WGA

TECHNICAL MEMORANDUM

PROJECT NO.: WGA253159

DOCUMENT NO.: WGA253159-HY-TM-0001_B

DATE: 17 MARCH 2026

COMPANY NAME	Waiheke Mon E Limited
ATTENTION	s 9(2)(a)
SUBJECT	Waiheke Onsen Groundwater Sourced Water Supply Assessment for Fast Track Consent Referral

EXECUTIVE SUMMARY

Waiheke Mon E Limited (WME) has engaged Wallbridge Gilbert Aztec (WGA) to provide hydrogeological services relating to the supply of bore water to support the consenting of Waiheke Onsen located at 32 Tiri Road, Oneroa, Waiheke Island (the Site). The Site is located between Oneroa and Matiatia Bay, approximately 900 m east of the Matiatia Bay ferry terminal.

The Site is not currently served by any water supply infrastructure networks. Options available to service the required supply are limited to roof rainwater capture, groundwater abstraction from the greywacke bedrock, and water treatment and reuse. The supply of warm mineralised groundwater for the onsen facility is a key component of the proposed development. A water supply bore, the WME Bore, has been installed at the northern end of the Site to a depth of 400 m for this purpose.

Fractured greywacke forms the bedrock for much of the island. This greywacke is the main component of the Waiheke Aquifer, which is designated as a High-use Aquifer Management Area under the Auckland Unitary Plan (AUP). Under the AUP, groundwater allocation from this aquifer should not exceed 35% of average annual recharge as determined by the Auckland Council (AC). AC has advised that the western side of Waiheke Island currently has groundwater totalling approximately 37,000 m^3/year available for allocation. Applications for resource consents from within this area are still being accepted. There is no indication from groundwater level monitoring records that existing groundwater abstraction would be placing the local resource under pressure.

Based on the production capacities of nearby deep bores, the WME Bore has an estimated production capacity of 135 m^3/day. However, allocable groundwater availability on Waiheke Island under the AUP is approximately 210 m^3/year per hectare of contributing catchment to any specific bore. Based on an estimated groundwater contributing catchment to the WME Bore of 28.3 ha, groundwater available to this bore is approximately 5,940 m^3/year or an average of 16.3 m^3/day. Drawdown effects from groundwater abstraction at 16.3 m^3/day are not expected to significantly impact water availability at nearby bores.

The annual groundwater allocation can be taken at any time though the year. The bore's estimated production capacity is substantially higher than the average allocable groundwater available to the bore. This differential enables higher production rates during the peak occupation season, offset by lower production during off-peak periods. This operational flexibility would enable WME to manage the use of water from different sources to meet the needs of the Waiheke Onsen facility.

A methodology has been provided as a basis for further assessment of groundwater availability and potential effects on nearby users and surface water bodies. This methodology may form the basis for the production of a substantive report to support consenting of a groundwater take under a fast-track consenting process.

Based on WGA's experience, and the information which has been received and evaluated to date, WGA can see no reason why the consenting of a groundwater take to support the Waiheke Onsen development could not proceed under a fast-track application.

1. INTRODUCTION

Waiheke Mon E Limited (WME) has engaged Wallbridge Gilbert Aztec (WGA) to provide hydrogeological services relating to the supply of bore water to support the consenting of Waiheke Onsen located at 32 Tiri Road, Oneroa, Waiheke Island (the Site). The Site is located between Oneroa and Matiatia Bay, approximately 900 m east of the Matiatia Bay ferry terminal (Figure 1).

An application is to be lodged for acceptance of this project into a fast-track consents approval process. This application is seeking authorisation for consenting of the development of a hotel and spa complex, and associated infrastructure (Figure A1 attached in Appendix A).

The Site is not currently served by any water supply infrastructure networks. Options available to service the required supply are limited to roof rainwater capture, groundwater abstraction from the greywacke bedrock that is targeted by most bores on Waiheke Island, and water treatment and reuse.

This memorandum provides a high-level summary of the potential availability of groundwater from the aquifer underlying the Site to provide for the proposed development. WGA understands this memorandum is to be used to support the application to have the development consented through the fast-track process. A substantive water supply and effects assessment report would need to be produced in the future to support the consent application.

2. WATER REQUIREMENTS

An initial assessment of water demand for Waiheke Onsen has been undertaken by Maven Associates Ltd (Maven). The projected average daily water demands for the development are summarised on a monthly basis in Table 1. WGA understands that the volumes identified in Table 1 are required to address the needs for potable quality water at the facility. On-site uses that do not require water of a potable standard are to be addressed through water recycling and reuse, with these volumes not included in Table 1. Of the totals summarised in Table 1, the average daily demand for bore water under the current water supply planning is 16 m^3/day (Watersmart 2026), although this may vary on a seasonal basis.

Table 1: Projected Water Demand

MONTH	TOTAL (L/day) (1,2)
January	59,232
February	56,288
March	50,399
April	41,567
May	29,790
June	25,080
July	26,846
August	25,080
September	32,734
October	41,567
November	47,455
December	56,288

Note:

1) Source Maven (2026), Table 3.

2) Demand has taken water reuse and projected seasonal occupancy of facilities into account. The values presented represent the required “new” water to supply the facility.

LEGEND

- Bores
- Site

N

0 100 200 300 m

Scale 1:8,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 1

Waiheke Onsen Groundwater Take

Locality Map

3. AUCKLAND COUNCIL POLICIES AND RULES

AC policies and rules applying to the taking of groundwater on Waiheke Island are presented in Appendix B. From the perspective of fast-track consenting of the proposed abstraction for the Waimauku West development, the key matters are as follows.

Policy D1.3.

1. Manage proposals to take and use water from High-use Aquifer Management Areas in Table D1.3.1 to prevent groundwater allocation exceeding availability, also having regard to Table B1 Aquifer water availabilities in Appendix 3 Aquifer water availabilities and levels.
2. Require resource consents for all proposals to take and use water from the High Use Aquifer Management Areas in Table D1.3.1 (other than takes permitted by section 14(3)(b) of the Resource Management Act 1991) to assess the impacts of the proposal on water availability levels and to take account of new information on water availability as it becomes available.

The aquifers underlying Waiheke Island are cumulatively referred to as the Waiheke Aquifer, and are treated as a single aquifer for the purposes of the Auckland Unitary Plan (AUP). The combined aquifers underlying Waiheke Island are defined as a High Use Management Area for groundwater under the AUP. The implications of this definition are considered in Section 4.3, below.

Under the AUP Appendix 3: Aquifer Water Availabilities and Levels, Table 1, the Waiheke Aquifer is considered to come under the description of “All other aquifers with connection to a surface water body”. On that basis, groundwater allocation should not exceed 35% of average annual recharge as determined by AC.

A complete assessment of the proposed abstraction against the Auckland Unitary Plan policies and rules would be provided as part of the substantive report evaluating the effects of the proposed groundwater take.

4. GROUNDWATER RESOURCE

4.1 Geology

The geology of the western end of Waiheke Island consists predominantly of hard fractured dark grey sandstones and siltstones that, for the purposes of this report, are collectively referred to as greywacke (Figure 2). A lens of siliceous argillite enclosed in the greywacke intersects the southeastern corner of the Site. The greywacke, which forms the bedrock for much of the island, is overlain to the east by a marine sandstone called the Oneroa Member of the Waitemata Group rock sequence. Silts, sands and gravels belonging to the Tauranga Group fill the valley floors to the north and west of the Site.

4.2 Aquifer Characteristics

The existing WME Bore has not yet been tested to determine the hydraulic characteristics of the surrounding greywacke aquifer. However, hydrogeological investigations undertaken on a wide range of projects in the Auckland and Waikato regions provide good guidance on the expected behaviour of the greywacke bedrock across these regions.

The key parameter of interest for assessing drawdown effects on nearby bores is the hydraulic conductivity of the greywacke bulk rock mass. Analysis of data from a pumping test performed on the Church Bay Bore on Waiheke Island (Alldred & Field 1990) produced a hydraulic conductivity value of 3×10^{-7} m/s. Investigations into the hydraulic characteristics of greywacke exposed in quarries around the Auckland region indicated the bulk rock mass hydraulic conductivity of this lithology may range from 1×10^{-7} m/s (PDP 2002) to 2×10^{-5} m/s (PDP 2025). For the purposes of this preliminary assessment, a value of 3×10^{-7} m/s has been accepted.

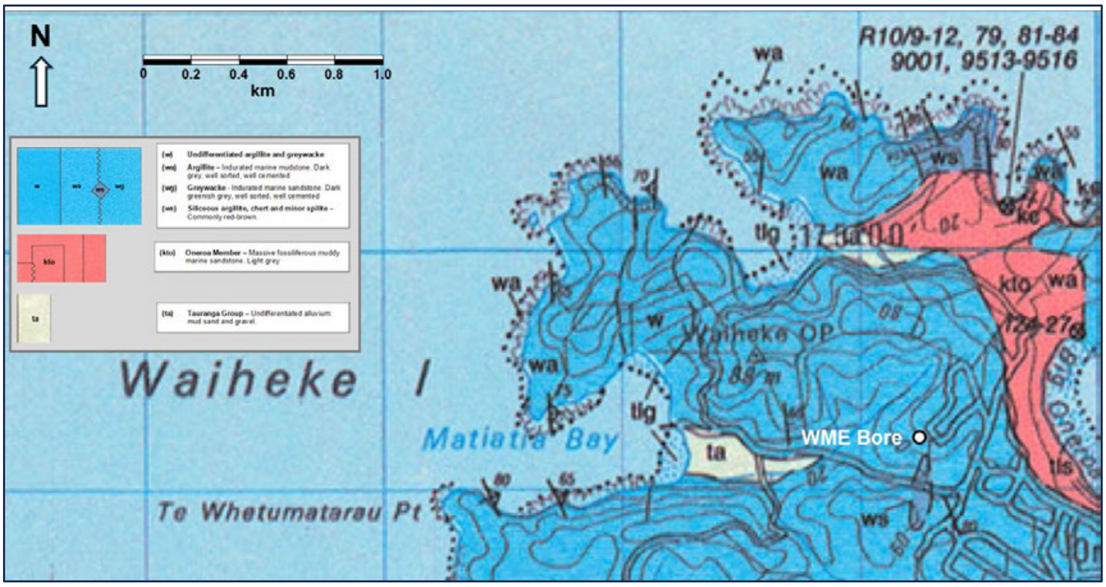


Figure 4-1: Extract of Geological Map for Western Waiheke Island (Kermode 1992)

4.3 Groundwater Available for Allocation

The combined aquifers underlying Waiheke Island are defined as a High Use Management Area for groundwater under the AUP (Figure 3). AC has advised that the western side of Waiheke Island currently has approximately 37,000 m^3/year available for allocation and applications for resource consents from within this area are still being accepted (Delport 2025, pers comm). An annual allocation of 37,000 m^3/year is equivalent to an average abstraction of slightly over 100 m^3/day.

