Proposed Southland Water and Land Plan
Wilkins Appeal – The Status of The Garvie Aquifer Groundwater
Southland, New Zealand
Project #31137-02

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PROPOSED SOUTHLAND WATER AND LAND PLAN - WILKINS APPEAL THE STATUS OF THE GARVIE AQUIFER GROUNDWATER SOUTHLAND, NEW ZEALAND

1.0 INTRODUCTION

The main purpose of this document is to examine site-specific hydrogeologic data for the Wendonside Groundwater Management Zone (GMZ) and the Garvie Aquifer to determine whether the entire Garvie Aquifer should be classified as a "confined" or "semi-confined" aquifer.

Environment Southland's Land and Water Plan (LWP, 2017, p. 15)[1] states:

> "It is noted that the Garvie Aquifer which was managed as a confined aquifer under the RWP, has been incorporated into the proposed Wendonside groundwater management zone. Reclassification of this aquifer system is **based on improved hydrogeological information that indicates that individual water-bearing layers in this area are hydraulically connected[2]**, so allocation is best managed in terms of a single primary allocation volume for all groundwater takes, regardless of depth."

Environment Southland's Beacon website[3] describes the hydrogeology of the Wendonside GMZ as:

> "… deeper gravel layers across central and southern parts of the Wendonside GMZ host a **highly permeable semi-confined aquifer[4]** system."
>
> "**Differences in static water level between intermediate and deeper water-bearing layers** reflect the **semi-confined nature of deeper groundwater[5]**."
>
> "**Groundwater levels in deeper semi-confined water-bearing-layers exhibit limited response to seasonal variations in rainfall recharge, instead following longer-term rainfall variation[6]**."

[1] Environment Southland. 2017. Groundwater Provisions of the Proposed Southland Water and Land Plan, Technical Background. Dated June 2017.
[2] Bold font added by author.
[3] Environment Southland Beacon website https://maps.es.govt.nz
[4] Bold font added by author
[5] Bold font added by author
[6] Bold font added by author

2.0 DEFINITIONS OF CONFINED, UNCONFINED, AND SEMI-CONFINED AQUIFERS ACCORDING TO pSWLP

First, the proposed Southland Water and Land Plan (pSWLP, 2018, p.106)[7] defines a confined aquifer as:

> "An aquifer which is **overlain by a low permeability or impermeable layer** where **water in the aquifer is under pressure**."[8]

"Under pressure" means that the water level in a well completed in the aquifer rises above the top of the aquifer.

Second, the pSWLP (2018, p.117) defines an unconfined aquifer as:

> "An aquifer with **no upper confining layer** so that the **system is not under pressure**, and its **water table levels fluctuate both seasonally and from year to year**."[9]

Finally, the pSWLP (2018, p.183) defines a semi-confined aquifer as:

> "… **exhibiting significant departure from 'ideal' confined aquifer conditions**[10]."

We assume that "ideal" confined aquifer conditions refer to the behaviour of the aquifer during aquifer tests as indicated by drawdown versus time data plots. The drawdown versus time data for an aquifer test in an ideal confined aquifer follows the shape of the Theis curve (Freeze and Cherry, 1979, p. 318)[11].

3.0 ENVIRONMENT SOUTHLAND'S STATED BASES FOR THE CURRENT PROPOSED STATUS OF THE GARVIE AQUIFER - PART OF THE WENDONSIDE AQUIFER

The LWP (2017, p. 15) considers the Garvie Aquifer to be part of the Wendonside Aquifer because: "… Reclassification of this aquifer system is **based on improved hydrogeological information that indicates that individual water-bearing layers in this area are hydraulically connected** …"[12]. However, LWP (2017) does not indicate specifically what the "improved hydrogeological information" is or what "hydraulically connected" means.

[7] Environment Southland. 2018. Proposed Southland Water and Land Plan Part A. Decisions Version Dated April 4, 2018.
[8] Bold font added by author.
[9] Bold font added by author.
[10] Bold font added by author.
[11] Freeze RA and Cherry JA. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, NJ.
[12] Bold font added by author

4.0 INDICATIONS THAT THE GARVIE AQUIFER IS A CONFINED AQUIFER

There are five lines of evidence that indicate the Garvie Aquifer is a confined aquifer at a minimum in the central Wendonside area. These lines of evidence include:

- Geological descriptions from borehole records: Is the aquifer overlain by an aquitard?
- Static groundwater elevations on well completion relative to the elevation of the top of the aquifer: Is the aquifer pressurized?
- Temporal variations in groundwater elevations: Are there annual and seasonal cycles similar to those in shallow water-bearing zones?
- Hydraulic parameters determined from aquifer tests: Do the storativity values from the aquifer tests indicate confined conditions?
- Drawdown versus time plots during aquifers tests: Are there deviations from "ideal" confined aquifer behaviour indicative of leaky/confined conditions?

The following sections discuss site-specific data related to these lines of evidence.

