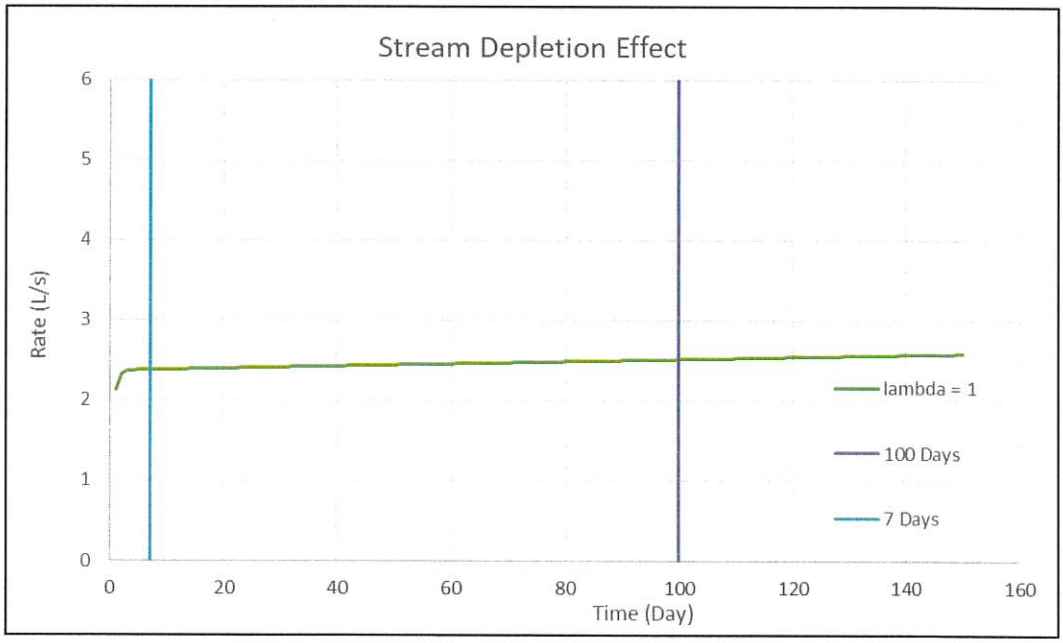


FIGURE 10: STREAM DEPLETION CALCULATION



This assessment of the groundwater – surface water interaction is supported by a recent report on groundwater dynamics for the Waikawa and Ohau catchments (GNS, 2019). The report used numerous water chemistry tracer techniques to aid understanding of the groundwater recharge and discharge and interactions with surface water. Of particular interest here is the groundwater surface water interaction findings. Elevated Radon tracer results indicated that groundwater is discharging into the river near the confluence of the Kuku Stream and Ohau River, this location is just upstream from where they intercept the Quaternary sands. This indicates that the Quaternary sands have low permeability, forcing the groundwater flow from the Quaternary gravels back to the surface, to discharge via the

river and stream to sea. This is where one would also expect older water in the stream and river, discharging from the groundwater system with longer transit time (GNS, 2019).

FIGURE 11: ONE PLAN POLICY 16-6

Policy 16-6: Effects of groundwater takes on surface water *bodies^*

The effects of groundwater takes on surface water *bodies^*, including *wetlands^*, must be managed in the following manner:

a. An appropriate scientific method must be used to calculate the likely degree of connection between the groundwater and surface water^ at the location of the groundwater take.
b. Subject to (a), the potential adverse *effects^* of groundwater takes on surface *water^* depletion must be managed in accordance with **Table 16.1**.

Table 16.1 Surface *water^* depletion

CLASSIFICATION OF SURFACE *WATER^* DEPLETION *EFFECT^*	MAGNITUDE OF SURFACE *WATER^* DEPLETION EFFECT^	MANAGEMENT APPROACH
Riparian	Any groundwater take screened within the geologically recent bed strata of a surface water *body^*.	The groundwater take is subject to the same restrictions as a surface *water^* take, unless there is clear hydrogeological evidence that demonstrates that the *effect^* of pumping will not impact on the surface water *body^*.
High	The surface *water^* depletion *effect^* is calculated as 90% or greater of the groundwater pumping rate after seven days of pumping, or 50% or greater of the average groundwater pumping rate after 100 days of pumping.	The groundwater take is subject to the same restrictions as a surface water^ abstraction.
Medium	The surface *water^* depletion *effect^* is calculated as 20% or greater and less than 50% of the groundwater pumping rate after 100 days of pumping.	The calculated loss of surface *water^* is included in the surface *water^* allocation regime, but no specific minimum flow restrictions are imposed on the groundwater take.
Low	The surface *water^* depletion effect^ is calculated as less than 20% of the groundwater pumping rate after 100 days of pumping.:	The calculated loss of surface *water^* is not included in the surface *water^* allocation regime and no specific minimum flow restrictions are imposed on the groundwater take.

The flowing artesian head of bore #361063 and discussion in the AEE report place this location within the area where the groundwater is actively discharging to the surface water as noted by GNS (2019). This same setting is expected at the location of the Muhunoa West Road site and here too the low permeability sands are likely to mean the rate of discharge through them is slow, such that if a viable aquifer is found at depth the interaction with the surface will be low and slow.

4.3 COASTAL IMPACT

In terms of coastal impact associated with this abstraction reference to the HRC POL 16-7, provided in Appendix 1, aims to manage takes based on distance from the mean high-water springs line. The distance identified in the plan is 5km, within which specific consideration of the potential to induce saline intrusion is required. It is also noted that consents to take groundwater within 5kms of the coast must contain conditions relating to the monitoring of electrical conductivity and restriction or suspension of takes if specified electrical conductivity thresholds are reached or exceeded. These will be determined on a case by case basis.

The eastern boundary of the Muhunoa West Road site is the coastal boundary. On this property the maximum distance to the coastline is approx. 1,250m. The actual distance for any new well is likely to be less than this, so consideration of saline intrusion and monitoring conditions will be required. Based on this distance and the parameters determined from the Seymour well the drawdown forward model predicts a seasonal drawdown of the order of 0.09m at the coastal margin or slightly more if the well is more centrally located within the property.

However, as noted in the previous section the presence and nature of the marine sands deposited at the coastal margin indicate they will effectively form a barrier. The low permeability of the sands is shown to push the fresh groundwater upwards so that it discharges via the river channels (GNS, 2019). This means the potential for abstraction in this area to result in significant groundwater gradient reversal such that saline intrusion is a risk is considered low.

4.4 AQUIFER SUSTAINIBILITY

It is important to consider the long-term sustainability of the aquifer. This is best achieved through setting of a seasonal or annual allocation limit. There is an annual allocation limit for the Horowhenua Groundwater Management Zone (GWMZ), that is based on 5% of the average annual rainfall. Communication with HRC in April 2020 confirmed the current daily allocation from this zone 20,487m³ and the annual is 3,627,101m³ or 13% of the allocable volume. There is therefore significant allocation available within this zone.

So long as the irrigation abstraction is considered as groundwater and not surface water, the potential of the proposed application to adversely impact on long term sustainability is considered "less than minor".