WGA understands that AC calculates the groundwater allocation for the greywacke aquifer under Waiheke Island by multiplying the applicable catchment area by the groundwater recharge rate to give the annual volumetric recharge. The allocable volume is limited to 35% of the annual volumetric recharge, with the remainder left in the aquifer to prevent environmental impacts such as saline water intrusion to the aquifer.

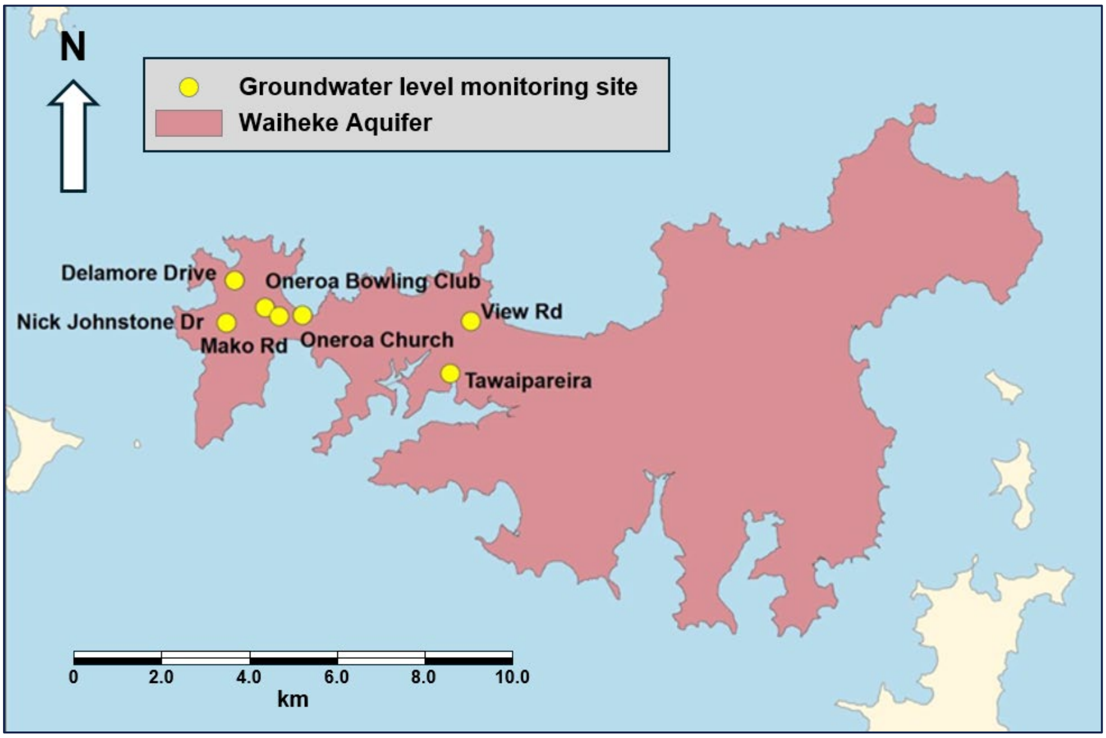


Figure 4-2: Aquifers and Monitoring Sites on Waiheke Island (from Kalbus et al 2017)

Average annual rainfall in the general area of the site has been estimated at between 1,100 mm and 1,200 mm (Chapell 2014). Taking into account the local topography, geology and land cover, rainfall recharge to the underlying groundwater system is expected to be in the order of 5% of rainfall (SKM 2007). This value derived from stream flow gauging and soil moisture balance modelling is consistent with assessment of recharge to greywacke aquifers elsewhere in Auckland. On this basis, recharge to groundwater is approximately 600 mm/ha/year. With annual allocation limited to 35% of the annual volumetric recharge, this equates to an allocable volume of approximately 204 m^3/ha/year.

A contributing catchment needs to be defined for a specific water supply bore to determine the allocable water available to that bore. The estimated contributing catchment for the WME Bore is presented in Figure 4. The boundaries to this catchment have been defined based on the following assumptions:

1. Pumping from the WME Bore will not result in groundwater drawdown that will extend beyond nearby streams that are expected to carry permanent flows.
2. Pumping from the WME Bore may result in drawdown of groundwater levels beneath ridgeline catchment divides, but will not significantly shift the position of the hydraulic catchment divide.

In addition to the above boundaries, the positions of connection contributing catchment boundaries are based on reasonable interpretation of the likely extent of any groundwater capture area. The contributing catchment presented in Figure 4 of 28.3 ha may overestimate the actual achievable catchment as the groundwater table along the eastern edge of the defined catchment, to the east of Tiri Road, may be too low for the WME Bore to capture groundwater from this area.

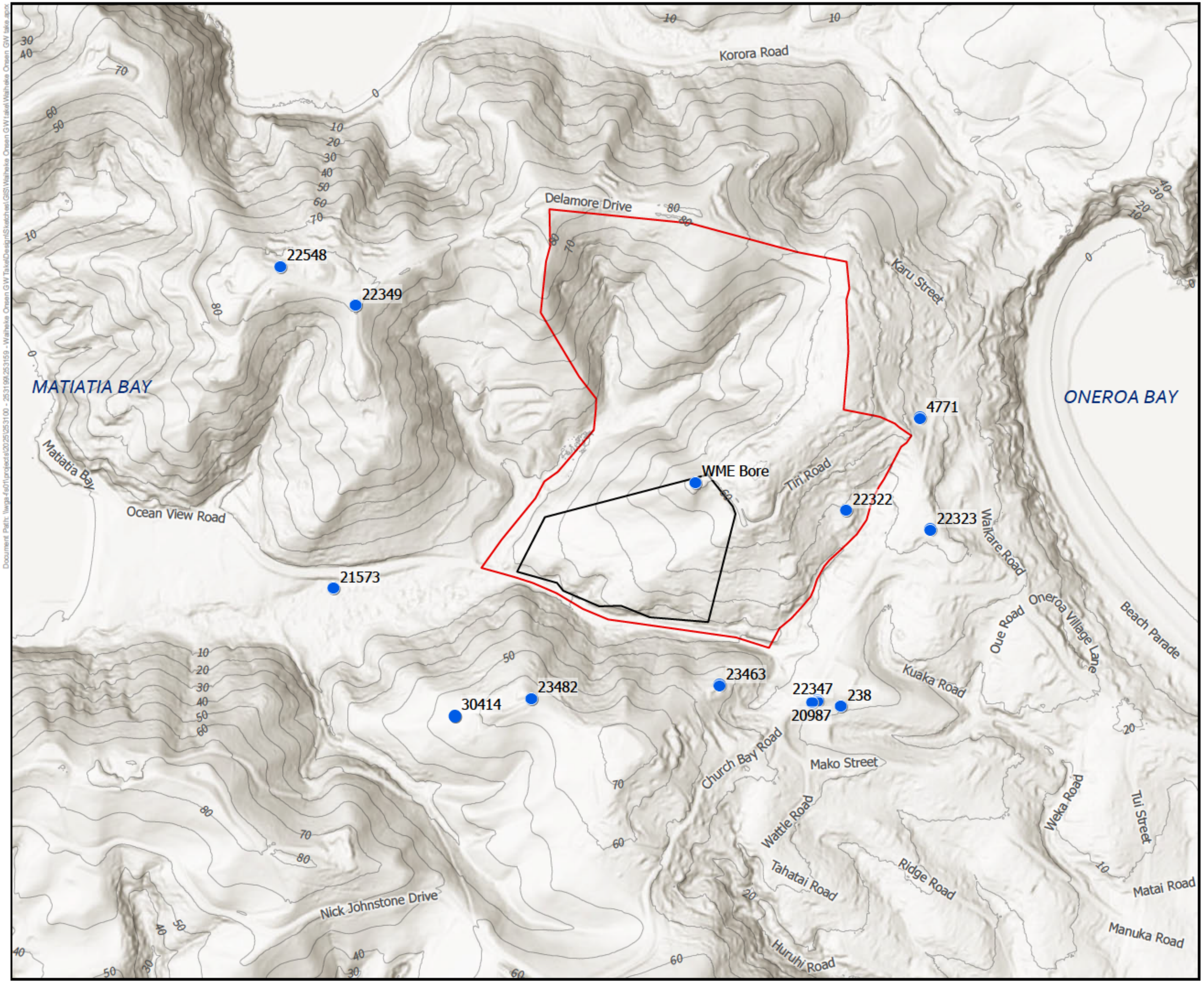
Based on the information presented above, WGA estimates that groundwater availability is approximately 210 m^3/year per hectare of contributing catchment (Table 2). For the defined contributing catchment of 28.3 ha, this equates to approximately 5,943 m^3/year or 16.3 m^3/day.

