TECHNICAL MEMORANDUM

PROJECT NO.: WGA212384

DATE: 7 MAY 2025

COMPANY NAME	Te Kowhai East Limited Partnership
ATTENTION	Jon Crooks
SUBJECT	Potential Groundwater Supply, Te Kowhai East

1. INTRODUCTION

Te Kowhai East Limited Partnership (Te Kowhai East) is seeking to provide a water supply for a planned industrial land development at 30 Mathers Road, Te Kowhai. Initial assessments have previously been carried out, including a review of available information from Waikato Regional Council databases on nearby bores (WGA 2021), followed by on-site drilling and testing (WGA 2022).

This memorandum summarises the results of the initial desk top review and on-site testing to provide estimated bore capacities and treatment requirements for a water supply at the site.

2. GEOLOGICAL AND HYDROGEOLOGICAL SETTING

Hamilton Basin, a large tectonic basin centred on Hamilton City with an area of approximately 2,000 km^2 and traversed by the Waikato River. The basin is surrounded by ranges of Mesozoic (Manaia Hill Group) and Tertiary age (Te Kuiti and Waitemata Groups) rocks. At depth, basement greywacke underlies the sedimentary deposits that infill the basin (GNS 2005).

The basin is infilled with Tauranga Group alluvial sediments dating from the Pliocene to the middle Holocene, overlain by late Holocene unconsolidated alluvial and colluvial sediments. The Tauranga Group sediments are up to 300 m thick and include gravels, sands, silt, muds and peats of fluvial, lacustrine and distal ignimbritic origin. The Hinuera Formation of the Tauranga Group underlies much of the Hamilton Basin. This formation was deposited by braided river systems of the Waikato River, initiated by the supply of large volumes of sediment from volcanism in the Taupo Volcanic Zone (Petch 1987). Underlying the low hills within the basin are older ignimbrites, tephra deposits and alluvium (Lowe 2010).

The Hinuera Formation contains the aquifers used most extensively for water supplies across the Hamilton Basin. Within this formation, the most productive aquifers consist of well sorted coarse sands and gravels. Discontinuous sequences of rhyolitic and pumiceous gravelly sands and gravels are interspersed with pumiceous silt, clay and peat layers. Lithological variability generally results in multiple zones of higher permeability within the formation rather than a single, continuous aquifer (Schofield 1972). The upper sedimentary layers contain perched aquifers, which can dry out over the summer period and generally drain to the closest gully system.

The proposed development area is situated in an area of paleochannel formed by the historical Waikato River, referred to as the Te Kowhai Channel (McCraw 2011). These paleochannel areas can contain grater thicknesses of Hinuera Formation sands and gravels than in nearby areas outside the paleochannel alignment.

Literature values for the hydraulic conductivity of sediments in the Hamilton Basin range from 0.5 m/day in the silt and peat layers to 13.5 m/day in the course gravelly sands. Aquifer transmissivity values derived from pumping tests range from 10 m^2/day to 1,000 m^2/day but are usually less than 100 m^2/day. The deeper aquifers have variable aquifer properties and analyses of local pumping tests have resulted in transmissivities calculated at between 20 m^2/day and 300 m^2/day. Local bore flow rates in the area are described in Section 3.

Regional groundwater flows in the area of Hamilton are generally towards the northwest, from the basin edges to the southeast. Major groundwater discharge occurs into the Waikato River and its tributaries located in deeply incised gullies (Petch and Marshall 1988).

The estimated transmissivity values from testing of nearby bores suggest aquifer hydraulic conductivities may decline with increasing depth of cover. However, the increased depth provides additional available water column to allow higher drawdown during pumping and therefore production flow rates.

3. NEARBY BORES

There are few deep bores in the Te Kowhai area. There is a 500 m deep exploration drill hole (72_9171, registered under the name Waikato Natural Gases Ltd) at 139 Onion Road but no lithological data is available in the WRC database. The deepest water bore within 2.5 km of the centre of the site is only 52 m deep.