5.0 CONCLUSIONS

The following conclusions are drawn from this report:

- This report provides a review of the feasibility of obtaining a resource consent for an irrigation water permit at 765 Muhunoa West Road, Ohau, Levin. The use is for the irrigation of a new golf course and associated facilities, located at the coast to the southwest of Levin and on the northern bank of the Ohau River mouth. This application requires consideration of the RMA (1991) and the Horizons Regional Council (HRC) - One Plan.
- The current rate estimate for abstraction is 1,500m³/d to 2,000m³/d. The irrigation demand for the location was calculated using the SPASMO irrigation demand calculator. The monthly per Ha rate is 100mm and the annual ranges from 350mm to 375mm, dependant on soil type, plus an additional 20% to account for distribution inefficiencies. The total area of the site is 107Ha, using the estimated abstraction rate of 1,500m³/d to 2,000m³/d then the irrigable area is estimated as 38.76Ha to 51.68Ha with an annual requirement estimated as 168,606m³ to 224,806m³. Ultimately, the abstraction potential may be dictated by the ground conditions encountered at the site.
- The property is within the Horowhenua GWMZ, there is allocation available within this zone. It is also within SWMZ Ohau (Ohau_1) and the sub-catchment Lower Ohau (Ohau_1b), applications are with HRC for this allocatable surface water. No further surface water is available.
- In terms of geology the area represents the south-western margin of the south Wanganui Basin. Groundwater recharge is from rainfall infiltration over the Tararua Range and flow is west to northwest and approximates the surface water drainage patterns. The coastal site is dominated by sand dunes with dune ridges aligned northwest/southeast, inland from the dunes are alluvial deposits. Underlying the surficial dune deposits are beach deposits consisting of alternating marginal marine gravel with sand, mud, and beach ridges. These marine sediments form a hydraulic barrier to the sea, groundwater is discharged upwards at the margin between these sediments and the alluvial material. Discharge to the sea occurs via the main river channels.
- There are no surrounding wells located within 1km of the centre of the Muhunoa West Rd property and only 5 wells within 1.5kms. The well log information corresponds with the local geology description showing surficial aeolian dune sands overlying marginal marine sediments.
- There is one well, bore #361063, it is located a similar distance inland as the Muhunoa West Road property, but is on the southern bank of the Ohau River. This well holds a consent for irrigation with a maximum daily rate of 4,098m³ and an annual volume of 410,770m³. It indicates that there is the potential to encounter gravel units at depths in this area that have the potential to supply. Data from the pump testing of this well is used as an analogue to assess the potential surrounding effects for a similar well at Muhunoa West Road.
- State of the Environment (SOE) water quality monitoring in the area indicates concentrations of some determinants may exceed the NZ Drinking Water Guideline

values. Further consideration is required in relation to the quality of the water that may be encountered and the ultimate use of that water.

- A review of the aquifer test data from bore #361063 showed that the original analysis could be replicated and confirmed that the aquifer is a highly transmissive leaky confined aquifer, but the value for leakage is low.
- Preliminary prediction of well interference indicates the magnitude of drawdown may be small. If the assessment is based on a roughly central location at the site, then given the general absence of nearby wells, it is considered likely that the potential for adverse impacts on surrounding wells will be "less than minor".
- Connection to the nearby stream for bore #361063 was assessed at 5% of the pumped volume after 100 days, placing it in the low category for stream depletion. This level of impact was considered minor, with management based on river flows or surface water allocation not required.
- In terms of coastal impact and the potential for the proposed abstraction to induce saline intrusion the risk is also considered as low.
- There is available allocation within the Horowhenua GWMZ. So long as the irrigation abstraction is considered as groundwater and not surface water.

6.0 RECOMMENDATIONS

Whilst there are indications of the likely presence of a viable aquifer at depths of about 30m to 50m, and that abstraction from this level will have minimal surrounding impact on the environment, there remains uncertainty. This is because of the absence of existing wells at the site and the need to infer conditions from other nearby wells, including wells on the other side of the Ohau River main channel. This kind of geological environment can produce some spatial heterogeneity within the deposits.

To prove the presence of an aquifer a well at the site is required. To manage costs initially, and to provide a suitable monitoring well for future aquifer pump testing, it is recommended to start with a small diameter exploration well. This will allow identification, or otherwise, of a viable aquifer sequences and confirm its depth. Samples can also be collected to test the quality of the water in the aquifer.

If a potentially viable unit is identified, then a larger diameter production well should be constructed. The aquifer pump testing will need to be carried out on the production well and the exploratory well can be used as a monitor well.

If the water quality is unsuitable to provide a drinking supply, but is suitable for irrigation, then consideration could be given to the installation of a separate well, that is shallower and located closer to the river that might provide more potable water as a separate permitted take.

7.0 REFERENCES

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APPENDIX 1

LEGISLATIVE REQUIREMENTS

Resource Management Act (1991) – Relevant Excerpts

Part 2
Purpose and principles

5 Purpose

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, **sustainable management** means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

6 Matters of national importance

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:

(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:

(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:

(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:

(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:

(f) the protection of historic heritage from inappropriate subdivision, use, and development:

(g) the protection of protected customary rights:

(h) the management of significant risks from natural hazards.

Section 6(f): inserted, on 1 August 2003, by section 4 of the Resource Management Amendment Act 2003 (2003 No 23).

Section 6(g): replaced, on 1 April 2011, by section 128 of the Marine and Coastal Area (Takutai Moana) Act 2011 (2011 No 3).

Section 6(h): inserted, on 19 April 2017, by section 6 of the Resource Legislation Amendment Act 2017 (2017 No 15).

7 Other matters

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to—

(a) kaitiakitanga:

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(ba) the efficiency of the end use of energy:

(c) the maintenance and enhancement of amenity values:

(d) intrinsic values of ecosystems:

(e) *[Repealed]*

(f) maintenance and enhancement of the quality of the environment:

(g) any finite characteristics of natural and physical resources:

(h) the protection of the habitat of trout and salmon:

(i) the effects of climate change:

(j) the benefits to be derived from the use and development of renewable energy.

Section 7(aa): inserted, on 17 December 1997, by section 3 of the Resource Management Amendment Act 1997 (1997 No 104).

Section 7(ba): inserted, on 2 March 2004, by section 5(1) of the Resource Management (Energy and Climate Change) Amendment Act 2004 (2004 No 2).

Section 7(e): repealed, on 1 August 2003, by section 5 of the Resource Management Amendment Act 2003 (2003 No 23).

Section 7(i): inserted, on 2 March 2004, by section 5(2) of the Resource Management (Energy and Climate Change) Amendment Act 2004 (2004 No 2).

Section 7(j): inserted, on 2 March 2004, by section 5(2) of the Resource Management (Energy and Climate Change) Amendment Act 2004 (2004 No 2).

Schedule 4
Information required in application for resource consent

s 88, Schedule 1

Schedule 4: replaced, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

1 Information must be specified in sufficient detail

Any information required by this schedule, including an assessment under clause 2(1)(f) or (g), must be specified in sufficient detail to satisfy the purpose for which it is required.

Schedule 4 clause 1: replaced, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

1AA *[Repealed]*

Schedule 4 clause 1AA: repealed, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

1A Matters to be included in assessment of effects on environment

[Repealed]

Schedule 4 clause 1A: repealed, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

2 Information required in all applications

(1) An application for a resource consent for an activity (the **activity**) must include the following:

- (a) a description of the activity:
- (b) a description of the site at which the activity is to occur:
- (c) the full name and address of each owner or occupier of the site:
- (d) a description of any other activities that are part of the proposal to which the application relates:
- (e) a description of any other resource consents required for the proposal to which the application relates:
- (f) an assessment of the activity against the matters set out in Part 2:
- (g) an assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b).

(2) The assessment under subclause (1)(g) must include an assessment of the activity against—

- (a) any relevant objectives, policies, or rules in a document; and
- (b) any relevant requirements, conditions, or permissions in any rules in a document; and
- (c) any other relevant requirements in a document (for example, in a national environmental standard or other regulations).