The largest uncertainty in any factor contributing to this calculation is the annual recharge rate, which has in other greywacke catchments exceeded around Auckland and in the Waikato reached 7%. However, an increase of 1% in rainfall recharge only results in an associated increase in available water of approximately 3 m^3/day.

Table 2: Groundwater Availability

PARAMETER	UNITS	PER HECTARE	WME BORE
Contributing Catchment Area	ha	1.0	28.3
	m^2	10,000	283,000
Rainfall Average	m/year	1.2	1.2
Recharge Percentage of Rainfall	%	5	5
Annual Recharge	m^3	600	16,980
Allocation Percentage of Recharge	%	35	35
Annual Availability	m^3	210	5,943
Average Daily Availability	m^3/day	0.6	16.3

The projected average daily availability of water from the WME Bore of 16.3 m^3 (16,300 L/day) is between 27% and 65% of the projected daily potable water demand for the facility (Table 1). However, it is reasonably expected that the bore production capacity will substantially exceed the average daily availability (refer to Section 4.5). Therefore, the daily water take from the bore may be varied throughout the year, to provide the Waiheke Onsen facility with flexibility in operational water management, provided the annual allocable volume of 5,943 m^3/year is not exceeded. The application of this flexibility is considered further in Section 4.7.



LEGEND

- Bores
- Site
- Contours
- Overland Flow Paths
- Contributing Catchment Area

N

0 100 200 300 m

Scale 1:8,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure 4

Waiheke Onsen Groundwater Take

Contributing Catchment Area to WME Bore

4.4 Local Groundwater Resource Status

A multi-level groundwater level monitoring well on Delamore Drive (Bore ID 22349) is maintained and monitored manually by AC (Figure 3). The Delamore Drive monitoring well is located approximately 600 m northwest from the WME Bore. The geological log for this monitoring well indicates the entire bore was drilled through greywacke, with the exception of the surficial soils (Table C1 in Appendix C).

Monitoring of the Delamore Drive monitoring well started in 2005 (Table 3). The most recent publicly documented results are presented by Kalbus et al (2017).

Key points arising from monitoring of groundwater levels at the Delamore Drive monitoring well are as follows:

1. There is a steep downward hydraulic gradient between the two deeper monitoring points of approximately 0.35 m/m (Figure 5; Table 4). This downward gradient is indicative of a low local rock mass permeability and confirms that the local hills act as groundwater recharge areas.
2. The shallowest piezometer at this monitoring well (Delamore Drive @29) is likely to be consistently dry as it is above the groundwater table implied by the records from the two deeper piezometers.
3. Groundwater levels in the shallower piezometer (Delamore Drive @55) cover a much larger range than those in the deeper piezometer (Figure 5). The deeper piezometer is installed at a level approximately 23 m below mean sea level, whereas the shallower piezometer is approximately 28 m above mean sea level (Table 3). The fluctuations in the shallower piezometer represent the change in groundwater storage on a monthly and seasonal basis. These changes are in response to variations in rainfall recharge, local groundwater abstraction and the release of groundwater to local streams. The deeper groundwater levels do not change much over time as they are buffered by storage in the aquifer above sea level.
4. The local groundwater level trends for the period from 2006 to 2015 are either flat (Delamore Drive @105) or rising (Delamore Drive @55) (Table 4).

Overall, there was no indication that groundwater abstraction during the documented monitoring period from 2006 to 2015 was placing the local groundwater resource under pressure.

Table 3: Delamore Drive Groundwater Level Monitoring Well Layout (Kalbus et al 2017)

PARAMETER	DELAMORE DRIVE @29	DELAMORE DRIVE @55	DELAMORE DRIVE @105
Site Number	6479001	6479003	6479005
Bore ID	22349		
Easting/Northing (NZTM)	1778232 E, 5927911 N		
Ground Elevation (m RL) (1)	81.7	82.6	81.7
Depth (m BGL)	29	55	105
Screen Elevation (m RL) (1)	52.7	27.6	-23.3
Date Recording Commenced	27/07/2005	12/12/2005	27/07/2005
Lithology	Highly weathered greywacke	Unweathered greywacke	Unweathered greywacke

Note:

1) Units of metres Relative Level (m RL), which is equivalent to metres above mean sea level. Negative values imply elevations below mean sea level.

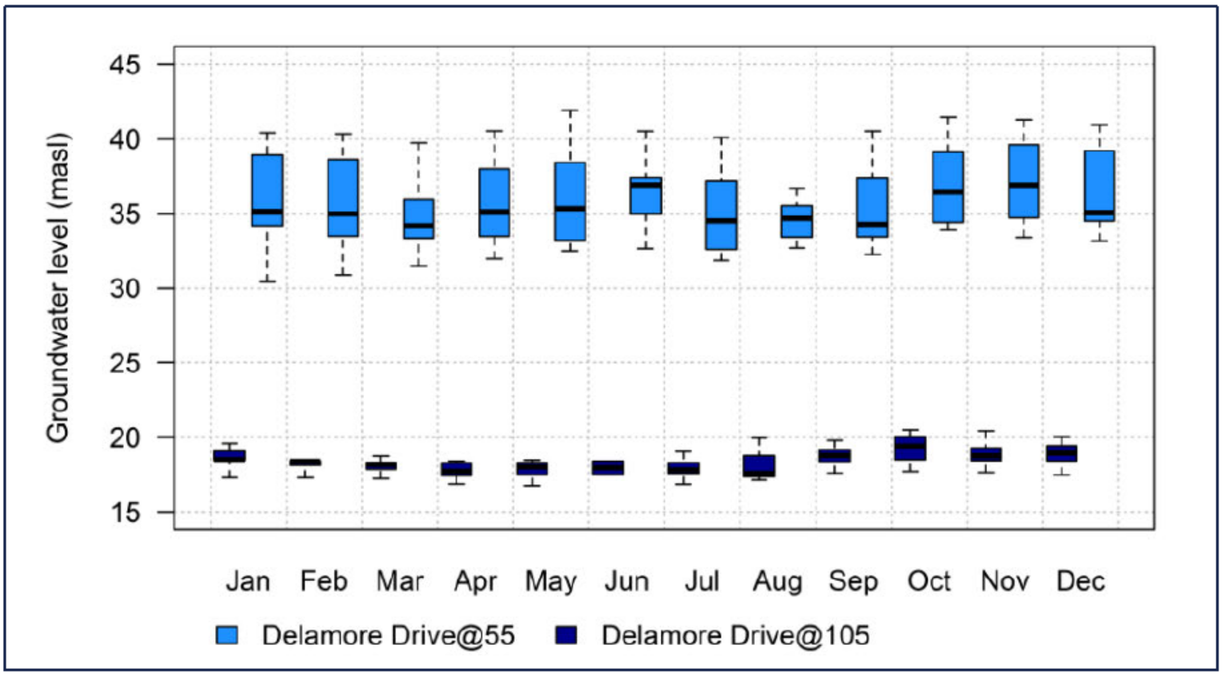


Figure 4-4: Monthly Groundwater Level Variations 2006-2015 at Delamore Drive (Kalbus et al 2017)

Table 4: Delamore Drive Groundwater Level Statistics, 2006 to 2015 (Kalbus et al 2017)

PARAMETER	DELAMORE DRIVE @55	DELAMORE DRIVE @105
Minimum groundwater level (m RL)	30.43	16.77
Maximum groundwater level (m RL)	41.92	20.49
Median groundwater level (m RL)	35.01	18.39
Average groundwater level (m RL)	35.86	18.37
Average downward vertical hydraulic gradient (m/m)	-	0.35 (1)
Trend (m/year)	0.66	-0.05

