OCEANAGOLD
WAIHI OPERATION

Shallow and Deep Aquifer Report 2024

Document Issuance and Revision History

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Approvals

	Position	Name	Date
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SHALLOW AND DEEP AQUIFER REPORT 2024

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INTRODUCTION

In 2019, the Waikato Regional Council (WRC) granted OceanaGold Waihi (OGNZL) consent 139551 ("the consent") to take groundwater to dewater the Martha Pit and associated underground workings to a level no lower than 500mRL. Earlier consents held by OGNZL allowed dewatering to a level no lower than 700 mRL.

Condition 9 of the consent requires that upon commencement of the consent and at five yearly intervals thereafter, OGNZL provides a shallow and deep aquifer monitoring report to the WRC. The report is to include, at least, the following information:

- The nature of the geology under the Martha Pit and immediate surrounds;
- Comment on the existing groundwater chemistry for the deep and shallow aquifers;
- Provide details of any wetland area and any other known aquatic ecological values that are dependent on the surface contribution of shallow and deep groundwater outflows; and
- Comment on the groundwater levels in the deep and shallow aquifers
- Comment on the effects the dewatering activity is having on the shallow and deep aquifers under the Martha Pit and immediate surrounds.

After the granting of the consent, underground water levels were held at 705 mRL until December 2020. Since this time, underground water levels have been progressively lowered via two dewatering bores located on the 800 level of the mine to enable mining in the Martha Underground. Underground water levels are now at 662 mRL.

This report is the second version of the Shallow and Deep Aquifer report prepared to meet conditions consent 139551 and is the first version to be prepared since dewatering below 700 mRL commenced.

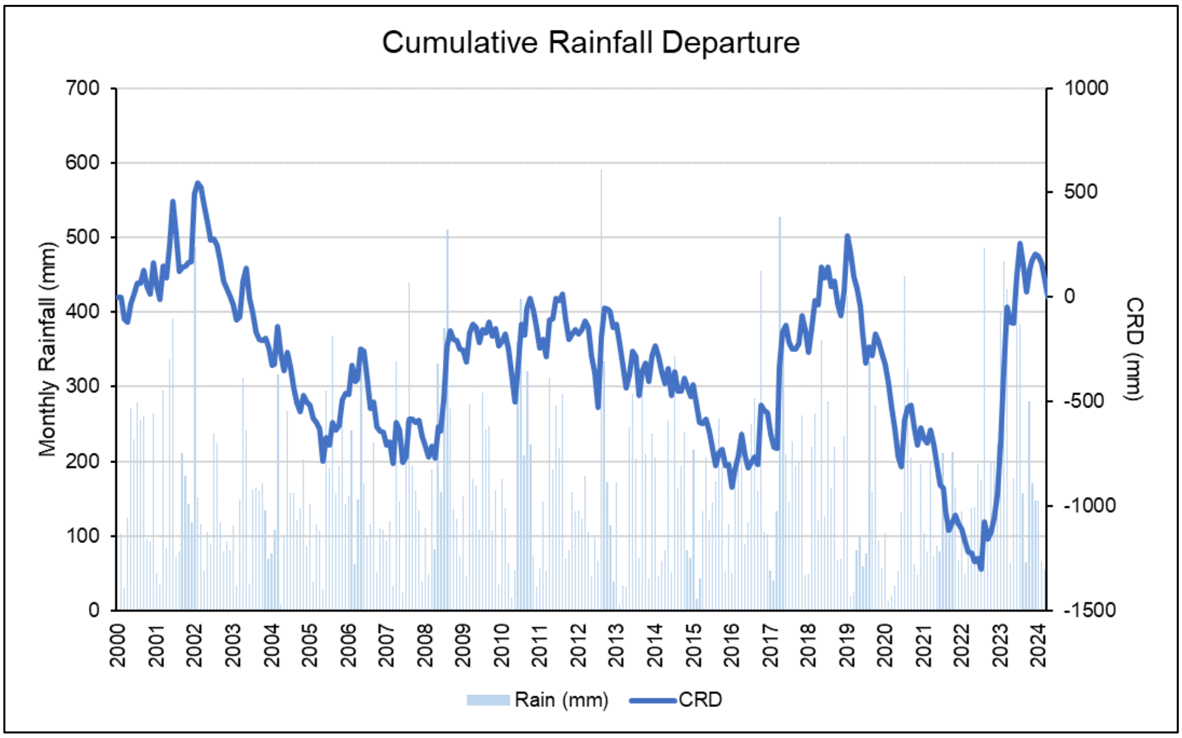
1 CLIMATE CONDITIONS

Historical rainfall data for Waihi has been collected since 1907, with annual measured rainfall ranging between 1249 and 3234 mm per annum.

Annual and seasonal rainfall trends are displayed in Figure 1, with data up to April 2024 included.

Cumulative Rainfall Departure (CRD) is a concept used to evaluate the temporal correlation of rainfall with surface water or groundwater levels. Rainfall departure signifies the difference between the normal rainfall and actual rainfall. The CRD plot presents monthly long-term trends in rainfall since 2000. During this reporting period (2019 – 2024), Waihi saw a period of below average rainfall from 2019 until July 2022, indicated by a decreasing slope in the CRD. Since July 2022, above average rainfall has occurred, with a rising slope shown in the CRD.

The 2023 annual rainfall (2898 mm) was more than the previous year (2403 mm in 2022), significantly more than 2021 (1560 mm), and 791 mm more than the historical average of 2107 mm.



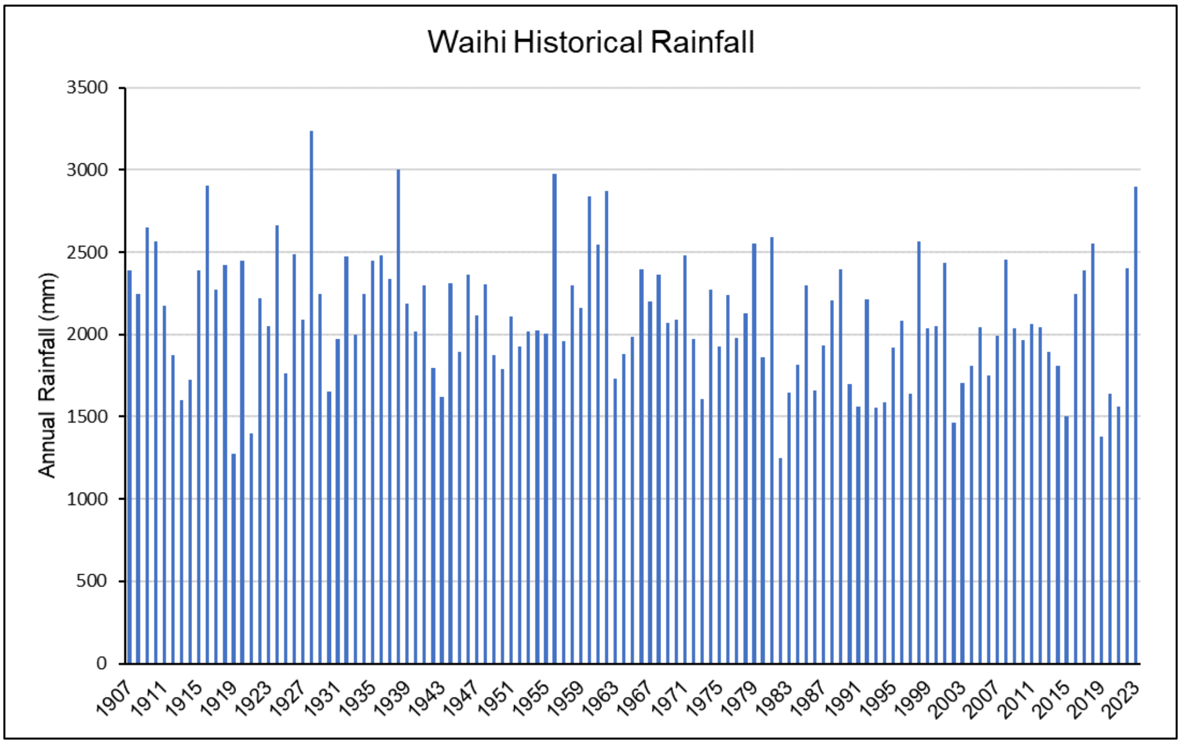


Figure 1: Annual and seasonal rainfall trends. A) CRD plot 2000–2024, B) Historical rainfall 1907–2024

2 GEOLOGICAL SETTING

This section is provided to meet Condition 9 a of the consent:

- *The nature of the geology under the Martha Pit and immediate surrounds.*

The mineralised veins of the Martha, Favona, Trio and Correnso gold deposits in Waihi are developed within Miocene age lava flows, intrusives and volcaniclastics of predominantly andesitic and minor dacitic composition (Figure 2). The andesites extend to depths greater than 600m below the surface and are extensively modified in places by weathering and hydrothermal alteration. The andesites are unconformably overlain by younger, unmineralised rhyolitic ignimbrites under much of the Waihi township. The ignimbrites drape over an eroded andesitic graben and horst landscape resulting in a volcaniclastic package that is highly variable in thickness (0 to >100m). Additionally, the ignimbrites exhibit variable textures, ranging from light weight, soft and pumice-rich horizons that are highly permeable to hard welded ignimbrites that appear less permeable. Paleosols (buried soils) and sedimentary deposits, such as alluvium and boulder alluvium (in places) mark the tops of successive eruption sequences.