(3) An application must also include an assessment of the activity's effects on the environment that—

- (a) includes the information required by clause 6; and
- (b) addresses the matters specified in clause 7; and
- (c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

Schedule 4 clause 2: replaced, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

104 Consideration of applications

(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to–

- (a) any actual and potential effects on the environment of allowing the activity; and
- (ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity; and
- (b) any relevant provisions of—
  - (i) a national environmental standard:
  - (ii) other regulations:
  - (iii) a national policy statement:
  - (iv) a New Zealand coastal policy statement:
  - (v) a regional policy statement or proposed regional policy statement:
  - (vi) a plan or proposed plan; and
- (c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

6 Information required in assessment of environmental effects

(1) An assessment of the activity's effects on the environment must include the following information:

(a) if it is likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity:

(b) an assessment of the actual or potential effect on the environment of the activity:

(c) if the activity includes the use of hazardous installations, an assessment of any risks to the environment that are likely to arise from such use:

(d) if the activity includes the discharge of any contaminant, a description of—

(i) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(ii) any possible alternative methods of discharge, including discharge into any other receiving environment:

(e) a description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect:

(f) identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted:

(g) if the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved:

(h) if the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).

(2) A requirement to include information in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

(3) To avoid doubt, subclause (1)(f) obliges an applicant to report as to the persons identified as being affected by the proposal, but does not—

(a) oblige the applicant to consult any person; or

(b) create any ground for expecting that the applicant will consult any person.

Schedule 4 clause 6: inserted, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

Schedule 4 clause 6(1)(c): amended, on 19 April 2017, by section 121(a) of the Resource Legislation Amendment Act 2017 (2017 No 15).

7 Matters that must be addressed by assessment of environmental effects

(1) An assessment of the activity's effects on the environment must address the following matters:

(a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects:

(b) any physical effect on the locality, including any landscape and visual effects:

(c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity:

(d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations:

(e) any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants:

(f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or hazardous installations.

(2) The requirement to address a matter in the assessment of environmental effects is subject to the provisions of any policy statement or plan.

Schedule 4 clause 7: inserted, on 3 March 2015, by section 125 of the Resource Management Amendment Act 2013 (2013 No 63).

Schedule 4 clause 7(1)(f): amended, on 19 April 2017, by section 121(b) of the Resource Legislation Amendment Act 2017 (2017 No 15).

Horizons Regional Council – One Plan excerpts

Issue 5-2: Water quantity and allocation

The use of both surface water and groundwater has increased dramatically during the last decade. The demand for surface water in the Ohau, Oroua and parts of the upper Manawatu catchments already exceeds supply, and other catchments are experiencing marked increases. This increased demand has the potential to adversely affect both instream values and the natural character of rivers, wetlands and lakes, if not managed. The amount of groundwater is generally capable of meeting demand within the Region, although there is a need to actively manage effects between bores* at a local level, the effects of groundwater takes on surface water, and to be vigilant about the risk of saltwater intrusion along the west coast.

Objective 5-3: *Water^* quantity and allocation

*Water^* quantity is managed to enable people, industry and agriculture to take and use *water^* to meet their reasonable needs while ensuring that:

a. For surface *water^*:
   i. minimum flows and allocation regimes are set for the purpose of maintaining or enhancing (where degraded) the existing life-supporting capacity of *rivers^* and their *beds^* and providing for the other Values in **Schedule B** as appropriate
   ii. takes and flow regimes for existing hydroelectricity are provided for before setting minimum flow and allocation regimes for other uses
   iii. in times of *water^* shortage, takes are restricted to those that are essential to the health or safety of people and communities, or drinking water^ for animals, and other takes are ceased
   iv. the amount of *water^* taken from *lakes^* does not compromise their existing life-supporting capacity
   v. the requirements of *water conservation orders^* are upheld
   vi. the instream geomorphological components of natural character are provided for.

   For the avoidance of doubt this list is not hierarchical.
b. For groundwater:
   i. takes do not cause a significant *adverse effect^* on the long-term groundwater yield
   ii. groundwater takes that are hydrologically connected to *rivers^*, are managed within the minimum flow and allocation regimes established for *rivers^*
   iii. groundwater takes that are hydrologically connected to *lakes^* or *wetlands^* are managed to protect the life-supporting capacity of the *lakes^* or *wetlands^*
   iv. the significant adverse *effects^* of a groundwater take on other groundwater and surface *water^* takes are avoided
   v. saltwater intrusion into coastal aquifers, induced by groundwater takes, is avoided.
c. In all cases, *water^* is used efficiently.

Policy 5-12: Reasonable and justifiable need for *water^*

Subject to **Policy 5-18**, the amount of *water^* taken by resource users must be reasonable and justifiable for the intended use. In addition, the following specific measures for ensuring reasonable and justifiable use of *water^* must be taken into account when considering consent applications to take *water^* for irrigation, public water supply*, animal drinking *water^*, dairy shed washdown or industrial use, and during reviews of consent *conditions^* for these activities.

a. For irrigation, *resource consent^* applications must be required to meet a reasonable use test in relation to the maximum daily rate of abstraction, the irrigation return period and the seasonal or annual volume of the proposed take. When making decisions on the reasonableness of the rate and volume of take sought, the Regional Council must:
   i. consider *land^* use, crop *water^* use requirements, on-site physical factors such as soil *water^*-holding capacity, and climatic factors such as rainfall variability and potential evapo-transpiration
   ii. assess applications either on the basis of an irrigation application efficiency of 80% (even if the actual system being used has a lower application efficiency), or on the basis of a higher efficiency where an application is for an irrigation system with a higher efficiency
   iii. link actual irrigation use to soil moisture measurements or daily soil moisture budgets in consent *conditions^*.
b. For domestic use, animal drinking *water^* and dairy shed washdown *water^*, reasonable needs must be calculated as:
   i. up to 300 litres per person per day for domestic needs
   ii. up to 70 litres per animal per day for drinking *water^*
   iii. up to 70 litres per animal per day for dairy shed washdown.
c. For industrial uses, *water^* allocation must be calculated where possible in accordance with best management practices for *water^* efficiency for that particular industry.
d. For public ***water supplies****, the following must generally be considered to be reasonable:
   i. an allocation of 300 litres per person per day for domestic needs, plus
   ii. an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus
   iii. an allocation for industrial use calculated, where possible, in accordance with best management practices for water^ efficiency for that particular industry, plus
   iv. an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities, New Zealand Defence Force facilities or correction facilities, plus
   v. an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools, plus
   vi. an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public ***water supply**** system, plus
   vii. an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative *district plan^* for the area and is reasonably forecast, plus
   viii. an allocation for leakage equal to 15% of the total of (i) to (vii) above.
e. When making decisions on consent applications where the existing allocation for a public water supply* exceeds the allocation determined in accordance with (d)(i) to (d)(vi) above:
   i. consideration must be given to imposing a timeframe within which it is reasonably practicable for the existing allocation to be reduced to the determined amount, or
   ii. if (i) is not imposed, an alternative allocation must be determined based on the particular social and economic circumstances of the community serviced by the ***public water supply**** and the actual and potential *effects^* of the abstraction on the relevant **Schedule B** Values for the reach of *river^* or its *bed^* affected by the take.

Policy 5-13: Efficient use of *water^*

*Water^* must be used efficiently, including by the following measures:

a. requiring *water^* audits and *water^* budgets to check for leakages and *water^*-use efficiency as appropriate
b. requiring the use of, or progressive ***upgrade**** to, infrastructure^ for *water^* distribution that minimises the loss of water^ and restricts the use of *water^* to the amounts determined in accordance with **Policy 5-12**
c. enabling the transfer of *water permits^*
d. promoting *water^* storage
e. raising awareness about *water^* efficiency issues and techniques
f. requiring monitoring of *water^* takes, including by installing *water^* metering and telemetry.