4.1 Observed Geology and Static Groundwater Levels

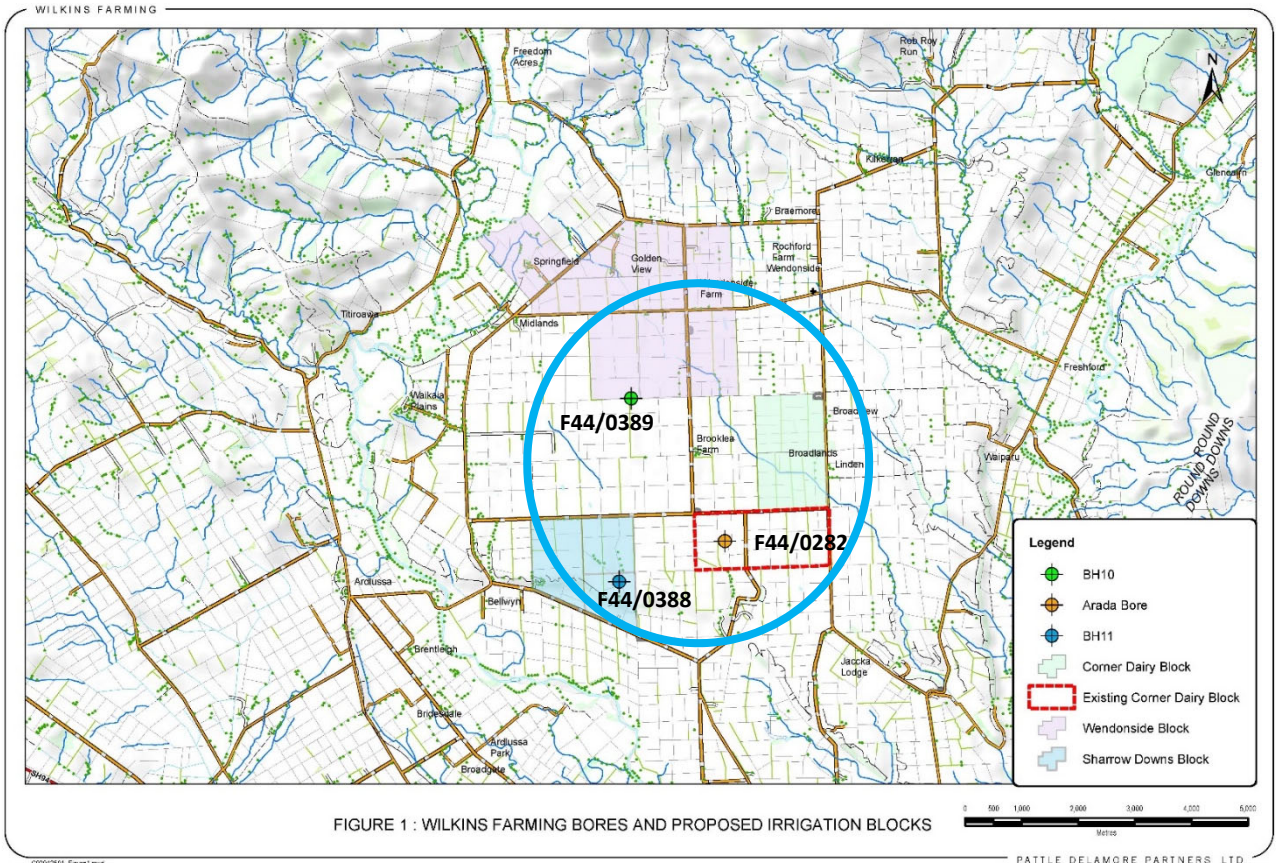

Figure 1. Locations of the PDP Aquifer Tests (F44/XXXX numbers added by Sklash)

PDP (2014)[13] summarizes PDP's groundwater supply investigations for Wilkins Farming Limited on the Wendonside Terrace. Figure 1 shows three locations where PDP conducted aquifer testing in 2014. Attachment A provides the borehole records for the wells in Figure 1.

Borehole F44/0389 Geology and Static Groundwater Level. The boring log for the F44/0389 (BH10 in Figure 1) indicates: (1) clay bound gravel extends from 4.5 mbgl to 37.5 metres below ground level (mbgl) and may extend to 50 mbgl, (2) the aquifer is gravel, cobbles, and boulders between 50 and at least 68.3 mbgl, which is the end of the boring, (3) the well is screened between 59.29 and 68.29 mbgl, and (4) the static water level on completion was 35.7 mbgl. PDP (2014, p.15) indicates the tested aquifer has a storativity of 1×10^{-6}, which is indicative of a confined aquifer. PDP (2014, p.17) also states that there is a potential for some leakage at this location.

In summary, at F44/0389:

- The aquifer is overlain by low permeability material, which is a requirement for a confined aquifer.
- The static water level was higher than the top of the aquifer (the aquifer was under pressure), which is a requirement for a confined aquifer.
- The aquifer has a very low storage coefficient, which is indicative of a confined aquifer.
- According to PDP (2014, p.17), there is a potential for some leakage at this location.

By the pSWLP definition, the aquifer tested at F44/0389 is a confined aquifer. We will examine the aquifer test data for the F44/0389 later in this report to focus on the question of leakage.

Borehole F44/0388 Geology and Static Groundwater Level. The boring log for borehole F44/0388 (BH11 in Figure 1) indicates: (1) clay bound silty gravel extends from 12.8 to 22.1 mbgl, (2) the aquifer is coarse silty gravel between 22.1 and 30.3 mbgl, (3) the well is screened between 24.25 and 30.25 mbgl, and (4) the static water level on completion was 13.52 mbgl. In addition, PDP (2014, p.13) describes the aquifer at F44/0388 as: "**highly permeable and well-confined with no indication of leakage from overlying strata over the period of the test**[14] and a very low storage coefficient."

In summary, at F44/0388:

- The aquifer is overlain by low permeability material, which is a requirement for a confined aquifer.

[13] Pattle Delamore Partners LTD (PDP). 2014. Wendonside Groundwater Abstraction Consent Applications: Groundwater Effects Report. Prepared for Wilkins Farming Limited. Dated August 2014.
[14] Bold font added by author.

- The static water level was higher than the top of the aquifer (the aquifer was under pressure), which is a requirement for a confined aquifer.

- The aquifer has a very low storage coefficient, which is indicative of a confined aquifer.

- The aquifer is: "… well-confined with no indication of leakage from overlying strata …"

By the pSWLP definition ("An aquifer which is overlain by a low permeability or impermeable layer where water in the aquifer is under pressure"), the aquifer tested at F44/0388 is a confined aquifer, not semi-confined**.**

Borehole F44/0282 Geology and Static Groundwater Level . The boring log for the F44/0282 (Arada well) indicates: (1) clay bound gravel extends from about the surface to 52.5 mbgl, (2) the aquifer is loose silty, sandy gravel between 52.5 and at least 59.53 mbgl, which is the end of the boring, (3) the well is screened between 54 and 60 mbgl, and (4) the static water level on completion was 33.3 mbgl. PDP (2014, p.20) reports the tested aquifer has a storativity of 1 x 10^{-4} to 1 x 10^{-5}, which is indicative of a confined aquifer. PDP (2014, p.20) also states that there is a potential for some leakage at this location.

In summary, at the F44/0282:

- The aquifer is overlain by low permeability material, which is a requirement for a confined aquifer.

- The static water level was higher than the top of the aquifer (the aquifer was under pressure), which is a requirement for a confined aquifer.

- The aquifer has a very low storage coefficient, which is indicative of a confined aquifer.

- According to PDP (2014, p.20), there is a potential for some leakage at this location.

By the pSWLP definition, the aquifer tested at F44/0282 is a confined aquifer. We will examine aquifer test data for F44/0264, which is near F44/0282, later in this report to focus on the question of leakage.

Figure 2 (after text) is a hydrostratigraphic cross-section[15] of the Garvie Aquifer based on geological materials and groundwater levels encountered in borings aligned approximately transverse (southwest to northeast) to the reported groundwater flow direction (northwest to

[15] A hydrostratigraphic cross-section summarizes the water transmitting capabilities of subsurface geologic units. "Aquifers" such as sand and gravel, transmit groundwater readily. "Aquitards", such as clayey soil or massive rock, do not transmit groundwater readily.

southeast, from Wilson, 2008)[16]. Figure 2 also considers the results of the aquifer tests at F44/0388 and F44/0282 that indicate the aquifer is confined and bounded (see Section 4.4). Accordingly, in Figure 2, we have assigned some materials logged by the drillers as having a "silty" component as "aquitard" material, based on the hydraulic behaviour of the aquifer.