Current groundwater use and historical flow testing information provides some indications on the potential flow rates from production bores, although many local bores have targeted domestic supply quantities only. Nearby bores have been tested at rates up to 1,560 m^3/day. The most productive bore (WRC 72_9372) is a 150 mm diameter, 86 m deep bore used for irrigation water supply. Most nearby bores have been tested at rates less than 200 m^3/day as they were designed to meet smaller demands.

Based on the available information from nearby bores, it appears that multiple water supply bores would be needed to provide the volumes required for the size of the Te Kowhai East development. These bores could be distributed in locations strategically positioned to enable future connection to the Hamilton City Council supply network.

Local treatment of water from these bores would be required to comply with NZ Drinking Water Standards for pathogens, salinity and dissolved iron. These treatment systems can be designed based on water sample analysis results from test bores.

Increased water flow rates are expected to be needed to meet peak use demands. Local storage of treated water may be required to provide security of supply during the expected peak demand periods.

Overall, based on our initial high-level review of the available information on other properties (WGA 2021), it appeared that new water supply bores could provide a supply to enable initial development of the land parcels in the area. Therefore, a drilling and testing programme was carried out in 2022 on the site.

4. ON-SITE EXPLORATION BORES

Two pilot holes were drilled on the site in 2022, approximately 1,100 m apart. Within each drill hole a 100 mm diameter water supply bore was installed. These bores were screened in two different and relatively deep aquifers.

The pilot drillhole at the first site (Bore 1), is located close to Te Kowhai Road and was drilled to depth of 202 m below ground level (bgl). Logging of the drilling samples indicated the geology consists predominantly of clay and silt layers with pumice down to 120 m bgl (below ground level). The pilot hole drilling samples indicated Bore 1 intersected a very clean gravel layer at 195 m bgl. Water flow testing from Bore 1 indicated this layer could produce a very high flow. The water quality from this aquifer is such that additional filtration and treatment for salts, dissolved iron and manganese, and boron is likely to be required.

When drilling the second test bore (Bore 2), a shallower pumice gravel aquifer (115 m bgl) showed potential as a productive layer (i.e. less silt than a similar layer intersected in Bore 1). Given the water quality characteristics of water from Bore 1, this shallower level aquifer was targeted by Bore 2 with the screen installed at 114.5 m to 120.8 m bgl.

The purpose of constructing 100 mm diameter “test” bores was to explore if there is sufficient groundwater available at an appropriate quality to meet the water supply requirements for the proposed subdivision. The preliminary drilling results from the two test bores at Te Kowhai East indicate full-size production bores should be able to access aquifers capable of delivering flows sufficient to meet the projected water supply requirements for the development. The 100 mm diameter bores also enable laboratory testing of the water quality prior to the installation of larger diameter production bores.

5. POTENTIAL ABSTRACTION RATES

Production flow tests were carried out on both bores. Each test was 8 hours in duration at a flow rate of 14 m^3/hour. WGA has carried out initial assessments of potential production bore capacity based on the recorded final drawdown from these tests and assumed bore depths (Table 1, Figure 1, Figure 2).

The final yield of any production bore will still need to be established once the bore is installed. This is achieved by undertaking a stepped flow rate test at the bore, to support the engineers in designating an appropriate pump and setting the placement of the pump inside the bore. A longer constant rate pumping test will also need to be performed at each production bore, with the drawdown curves analyses to support an assessment of effects arising from the proposed takes. However, the initial results from the existing tests are considered sufficient to apply for water allocation.

Table 1: Estimated Production Bore Capacities based on Existing Test Parameters

PARAMETER	BORE 1	BORE 2	UNITS
Duration of pumping	8	8	hours
Test flow rate	14	14	m^3/hour
Daily flow rate	336	336	m^3/day
Static water level	1.8	6	m bgl (1)
Bore water level after 8 hours pumping	7.5	16	m bgl (1)
Drawdown	5.7	10	m
Estimated aquifer Transmissivity from Specific Discharge values	59	34	m^2/day
Depth to top of bore screen	195	114.5	m bgl
Initial estimated potential maximum flow for a large diameter production bore	5,000 (2)	1,500 (2)	m^3/day

Notes: *1) m bgl is meters below ground level.*

2) Values based on a range of aquifer parameters and assumed bore depths as shown in Figures 1 and 2.