Policy 5-20: Overall approach for ***bore** management and groundwater allocation**

a. New ***bores**** must be constructed and managed in accordance with Policy **16-4**.
b. ***Groundwater Management Zones**** are mapped in **Schedule D**.
c. Total groundwater allocations must comply with the annual allocable volumes for ***Groundwater Management Zones**** set out in Policy **5-21**.
d. The measured or modelled *effects^* of a proposed groundwater take on other groundwater users, surface *water bodies^* and saltwater intrusion must be managed in accordance with Policies **16-1**, **16-5**, **16-6** and **16-7**.

Policy 5-21: Groundwater Management Zones

The total amount of consented groundwater allocated from each ***Groundwater Management Zone**** mapped in **Schedule D** must not exceed the annual allocable volume for the GWMZ* specified in **Schedule D**.

Objective 16-1: Regulation of takes, uses and diversions of *water^*

The regulation of takes, uses and diversions of *water^* in a manner that:

a. recognises and provides for the Values and management objectives in **Schedule B**, and
b. provides for the objectives and policies of **Chapter 5** as they relate to surface *water^* and groundwater use and allocation.

Policy 16-5: Effects of groundwater takes on other groundwater takes

a. Consent applications to take groundwater must include pumping tests and hydrogeological assessments in order to determine the likely impact on existing groundwater takes in the vicinity.
b. Consent *conditions^* restricting the rate and duration of pumping must be imposed on new takes of groundwater where this is necessary to avoid significant drawdown impacts on existing groundwater takes from properly-constructed, efficient and fully-functioning ***bores**** in the vicinity. A groundwater take is considered to be from a properly-constructed, efficient and fully-functioning ***bore**** in circumstances where the ***bore**** penetrates the aquifer from which water^ is being drawn at a depth sufficient to enable *water^* to be drawn all year (ie., the ***bore**** depth is below the range of seasonal fluctuations in groundwater level), the pump and ***bore**** are adequately maintained, the ***bore**** is of sufficient diameter and is screened to reasonably minimise drawdown, and the ***bore**** has a pump capable of drawing *water^* from its base to the *land^* surface.
c. *Consent conditions^* specifying short-term restrictions on the rate and duration of pumping may also be imposed on new takes of groundwater where this is necessary to avoid significant drawdown impacts on existing bores* that are not properly-constructed, efficient and fully-functioning, in order to allow sufficient time for such ***bores**** to be ***upgraded**** or replaced.
d. The Regional Council may encourage consent *applicants^* to consider the option of providing *water^* to neighbouring properties in circumstances where this would be more practical than meeting the requirements of (b) or (c).

Policy 16-6: Effects of groundwater takes on surface water *bodies^*

The effects of groundwater takes on surface water *bodies^*, including *wetlands^*, must be managed in the following manner:

a. An appropriate scientific method must be used to calculate the likely degree of connection between the groundwater and surface water^ at the location of the groundwater take.
b. Subject to (a), the potential adverse *effects^* of groundwater takes on surface *water^* depletion must be managed in accordance with **Table 16.1**.

Table 16.1 Surface *water^* depletion

CLASSIFICATION OF SURFACE *WATER^* DEPLETION *EFFECT^*	MAGNITUDE OF SURFACE *WATER^* DEPLETION EFFECT^	MANAGEMENT APPROACH
Riparian	Any groundwater take screened within the geologically recent bed strata of a surface water *body^*.	The groundwater take is subject to the same restrictions as a surface *water^* take, unless there is clear hydrogeological evidence that demonstrates that the *effect^* of pumping will not impact on the surface water *body^*.
High	The surface *water^* depletion *effect^* is calculated as 90% or greater of the groundwater pumping rate after seven days of pumping, or 50% or greater of the average groundwater pumping rate after 100 days of pumping.	The groundwater take is subject to the same restrictions as a surface water^ abstraction.
Medium	The surface *water^* depletion *effect^* is calculated as 20% or greater and less than 50% of the groundwater pumping rate after 100 days of pumping.	The calculated loss of surface *water^* is included in the surface *water^* allocation regime, but no specific minimum flow restrictions are imposed on the groundwater take.
Low	The surface *water^* depletion effect^ is calculated as less than 20% of the groundwater pumping rate after 100 days of pumping.;	The calculated loss of surface *water^* is not included in the surface *water^* allocation regime and no specific minimum flow restrictions are imposed on the groundwater take.