Figure 2 is consistent with Figure 3, the original conceptual model of the Garvie Aquifer (from the Environment Southland website). Both Figures 2 and 3 indicate that the Garvie Aquifer is overlain by an aquitard and bounded laterally (transverse to the groundwater flow direction) by low permeability material.[17]

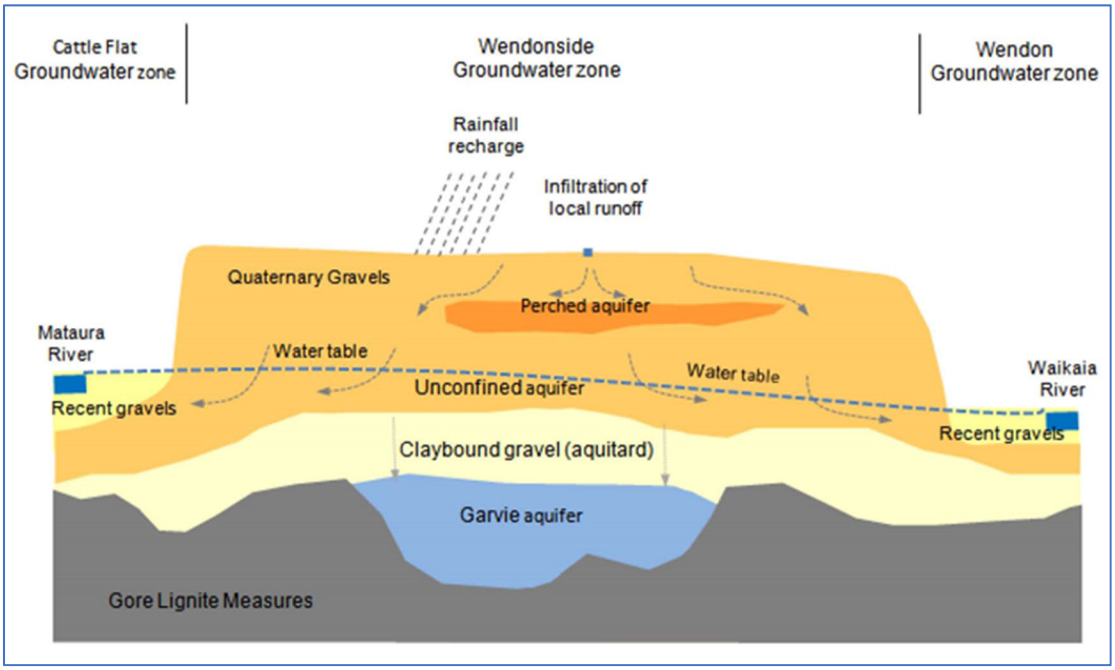

Figure 3. Original Conceptual Wendonside Terrace Hydrogeology (From the Environment Southland Website)

In summary, the site-specific geology and static groundwater elevation data indicate that in the central Wendonside area, at a minimum, the Garvie Aquifer is a confined aquifer that is bounded laterally (transverse to the groundwater flow direction). While some of the reporting on aquifer tests indicates the Garvie Aquifer is well-confined, other reporting suggests there is potential for some leakage. The question of leakage will be examined later in this report.

[16] Wilson K. 2008. Surface Water and Groundwater Relationships in the Mataura Catchment above Gore. Publication No. 2008-03. Environment Southland.

[17] Based on the geological descriptions at four adjacent borings and the aquifer test that indicated confined conditions, it is far more likely than not that the geology in F44/0264 was misclassified in the field.

4.2 Vertical Variations in Depth to Groundwater

Environment Southland's Beacon website states that for the Wendonside GMZ, "Differences in static water level between intermediate and deeper water-bearing layers reflect the semi-confined nature of the deeper groundwater."

The Environment Southland Beacon's website goes on to state:

"Depth to groundwater ranges from 3 to 5 metres below ground level around the northern margin of the Wendonside Terrace, to 15 to 20 metres below ground level in central areas, and up to 30 metres below ground level in deeper water-bearing layers. Differences in static water level between intermediate and deeper water-bearing layers reflect the semi-confined nature of deeper groundwater."

It is not clear how Environment Southland arrived at their conclusion of semi-confined conditions. While the differences in static groundwater levels between the intermediate and deep permeable units can indicate a potential for downward or upward groundwater flow, the differences in static groundwater levels alone only indicate separate water-bearing zones. Figure 4 (from Freeze and Cherry, 1979)[18] clearly demonstrates this concept.

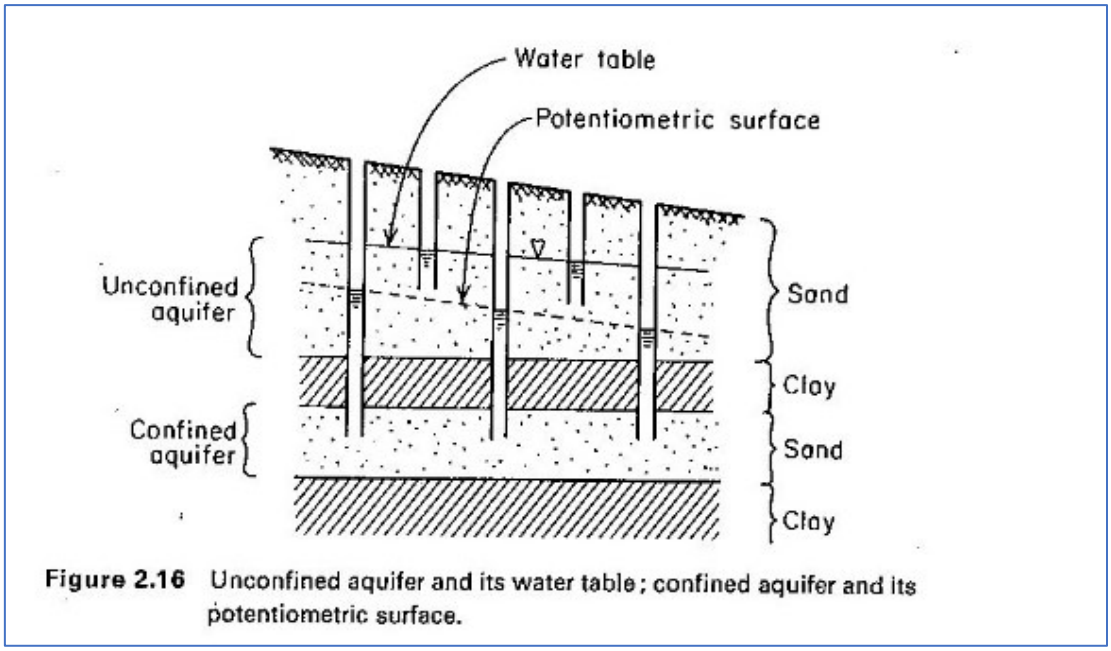

Figure 2.16 Unconfined aquifer and its water table; confined aquifer and its potentiometric surface.