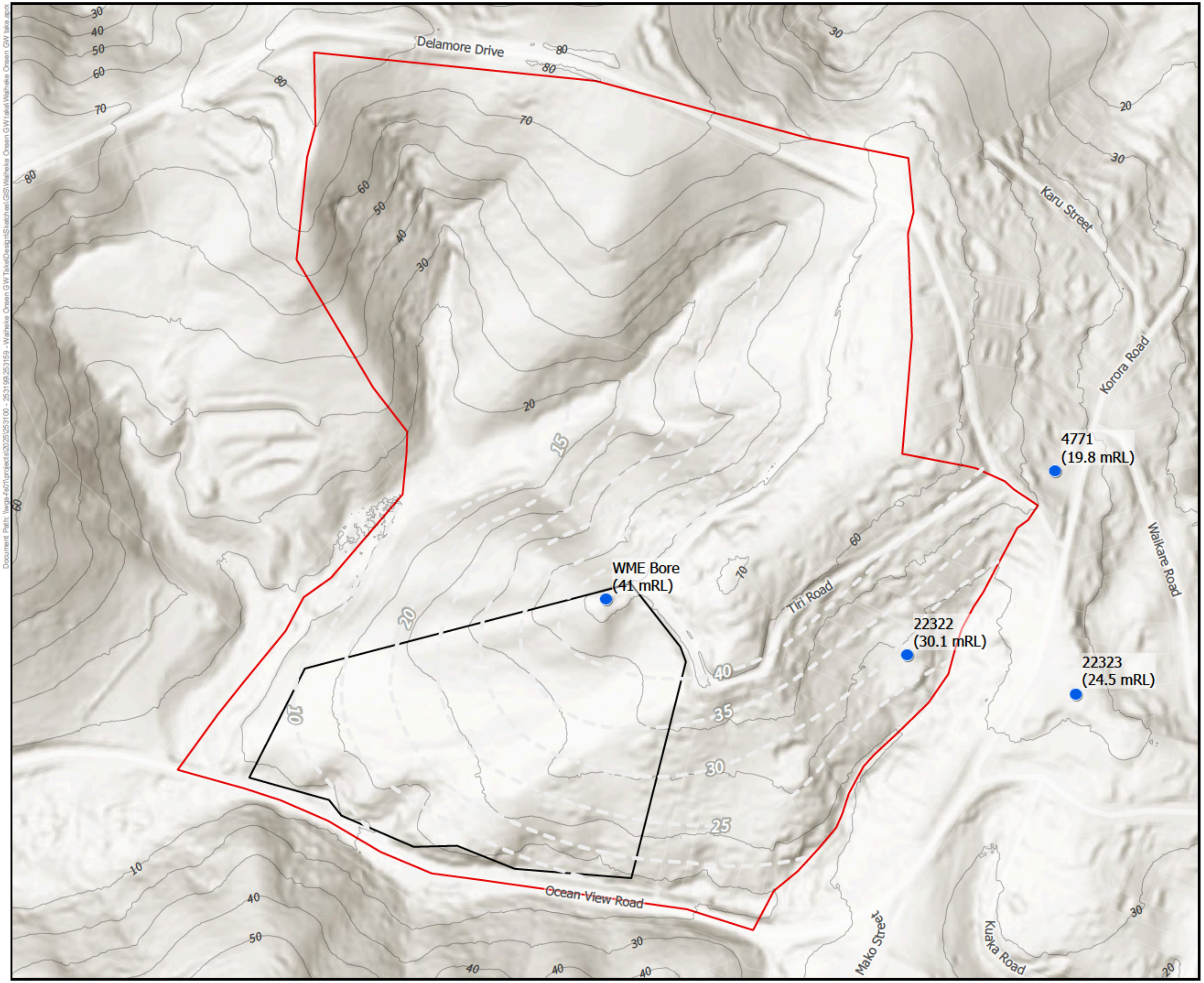
Note:

1) Hydraulic gradient value calculated based on assumed point pressure monitoring for these two piezometers at 55 m and 105 m BGL.

4.5 WME Bore Preliminary Production Capacity Estimate

The WME Bore was drilled to a depth of 400 m and is cased to a depth of 65 m BGL, with the bore being open-hole below that point (Figure C1 in Appendix C). Although the depth to groundwater in the driller's log (Figure C1) is given as 52.2 m BGL, it is likely that this measurement was affected by the drilling and well development process. Based on static groundwater level measurements from other nearby bores, it is reasonably expected that the static groundwater level in the WME Bore is on the order of 41 mRL (Figure 6), which equates to approximately 46 m BGL.

No hydraulic testing of the WME Bore has been undertaken to date, as it is expected that the bore will be deepened and the bore structure may be changed accordingly. In assessing the water supply capacity of the MWE Bore, WGA has assumed that no further work will be undertaken on extending the bore and the current structure of the casing will remain unchanged.



LEGEND

- Bores
- Groundwater Contours
- Contours
- Overland Flow Paths
- Site
- Contributing Catchment Area

N

0 25 50 75 100 m

Scale 1:4,000 @ A4

Coordinate System: NZGD 2000 New Zealand Transverse Mercator

WGA

Figure **6**

Waiheke Onsen Groundwater Take

Interpreted Local Groundwater Piezometric Map

Given the lack of test data from the WME Bore, a preliminary estimate for the potential abstraction rate has been derived from performance information for nearby bores. Water supply well performance summary information has been obtained from the Wells Aotearoa online database for 12 wells located within one kilometre of the WME Bore.

The production capacity of the WME Bore has been estimated based on the specific capacities of nearby bores (Table 5). The WME Bore production capacity is estimated at 135 m^3/day. The derivation of this bore performance is documented in greater detail in Appendix D. The calculated bore production capacity is significantly greater than the estimated average groundwater availability to the bore of 16.3 m^3/day (Table 2).

The difference between the WME Bore production capacity and the average groundwater availability at the bore implies that groundwater abstraction from the bore can be varied seasonally, provided the estimated annual availability of 5,943 m^3 (Table 2) is not exceeded. This characteristic of the bore would enable the proposed onsen facility to actively manage its abstraction rate to most efficiently support the needs of its clients. A set of tables demonstrating potential differences in abstraction rates for peak-season and off-season flows presented in Appendix E have been used to support the water supply modelling for the proposed Waiheke Onsen development.

Table 5: Production Capacities of WME Bore and Nearby Bores

BORE ID	OPEN HOLE LENGTH (m)	PRODUCTION CAPACITY (m^3/day)	DRAWDOWN DURING PRODUCTION (m)	BORE SPECIFIC CAPACITY (m^3/day/m)	SPECIFIC CAPACITY PER METRE OF OPEN HOLE (m^3/day/m/m)
4771	58	72	35	2.1	0.035
21573	87.1	158	78	2.0	0.023
22322	76.5	8	36	0.2	0.003
22323	75.5	53	24	2.2	0.029
22548	72	29	10	2.9	0.040
23463	157.5	6	41.6	0.1	0.001
23482	55	22	24	0.9	0.016
WME Bore	**336**	**135 (4)**	**19 (3)**	**7.1 (2)**	**0.021 (1)**

Notes:

1) Calculated as average from existing nearby deep bores.
2) Calculated based on specific capacity per metre of open hole and WME Bore open hole length.
3) Based on an estimated SWL of 46 m BGL and the casing depth of 65 m.
4) Calculated from specific capacity of bore and available drawdown.

4.6 Groundwater Drawdown Effects

A preliminary assessment of the potential drawdown effects on nearby bores has been based on the following assumptions:

1. Hydraulic conductivity: 3×10^{-7} m/s
2. Storativity: 0.03
3. Pumping rate: 16.3 m^3/day average through the production period
4. Production period: 365 days

An analysis of the potential drawdown effects with respect to distance from the WME Bore indicates drawdown at the nearest bore (22322, Figure 6), located approximately 230 mm from the WME Bore, would be approximately 0.25 m after 365 days pumping (Figure 7). This magnitude of interference drawdown is considered to be insignificant in terms of water availability at the neighbouring bore. A copy of the analysis sheet is provided in Appendix F. This projected drawdown does not take into account seasonal rainfall recharge to the aquifer system and therefore conservatively overestimates the extent and magnitude of groundwater drawdown to be expected.

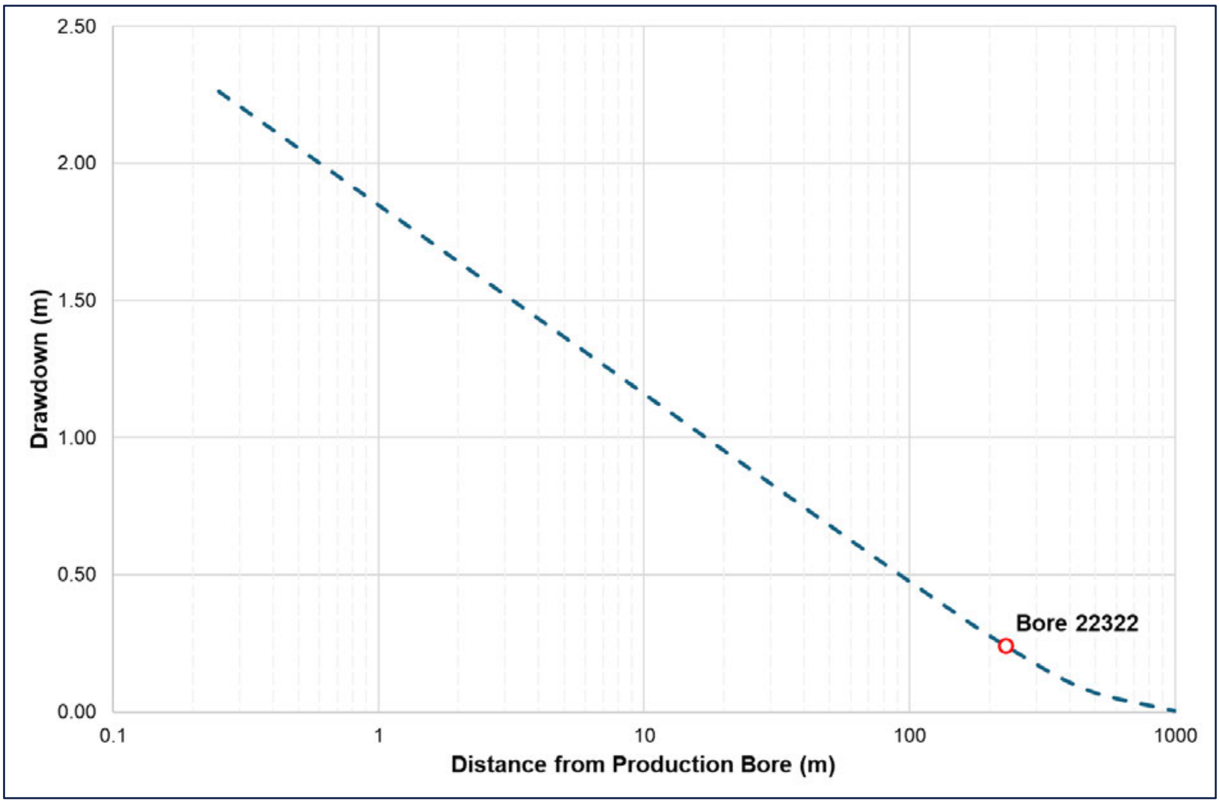


Figure 4-6: Projected Groundwater Drawdown Versus Distance from WME Bore after 365 Days Pumping

4.7 Seasonal Variability in Groundwater Production

Preliminary assessment work has been undertaken by Watersmart (2026) into options for meeting the proposed Waiheke Onsen water demand (Section 2) using a combination of rainfall capture and groundwater abstraction. The bore can provide sufficient water to service the proposed facility based on a constant daily abstraction rate throughout the year. However, the abstraction rate may be varied seasonally in line with occupancy rates or for other operational reasons.