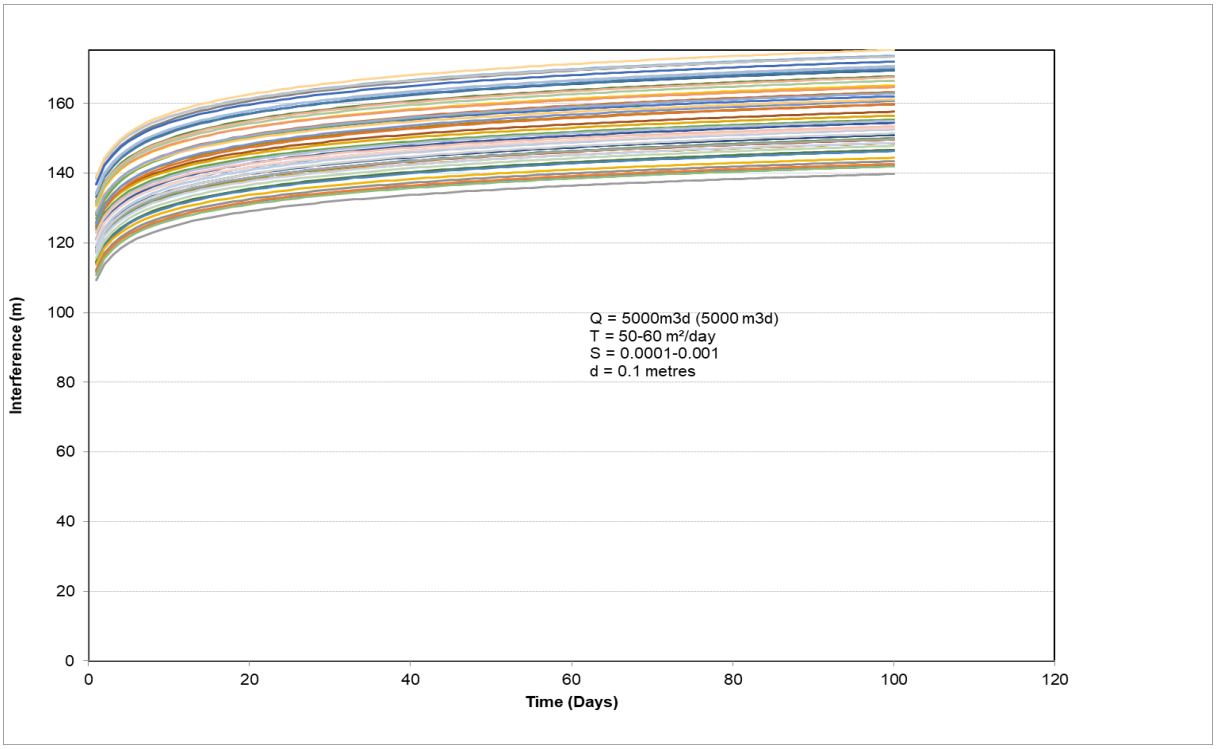


Figure 1: Estimated Bore 1 Drawdown Based on Initial Production Test Results

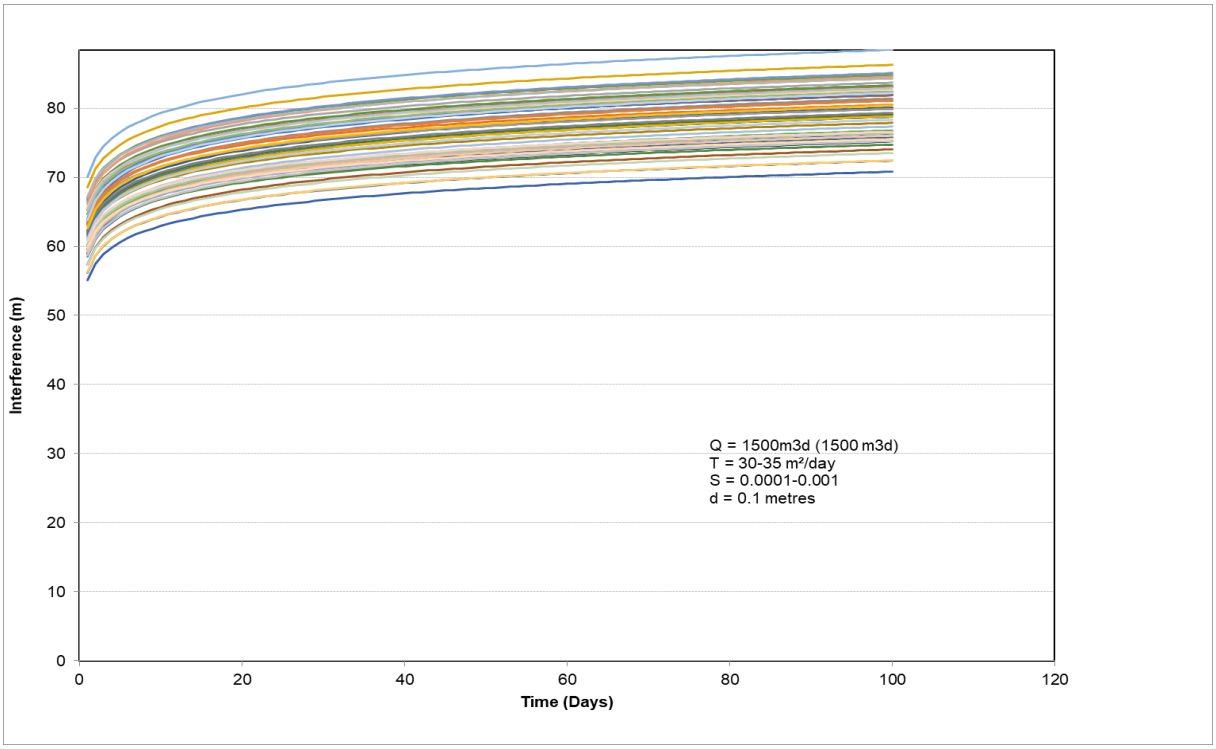


Figure 2: Estimated Bore 2 Drawdown Based on Initial Production Test Results

Te Kowhai East have calculated the estimated water requirements for the development based on four demand scenarios (Table 2). The water requirements under each demand scenario have been considered with and without water use reduction fixtures (Table 3). The initial results indicate that Bore 2 alone could meet the daily requirements for three of the four scenarios (Table 3).

Table 2: Basis for Water Use Scenarios

SCENARIO MODELS[1]		POPULATION	STANDARD USAGE	WITH WATER REDUCTION FIXTURES (WRF)
		People Over 188 ha	Litres/Person/Day	
1	RITS – 45 people/ha	8,460	260	240
2	Economic Case[2]	2,200	260	240
3	Day staff – high usage[3]	2,200	60	40
4	Day staff – low usage[3]	2,200	40	20

Notes: (1) Demand calculated by Te Kowhai East*.*
(2) Economic Case as per Urban Economics directly employed full time equivalents.
(3) It is anticipated that day staff usage will closely match wastewater flow allowances based on GD06 Table 18.

Table 3: Calculated Water Requirements for the Te Kowhai East Site

SCENARIO		STANDARD USAGE			WITH WATER REDUCTION FIXTURES			
Municipal or Bore Supply		Average Demand m^3/year	Average Demand m^3/day	Peak Demand L/s	Average Demand m^3/year	Average Demand m^3/day	Average Demand L/s	Peak Demand L/s
1	RITS – 45 p/ha	802,854	2,200	127	741,096	2,030	23.50	117.50
2	Economic Case	208,780	572	33	192,720	528	6.11	30.56
3	Day staff – high usage	48,180	132	8	32,120	88	1.02	5.09
4	Day staff – low usage	32,120	88	5	16,060	44	0.51	2.55

An abstraction of up to 2,200 m^3/day from one bore could cause relatively large drawdown in groundwater pressure around the production bore. However, there are few deep bores in this area. The closest deep bore to Bore 1 is located approximately 2.5 km to the west. The closest deep bore to Bore 2 is located approximately 2 km to the north.