There is a discontinuous layer of recent alluvium beneath the Waihi township that is located in areas where old streams and river channels cut into the ignimbrites and andesite units. These alluvial deposits are extensive to the east of Waihi where they are associated with the drainage systems of the Ohinemuri River catchment.

The most common effect of hydrothermal alteration on the andesitic host rocks surrounding the veins is the alteration of primary feldspars to illite and smectite clays and the introduction of pervasive potassic feldspar. Illite and smectite clays generally cause the host rocks to lose their internal strength forming weaker and usually more friable rock. The extent of clay alteration is highly variable and dependant on veining and the host rock type. In Waihi the strongly clay altered zones are usually concentrated within close proximity to the veins or faults (e.g. within the hanging wall of Favona) and within the vein zones themselves (e.g. Martha, Correnso and Trio). Potassic alteration on the other hand generally increases the overall strength of the host rocks which often results in the rocks surrounding the veins being more resistant to weathering and forming bluffs such as the Martha Hill (prior to mining of the Martha Open Pit) and Union Hill in Waihi. Paleo-weathering and hydrothermal alteration appear to have created an extensive low-permeability clay-rich horizon within the upper part of the andesite sequence. This horizon generally separates the andesites, hydro-geologically, from the younger overlying sequence of permeable rhyolitic ignimbrites. Exposure of the altered andesite in the southern wall of the Martha Pit indicates that the weathered clay horizon may extend up to 30m in thickness.

In the vicinity of the Martha vein zone the groundwater is largely concentrated within old underground mine workings, faults and veins where the historical mine workings act as effective conduits allowing inflow of groundwater water from the area surrounding the current Martha Open pit.

Principal veins and faults at both Martha and Favona dip to the south-east while the Correnso vein strikes north-north-west with an easterly dip. The Trio-Union-Amaranth veins are located on a paleotopographic high, informally referred to as the Union Horst that separates the Martha vein system from the Favona-Moonlight vein systems.

There is a hydrogeological connectivity between the Martha vein system and the Trio-Union-Amaranth vein system which is thought to be facilitated by the connecting Correnso structure. This was demonstrated historically by the rise and fall of ground water levels in the Union Hill shaft in unison with the rise and fall of water levels in the Martha Open Pit. There is only a very weak hydro-geological connectivity between the Martha system and the Favona system, shown by a lack of mutual response in the measured ground water levels. The zone of separation between the two groundwater systems is not well defined, but may be due to a fault boundary, either the No 9 fault or the Favona footwall fault, both of which are north to northeast trending and have a perceived strike extent exceeding 1km.

Groundwater inflow is predominantly controlled by infiltration from overlying layers and through outcrops of ignimbrite in the beds of streams and at the ground surface. The rhyolitic ignimbrite sequence is generally considered compressible and to date has accounted for most of the dewatering induced settlement around the mine site. This is indicated by settlement magnitude generally corresponding to the thickness of the rhyolitic ignimbrite and the magnitude of dewatering in these materials.

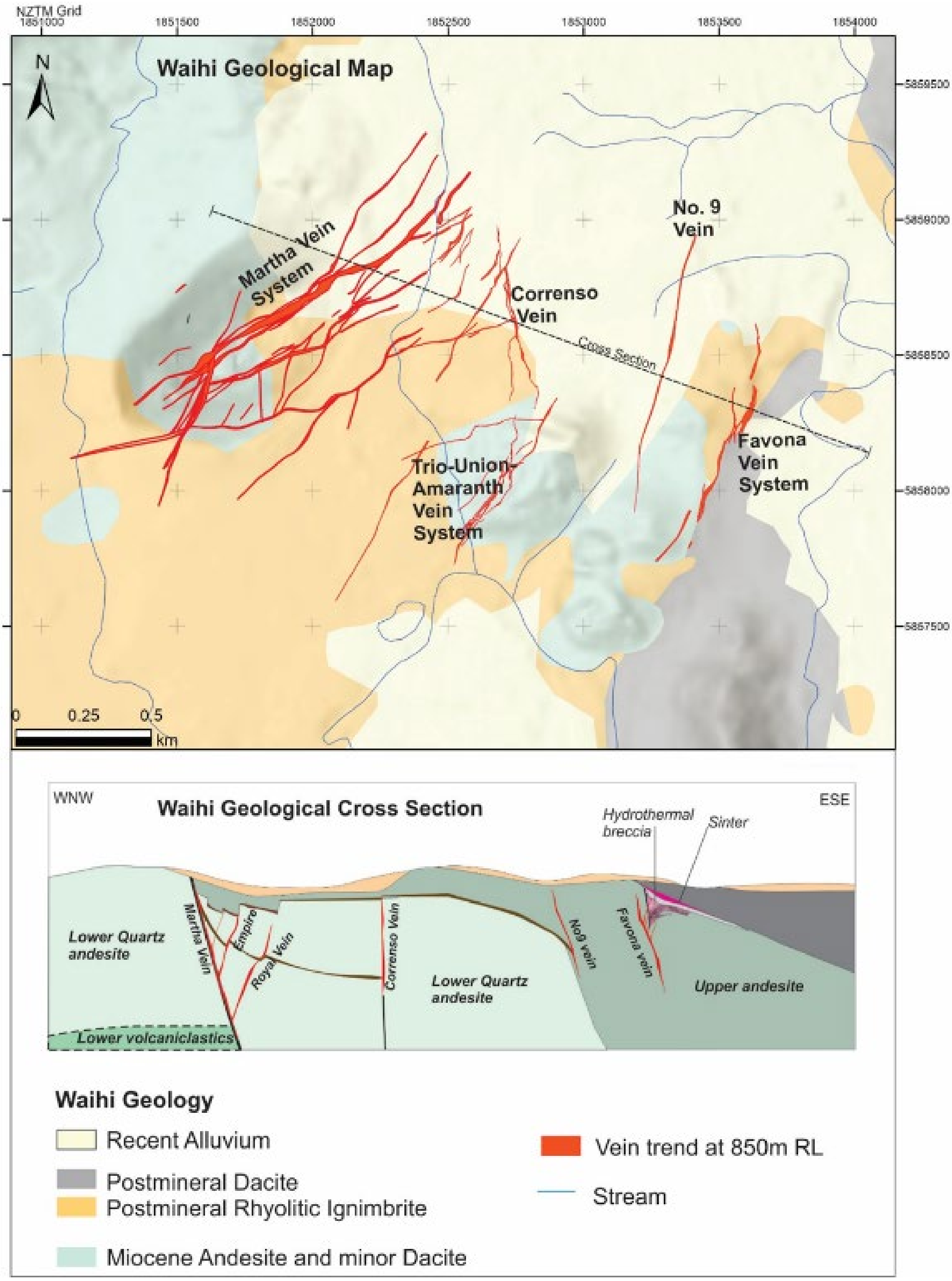


Figure 2: Geological map and cross section of the Waihi area showing the distribution of quartz veining and dominant geological rock units

3 GROUNDWATER CHEMISTRY

This section is provided to meet Condition 9 b of the consent:

- *Comment of the groundwater chemistry for the deep and shallow aquifers.*

A review of existing piezometers suitable for baseline water chemistry sampling of shallow and deep aquifers of the mine area was undertaken by WWLA in May 2023 in order to demonstrate compliance with Project Martha Consent 139551. WWLA's sampling recommendations are included as Appendix A. The piezometers selected for sampling consisted of three standpipe piezometers in alluvium, five in younger volcanics, and three in andesite. The construction of one new groundwater bore in alluvium was also recommended by WWLA. Piezometer details are shown in Table 1.

Due to limitations of sampling equipment and piezometer construction (due to narrow bore diameter, bore depth, and large purge volumes required) some of the suggested locations are unable to be sampled easily. Sampling was possible from seven of these piezometers and these have been added to the groundwater monitoring schedule. The locations of piezometers added to the sampling schedule are shown in Figure 3.