One example scenario summarised in Table 6 indicates seasonal variations in occupancy and therefore bore water demand can be addressed by operational management of groundwater abstraction combined with on-site water buffer storage. The outcomes from this scenario indicate the water demand for the Waiheke Onsen facility can be met through effective management of water from the available sources. The maximum pumping rate incorporated in the example presented in Table 6 is substantially below the interpreted capacity of the bore (Section 4.5)

Table 6: Preliminary Example of Water Sourced to Meet Waiheke Onsen Monthly Demand

MONTH	OCCUPANCY	TOTAL DEMAND (1) (L/day)	BORE WATER SUPPLY (L/day)	BORE WATER SUPPLY (m³/month)	PERCENTAGE OF DEMAND
January	90%	59,232	24,858	770.60	42%
February	85%	56,288	23,477	657.36	42%
March	75%	50,399	20,715	642.17	41%
April	60%	41,567	16,572	497.16	40%
May	40%	29,790	11,048	342.49	37%
June	32%	25,080	8,838	265.15	35%
July	35%	26,846	9,667	299.68	36%
August	32%	25,080	8,838	273.99	35%
September	45%	32,734	12,429	372.87	38%
October	60%	41,567	16,572	513.73	40%
November	70%	47,455	19,334	580.02	41%
December	85%	56,288	23,477	727.79	42%
TOTAL ANNUAL (m^3)				**5,943**	

Note:

1) Demand guidance provided by Watersmart (2026).

5. WATER QUALITY

One water sample was obtained from the WME Bore during the bore installation. The sample was submitted to an accredited laboratory for analysis, with the analysis results sheet presented in Appendix G.

For preliminary guidance, the laboratory analysis results indicate:

- The *E. coli* count was <1 per 100 mL, which means the water meets the NZ drinking water criteria for bacterial pathogens.
- The turbidity and total suspended solids were 440 NTU and 420 g/m^3, respectively. These values are high and would generally not be acceptable for potable water. However, it is reasonably expected the suspended solids concentrations and turbidity will decrease with further development of the bore. These elevated values are not considered to represent a significant issue for the proposed use of the water.
- Dissolved nitrogen and phosphorus concentrations are low.
- Of the other parameters, only the result for total lead (0.0144 g/m^3) is above the maximum acceptable value for drinking water in New Zealand (0.01 g/m^3). This elevated result is likely influenced by the elevated total suspended solids concentration in the water, and is likely to decrease following further development of the bore.

Overall, the quality of the groundwater sourced from the WME Bore is expected to be appropriate for the intended uses in the Onsen facility.

Groundwater abstraction from coastal aquifer systems is often associated with a degree of risk of saline water intrusion from the ocean into the aquifer. In this case, the WME Bore is located on a ridge approximately midway between the northern and western coasts of the island. Furthermore, the allocation limit applied to the Waiheke Aquifer under the AUP takes into account the need to protect the aquifer from saline water intrusion. For these reasons, the risk of saline water intrusion to the aquifer arising from the proposed groundwater abstraction is assessed as being minimal.

6. METHODOLOGY FOR GROUNDWATER RESOURCE ASSESSMENT

The preliminary assessment documented in this memorandum is provided for guidance. Detailed water supply planning should not be undertaken on the basis of the information provided within. A detailed assessment is required to confirm the WME Bore production capacity and the potential effects of seasonally variable abstraction on the groundwater system, nearby groundwater users, and surface water flows.

The following methodology is recommended as a basis for further assessment and the production of a substantive report to support consenting of a water take under a fast-track consenting process:

1. Undertake stepped rate and constant rate pumping tests and potentially other investigations on the WME Bore. Analyse the acquired data to confirm the bore performance characteristics, the hydrogeological characteristics of the surrounding greywacke aquifer and the source of groundwater entering the bore.
2. Obtain copies of all pumping test analyses for nearby bores from AC. Evaluate these results, together with the results from testing of the Production Bore, to gain an understanding of the overall hydraulic behaviour of the greywacke aquifer in the Matiatia Bay to Oneroa area of Waiheke Island.
3. Obtain water samples from the WME Bore for groundwater age analysis.
4. Obtain full groundwater level records from nearby bores monitored by AC, together with records of all publicly available groundwater level measurements from nearby bores.
5. Undertake a stream bed geological survey and flow monitoring of streams around the site, to investigate the hydraulic connection between the streams and the surrounding groundwater system.
6. Update WME Bore pumping rates and schedules based on confirmed bore performance and contributing catchment area. Investigate options for increasing the groundwater contribution to satisfy the water demand of the proposed Waiheke Onsen facility.
7. Update projections of groundwater drawdown arising from updated abstraction rates, based on the above information. Analyse groundwater drawdown effects on nearby groundwater users, local streams and wetlands. Confirm potential effects related to saline water intrusion risk to the greywacke aquifer.
8. Consult with AC regarding water allocation in the catchment and appropriate conditions of consent.

7. REFERENCED DOCUMENTS

Alldred H, Field H 1990. Report on testing and analysis of the Church Bay Bore water supply, Church Bay Estate, Waiheke Island. Report produced for Church Bay Cooperative.

Chappell P R 2014. The climate and weather of Auckland. Report produced by the National Institute of Water and Atmospheric Research. NIWA science and technology series number 60.

Edbrooke S W (compiler) 2001. Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.

Fearon Hay Architects 2026. Onsen Resort and Hotel. Onsen Design Pack dated 13 March 2026.

Kalbus E, Buckthought L, Perks A, Boyle J 2017. State of the environment: groundwater state and trends in the Auckland region 2016. Auckland Council technical report TR2017/034.

Kermode L O 1992. Geology of the Auckland urban area. Scale 1:50 000. Institute of Geological & Nuclear Sciences geological map 2.

Maven 2026. Prelim Civil Infrastructure Report. 32 Tiri Road, Oneroa, Waiheke Island. Report produced for Waiheke Mon E Limited by Maven Associates Limited. Maven report 135049. Dated 16 March 2026.

PDP 2002. Whitford Quarry Expansion, groundwater feasibility assessment. Prepared by Pattle Delamore Partners Ltd. June 2002.

PDP 2025. Proposed Sutton Block expansion groundwater & surface water effects assessment. Report produced for Stevenson Aggregates Ltd by Pattle Delamore Partners Ltd. March 2025.

SKM 2007. Waiheke Island - extended groundwater model. Report produced for Auckland Regional Council by Sinclair Knight Merz Ltd.

Watersmart 2026. Recommendation of water efficiency and reduction for Waiheke Island Resort Project. 32 Tiri Road, Oneroa, Waiheke Island. Report produced for Maven Associates Limited by Watersmart Ltd.

8. CONCLUSION

The preliminary assessment documented in this memorandum indicates:

- Groundwater sourced from the WME Bore should be sufficient to supply a significant portion of the overall water demand to the proposed Waiheke Onsen development.
- The quality of the groundwater is expected to be appropriate for the intended uses in the Onsen facility.

A methodology has been provided as a basis for further assessment of groundwater availability and potential effects on nearby users and surface water bodies. This methodology may form the basis for the production of a detailed assessment and a substantive report to support consenting of a groundwater take under a fast-track consenting process.

Based on WGA's experience, and the information which has been received and evaluated to date, WGA can see no reason why the consenting of a groundwater take to support the Waiheke Onsen development could not proceed under a fast-track application.

Should you have any questions regarding the content of this memorandum, please contact the undersigned.

Yours Sincerely

Brett Sinclair
Senior Principal Hydrogeologist
WALLBRIDGE GILBERT AZTEC

APPENDIX A WAIHEKE ONSEN MASTERPLAN
APPENDIX B AUCKLAND REGIONAL PLAN POLICIES AND RULES
APPENDIX C BORE LOGS
APPENDIX D BORE PERFORMANCE DERIVATION
APPENDIX E SEASONAL GROUNDWATER ABSTRACTION ESTIMATES
APPENDIX F GROUNDWATER DRAWDOWN CALCULATION SHEETS
APPENDIX G GROUNDWATER QUALITY

APPENDIX A
WAIHEKE ONSEN MASTERPLAN

Figure A1. Waiheke Onsen Masterplan (Fearon Hay Architects 2026)

APPENDIX B
AUCKLAND REGIONAL PLAN POLICIES AND RULES

E7. Taking, using, damming and diversion of water and drilling

E7.1. Introduction

Taking, using, damming and diversion of surface water and groundwater provisions in this plan apply in accordance with section 14(1) and section 14(3) of the Resource Management Act 1991. They also provide for a limited range of discharges of water under section 15 of the Resource Management Act 1991 when associated with the diversion of surface water or drainage of production land. Drilling in accordance with section 9(2) of the Resource Management Act 1991 is also addressed because it is often associated with the taking of groundwater.

This section also addresses the diversion of surface water and groundwater, and should be read in conjunction with E36 Natural Hazards and flooding and E3 Lakes, rivers, streams and wetlands, with respect to the placement of fill and structures within floodplains and waterbodies.

E7.2. Objectives [rp]

(1) Objectives are located in E1 Water quality and integrated management, E2 Water quantity, allocation and use, D3 High-use Stream Management Areas Overlay and D8 Wetland Management Areas Overlay.