Figure 4. Static Water Level Differences Can Indicate Separate/Distinct Aquifers

[18] Freeze RA and Cherry JA. 1979. Groundwater. Prentice-Hall, Inc. Englewood Cliffs, NJ.

4.3 Temporal and Annual Variations in Groundwater Elevations

Part of the pSWLP (2018, p.117) definition for an unconfined aquifer is: "… its **water table levels fluctuate both seasonally and from year to year**."[19] This statement suggests that a confined aquifer does not fluctuate seasonally and/or from year to year. Environment Southland's Beacon website states that in the Wendonside GMZ, "Groundwater levels in deeper semi-confined water bearing layers exhibit **limited response to seasonal variations in rainfall recharge**[20], instead following longer-term rainfall variation." It is not clear what "limited" means.

Figure 5 compares the long-term water level hydrograph for a Garvie well to a Waipounamu Aquifer well (an unconfined aquifer according to Beacon). The key factors to examine, according to the pSWLP definition of an unconfined aquifer, are whether the groundwater hydrograph exhibits seasonal and temporal fluctuations. Note that although the Garvie hydrograph uses the y-axis on the left and the Waipounamu hydrograph uses the y-axis on the right, both y-axes represent 5 m.

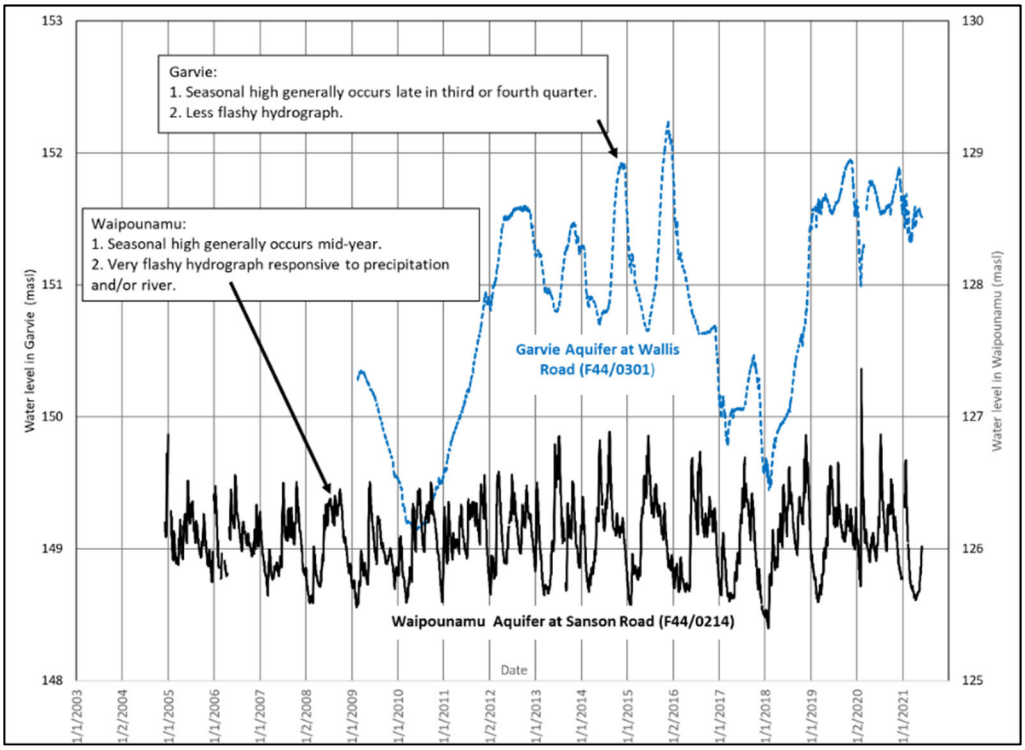

Figure 5. Comparison of Garvie and Waipounamu Groundwater Hydrographs

[19] Bold font added by author.
[20] Bold font added by author.

Figure 5 indicates seasonal cycles and flashiness (jagged) in the Waipounamu hydrograph, as expected for an unconfined aquifer. Seasonal cycles in the Garvie well hydrograph are less obvious if present at all, are apparently temporally offset in time relative to the Waipounamu cycles, and are much less flashy. The Garvie well hydrograph, therefore, is consistent with the Garvie Aquifer as a confined aquifer.

4.4 Garvie Aquifer "Aquifer Tests" - Revisited

We reviewed several of the aquifer tests conducted by PDP to determine if the drawdown response during aquifer tests on the Garvie Aquifer indicated semi-confined (leaky) conditions or confined conditions.

Figure 6 shows conceptual graphs of the expected drawdown responses during aquifer tests for "ideal" (perfectly confined), "leaky" ("semi-confined"), "unconfined" (water table), and "bounded" (laterally limited or connected to surface water) aquifers. In Figure 6, the panel on the left (from Freeze and Cherry, 1979) shows conceptual "Theis" type plots with both drawdown (y-axis) and time (x-axis) as log axes. The panel on the right are equivalent conceptual "Jacob" type plots that represent the same data but with drawdown on a linear y-axis and time on a log x-axis.