Groundwater quality sampling from these piezometers commenced during 2024 with the first samples collected in March 2024. Two additional wells were sampled in June 2024, but results were not available for inclusion in this report.

For the purposes of this report, groundwater sampled from the alluvium geological unit is considered to be from the shallow aquifer. Groundwater sampled from younger volcanics and andesite geological units are considered to be from the deep aquifer but are reported separately, given they are likely to have differing chemistry due to the surrounding geology.

Table 1: Martha piezometer details

Name	Geological Unit	Depth (mRL)	2023 Average GWL (mRL)	Average Water Depth (m)	Comments
P2-4	Alluvium	1101	1108	7	Sampling started
P77-S	Alluvium	1111	1115	4	Not enough to sample
P8-4	Alluvium	1112	1119	7	Sampling started
New	Alluvium				Proposed by WWLA. Not constructed yet
BH6	Younger Volcanics	1053	1112	59	Sampling started
BH7	Younger Volcanics	1079	1101	22	Sampling started (results not yet available)
BH9	Younger Volcanics	1074	1098	24	Sampling started
BH11	Younger Volcanics	1075	1095	20	Sampling started (results not yet available)
BH12	Younger Volcanics	1079	1106	27	Sampling started
P2-2	Andesite	1035	1046	11	Too narrow for sample

P77-D	Andesite	1031	1103	72	Too narrow for sample
P8-2	Andesite				Collapsed

Figure 3: Martha groundwater piezometer locations

Water quality sampling from the deep aquifer in the Project Martha area is also undertaken from two dewatering locations underground, known as 800 PC1 and 800 PC2, and shown in Figure 3 and Figure 4. Dewatering is undertaken from two boreholes at each location, with a combined sample for the two boreholes collected from a manifold at each of the locations. Sampling from these bores commenced in 2020 and is undertaken quarterly. This is the most representative sample of available of water quality in the deep aquifer below the mine, as little mixing with underground service water occurs.

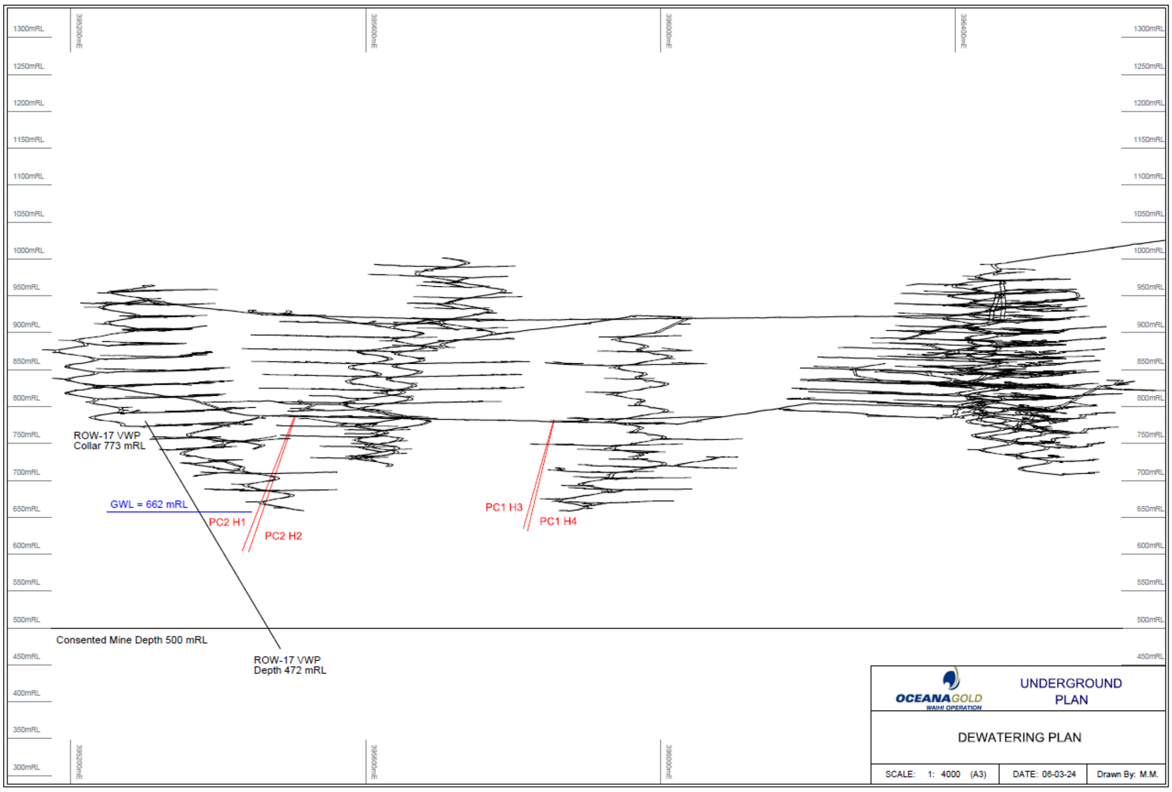


Figure 4: Underground dewatering bore locations, 800PC1 and 800PC2

Results from underground dewatering bore sampling and the initial round of piezometer sampling is summarised for each aquifer in the following sections and tabulated data is included as Appendix B.

3.1 Shallow Aquifer

The two piezometers sampled in the shallow aquifer are P2-4 and P8-4. Water quality results for indicator parameters are shown in Table 2: Shallow aquifer groundwater quality, and a piper trilinear diagram in Figure 5.

Both samples from the shallow aquifer are bicarbonate type waters with a mixture of cations. Further sampling of the shallow aquifer is required to characterise shallow aquifer chemistry and will be included in the next version of this report as well as the Dewatering and Settlement Report 2024.

Table 2: Shallow aquifer groundwater quality results

Well	Number of Samples	pH	EC (mS/m)	SO4 (g/m3)	Fe (g/m3)	Mn (g/m3)
P2-4	1	7.5	23.2	6	0.02	0.08
P8-4	1	6.8	14.6	4	2.7	0.64

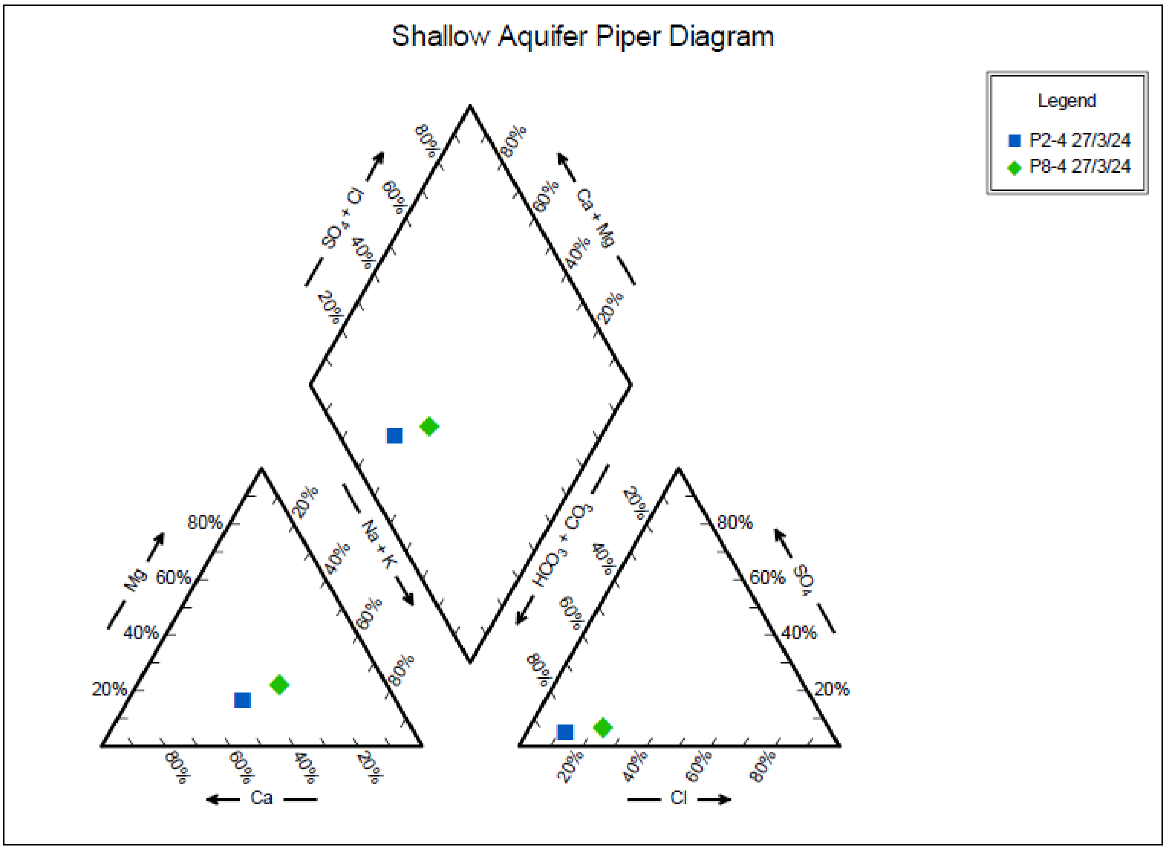


Figure 5: Shallow Aquifer Piper Diagram

3.2 Deep Aquifer

Summarised water quality results from sampling of the deep aquifer during the reporting period are included in Table 3. This includes quarterly sampling of the two underground dewatering bores in andesite from 2020, and the first round of sampling from piezometers in the younger volcanics.