E7.3. Policies [rp]

(1) Policies are located in E1 Water quality and integrated management, E2 Water quantity, allocation and use, D3 High-use Stream Management Areas Overlay and D8 Wetland Management Areas Overlay.

Table E7.4.1: Activity Table

ACTIVITY		ACTIVITY STATUS		
		All Zones	High- Use Stream Management Areas Overlay	Wetland Management Areas Overlay
Take and use of groundwater				
(A15)	Up to 20 m^3/day, when averaged over any consecutive five-day period, and no more than 5000 m^3/year	P	P	P
(A24)	Take and use of geothermal water for bathing use not otherwise provided for	D	D	D
(A26)	Take and use of groundwater not meeting the permitted activity or restricted discretionary activity standards or not otherwise listed	D	D	D

E7.6. Standards

E7.6.1. Permitted activities

All activities listed as permitted activities in Table E7.4.1 must comply with the following permitted activity standards.

E7.6.1.4. Take and use of groundwater up to 20 m^3/day when averaged over any consecutive 20-day period and no more than 5000 m^3/year

1. The groundwater take must not be geothermal water unless it is for a purpose specified in section 14(3)(c) of the Resource Management Act 1991.

2. The groundwater take must not be from the High-use Aquifer Management Areas Overlay.
3. The groundwater take must not be for the purpose of dewatering or groundwater level control.
4. The groundwater take must be located at least 100 m from any other existing lawfully established groundwater take from the same aquifer.
5. Notice on the prescribed form must be received by the Council 15 working days before undertaking this permitted activity.

The following text consists of extracts from **Overlay D.1** of the **Auckland Unitary Plan.**

D1.2 Objectives

1. Aquifers identified in the High-use Aquifer Management Areas Overlay are managed so they can continue to meet existing and future water take demands and provide base flow for surface streams.

D1.3. Policies

1. Manage proposals to take and use water from High-use Aquifer Management Areas in Table D1.3.1 to prevent groundwater allocation exceeding availability, also having regard to Table B1 Aquifer water availabilities in Appendix 3 Aquifer water availabilities and levels.
2. Require resource consents for all proposals to take and use water from the Highuse Aquifer Management Areas in Table D1.3.1 (other than takes permitted by section 14(3)(b) of the Resource Management Act 1991) to assess the impacts of the proposal on water availability levels and to take account of new information on water availability as it becomes available.

Table D1.3.1: High-use aquifer management areas

AQUIFER NAME DESCRIPTION	AQUIFER NAME DESCRIPTION
Waiheke	Refers to all aquifers

Appendix 3: Aquifer Water Availabilities and Levels

Table B1: Aquifer water availabilities – Aquifers Not Separately Listed

AQUIFER NAME	DESCRIPTION
Shallow, coastal aquifers	15% of average annual recharge as determined by the Auckland Council
All other aquifers with connection to a surface water body	35% of average annual recharge as determined by the Auckland Council
All other aquifers not separately listed without connection to a surface water body	65% of average annual recharge as determined by the Auckland Council

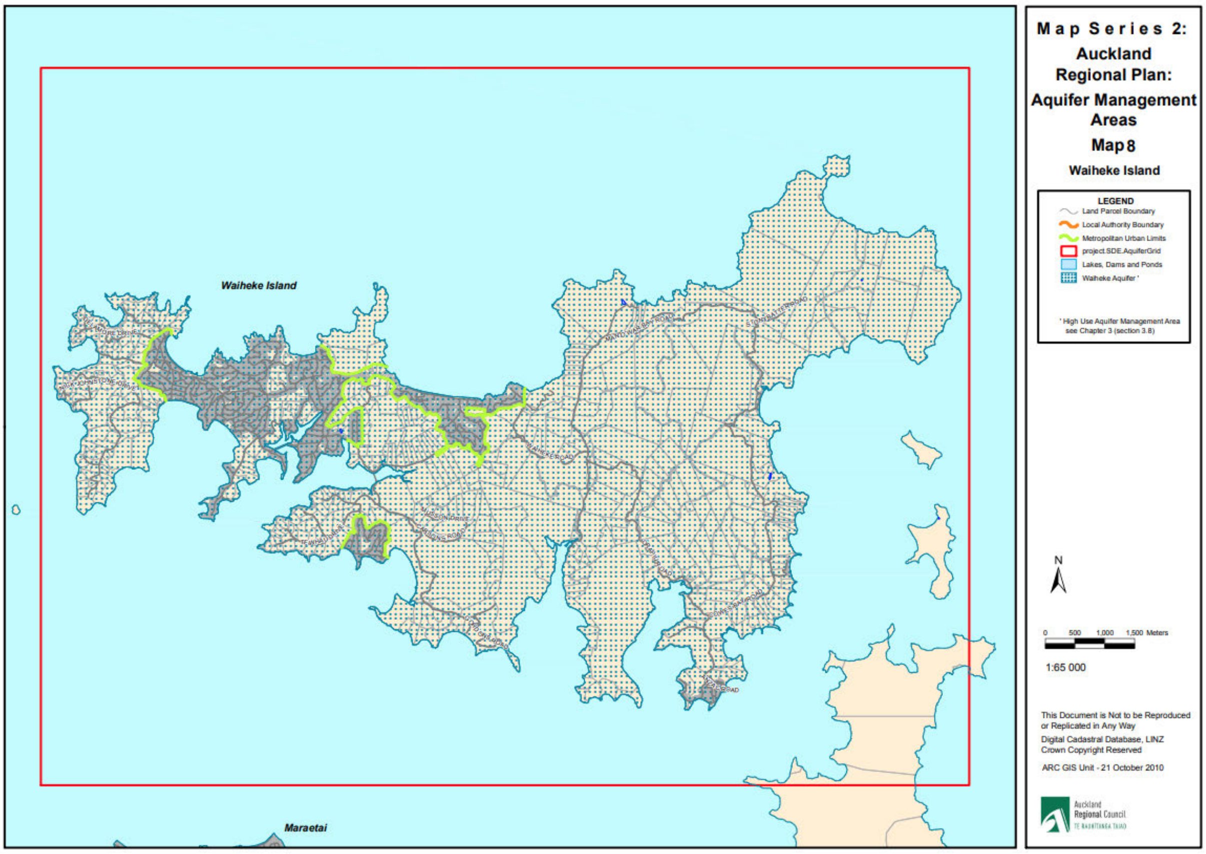


Figure B1. Auckland Regional Plan: Aquifer Management Areas, Map 8, Waiheke Island

APPENDIX C
BORE LOGS

McMILLAN Drilling

Client: Mark Ellis	Bore No.: BH 30908
Project: 32 Tiri Road, Waiheke Island	Job No.: 100459

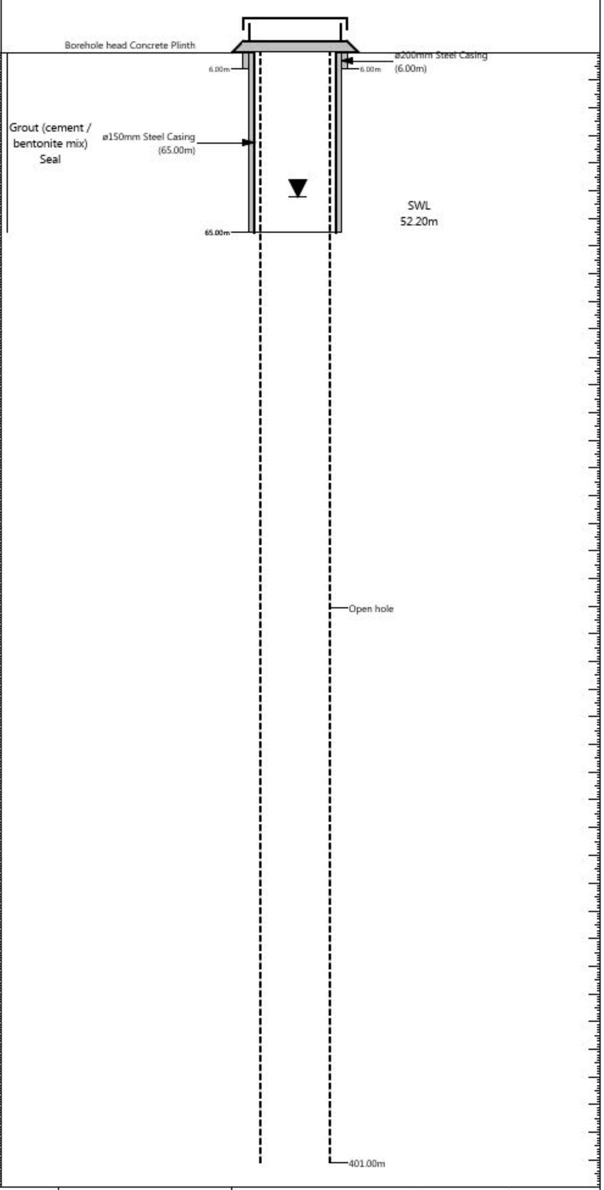
Site Location: 32 Tiri Road, Waiheke Island **Date:** 13/10/2021

Grid Reference: 1778774m E, 5927630m N (NZTM) Handheld GPS **Rig Operator:** S. Hoban

Lot Number: Lot 8 DP 53686 **Consent No.:** LUC 6036468 **Method / Rig:** Rotary Mud

Material Description	Depth (m)
CLAY.	
Reddish brown ROCK.	20.00m
SANDSTONE.	30.00m
ROCK. Strong.	40.00m
SANDSTONE. Highly fractured.	140.00m
SANDSTONE.	150.00m
SANDSTONE. Highly fractured.	188.00m
SANDSTONE.	200.00m
SANDSTONE. Highly fractured.	280.00m
SANDSTONE.	368.00m

Casing & Screen Installation



Remarks:	Development Duration (hr):	Flow Rate (gpm)	Flow Rate (l/sec)	Draw Down (m)	Duration (hr)
	Pumping Duration (hr):				

Bore Diameter: 100mm **Static Water Level:** 52.20m bgl

Total Bore Depth: 401.00m bgl **Total Depth Drilled:** 401.00m bgl

SHEET 1 OF 1

Generated with Core-GS by Geroc - Created: 15/03/2022 12:06:40 p.m.