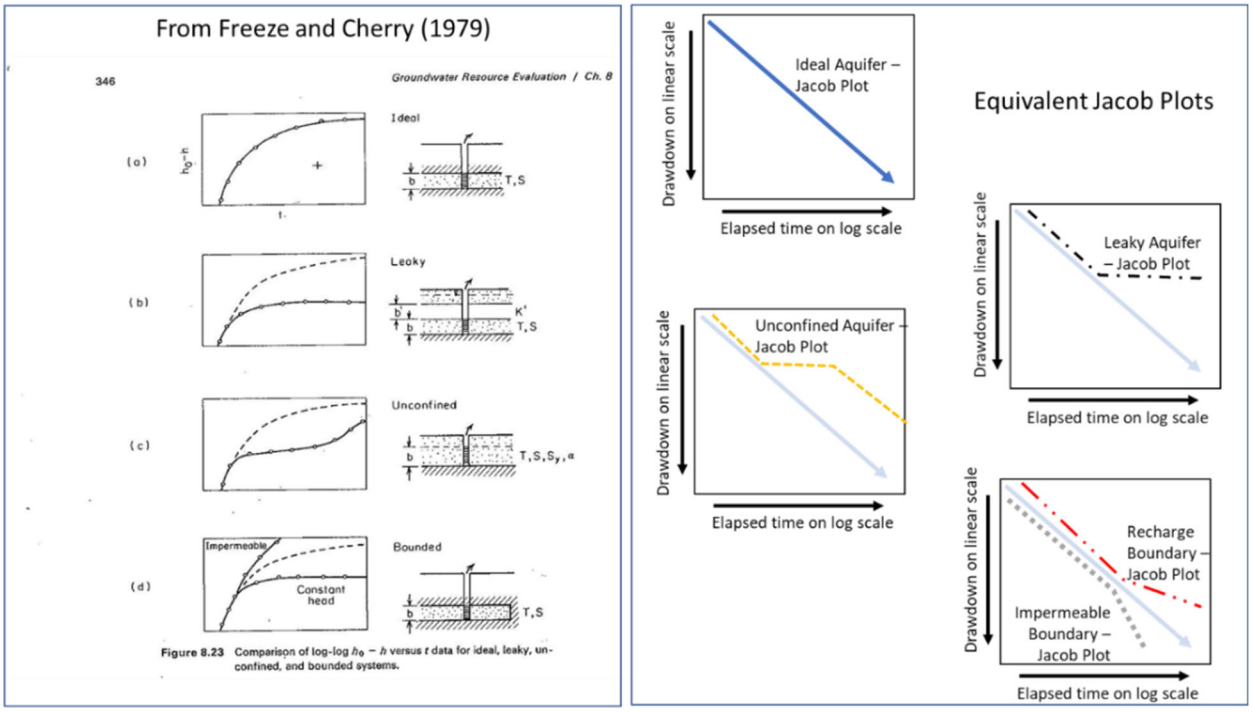

Figure 6. Expected Drawdown versus Time Responses for Various Aquifer Types

We compared several of the aquifer tests conducted on Garvie Aquifer wells to the conceptual plots in Figure 6 to determine if the Garvie Aquifer is leaky/semi-confined, or not.

F44/0389 Aquifer Test Review. Figure 7 (from PDP, 2014) is a Jacob Plot of the drawdown versus time data for the aquifer test on F44/0389 (BH 10 in Figure 1). PDP (2014, p.14) stated: "… It is possible that some leakage may occur as a result of pumping from the aquifer …" however, Figure 7 indicates no significant departure from ideal conditions in the drawdown response. Therefore, it is unclear why PDP (2014) suggested possible leakage.

F44/0388 Aquifer Test Review. Figure 8 (from PDP, 2014) is a Jacob Plot of the drawdown versus time data for the aquifer test at F44/0388 (BH 11 in Figure 1). PDP (2014, p.14) stated: "… It is possible that some leakage may occur as a result of pumping from the aquifer …" however, Figure 8 indicates no significant departure from ideal conditions in the drawdown response. Therefore, it is unclear why PDP (2014) suggested possible leakage.

F44/0282 Aquifer Test Review. Figure 9 is a Jacob plot of the drawdown versus time data that we prepared from the aquifer test at F44/0282 (Arada Bore). Figure 10 clearly indicates that the aquifer is bounded by barrier boundaries and that there is no indication of leakage. Figure 10 is a Theis type plot of the drawdown versus time data that we prepared from the aquifer test data (same data as the Jacob type plot). We also plotted the Theis curve (ideal confined conditions) on Figure 10 and matched the Theis curve to the observed data. Figure 10 also clearly indicates that the aquifer is bounded by one or more barrier boundaries and that there is no indication of leakage.

In summary, the aquifer test data we examined for the Garvie Aquifer in central Wendonside gave no indication of leaky or semi-confined conditions.

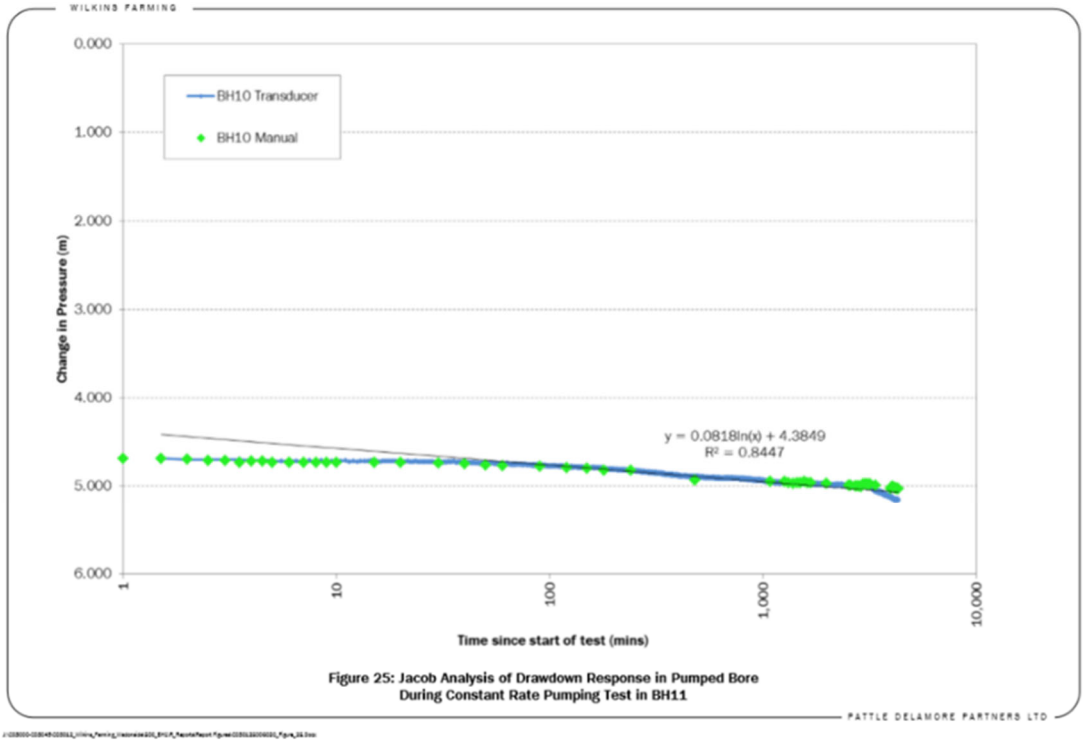

Figure 25: Jacob Analysis of Drawdown Response in Pumped Bore During Constant Rate Pumping Test in BH11

.. ***Figure 7. Jacob Plot of Aquifer Test Data – F44/0389 Pumping Well (note that "B11" in the PDP figure title should "BH10").***