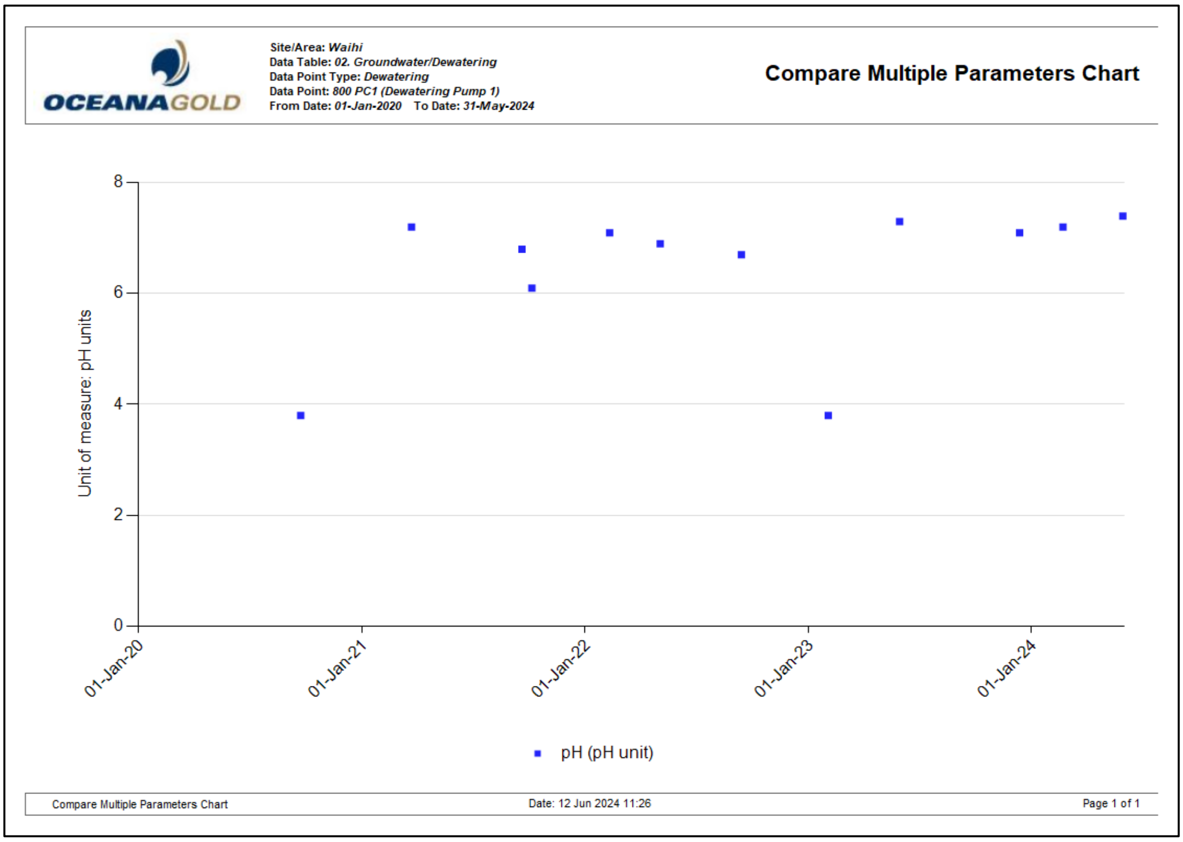
Figure 6 to Figure 7 show key chemistry parameters from sampling of 800 PC1 and PC2 since sampling started in 2020. Overall, results are stable from both sampling locations with pH around 6 on most sampling occasions. At both sampling locations, EC and sulphate are elevated but stable, manganese is at overall low levels, and iron is at low levels on most sampling occasions.

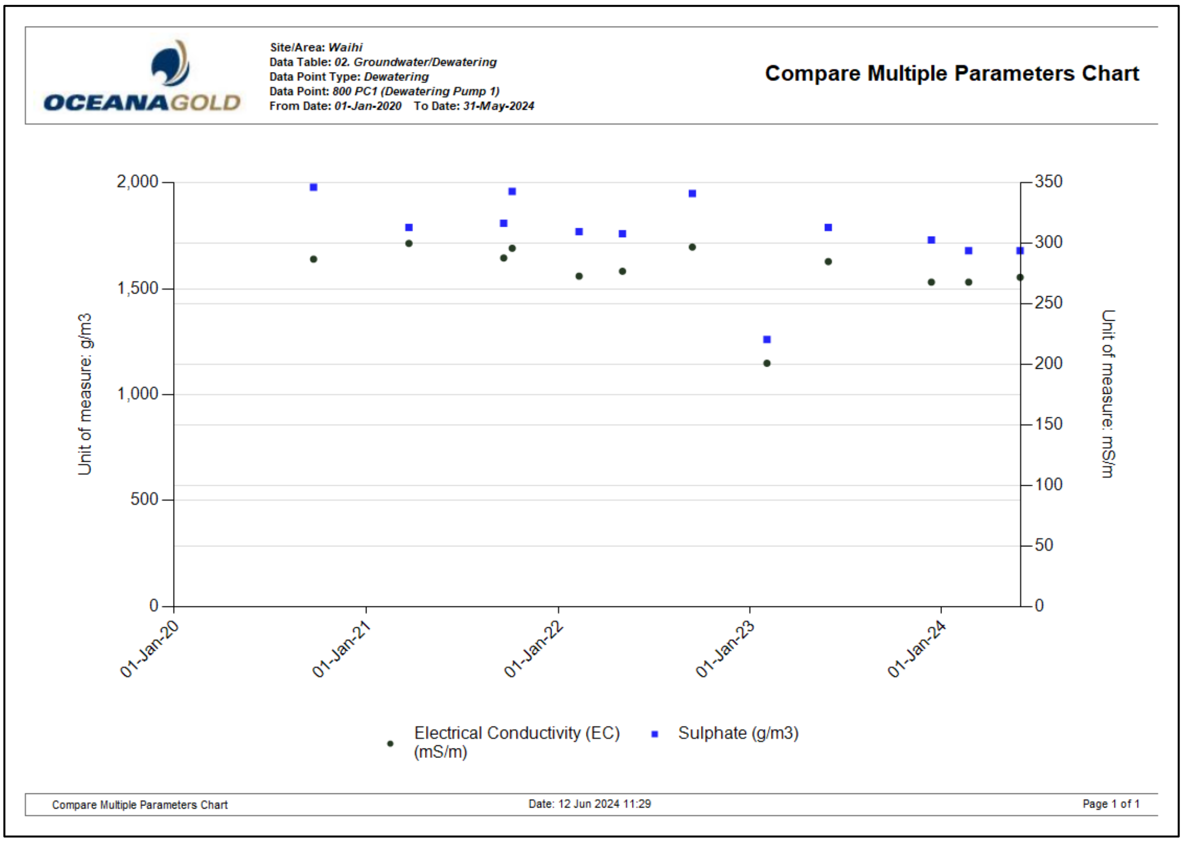
Additional data from sampling of the deeper piezometers will be available for and included in the next iteration of this report and the Dewatering and Settlement Report 2024.