Figure C1: WME Bore Driller's Log

Table C1: Delamore Drive Monitoring Well (ID# 22349) Geological Log

TOP LEVEL (m BGL)	BOTTOM LEVEL (m BGL)	STRATUM THICKNESS (m)	DESCRIPTION
0	0.2	0.2	Topsoil
0.2	1.3	1.1	Firm orange CLAY with black organic lenses.
1.3	14	12.7	Crumbly creamy orange CLAY with residual joint patterns – completely weathered GREYWACKE.
14	35.15	21.15	Light grey GREYWACKE, very weathered, extensively jointed.
35.15	72.65	37.5	Hard, unweathered GREYWACKE some low and high angle joints with iron staining, not frequent.
72.65	105.05	32.4	Hard grey GREYWACKE - no iron staining.

APPENDIX D
BORE PERFORMANCE DERIVATION

Table D1: Nearby Bore Locations and Depths

BORE ID [1]	EASTING	NORTHING	DISTANCE FROM WME BORE (m)	GROUND ELEVATION (mRL) [2]	DEPTH (m)
WME Bore	1778758	5927633	0	61.5	401
238	1778982	5927288	410	31.0	102
4771	1779104	5927732	360	45.0	88
20987	1778946	5927296	390	35.0	170
21573	1778200	5927470	580	4.0	117.75
22322	1778990	5927590	240	39.0	93
22323	1779120	5927560	370	42.5	106
22347	1778938	5927294	380	35.0	54
22349	1778234	5927906	590	80.6	104.6
22548	1778118	5927966	720	85.0	90
23463	1778795	5927320	320	44.0	180.5
23482	1778505	5927300	420	64.2	91
30414	1778387	5927273	520	55.5	100

Notes:

1) All data from Wells Aotearoa online database except the information for the WME Bore and the ground elevation.

2) Ground elevations at the bores estimated from the LIDAR topographic contours available through the AC online maps portal.

Table D2: Nearby Bore Depths and Static Groundwater Levels

BORE ID	GROUND ELEVATION (mRL) [1]	DEPTH (m)	CASING DEPTH (m) [2]	STATIC WATER LEVEL [2] (m BGL)
WME Bore	61.5	401	65	52.2 [3]
238	31.0	102	-	14.4
4771	45.0	88	30	25.2
20987	35.0	170	28	14.9
21573	4.0	117.75	30.65	0 [4]
22322	39.0	93	16.5	8.9
22323	42.5	106	30.5	18
22347	35.0	54	-	-
22349	80.6	104.6	-	-
22548	85.0	90	18	65
23463	44.0	180.5	23	25.4
23482	64.2	91	36	46
30414	55.5	100	30	35.6

Notes:

1) Ground elevations at the bores estimated from the LIDAR topographic contours available through the AC online maps portal.

2) No information is available for the cells shaded orange.

3) Depth to static water level (SWL) was recorded by the driller at 52.2 m below ground level (m BGL). However, this measurement may have been affected by the drilling operations. Review of SWL records for nearby bores suggests the SWL is more likely to be approximately 40 m BGL in this area.

4) Bore has slightly flowing artesian SWL.

Table D3: Nearby Bore Flows, Drawdowns and Specific Capacity Values

BORE ID	OPEN HOLD LENGTH (m) (1)	TESTED FLOW (m^3/day) (1)	DRAWDOWN (m) (1)	SPECIFIC CAPACITY (2) (m^3/day/m)	SPECIFIC CAPACITY PER METER OF OPEN HOLE (m^3/day/m/m) (3)
238	-	10	-	-	-
4771	58	72	35	2.1	0.035
20987	142	7	-	-	-
21573	87.1	158	78	2.0	0.023
22322	76.5	8	36	0.2	0.003
22323	75.5	53	24	2.2	0.029
22347	-	-	-		-
22349	-	-	-		-
22548	72	29	10	2.9	0.040
23463	157.5	6	41.6	0.1	0.001
23482	55	22	24	0.9	0.016
30414	70	10	-	-	-
WME Bore	336	**135** (7)	19 (6)	7.1 (5)	0.021 (4)

Notes:

1) Data from Wells Aotearoa online database. No data is available for cells shaded orange.

2) Specific capacity is the increase in flow of water resulting from a one metre increase in water drawdown in the bore.

3) Specific capacity per metre of open hole is the specific capacity of the bore divided by the length of open bore into which the groundwater can enter.

4) The average of the values in this column.

5) Value calculated by multiplying the specific capacity per metre of open hole in this bore by the open hole length.

6) Available drawdown in the WME Bore above the base of casing.

7) Potential flow rate calculated by multiplying the specific capacity for the WME Bore by the available drawdown. Flow has not been tested at bore.

APPENDIX E
SEASONAL GROUNDWATER ABSTRACTION PRELIMINARY ESTIMATES

The calculated available groundwater allocation is 5,950 m^3/year. If reduced occupancy through the off-season results in reduced groundwater demand, then groundwater availability during the high season is correspondingly increased, without affecting the total annual allocation.

The tables below provide indications of high-season and off-season abstraction rates based on maximum annual groundwater abstraction volumes of 5,950 m^3. These tables are based on assumed off-season groundwater demand of nil (Table E1), 10% of the average annual flow (Table E2), 20% of the average annual flow (Table E3), and 30% of the average annual flow (Table E4).

Table E1: Available High Season Flow Rates if Off-Season Abstraction is Nil

HIGH SEASON (days)	HIGH SEASON FLOW RATE (m^3/day)	OFF SEASON FLOW RATE (m^3/day)
365	16.3	-
270	22.0	0
180	33.1	0
90	66.1	0

Table E2: Available High Season Flow Rates if Off-Season Abstraction is 10% of Average

HIGH SEASON (days)	HIGH SEASON FLOW RATE (m^3/day)	OFF SEASON FLOW RATE (m^3/day)
365	16.3	-
270	21.5	1.63
180	31.4	1.63
90	61.1	1.63

Table E3: Available High Season Flow Rates if Off-Season Abstraction is 20% of Average

HIGH SEASON (days)	HIGH SEASON FLOW RATE (m^3/day)	OFF SEASON FLOW RATE (m^3/day)
365	16.3	-
270	20.9	3.26
180	29.7	3.26
90	56.1	3.26

Table E4: Available High Season Flow Rates if Off-Season Abstraction is 30% of Average.

HIGH SEASON (days)	HIGH SEASON FLOW RATE (m^3/day)	OFF SEASON FLOW RATE (m^3/day)
365	16.3	-
270	20.3	4.89
180	28.0	4.89
90	51.2	4.89

APPENDIX F
GROUNDWATER DRAWDOWN CALCULATION SHEETS

Time-drawdown calculations using Theis equation

Aquifer parameters

T	8.7	m2/d
S	0.03000	
B		

Pumping rate

Q	0.19	l/s

Radius (m)	0.25	100	200
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
0.01	0.695	-	-
0.02	0.798	-	-
0.05	0.934	-	-
0.1	1.038	-	-
0.5	1.278	-	-
1	1.382	0.000	-
2	1.485	0.000	-
5	1.622	0.011	0.000
10	1.726	0.041	0.001
20	1.829	0.097	0.011
50	1.966	0.201	0.057
100	2.070	0.292	0.120
365	2.263	0.477	0.280

Distance-drawdown calculations using Theis equation

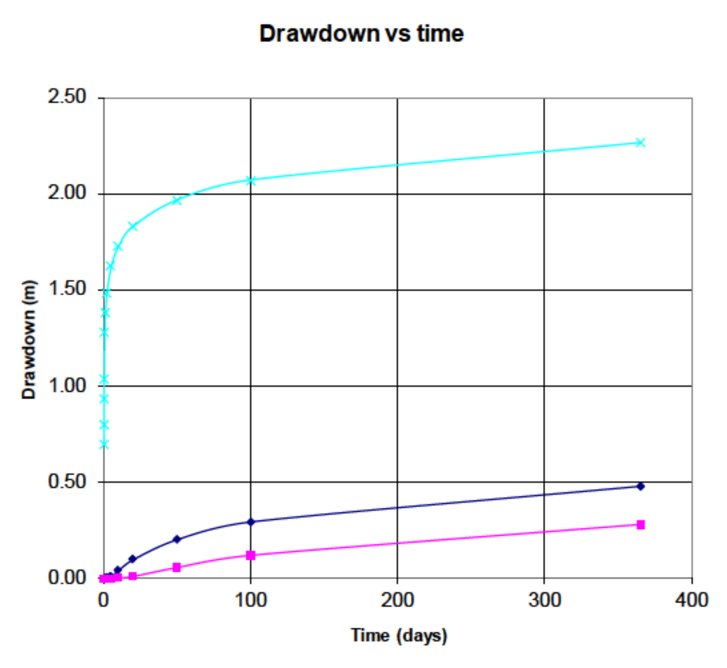
Aquifer parameters

T	8.6832	m2/d
S	0.03	
B		

Pumping rate

Q	0.18865741	l/s

Time (days)	1	7	365
Radius (m)	Drawdown (m)	Drawdown (m)	Drawdown (m)
0.25	1.382	1.672	2.263
0.5	1.175	1.465	2.056
1	0.968	1.258	1.849
2	0.761	1.051	1.642
4	0.555	0.844	1.435
8	0.354	0.638	1.228
16	0.170	0.435	1.021
32	0.040	0.241	0.814
64	0.001	0.083	0.608
128	0.000	0.007	0.405
230	-	0.000	0.242
460	-	-	0.083
1000	-	-	0.004