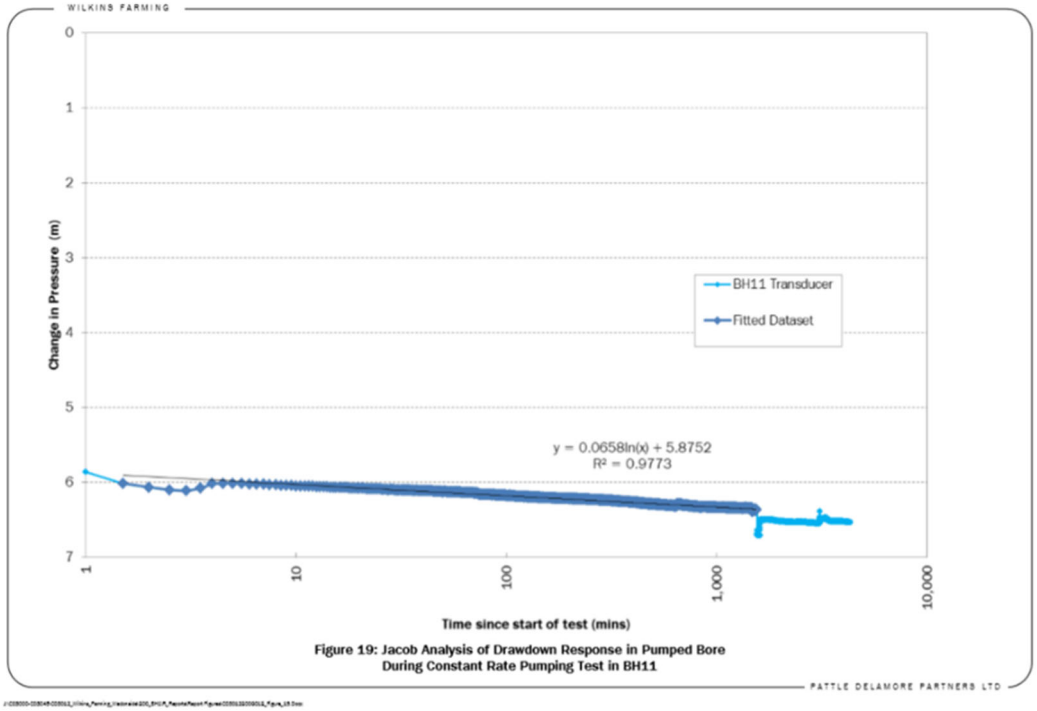

Figure 19: Jacob Analysis of Drawdown Response in Pumped Bore During Constant Rate Pumping Test in BH11

Figure 8. Jacob Plot of Aquifer Test Data – F44/0388 Pumping Well

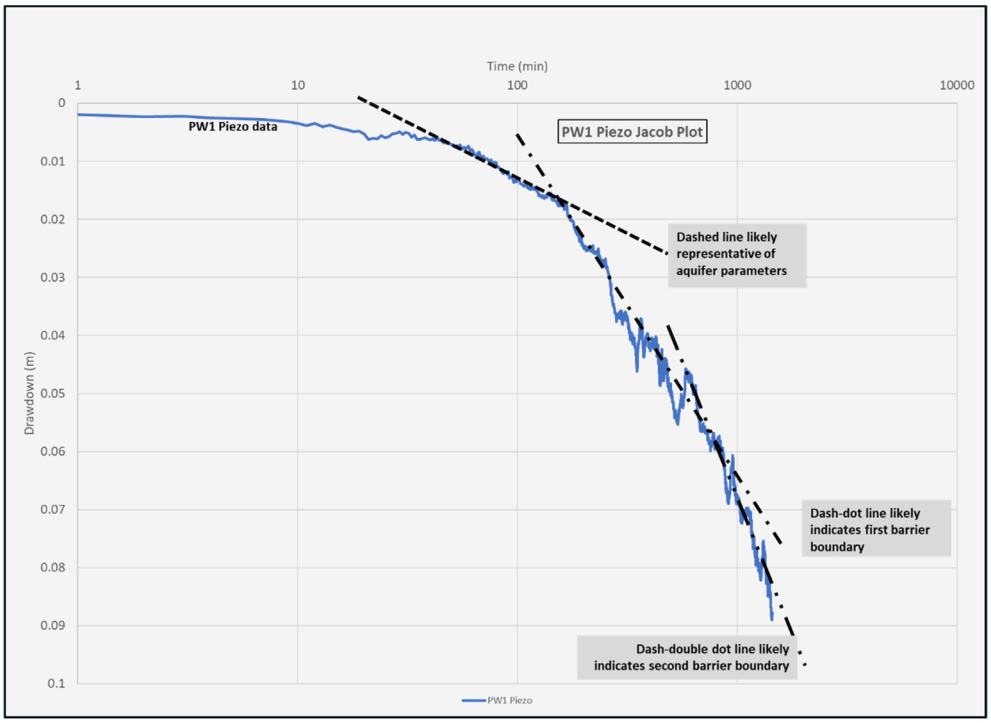

Figure 9. Jacob Plot of PW1 Piezo (F44/0264) for F44/0282 Aquifer Test

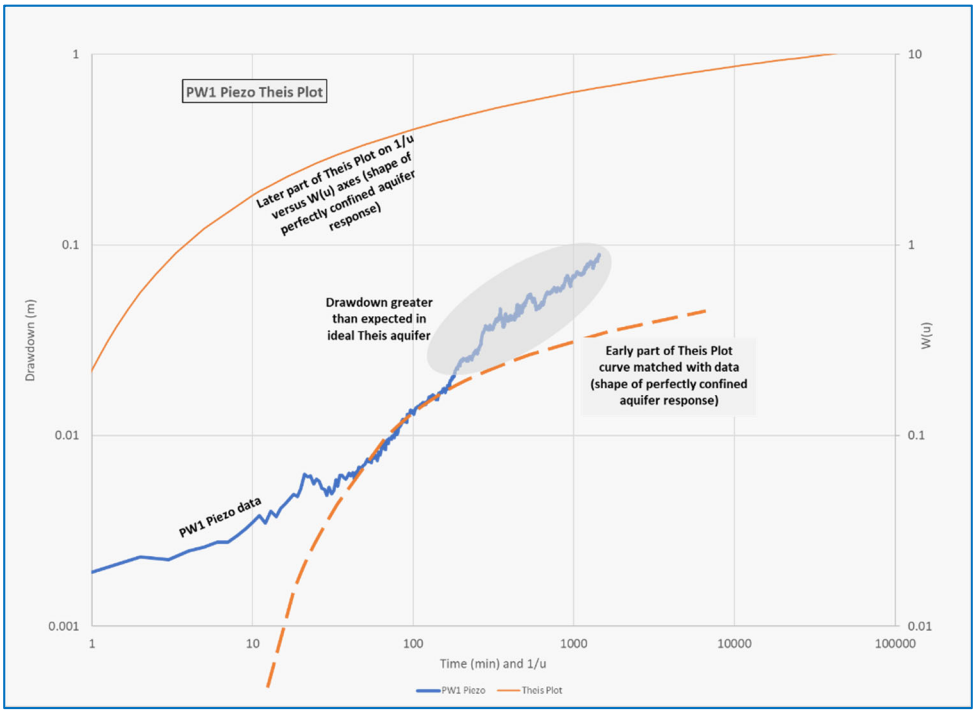

Figure 10. Theis Plot of PW1 Piezo (F44/0264) for F44/0282 Aquifer Test

5.0 SUMMARY AND CONCLUSIONS

The main purpose of this document was to examine site-specific hydrogeologic data for the Wendonside GMZ and Garvie Aquifer to determine whether the Garvie Aquifer should be classified as a "confined" or "semi-confined" aquifer, at least in central Wendonside. We examined the Garvie Aquifer with respect to geology, pressurization, groundwater level fluctuation patterns, storativity values, and drawdown trends from aquifer tests. Our review indicates:

- Geologic conditions in the central Wendonside area indicate there is an aquitard above the Garvie Aquifer, consistent with a confined aquifer designation for the Garvie Aquifer.