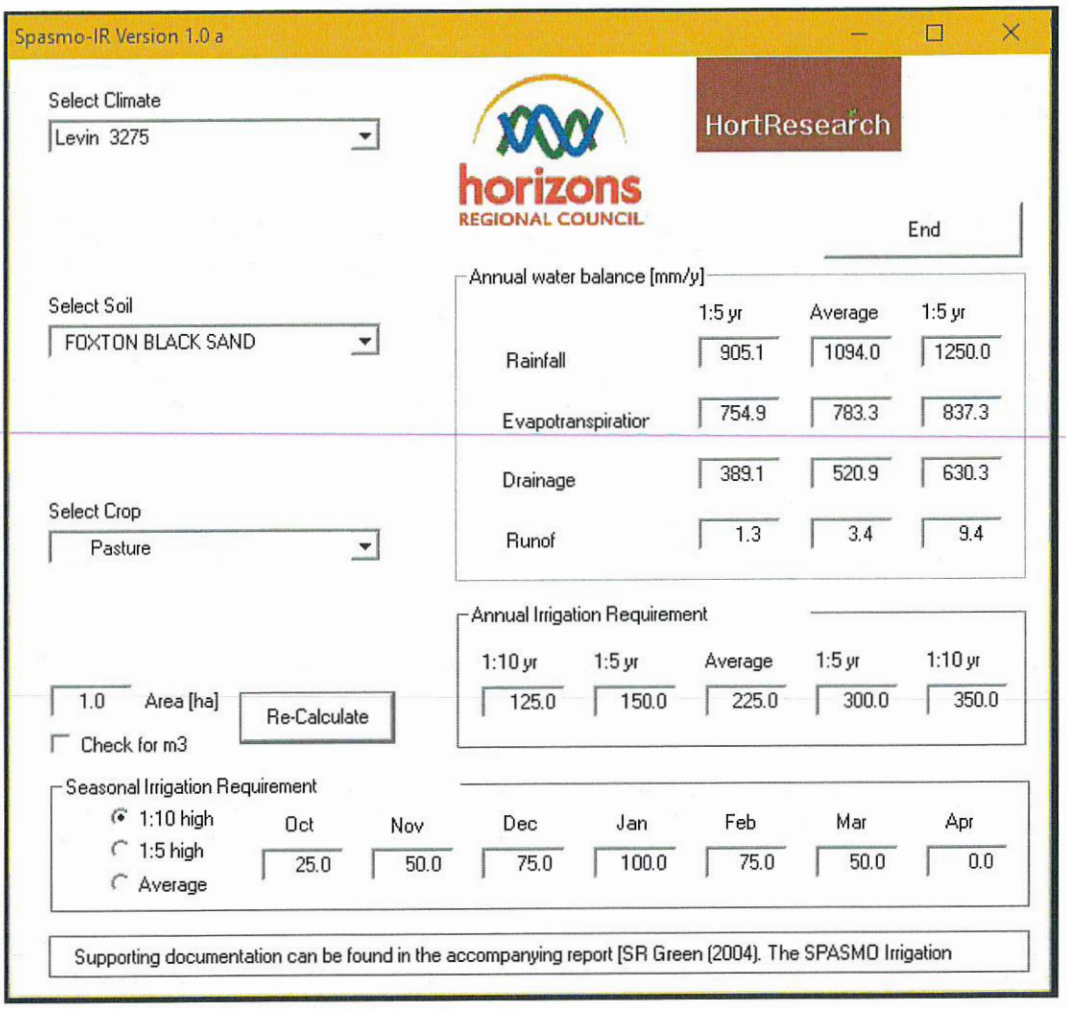
Policy 16-7: Saltwater intrusion

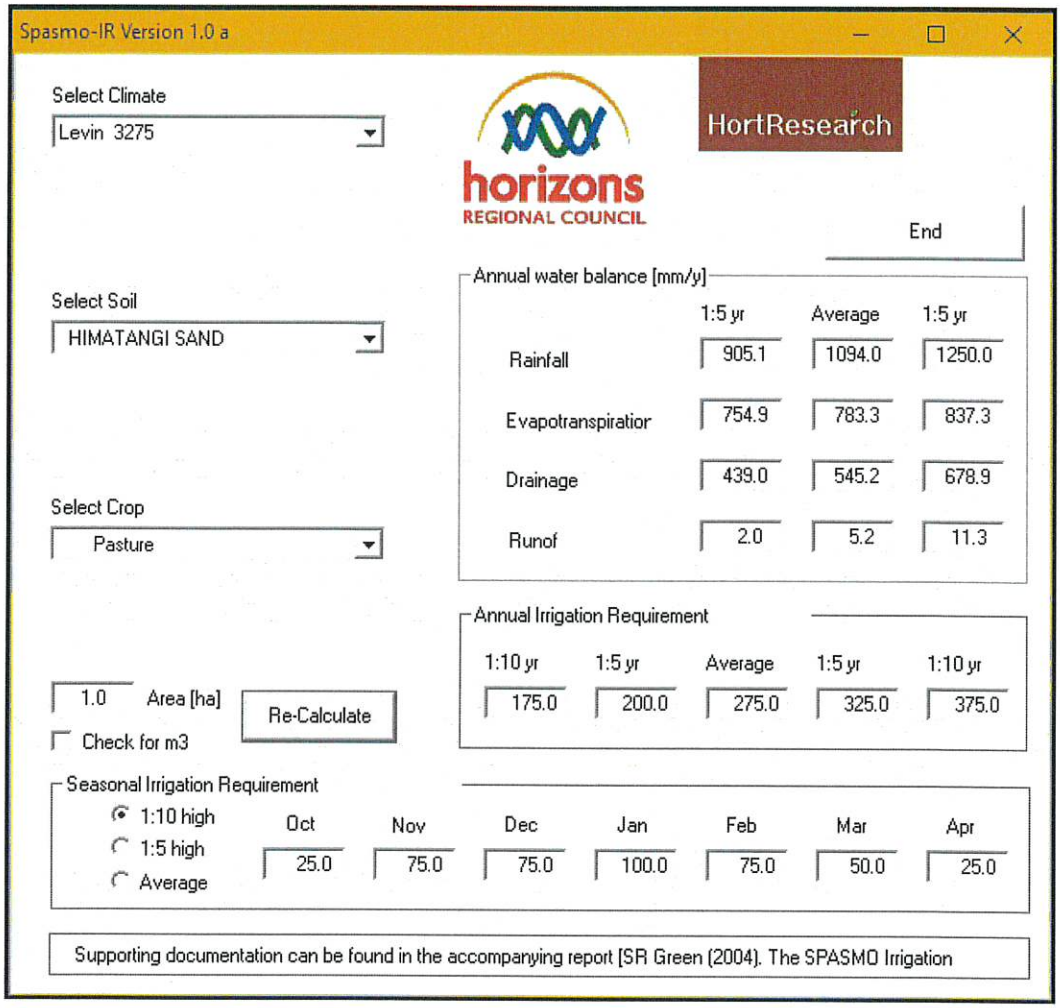
Saltwater intrusion along the coastal margins of the Region arising from groundwater takes must be managed by the following measures:

a. Consent *applicants^* wishing to take groundwater within 5 km of the coastal mean high water springs line must be required to carry out pumping tests and hydrogeological assessments in order to determine the level of drawdown at the coast and the likelihood of inducing saltwater intrusion.
b. In cases where saltwater intrusion might occur, the consent application may be declined or the amount of *water^* that can be taken must be limited to an amount that restricts the likelihood of saltwater intrusion.
c. In addition, consents to take groundwater within 5 km of the coastal mean high water springs line must contain *conditions^* relating to the monitoring of electrical conductivity and the restriction or suspension of takes if specified electrical conductivity thresholds are reached or exceeded. These monitoring requirements and electrical conductivity thresholds will be determined on a case-by-case basis.

APPENDIX 2

IRRIGATION DEMAND MODELS


Spasmo-IR Version 1.0 a
Select Climate
Levin 3275
horizons
REGIONAL COUNCIL
HortResearch
End
Annual water balance [mm/y]
1:5 yr
Average
1:5 yr
Rainfall
905.1
1094.0
1250.0
Evapotranspiratior
754.9
783.3
837.3
Drainage
389.1
520.9
630.3
Runof
1.3
3.4
9.4
Select Soil
FOXTON BLACK SAND
Select Crop
Pasture
Annual Irrigation Requirement
1:10 yr
1:5 yr
Average
1:5 yr
1:10 yr
125.0
150.0
225.0
300.0
350.0
1.0
Area [ha]
Re-Calculate
Check for m3
Seasonal Irrigation Requirement
1:10 high
1:5 high
Average
Oct
Nov
Dec
Jan
Feb
Mar
Apr
25.0
50.0
75.0
100.0
75.0
50.0
0.0
Supporting documentation can be found in the accompanying report [SR Green (2004). The SPASMO Irrigation


Spasmo-IR Version 1.0 a
Select Climate
Levin 3275
horizons
REGIONAL COUNCIL
HortResearch
End
Annual water balance [mm/y]
1:5 yr
Average
1:5 yr
Rainfall
905.1
1094.0
1250.0
Evapotranspiratior
754.9
783.3
837.3
Drainage
439.0
545.2
678.9
Runof
2.0
5.2
11.3
Select Soil
HIMATANGI SAND
Select Crop
Pasture
Annual Irrigation Requirement
1:10 yr
1:5 yr
Average
1:5 yr
1:10 yr
175.0
200.0
275.0
325.0
375.0
1.0
Area [ha]
Re-Calculate
Check for m3
Seasonal Irrigation Requirement
1:10 high
1:5 high
Average
Oct
Nov
Dec
Jan
Feb
Mar
Apr
25.0
75.0
75.0
100.0
75.0
50.0
25.0
Supporting documentation can be found in the accompanying report [SR Green (2004). The SPASMO Irrigation

IRRIGATION REASONABLE USE DATABASE

5 STEPS - TO GET THE IRRIGATION REQUIREMENTS INFORMATION YOU NEED FOR IRRIGATION PLANNING, CONSENTING AND DESIGN

IRRIGATION NEW ZEALAND | Ministry for Primary Industries Manatū Ahu Matua | Sustainable Farming Fund | LGA | aqualinc

1 Enter the address or coordinates (latitude, longitude) of your farm and click 'Locate' or click on the map

-40.644 , 175.171 Locate

Map Satellite

Koputaroa, Hokio Beach, Levin, Ohau, Muhunoa East, Waikawa Beach, Manakau, Otaki Beach, MANAWATU-WANGANUI, MANAWATU, WELLING

Google Map data ©2020 Terms of Use Report a map error

2 Select Crop: Pasture

3 Select Plant Available Water: (a) Most likely PAW in this area

4 Select Irrigation Method: 80% Efficient Irrigator

5 Fetch Data

Farm Details		Plant Available Water Details			Irrigation Requirements				
Description		PAW(mm)	Indicative Likelihood	Area (hectares)		Per Hectare		Total Area	
Latitude	-40.644	140	27.2	1	System Capacity	0.61	(l/s/ha)	0.61	(l/s)
Longitude	175.171			0	System Capacity	5.3	(mm/day)		
Council	Horizons			0	Daily Volume	53	(m^3/ha)	53	(m^3)
Climate Site ID	P184139			0	7 Day Volume		(m^3/ha)		(m^3)
Distance to Climate Site (km)	3.46			0	28 Day Volume		(m^3/ha)		(m^3)
Rainfall (mm)	1000		Total area =	1	90% ile Annual Volume	5,040	(m^3/ha)	5,040	(m^3)

These estimates of irrigation requirements are based on the assumption that the crop you selected can be grown and irrigated at the site you have selected. Constraints such as topography and crop-specific climate requirements are not taken into account.