Alternatively, to manage potential drawdown effects on other deep bores, the proposed take can be split between the two bore sites to reduce the drawdown effect of one abstraction point.

6. WATER QUALITY

Both bores would need significant water treatment systems installed to ensure the delivered water quality complies with New Zealand drinking water standards. The water quality sample from Bore 1 shows high concentrations of salts, dissolved iron and manganese, and boron. In terms of water quality, Bore 2 has slightly lower sodium chloride, dissolved iron, dissolved manganese and boron. The boron concentration is over the drinking water standard, and the other parameters will require treatment to manage taste and staining issues.

One approach to potentially reduce water treatment requirements is blending and dilution of the bore water with the rainwater harvesting. This approach may also mitigate the need for a decentralised treatment.

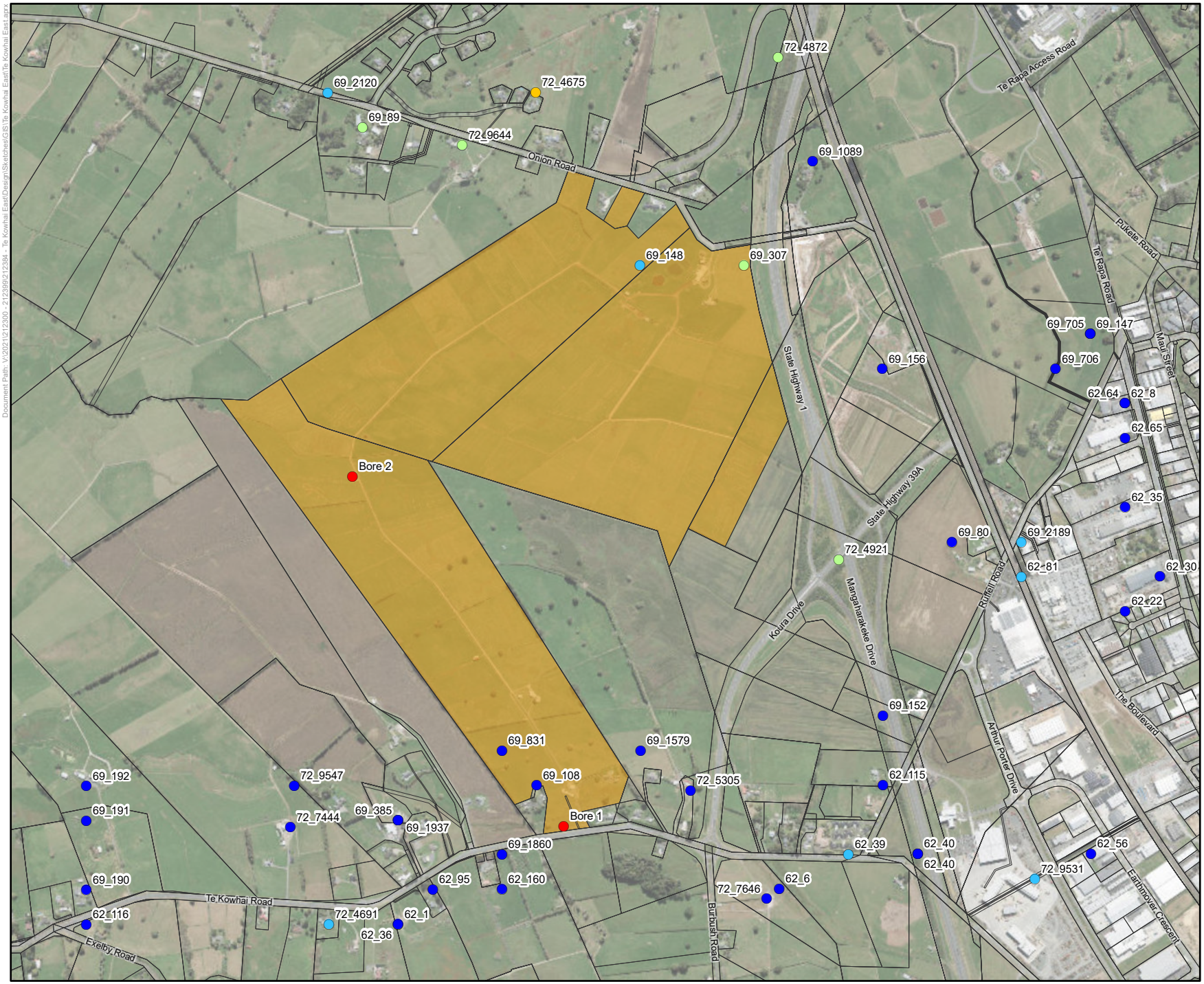
The difference in bore water quality with collected rainwater may be significant enough to enable blending to achieve a suitable water quality. Bore 2 would require approximately 50% dilution to meet drinking water criteria. Alternatively, a reverse osmosis system can be installed to provide the drinking water component at the lower drinking water volumes. For example, based on Scenario 3, staff numbers and high usage volumes would require treatment at 92 L/min, which should be achievable with commercial reverse osmosis systems.