- Static groundwater elevations in wells completed in the Garvie Aquifer are above the top of the aquifer, consistent with a confined aquifer designation for the Garvie Aquifer.

- The observation of differences in static water levels between the mid-depth and deep water-bearing zones is not in itself an indicator of semi-confined or leaky conditions or hydraulic connection, as suggested by Environment Southland.

- The water level hydrograph for the Garvie Aquifer does not reflect seasonal cycles one would expect from an unconfined aquifer. This is consistent with a confined aquifer designation for the Garvie Aquifer.

- Low storativity values calculated for the Garvie Aquifer are consistent with a confined aquifer designation for the Garvie Aquifer.

- Aquifer test responses for the Garvie Aquifer indicate a well-confined, bounded aquifer; not a semi-confined/leaky aquifer.

None of the data we examined for the Garvie Aquifer for the central Wendonside area supports the notion that the Garvie Aquifer is semi-confined/leaky.

6.0 SIGNATURE

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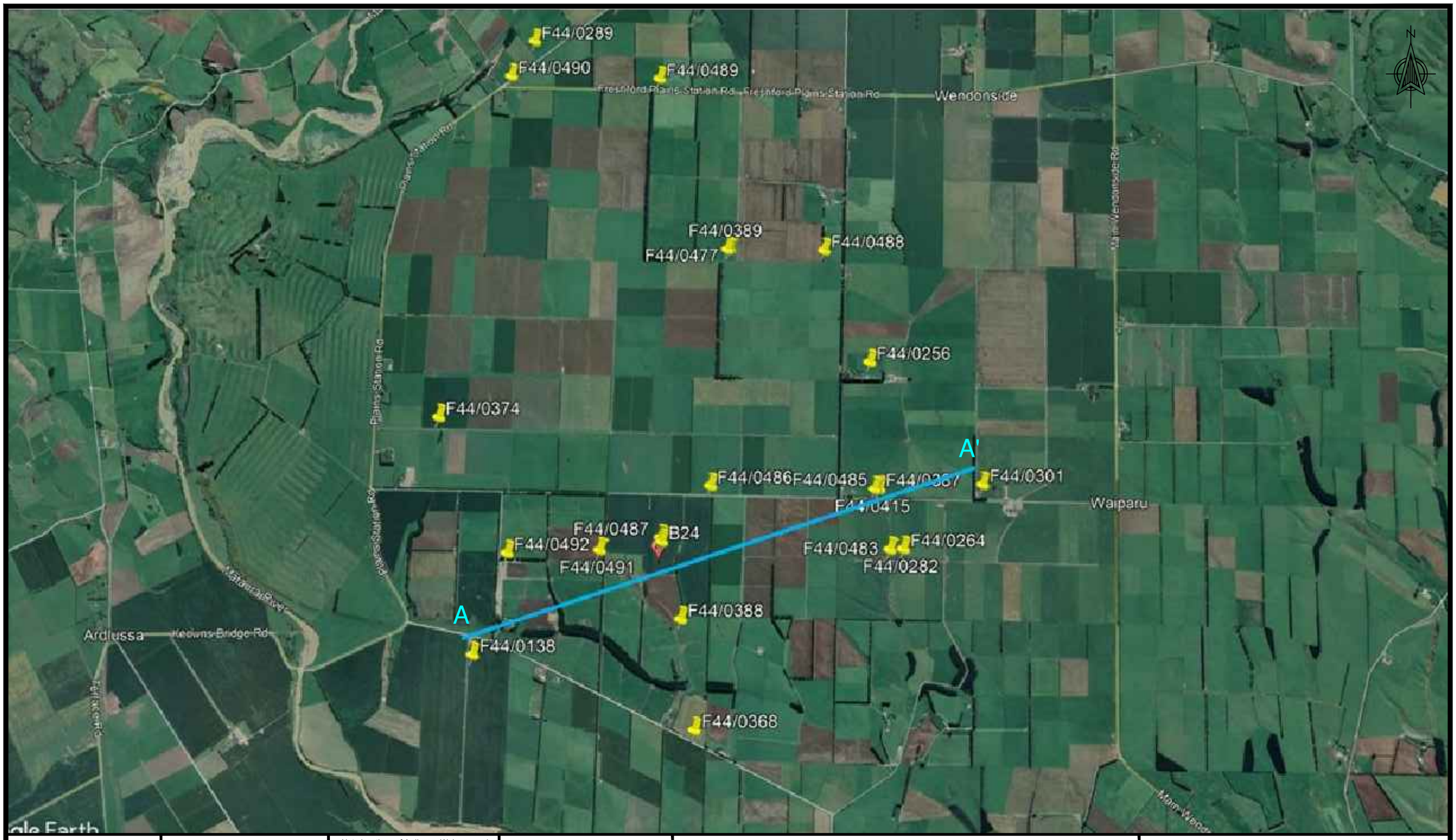
November 9, 2021

FIGURES



SCALE 1:30,000
0 500 1000m

File: K:\2021\31137-02 Wilkins Farming Co Ltd\CAD\Water and Land Plan\31137-02 Figure 2A.dwg Date: 2021/11/09

Note locations of Ardlussa, Waiparu, and Wendonside, and figure scale for locations of borings.

Source: Basemap provided by Google Earth Pro.

Dragun Corporation
Environmental Advisors

PROPOSED SOUTHLAND WATER AND LAND PLAN - WILKINS APPEAL
THE STATUS OF THE GARVIE AQUIFER GROUNDWATER
SOUTHLAND, NEW ZEALAND

FIGURE 2A
BORING LOCATION AND CROSS-SECTION ORIENTATION MAP

A

A'

ELEVATION
(masl)

190
180
170
160
150
140
130
120

F44/0138 (P)
F44/0492 (P)
F44/0491 (P)
F44/0487 (P)
F44/0388 (P)
F44/0486 (P)
F44/0415 (P)
F44/0485 (P)
F44/0387 (P)
F44/0282 (P)
F44/0264 (P)
F44/0301 (P)

ASSUMED GRADE

Wendonside
Aquifer/Aquitard

Garvie
Aquifer

Tested as bounded
confined aquifer

Tested as bounded
confined aquifer

LEGEND

- Aquifer Material in Boring
- Aquitard Material in Boring
- Hydrostratigraphic Boundary (interpreted)
- Initial Static Water Level
- Interpreted Aquifer Material
- Interpreted Aquitard Material
- Well Screen
- F44/#### Boring/Well Designation
- masl Metres above sea level
- (P) Projected

HORIZONTAL SCALE: NONE
VERTICAL SCALE: 1:500
VERTICAL EXAGGERATION: 20:1

File: K:\2021\31137-02 Wilkins Farming Co Ltd\CAD\Water and Land Plan\31137-02 Figure 2B Cross Section.dwg Date: 2021/11/09

NOTES:
1. Some borings are depicted slightly east or west to better illustrate the geology.
2. The position of hydrostratigraphic boundaries is explained in Section 4.1 of the text.