Irrigation requirements may be less than reported here if your soils are poorly drained or the water table is close to the soil surface.

Detailed Results | Save this Page | Background Information

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APPENDIX 3

SELECTED SURROUNDING WELL LITHOLOGIES

Selected Lithologies

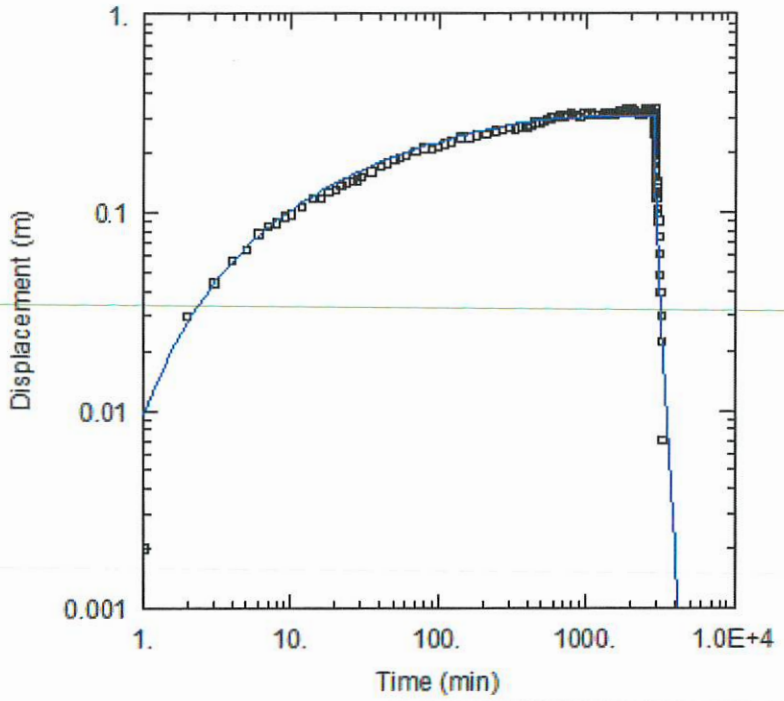
id	Easting	Northing	From	To	Lithology	Driller's Description	stn_type
361021	2694396	6060883	0	2	Sand	Brown fine silty sand, loose	Borehole
361021	2694396	6060883	2	6.5	Sand	Blue medium sand, loose	Borehole
361021	2694396	6060883	6.5	12	Sand	Grey coarse sand && some shells, loose	Borehole
361021	2694396	6060883	12	24	Sand	Grey fine silty sand	Borehole
361060 x							
361051	2694600	6059300	0	0.5	Top Soil	Top soil	Borehole
361051	2694600	6059300	0.5	2.8	Sand	Brown sand medium	Borehole
361051	2694600	6059300	2.8	4.2	Sand	Brown medium sand with peat	Borehole
361051	2694600	6059300	4.2	7	Sand	Blue medium sand water bearing	Borehole
361051	2694600	6059300	7	7.5	Clay	Blue clay	Borehole
361051	2694600	6059300	7.5	12.5	Sand	Blue coarse sand water bearing	Borehole
361051	2694600	6059300	12.5	20.3	Sand	Blue medium sand sand with small amount of gravel	Borehole
361051	2694600	6059300	20.3	23.8	Clay	Blue clay	Borehole
361051	2694600	6059300	23.8	24.5	Gravel	Blue gravel with coarse sand 75-25 wb	Borehole
361051	2694600	6059300	24.5	28.9	Gravel	Blue gravel water bearing	Borehole
361051	2694600	6059300	28.9	29.6	Gravel	Blue gravel with some sand	Borehole
361051	2694600	6059300	29.6	31	Gravel	Blue gravel and coarse sand 50-50 wb	Borehole
361051	2694600	6059300	31	31.8	Sand	Blue medium sand wb	Borehole
361051	2694600	6059300	31.8	32.2	Gravel	Blue gravel and sand	Borehole
361051	2694600	6059300	32.2	39.2	Sand	Blue medium sand wb	Borehole
361051	2694600	6059300	39.2	39.8	Peat	Peat with medium sand 50-50	Borehole
361051	2694600	6059300	39.8	45.8	Sand	Brown coarse to medium sand wb swl -0.6 m fe=0.5ppm mn 0.3ppm	Borehole
361041	2694699	6059345	0	2	Sand	Brown sand	Borehole
361041	2694699	6059345	2	8	Sand	Blue sand	Borehole
361041	2694699	6059345	8	14	Sand	Blue sand && wood, w/b	Borehole
361041	2694699	6059345	14	25	Sand	Blue fine sand, w/b	Borehole
361041	2694699	6059345	25	33	Sand	Dark blue/green semi-cemented sand, w/b	Borehole
361041	2694699	6059345	33	37	Sand	Blue clean sand, w/b	Borehole
361003 x							
361012	2695200	6061300	0	2	Top Soil	Black/brown sandy organic soil	Borehole
361012	2695200	6061300	2	10	Sand	Sands, fine, yellow/brown graded<0.25mm	Borehole
361012	2695200	6061300	10	17	Sand	Sands, fine, well graded<0.25mm, blue/grey, wood fragments throughout	Borehole
361012	2695200	6061300	17	19	Sand	Clayey sands, very fine<0.2mm, dark blue/grey well graded 01m thick	Borehole
361012	2695200	6061300	19	20.5	Sand	Blue/grey sands, fine well graded	Borehole
361012	2695200	6061300	20.5	23	Sand	Sands, med <0.4mm, well graded, blue/grey with small silt band, firm dark blue/grey	Borehole