Table 3: Deep aquifer groundwater quality results (andesite and younger volcanics)

Well	Geological Unit	Number of Samples	Average pH	Average EC (mS/m)	Average SO4 (g/m3)	Average Fe (g/m3)	Average Mn (g/m3)
BH6	Younger volcanics	1	6.8	14.6	2	0.1[1]	0.55[1]
BH12	Younger volcanics	1	7.5	21.4	19	0.02[1]	0.08[1]
BH9	Younger volcanics	1	6.0	6.5	6	0.02[1]	0.06[1]
800PC1	Andesite	11	6.4	276.4	1771	16.67[2]	14.88[1]
800PC2	Andesite	9	6.1	282.8	1889	12.22[2]	16.79[1]

[1] Dissolved
[2] Acid soluble





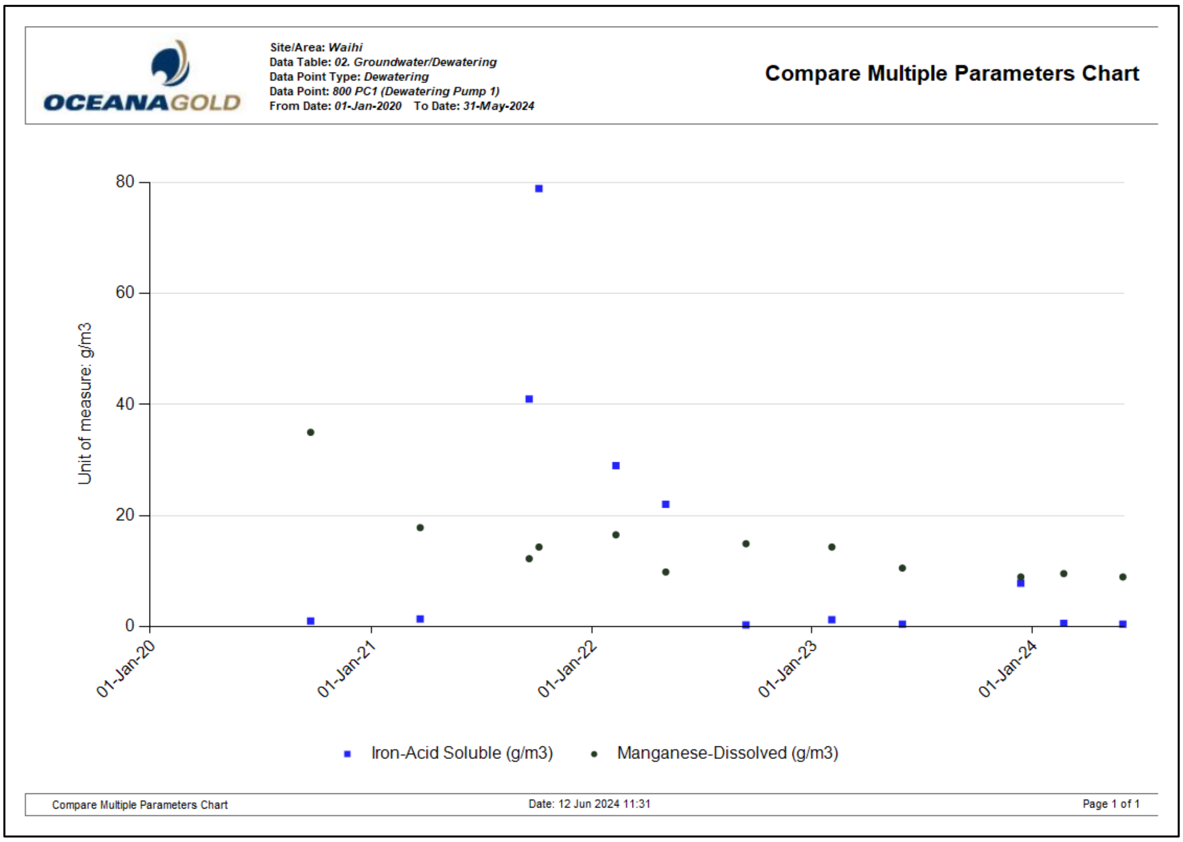
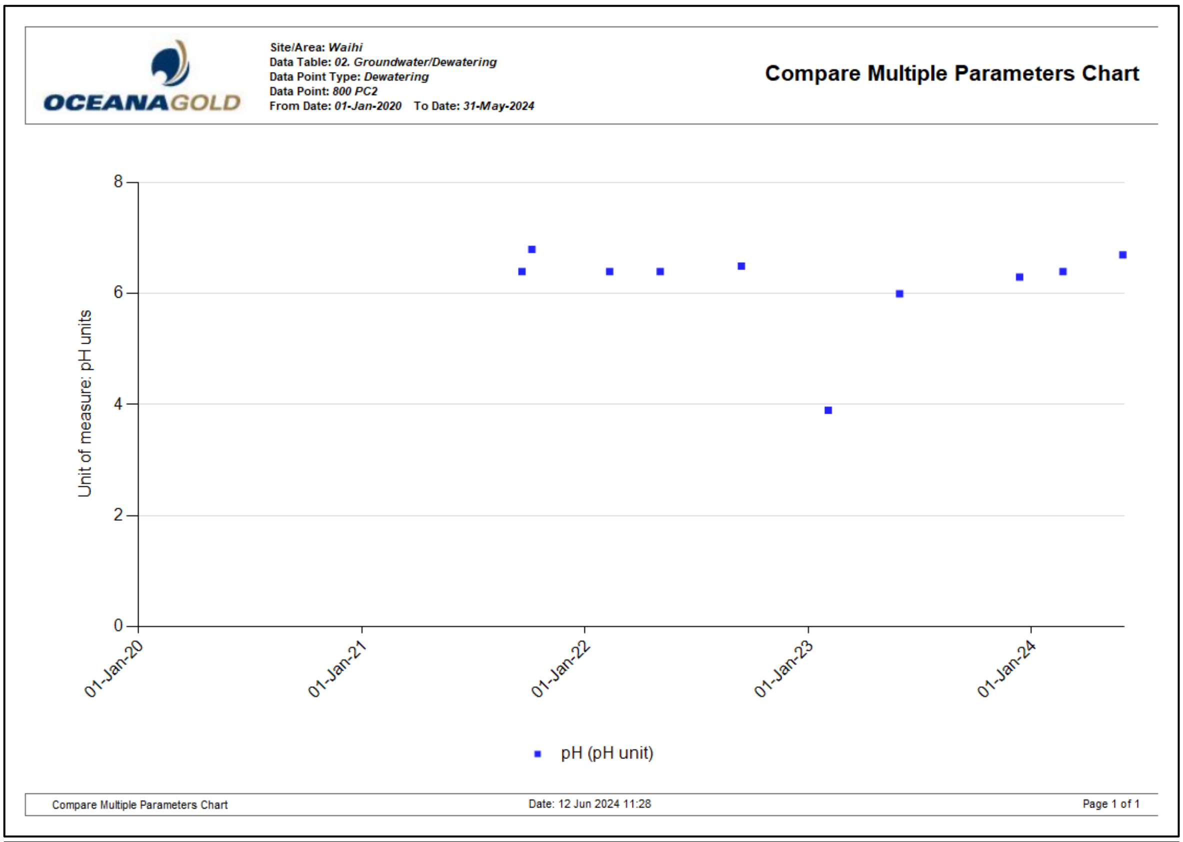