Yours Sincerely

Clare Houlbrooke
Principal Hydrogeologist
WALLBRIDGE GILBERT AZTEC

APPENDIX A BORE MAP
APPENDIX B REFERENCES

APPENDIX A
BORE MAP



LEGEND

Bore (Depth (m))

- <10
- 10 - 25
- 25 - 50
- 50 - 75
- >75

Property Boundary

N

0 100 200 300 400 m

Scale 1:15,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure **1**

Te Kowhai East

Potential Investigation Locations

DAILY DRILLING REPORT

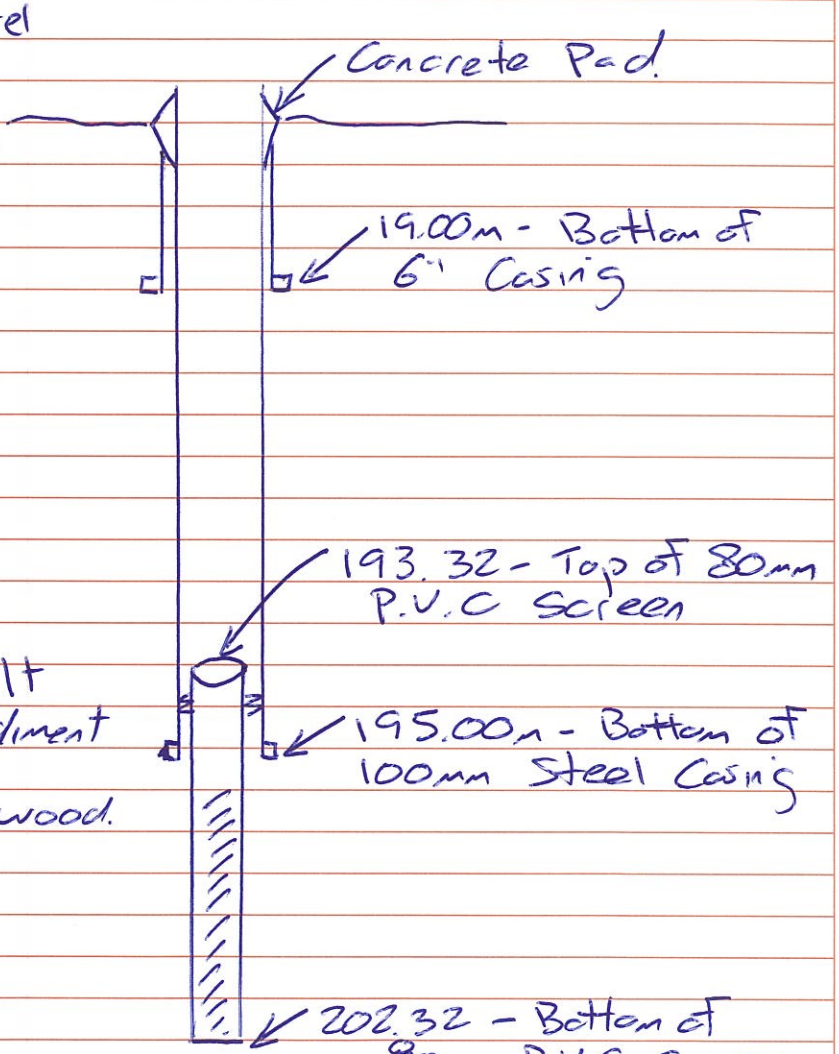
Brown Bros. (N.Z) Limited, P.O. Box 10183, Hamilton
Phone: 07 849 2919 | Fax: 07 849 1729
Email: kelly@brownbro.co.nz