Deeper wells - more distant - due west

362131	2696361	6058957	0	6.1	Sand	Brown sand	Borehole
362131	2696361	6058957	6.1	12.2	Sand	Grey sand	Borehole
362131	2696361	6058957	12.2	28.4	Sand	Brown sand	Borehole
362131	2696361	6058957	28.4	29	Peat	Peat, wood, grey sand	Borehole
362131	2696361	6058957	29	45.4	Sand	Grey sand	Borehole
362131	2696361	6058957	45.4	46.7	Sand	Fatty sand	Borehole
362131	2696361	6058957	46.7	54.6	Sand	Grey sand	Borehole
362131	2696361	6058957	54.6	55.2	Sand	Coarse grey sand, fine gravel, shells, w/b	Borehole
362131	2696361	6058957	55.2	55.8	Gravel	Blue clay bound gravel	Borehole
362131	2696361	6058957	55.8	56.4	Gravel	Blue loose gravel, w/b	Borehole
362166 x							
361011	2696002	6059120	0	1.5	Peat	Peat, wood && soil	Borehole
361011	2696002	6059120	1.5	9.5	Sand	Grey sand, small water lenses	Borehole
361011	2696002	6059120	9.5	10.1	Top Soil	Woood && sand, small water lenses	Borehole
361011	2696002	6059120	10.1	22.6	Sand	Grey sand, small water lenses	Borehole
361011	2696002	6059120	22.6	23.2	Sand	Brown clay bound sand	Borehole
361011	2696002	6059120	23.2	24.4	Sand	Coarse brown sand	Borehole
361011	2696002	6059120	24.4	26.5	Sand	Brown fatty sand	Borehole
361011	2696002	6059120	26.5	48.2	Sand	Coarse brown sand	Borehole
361011	2696002	6059120	48.2	58	Sand	Hard grey sand	Borehole
361011	2696002	6059120	58	61	Sand	Grey sand	Borehole
361011	2696002	6059120	61	62	Gravel	Gravel && clay	Borehole
362306 x							
361063	2693650	6057766	0	5.5	Sand	Sand	Borehole
361063	2693650	6057766	5.5	10	Sand	Sand - cemented	Borehole
361063	2693650	6057766	10	22	Silt	Very silty sand (close to clay)	Borehole
361063	2693650	6057766	22	26.7	Peat	Peat/clay	Borehole
361063	2693650	6057766	26.7	28.2	Gravel	Gravel W/B and gravel fines	Borehole
361063	2693650	6057766	28.2	33.86	Gravel	Gravel W/B - Good range of sizes	Borehole
361063	2693650	6057766	33.86	35.11	Sand	Silty sand	Borehole

APPENDIX 4

MODEL SOLUTION DATASHEETS



MODELLING OF EXISTING TEST DATA

Data Set: C:\...\Re-analysis Seymour Well Data.agt
Date: 06/29/20 Time: 11:30:11

PROJECT INFORMATION

Company: Lattey Group
Client: Grenadier Developments
Project: J20043
Location: Muhunoa West Road, Levin
Test Well: #361063
Test Date: 26/01/2011

AQUIFER DATA

Saturated Thickness: 7. m
Aquitard Thickness (b'): 19. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b''): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
#361063	0	0

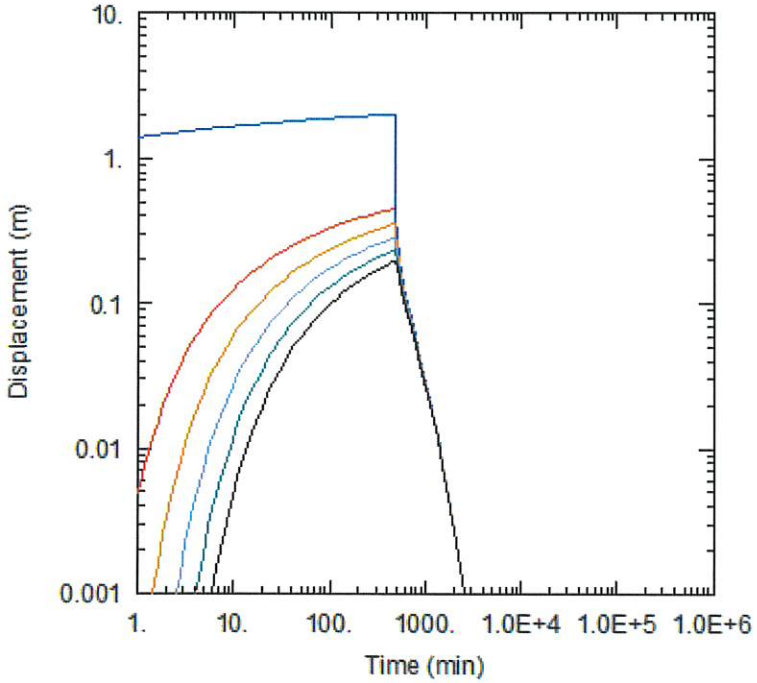
Observation Wells

Well Name	X (m)	Y (m)
▫ Seymour Bore	392	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Cooley-Case

T = 3784.3 m^2/day
r/B = 0.1593
S'/Sy = 0.
S = 8.603E-5
ß = 0.07147
L/b' = 0.



MAXIMUM RATE FORWARD MODEL - BASED ON SEYMOUR WELL DATA

Data Set: C:\...\Max Rate - FM based on Seymour Well Data.aqt
Date: 06/29/20 Time: 11:31:39

PROJECT INFORMATION

Company: Lattey Group
Client: Grenadier Developments
Project: J20043
Location: Muhunoa West Road, Levin
Test Well: #361063
Test Date: 26/01/2011

AQUIFER DATA

Saturated Thickness: 7. m
Aquitard Thickness (b'): 19. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	0	0

Observation Wells

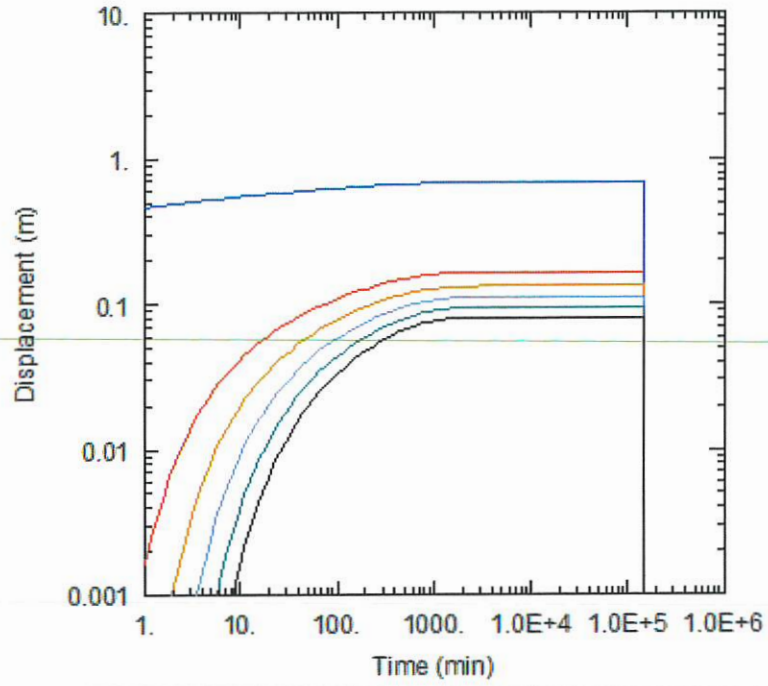
Well Name	X (m)	Y (m)
▫ 500m	500	0
▫ New Well	0	0
▫ 750m	750	0
▫ 1000m	1000	0
▫ 1250m	1250	0
▫ 1500m	1500	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Cooley-Case

T = 3784.3 m^2/day
1/B = 0.0003186 m^{-1}
S'/Sy = 0.

S = 8.603E-5
ß/r = 0.0001429 m^{-1}
L/b' = 0.