Figure 6: 800 PC1 Key Chemistry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Site/Area: Waihi
Data Table: 02. Groundwater/Dewatering
Data Point Type: Dewatering
Data Point: 800 PC2
From Date: 01-Jan-2020 To Date: 31-May-2024
Compare Multiple Parameters Chart
Unit of measure: pH units
0
2
4
6
8
01-Jan-20
01-Jan-21
01-Jan-22
01-Jan-23
01-Jan-24
pH (pH unit)
Compare Multiple Parameters Chart
Date: 12 Jun 2024 11:28
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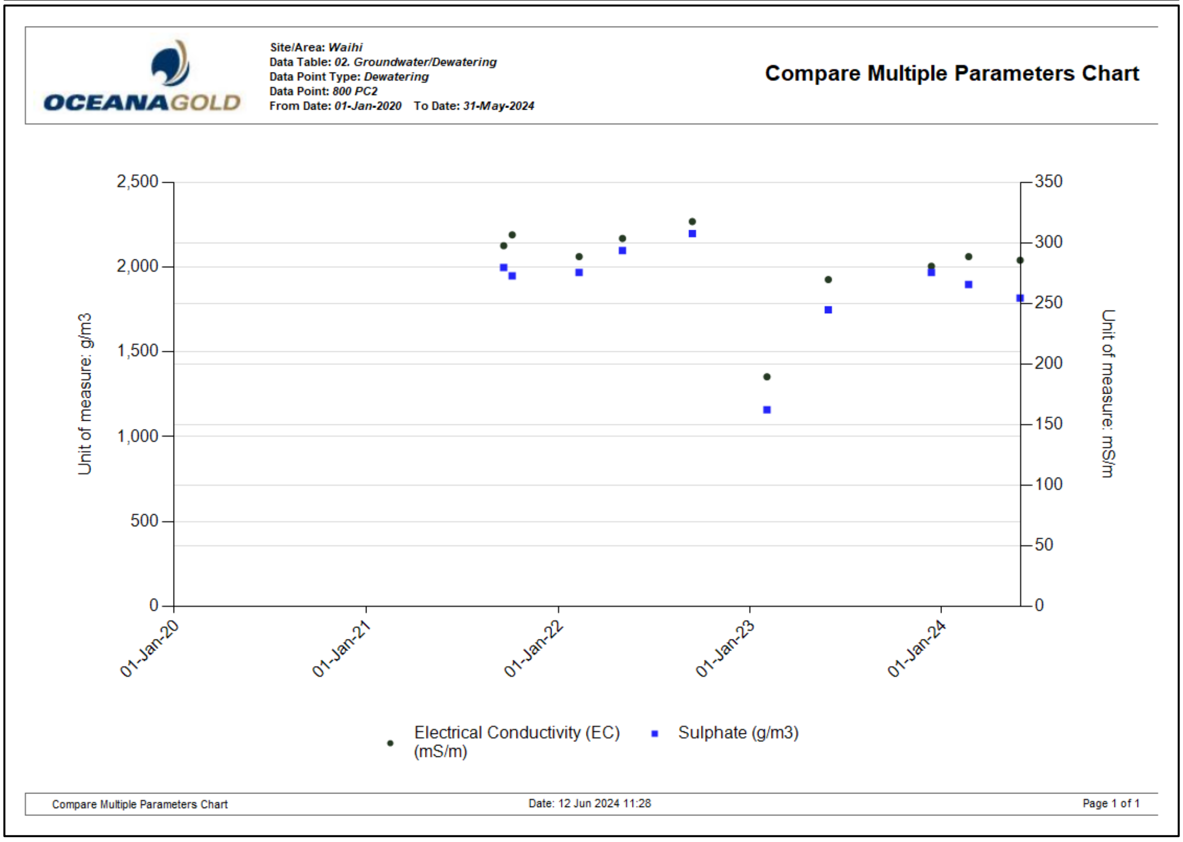
OCEANAGOLD
Site/Area: Waihi
Data Table: 02. Groundwater/Dewatering
Data Point Type: Dewatering
Data Point: 800 PC2
From Date: 01-Jan-2020 To Date: 31-May-2024
Compare Multiple Parameters Chart
Unit of measure: g/m3
0
500
1,000
1,500
2,000
2,500
Unit of measure: mS/m
0
50
100
150
200
250
300
350
01-Jan-20
01-Jan-21
01-Jan-22
01-Jan-23
01-Jan-24
Electrical Conductivity (EC) (mS/m)
Sulphate (g/m3)
Compare Multiple Parameters Chart
Date: 12 Jun 2024 11:28
Page 1 of 1

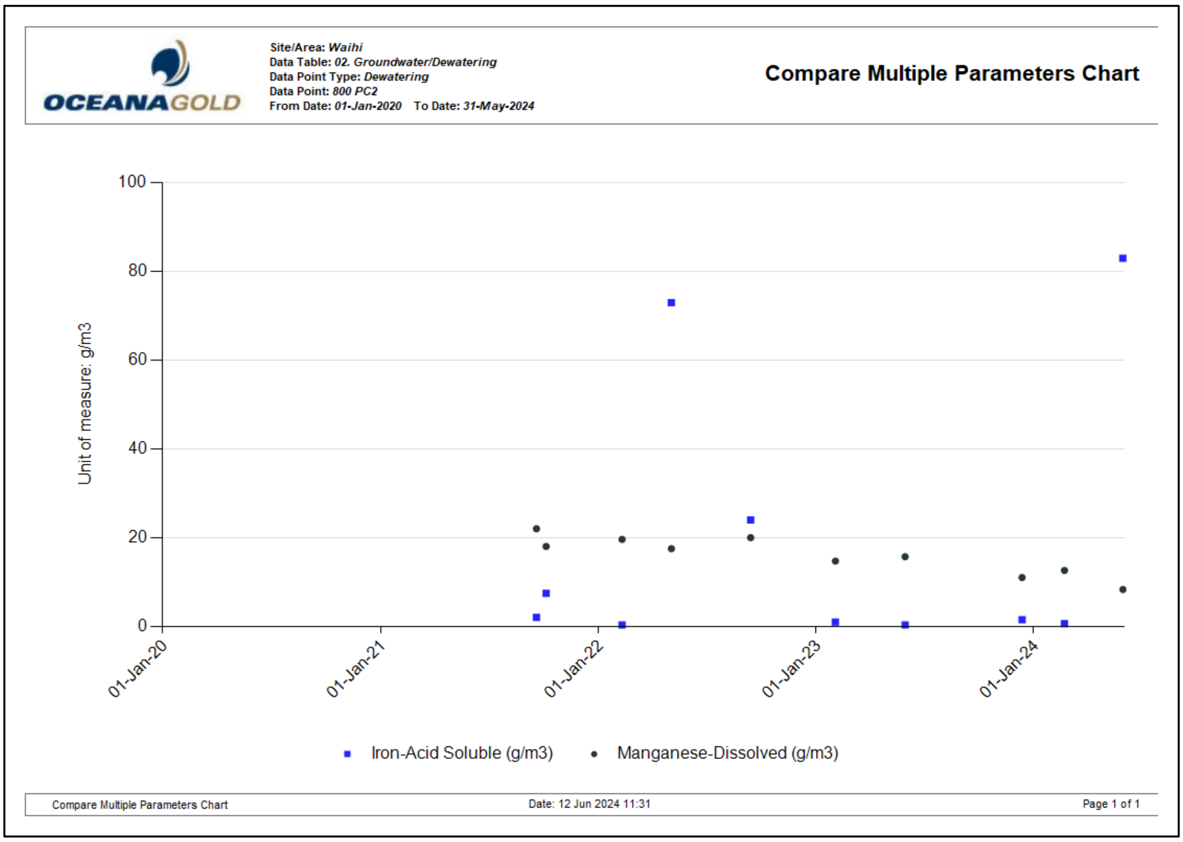

Figure 7: 800 PC2 Key Chemistry

The piper chart for the deep aquifer (Figure 8) shows water sampled from underground dewatering bores deep in the aquifer has remained stable since sampling commenced, with high proportions of sulphate and calcium. Water from the younger volcanics is more varied with all three sampling points showing differing proportions of cations and anions.

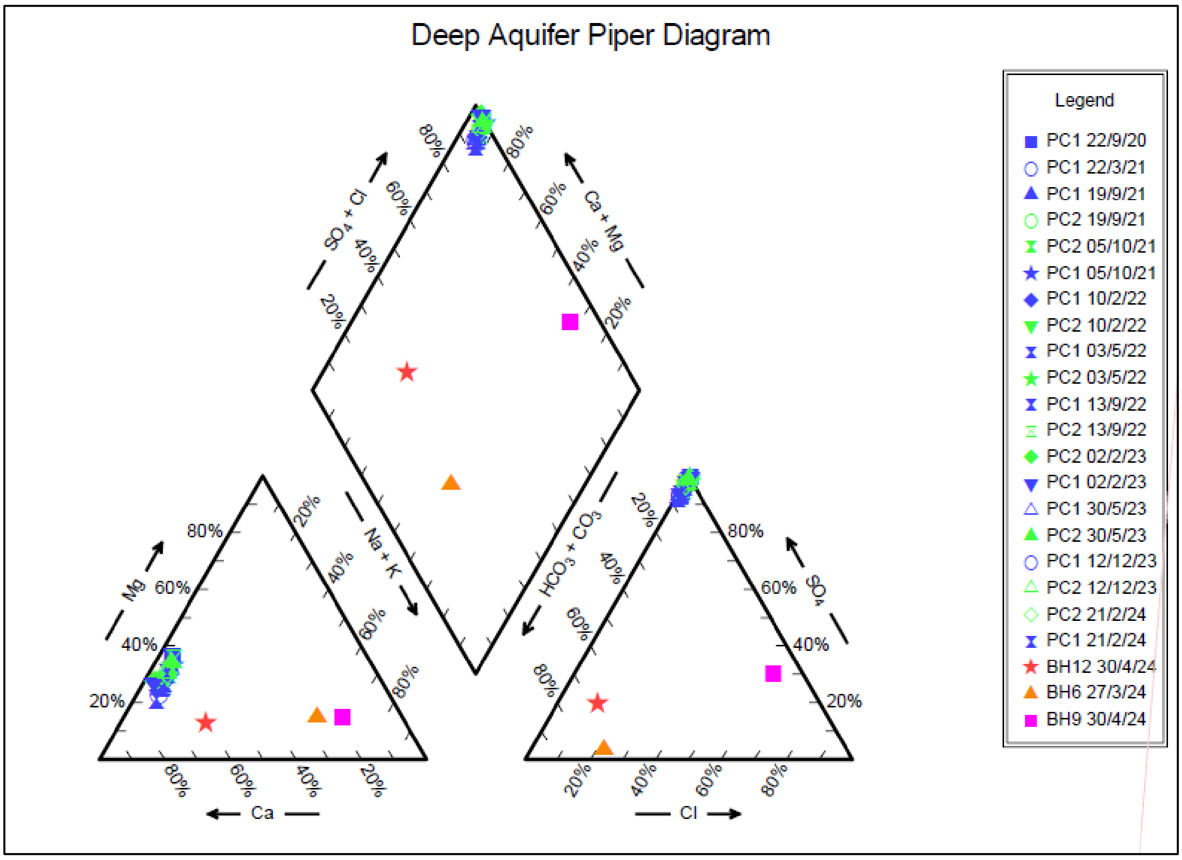

Figure 8: Deep Aquifer Piper Diagram

4 GROUNDWATER LEVELS

This section is provided to meet Condition 9 d of the consent:

- *Comment on the groundwater levels in the deep and shallow aquifers,*

and:

- *Comment on the effects the dewatering activity is having on the shallow and deep aquifers under the Martha Pit and immediate surrounds.*

4.1 Method

OGNZL has maintained a piezometer network within and around Martha Mine since 1987. Additional Correnso/SUPA piezometers were installed in 2011, 2014 and 2016. P106 was drilled and four vibrating wire piezometers (VWP) installed in that drill hole during 2017. It is located to the northwest of Martha Pit (Figure 9). Seven Project Martha piezometers were added to the network during 2019, three during 2021 and two more during 2022/23 (P122 & P123).

The current piezometer network, well depths and average 2023 water depths are shown in Table 4.

Table 4. Piezometer network well depths and average water depths for 2023

ALLUVIUM					
Well ID	**Depth (mRL)**	**2023 Average GWL (mRL)**	**Average Water Depth (m)**	**Piezometer Type**	**Comment**
P2-4	1101	1108	7	Standpipe	
P8-4	1112	1119	7	Standpipe	
P63-S	1113	1118	5	Standpipe	
P76-S	1109	1112	3	Standpipe	
P77-S	1111	1115	4	Standpipe	
P87-S	1110	1116	6	Standpipe	
P91-1	1113	1120	7	VWP	
P93-1	1105	1117	12	VWP	
P94-1	1114	1115	1	VWP	
P101-1	1102	1110	8	VWP	
P102-1	1109	1115	6	VWP	
WC201-4	1104	1111	7	Standpipe	
WC201-5	1110	1111	1	Standpipe	
GLD04S	1080	1086	6	Standpipe	
YOUNGER VOLCANICS					
Well ID	**Depth (mRL)**	**2023 Average GWL (mRL)**	**Average Water Depth (m)**	**Piezometer Type**	**Comment**
P2-3	1073	1092	19	Standpipe	
P4-2	1048	1089	41	Standpipe	
P7-2	1039	1091	52	Standpipe	
P7-3	1081	1091	10	Standpipe	
P8-3	1093	1117	24	Standpipe	
P27-1	1074	1079	5	Standpipe	
P63	1070	1091	21	Standpipe	
P64-I	1086	1102	16	Standpipe	
P76-I	1073	1105	32	Standpipe	
P77-I & P77-I2	1046	1103	57	Standpipe	
P78-S	1110	1111	1	Standpipe	
P78-I	1066	1106	40	Standpipe	
P79-S	1091	1097	6	Standpipe	
P79-I	1061	1095	34	Standpipe	
P87-I	1070	1111	41	Standpipe	
P90-1	1100	1115	15	VWP	
P90-2	1020	1101	81	VWP	
P91-2	1097	1119	22	VWP	

P91-3	1011	1113	102	VWP	
P92-1	1096	1120	24	VWP	
P92-2	1000	1109	109	VWP	
P93-2	1015	1091	76	VWP	
P94-2	1094	1115	21	VWP	
P94-3	1016	1102	86	VWP	
P95-1	1091	1117	26	VWP	
P95-2	1031	1103	72	VWP	
P100-1	1066	1085	19	VWP	
P100-2	996	1056	60	VWP	
P101-2	1083	1103	20	VWP	
P101-3	1068	1094	26	VWP	
P102-2	1079	1103	24	VWP	
P102-3	1055	1097	42	VWP	
P107	1089	1111	22	Standpipe	
P108	1116	1123	7	Standpipe	
P109	1091	1096	5	Standpipe	
P110	1097	1107	10	Standpipe	
P111-1	1100	1108	8	VWP	
P112-1	1058	1059	1	VWP	
P113	1062	-	-	Standpipe	Dry
P113A	1070	1072	2	VWP	
P114	1054	1059	5	Standpipe	
P115	1072	1095	23	Standpipe	
P116	1045	1092	47	Standpipe	
P122-1	1092	1101	9	VWP	
P122-2	1060	-	-	VWP	Dry
BH6	1053	1112	59	Standpipe	
BH7	1079	1101	22	Standpipe	
BH9	1074	1098	24	Standpipe	
BH11	1075	1095	20	Standpipe	
BH12	1079	1106	27	Standpipe	
GLD04I	1065	1087	22	Standpipe	
ANDESITE					
Well ID	**Depth (mRL)**	**2023 Average GWL (mRL)**	**Average Water Depth (m)**	**Piezometer Type**	**Comment**
P2-1	974	975	1	Standpipe	
P2-2	1035	1046	11	Standpipe	
P7-1	989	1003	14	Standpipe	
P8-1	976	1027	51	Standpipe	

P9-1	1037	1119	82	Standpipe	
P69-S	1114	1137	23	Standpipe	
P69-D	1063	1092	29	Standpipe	
P75	979	1072	93	Standpipe	
P76-D	1056	1099	43	Standpipe	
P77-D	1031	1103	72	Standpipe	
P78-D	1053	1073	20	Standpipe	
P79-D	1048	1094	46	Standpipe	
P87-D	1025	1103	78	Standpipe	
P90-3	983	1087	104	VWP	
P91-4	971	1103	132	VWP	
P92-3	965	1102	137	VWP	
P93-4	975	1041	66	VWP	
P94-4	976	993	17	VWP	
P95-3	1001	1061	60	VWP	
P100-3	981	1048	67	VWP	
P100-4	956	990	34	VWP	
P101-4	1037	1040	3	VWP	
P102-4	1027	1032	5	VWP	
P106-1	1100	-	-	VWP	Dry
P106-2	1060	-	-	VWP	Dry
P106-3	1010	-	-	VWP	Dry
P106-4	974	-	-	VWP	Dry
P111-2	1088	-	-	VWP	Dry
P111-3	1055	1060	5	VWP	
P112-2	1035	-	-	VWP	Dry
P112-3	998	-	-	VWP	Dry
P113A	1035	1060	25	VWP	
P122-3	1032	-	-	VWP	Dry
P122-4	933	-	-	VWP	Dry
P123-1	1044	1112	68	VWP	
P123-2	1004	1006	2	VWP	
P123-3	964	971	7	VWP	
P123-4	924	925	1	VWP	
WC201-1	1059	1064	5	Pneumatic	
WC201-2	1077	1080	3	Pneumatic	
WC201-3	1097	1100	3	Pneumatic	
WC202-1	1032	1079	47	Pneumatic	
GLD04D	1020	1086	66	Standpipe	

Note: VWP = Vibrating Wire Piezometer

All piezometers are monitored on a monthly basis as required by the consent conditions. The water levels are translated to the mine datum reference level to enable comparison between bores or areas. Vibrating wire piezometers record values at daily intervals with the data downloaded monthly.

4.2 Results

The Waihi town piezometer network currently has 53 dipped piezometers and four pneumatic piezometers. An additional 14 data loggers connected to 50 vibrating wire piezometers are also included in monitoring Waihi East, south of the Martha Pit and northwest of the Martha Pit (Figure 9). Groundwater contour plans have been updated for the three principal geological units: alluvium (plus shallow groundwater in weathered younger volcanic materials), younger volcanics (including ignimbrite), and andesite. Groundwater contour plans and level trends included in this report do not include VWPs, the Dewatering and Settlement Report 2023 should be referred to for results from VWPs. The groundwater plans are presented in Figure 10, Figure 12 and Figure 15 respectively.