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PROPOSED SOUTHLAND WATER AND LAND PLAN - WILKINS APPEAL
THE STATUS OF THE GARVIE AQUIFER GROUNDWATER
SOUTHLAND, NEW ZEALAND

FIGURE 2B
CROSS-SECTION A-A'

ATTACHMENT

The Status of the Garvie

BH10

2100

MCNEILL DRILLING CO LTD
WATER BORE/WELL SUMMARY FORM

CLIENTS NAME: Bore 13 Ray Wilkins	Phone no.	RESOURCE CONSENT NO:
FULL ADDRESS: Wendon side Church Rd South Riversdale		BORE SIZE: 400mm
RAPID NO: 96		START DATE: 25/3/14
GRID REFERENCE: 2175315 , 5484028		FINISH DATE: 31/3/14
DRILLER: Neil Simmons		
MEASURED FROM: Ground 300mm UPSTAND ☑		MACHINE: DR24
TOTAL DEPTH BORE: 68.29m		DRILL METHOD: Dual rotary
TOP LEADER: 58.31m		
STATIC WATER LEVEL: 35.70m		
SCREEN :SLOT: 2.5mm		LENGTH: 9.00m
TYPE: Stainless Steel		SIZE: 340 mm
PVC SLOTTED: TOP:		BASE: 68.29m
SCREEN/LEADER/~~SUMP~~: 9.98		SUMP SIZE:
TOTAL CASING USED: 59.48m		
AIRLIFTED/PUMPED AT:		
TEST PUMP PERIOD:		
DRAWDOWN FROM SWL:		
AIR/PUMP INTAKE:		
BACTERIAL WATER TEST:		
CHEMICAL WATER TEST:		
IMPERVIOUS SEAL AT GROUND LEVEL AROUND CASING ☑		
CASING TOP SEALED TO PREVENT CONTAMINATION ☑		

COMMENTS:

BORE LOG:

00.00 - 4.5	yellow Silty Gravels
4.5 - 37.5	yellow Silty Gravels clay Bound
37.5 - 50	yellow Silty Gravels Some clay
50 - 63.5	yellow Sandy Gravels
63.5 - 67.8	Sandy Cobbles
67.8 - 68.3	gravels Boulders
68.3 - ~~68.3~~ TD	Clay

ENTERED

BH11

MCNEILL DRILLING CO LTD
WATER BORE/WELL
SUMMARY FORM

CLIENTS NAME: Bore 11 Ray Willkins	PHONE NO.	RESOURCE CONSENT NO:
FULL ADDRESS: Waipounamu Rd riversdale		BORE SIZE: 400mm
RAPID NO: 860		START DATE: 18/3/14
GRID REFERENCE: 2175117, 5480817		FINISH DATE: 21/3/14
DRILLER: Neil Simmons		
MEASURED FROM: Ground 300mm UPSTAND ☑		MACHINE: DR24
TOTAL DEPTH BORE: 34.26m		DRILL METHOD: Dual rotary
TOP LEADER: 23.25m		
STATIC WATER LEVEL: 13.52m		
SCREEN :SLOT: 2.5mm		LENGTH: 6.00m
TYPE: Stainless Steel		SIZE: 340mm
PVC SLOTTED: TOP:		BASE: 30.25m
SCREEN/LEADER/SUMP: 11.01		SUMP SIZE: 4.01m
TOTAL CASING USED: 24.40m		
AIRLIFTED/PUMPED AT:		
TEST PUMP PERIOD:		
DRAWDOWN FROM SWL:		
AIR/PUMP INTAKE:		
BACTERIAL WATER TEST:		
CHEMICAL WATER TEST:		
IMPERVIOUS SEAL AT GROUND LEVEL AROUND CASING ☑		
CASING TOP SEALED TO PREVENT CONTAMINATION ☑		
COMMENTS: Bore ID BH11PWSD. as told Mike Wilkins		

BORE LOG:

00.00- 4.2	yellow Silty Gravel
4.2 - 7.5	yellow clay Bound Silty Gravel
7.5 - 12.8	yellow Silty Gravel
12.8 - 22.1	yellow Silty Gravel Some Clay Bound
22.1 - 30.3	Coarse yellow Silty Gravel
30.3 - 32.8	Blue Silt
32.8 - 34.25	Blue mudstone

1434

Arada

MCNEILL DRILLING CO LTD
WATER BORE/WELL
SUMMARY FORM

CLIENTS NAME: Ray Withins	RESOURCE CONSENT NO: 205624
FULL ADDRESS: West Rd Riversdale	BORE SIZE: 12 inch
RAPID NO: N 5481512 E 2176965	START DATE: 25/7/08
GRID REFERENCE:	FINISH DATE: 29/7/08
DRILLER: E Pascoe	
MEASURED FROM: T.O.C 300mm UPSTAND ☑	MACHINE: V8 Schramm
TOTAL DEPTH BORE: 60m	DRILL METHOD: Holts
TOP LEADER: 53.5	
STATIC WATER LEVEL: 33.3	
SCREEN :SLOT: 2.5mm	LENGTH:
TYPE: S/S	SIZE:
PVC SLOTTED: — TOP: —	BASE:
SCREEN/LEADER/SUMP: 6m screen ½ leader	SUMP SIZE:
TOTAL CASING USED: 54m	
AIRLIFTED/PUMPED AT:	
TEST PUMP PERIOD:	
DRAWDOWN FROM SWL:	
AIR/PUMP INTAKE:	
BACTERIAL WATER TEST:	
CHEMICAL WATER TEST:	
IMPERVIOUS SEAL AT GROUND LEVEL AROUND CASING ☑	
CASING TOP SEALED TO PREVENT CONTAMINATION ☑	

COMMENTS: Caps readings at pump shed By road is N 5481514 E 2177302

BORE LOG:

00.00- 4m top Soil
4m - 48.5m Silty Sandy Clay Bd Gravels
48.5 - 52.5m Clay Bd Gravels
52.5 - 59.5m Tobee Silty Sandy Gravels