FORWARD MODEL BASED ON SEYMOUR WELL DATA

Data Set: C:\...\Seasonal FM based on Seymour Well Data.aqt
Date: 06/29/20 Time: 11:32:15

PROJECT INFORMATION

Company: Lattey Group
Client: Grenadier Developments
Project: J20043
Location: Muhunoa West Road, Levin
Test Well: #361063
Test Date: 26/01/2011

AQUIFER DATA

Saturated Thickness: 7. m
Aquitard Thickness (b'): 19. m
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	0	0

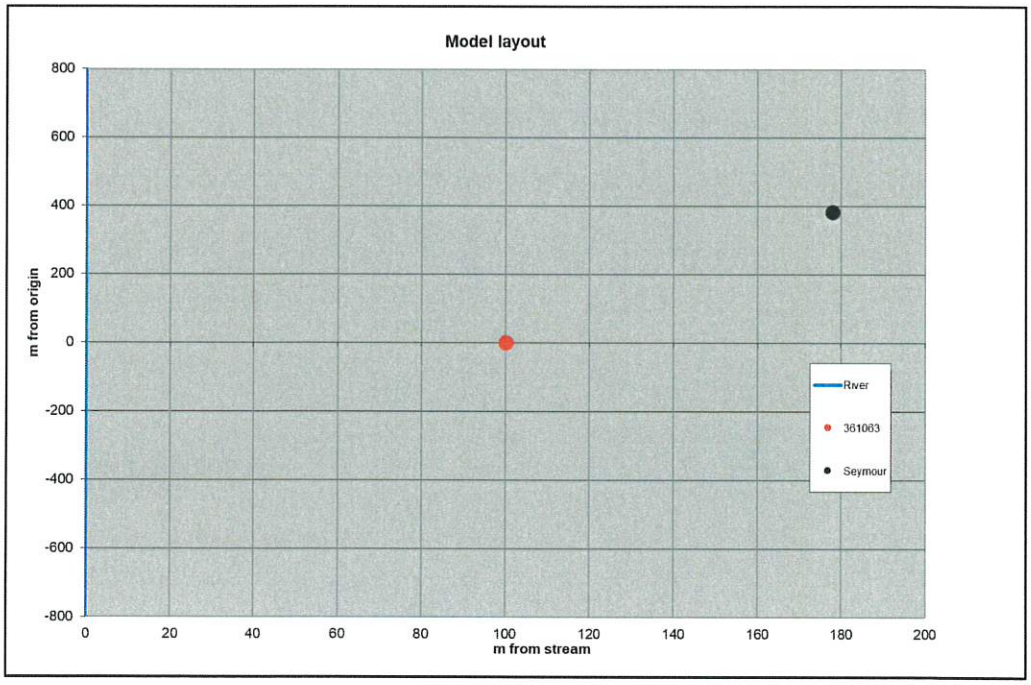
Observation Wells

Well Name	X (m)	Y (m)
500m	500	0
New Well	0	0
750m	750	0
1000m	1000	0
1250m	1250	0
1500m	1500	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Cooley-Case

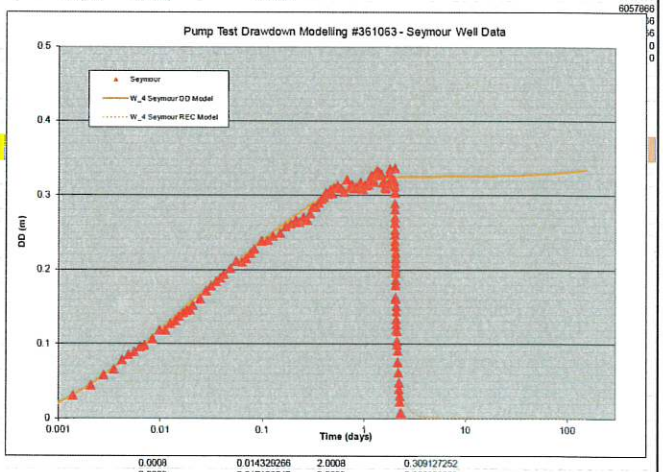
T = 3784.3 m^2/day
1/B = 0.0003186 m^{-1}
S'/Sy = 0.
S = 8.603E-5
ß/r = 0.0001429 m^{-1}
L/b' = 0.



Pumping Well			361063							
Stream Dist				100 m		Modelled Wells				
Obs well			Seymour							
Obs well		X		178 m	6057866	6057866	6057866			
Obs well		Y		384 m	-2693650	-2693650	-2693650			
Q			43.6	3767.04 m^3/day						
T				5200 m/day						
S				0.0001						
k'/b'				0.00013 /day						
Sigma				0.1						
lambda				0.1 m/day						
Test Duration (c			2							

Test Data (Drawdown & Recovery)

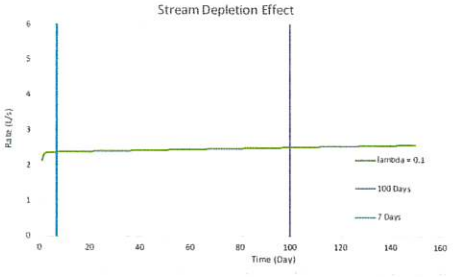
Seymour Time (mins)	Seymour Time (d)	Seymour DD (m)	Time (mins)	Time (d)
1	0.000694444	0.002		
2	0.001388889	0.03		
3	0.002083333	0.044		
4	0.002777778	0.057		
5	0.003472222	0.065		
6	0.004166667	0.078		
7	0.004861111	0.085		
8	0.005555556	0.088		
9	0.00625	0.095		
10	0.006944444	0.097		
12	0.008333333	0.106		
14	0.009722222	0.118		
16	0.011111111	0.118		
18	0.0125	0.126		
20	0.013888889	0.13		
22	0.015277778	0.136		
24	0.016666667	0.141		
26	0.018055556	0.144		
28	0.019444444	0.145		
30	0.020833333	0.151		
35	0.024305556	0.16		
40	0.027777778	0.17		
45	0.03125	0.177		
50	0.034722222	0.183		
55	0.038194444	0.188		
60	0.041666667	0.193		
70	0.048611111	0.201		
80	0.055555556	0.21		
90	0.0625	0.209		



0.0008	0.014326266	2.0008	0.309127252
0.0009	0.017133047	2.0009	0.306329663
0.001	0.01998841	2.001	0.303578493
0.0013	0.027666291	2.0013	0.295791188
0.002	0.043084265	2.002	0.280374558

Pumping Well			361063					% depletion		
Stream Dist				100 m				After 7 days	After 100 days	
Obs well			Seymour					0%	0%	
Obs well		X		178 m				0%	0%	
Obs well		Y		384 m			lambda = 0.1	6%	6%	
Q			42	3628.8 m^3/day						
T				5200 m/day						
S				0.0001						
k'/b'				0.00013 /day						
Sigma				0.1						
lambda				0.1 m/day						

DD Time (d)	lambda = Depletion (m3/d)	Depletion (L/s)	lambda = Depletion (m3/d)	Depletion (L/s)	lambda = 0.1 Depletion (m3/d)	Depletion (L/s)
1	0.00	0.00	0.00	0.00	184.44	2.13
2	0.00	0.00	0.00	0.00	200.67	2.32
3	0.00	0.00	0.00	0.00	204.10	2.36
4	0.00	0.00	0.00	0.00	205.00	2.37
5	0.00	0.00	0.00	0.00	205.30	2.38
6	0.00	0.00	0.00	0.00	205.45	2.38
7	0.00	0.00	0.00	0.00	205.57	2.38
8	0.00	0.00	0.00	0.00	205.68	2.38
9	0.00	0.00	0.00	0.00	205.79	2.38
10	0.00	0.00	0.00	0.00	205.90	2.38
11	0.00	0.00	0.00	0.00	206.02	2.38
12	0.00	0.00	0.00	0.00	206.14	2.39
13	0.00	0.00	0.00	0.00	206.27	2.39
14	0.00	0.00	0.00	0.00	206.39	2.39
15	0.00	0.00	0.00	0.00	206.52	2.39
16	0.00	0.00	0.00	0.00	206.65	2.39
17	0.00	0.00	0.00	0.00	206.77	2.39
18	0.00	0.00	0.00	0.00	206.90	2.39
19	0.00	0.00	0.00	0.00	207.03	2.40
20	0.00	0.00	0.00	0.00	207.16	2.40
21	0.00	0.00	0.00	0.00	207.28	2.40
22	0.00	0.00	0.00	0.00	207.41	2.40



APPENDIX 5

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