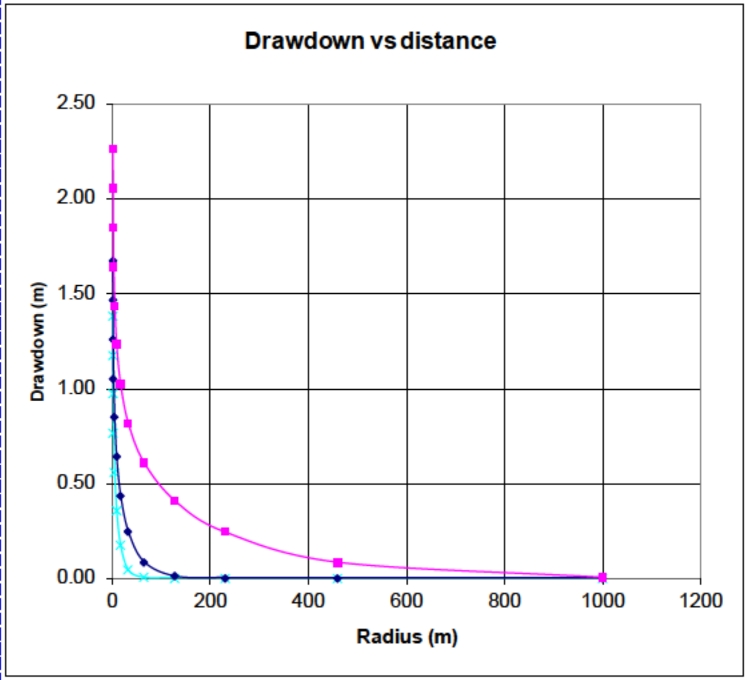


Figure F1: Groundwater Drawdown Analysis Sheet

APPENDIX G
GROUNDWATER QUALITY

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

0508 HILL LAB (44 555 22)
+64 7 858 2000
mail@hill-labs.co.nz
www.hill-labs.co.nz

Certificate of Analysis

Client:	McMillan Drilling (NI) Limited	**Lab No:**	3938640 SPv1
Contact:	John Oliver	**Date Received:**	16-Jul-2025
	C/- McMillan Drilling (NI) Limited	**Date Reported:**	23-Jul-2025
	PO Box 1189	**Quote No:**	131389
	Pukekohe	**Order No:**	NI9199
	Auckland 2340	**Client Reference:**	
		Submitted By:	John Oliver

Sample Type: Aqueous

	Sample Name:	Marc Ellis 15-Jul-2025 9:40 am
	Lab Number:	3938640.1
Individual Tests		
Sum of Anions	meq/L	8.3
Sum of Cations	meq/L	7.4 #2
Turbidity	NTU	440
pH	pH Units	7.8
Total Acidity (pH 8.3)	g/m³ as $CaCO_3$	4.9
Total Alkalinity	g/m³ as $CaCO_3$	230
Total Alkalintiy as HCO3	g/m³ as HCO_3	280
Bicarbonate	g/m³ at 25°C	280
Langelier Saturation Index		0.2
Total Hardness	g/m³ as $CaCO_3$	135
Electrical Conductivity (EC)	mS/m	72.5
Total Suspended Solids	g/m³	420
Total Dissolved Solids (TDS)	g/m³	390
Sample Temperature*	°C	20.0
Total Barium	g/m³	0.052
Total Boron	g/m³	0.045
Dissolved Calcium	g/m³	29
Total Calcium	g/m³	32
Total Iron	g/m³	7.2
Dissolved Magnesium	g/m³	12.4
Total Magnesium	g/m³	13.5
Total Manganese	g/m³	0.43
Total Mercury	g/m³	< 0.00008
Total Molybdenum	g/m³	0.0142
Dissolved Potassium	g/m³	6.6 #1
Total Potassium	g/m³	6.1 #1
Total Selenium	g/m³	< 0.0011
Dissolved Sodium	g/m³	110 #1
Total Sodium	g/m³	105 #1
Bromide	g/m³	0.63
Chloride	g/m³	121
Fluoride	g/m³	0.50
Total Ammoniacal-N	g/m³	0.018
Nitrite-N	g/m³	< 0.002
Nitrate-N	g/m³	< 0.002
Nitrate-N + Nitrite-N	g/m³	< 0.002
Dissolved Reactive Phosphorus	g/m³	< 0.004
Phosphate	g/m³	< 0.013

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Aqueous		
	Sample Name:	Marc Ellis 15-Jul-2025 9:40 am
	Lab Number:	3938640.1
Individual Tests		
Reactive Silica	g/m³ as SiO_2	12.1
Sulphate	g/m³	12.4
Absorbance at 270 nm	AU cm-1	0.028
Total Coliforms and E.coli		
Escherichia coli	MPN / 100mL	< 1
Total Coliforms	MPN / 100mL	5
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn		
Total Arsenic	g/m³	< 0.0011
Total Cadmium	g/m³	0.00049
Total Chromium	g/m³	0.00182
Total Copper	g/m³	0.0020
Total Lead	g/m³	0.0144
Total Nickel	g/m³	0.00153
Total Zinc	g/m³	12.2

Analyst's Comments

#1 It has been noted that the result for the dissolved fraction was greater than that for the total fraction, but within analytical variation of the methods.

#2 It was observed that the results for 'Sum of Anions' and 'Sum of Cations' were not in good agreement. This was largely attributed to the high level of sediment contained in the sample. The anions and cations analysed, were determined on the filtered sample, with the exception of Alkalinity. The Alkalinity was determined in accordance with APHA 'Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005', which states; 'Do not filter, dilute, concentrate or alter the sample.' The sediment present in the sample may have contributed to the result obtained for Alkalinity and therefore added to the result for 'Sum of Anions'.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Glass Fibre	Sample filtration through glass fibre filter.	-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E : Online Edition.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEquiv/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H^+) also included in calculation if available. APHA 1030 E : Online Edition.	0.05 meq/L	1
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1
Total Acidity (pH 8.3)	Titration to pH 8.3 with standard sodium hydroxide solution, phenolphthalein indicator. APHA 2310 B : Online Edition.	1.0 g/m³ as $CaCO_3$	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) : Online Edition.	1.0 g/m³ as $CaCO_3$	1
Total Alkalintiy as HCO3	Calculation: Alk as CaCO3 x (61/100) x 2.	1.3 g/m³ as HCO_3	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D : Online Edition.	1.0 g/m³ at 25°C	1
Langelier Saturation Index	Calculation: from pH, Total Alkalinity, Ionic Strength, Temperature* and Calcium. This calculation assumes that; 1) the calcium carbonate is in the form of calcite, 2) the effects associated with calcium ion pairs are negligible and 3) and the effect of alkalinity contributed or consumed by species other than HCO_3^-, CO_3^{2-}, OH^- and H^+ is not significant. ***Note: For accurate calculation of the Langelier Saturation Index (LSI), the sample temperature should be taken using a calibrated thermometer at the time of sampling and recorded on the paperwork submitted with the sample. If a sample temperature is not supplied, a nominal temperature of 20°C will show in the results table above and be used in the calculation. In this case, please interpret the LSI result with caution**. APHA 2330 B : Online Edition.	-	1
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B : Online Edition.	1.0 g/m³ as $CaCO_3$	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) : Online Edition.	3 g/m³	1
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) : Online Edition.	10 g/m³	1
Sample Temperature*	A nominal sample temperature of 20°C has been assumed by the laboratory.	0.1 °C	1
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B : Online Edition.	-	1
Total Barium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0053 g/m³	1
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0053 g/m³	1
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.05 g/m³	1
Total Calcium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m³	1
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m³	1
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.02 g/m³	1
Total Magnesium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m³	1
Total Manganese	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.00053 g/m³	1
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1
Total Molybdenum	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.00021 g/m³	1
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.05 g/m³	1
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.053 g/m³	1
Total Selenium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.0011 g/m³	1
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.02 g/m³	1
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.021 g/m³	1
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.05 g/m³	1
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m³	1
Fluoride	Direct measurement, ion selective electrode. APHA 4500-F^- C : Online Edition.	0.05 g/m³	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1
Phosphate from DRP	Calculation: Dissolved Reactive Phosphorus (DRP) * Molecular weight of Phosphate ion (PO_4^{3-}) / Atomic weight of Phosphorus (P). In-house calculation.	0.004 g/m^3	1
Reactive Silica	Filtered sample. Heteropoly blue colorimetry. Flow Injection Analyser. APHA 4500-SiO_2 F (modified) : Online Edition.	0.10 g/m^3 as SiO_2	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1
Absorbance at 270 nm	Filtered sample. Spectrophotometry, 1cm cell. APHA 5910 B : Online Edition.	0.002 AU cm^{-1}	1
Heavy metals, totals, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B : Online Edition.	0.000053 - 0.0011 g/m^3	1
Total Coliforms and E.coli			
Escherichia coli	MPN count using Colilert (Incubated at 35°C for 24 hours) and 97 wells. APHA 9223 B : Online Edition.	1 MPN / 100mL	1
Total Coliforms	MPN count using Colilert (Incubated at 35°C for 24 hours) and 97 wells. APHA 9223 B : Online Edition.	1 MPN / 100mL	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 16-Jul-2025 and 23-Jul-2025. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Yu-Hsuan (Coco) Hsueh BSc (Tech)
Client Services Manager - Environmental