BROWN BROS DRILLING

DATE	26 August 2022	DRILLING METHOD	Mud Rotary
CLIENT	Te Kowhai East Partnership	BORE DIAMETER	
STREET LOCATION	270 Te Kowhai Rd	DRILLING FROM	To
TOWN / CITY	Horotiu	CASING FROM	To
BORE #	1	S.W.L. (m)	1.80m

METHOD	FROM	TO	RUN	RECOVERY	
Geology	BH1				
	0.00	17.68			Blue sand gravel
	17.68	30.73			Silt
	30.73	32.42			Peat
	32.42	38.76			Green silt Pumice
	38.75	45.22			Silt Pumice
	45.22	47.41			Pumice
	47.41	57.63			Peat
	57.63	61.20			Pumice
	61.20	68.00			Peat
	68.00	90.38			Pumice & Peat
	90.38	99.76			Green Silt
	99.76	111.47			Pumice Peat
	111.47	113.72			Pumice
	113.72	117.86			Fine Sand silt
	117.86	120.00			Peat
	120.00	129.05			Green silt
	129.05	135.18			Green grey shell silt
	135.18	187.30			Peat, silt, marine sediment
	187.30	193.22			Gravel with wood.
	193.22	194.40			Gravel with some wood.
	194.40	195.50			Grey Mudstone
	195.50	200.30			Blue Gravel
	200.30	203.17			Gravel - little silt
	203.17	205.00			Silt Gravel
	205.00	207.76			Gravel - little silt
	207.76	210.00			Brown silt - EOH

Test Well Schematic



COMMENTS AND MATERIALS

Pump Test Data: 8 hour Pump Test with bore producing 14m³/hr. drawing down to 7.50m below ground level - Stable

DRILLER	KILOMETRES	TIME	WORK HRS	TOTAL HRS
Drilling Rig 3	Drill Rig	Rig Working		Start
Driller	Heavy Tender	Stand-by		Finish
Assistant	Light Tender	Compressor		Total
Assistant	Transporter	Travel		
Other	Utility	After Hours		
Clients Rep	Other	Other		Motel

DAILY DRILLING REPORT

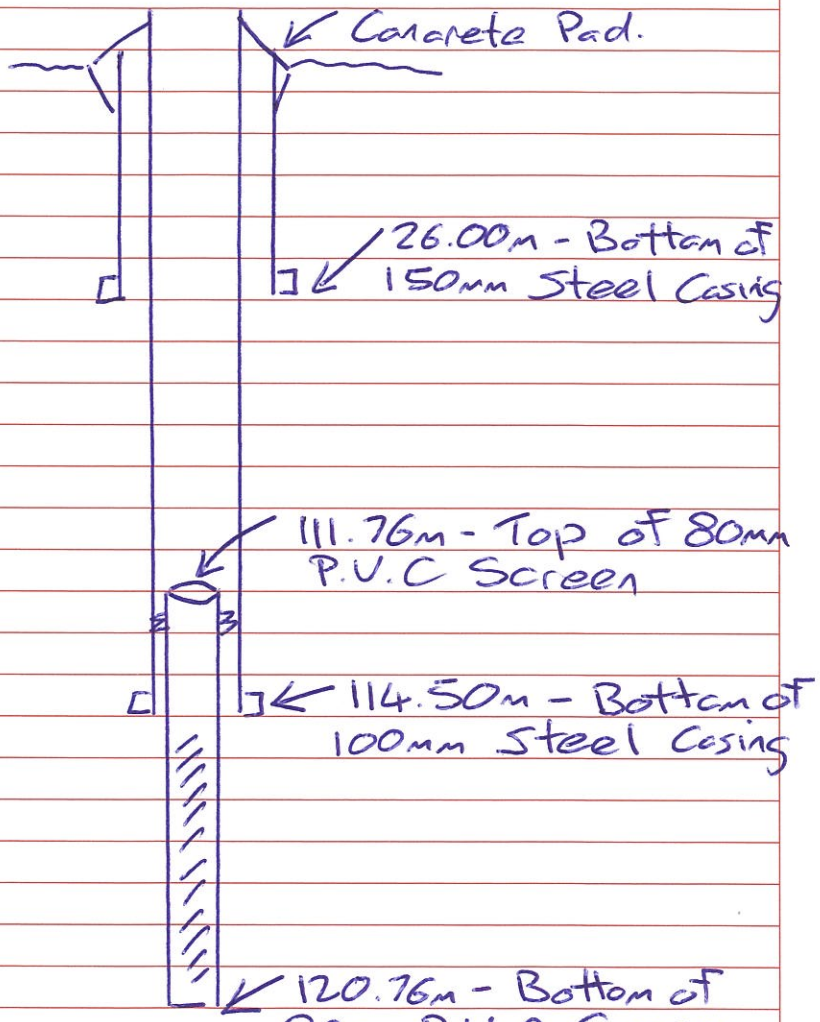
Brown Bros. (N.Z) Limited, P.O. Box 10183, Hamilton
Phone: 07 849 2919 | Fax: 07 849 1729
Email: kelly@brownbro.co.nz

BROWN BROS DRILLING

DATE	3 October 2022	DRILLING METHOD	Mud Rotary
CLIENT	Te Kowhai East Partnership	BORE DIAMETER	
STREET LOCATION	270 Te Kowhai Rd	DRILLING FROM	To
TOWN / CITY	Horotiu	CASING FROM	To
BORE #	2 - Test Bore	S.W.L. (m)	6.00

METHOD	FROM	TO	RUN	RECOVERY	Geology
	0.00	7.20			Silt
	7.20	25.24			Grey sand pumice
	25.24	27.35			Peat
	27.35	31.00			Silt
	31.00	49.66			Green sand pumice
	49.66	54.63			White pumice
	54.63	70.00			Peat Pumice-layered.
	70.00	72.00			Pumice
	72.00	86.45			Yellow grey Silt
	86.45	92.78			White Pumice
	92.78	111.66			Silts
	111.66	114.56			Pumice with tree
	114.56	122.00			Pumice
	122.00	129.21			Green Silt
	129.21	141.93			Silts
	141.93	152.27			Mud Stone
	152.27	159.60			Peat
	159.60	166.37			Silt
	166.37	187.21			Gritty Silt
	187.21	189.13			Blue gravel silt
	189.13	192.19			Green Blue gravel
	192.19	196.77			Grey Silt peat
	196.77	200.30			Gravel with vegetation
	200.30	203.45			Gravel
	203.45	209.50			Grey Silt - EOH

Well Schematic



COMMENTS AND MATERIALS

Pump Test Data: 8 hour Pump Test with Bore Producing 14m³/hr drawing down and stable at 16.00m below ground level

DRILLER	3	KILOMETRES		TIME	WORK HRS	TOTAL HRS	
Drilling Rig		Drill Rig		Rig Working		Start	
Driller		Heavy Tender		Stand-by		Finish	
Assistant		Light Tender		Compressor		Total	
Assistant		Transporter		Travel			
Other		Utility		After Hours			
Clients Rep		Other		Other		Motel	

APPENDIX B
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