4.2.1 Shallow Groundwater

Figure 10 shows the inferred contours for shallow groundwater in alluvium and weathered younger volcanic materials and shows the water level trends over time. The overall contour pattern and the trend plot demonstrates that the shallow groundwater system remains essentially unaffected by dewatering of the surface and underground mining operations. Shallow groundwater levels are controlled principally by rainfall infiltration, low surface soil permeability and natural and assisted drainage to surface water systems.

Contouring of the area southwest of Martha Mine has been restricted by the loss of access to the wells at sites WC203 and WC206. For the purposes of completing the contour plan it was assumed that groundwater levels in the alluvium at these locations remained the same as in previous years.

Figure 9: Waihi piezometer network 2024

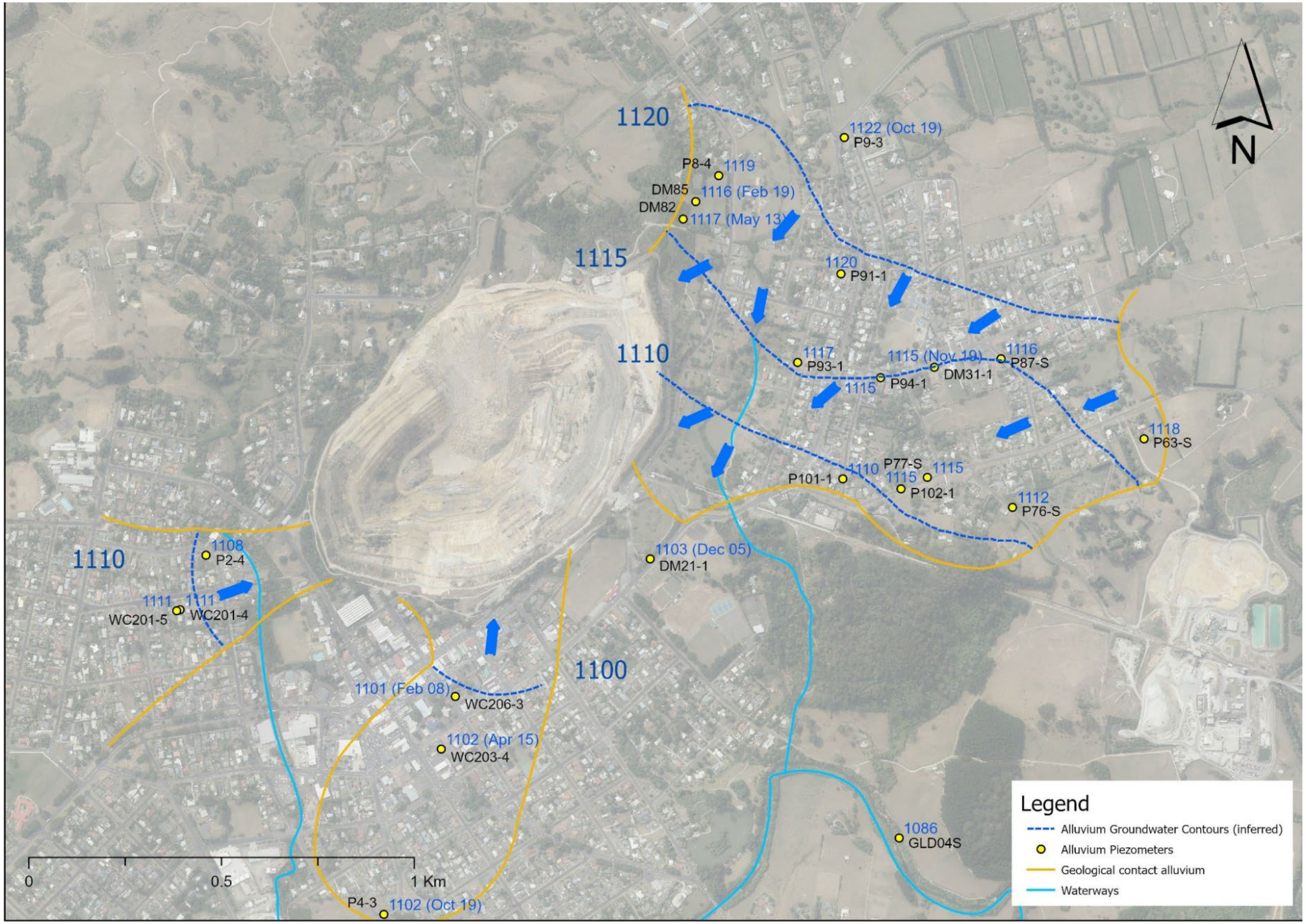

Figure 10: Alluvium water level contours

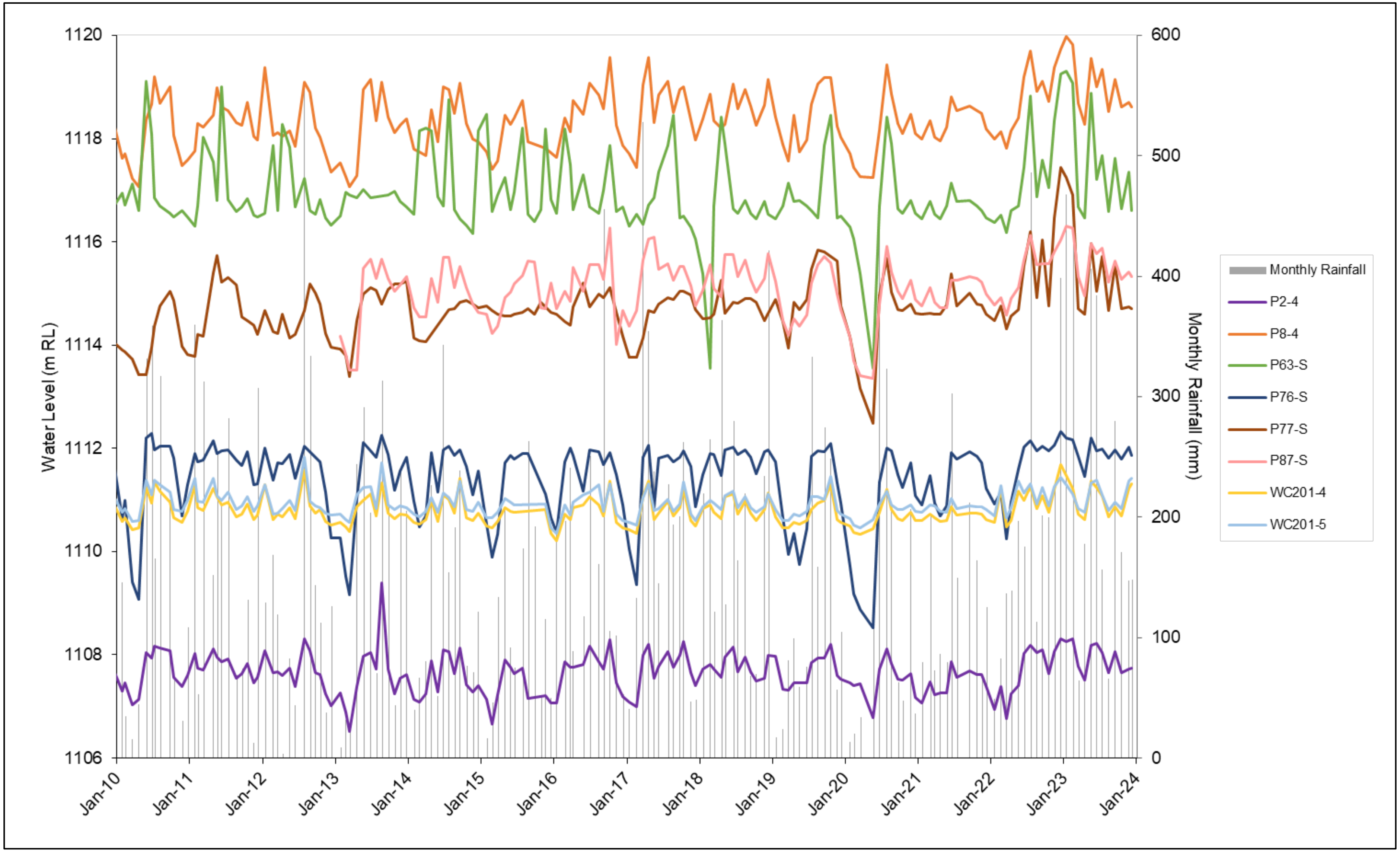

Figure 11: Groundwater level trends – shallow aquifer (alluvium & weathered contact of younger volcanics)

4.2.2 Younger Volcanics

Groundwater contours in the deeper portions of the younger volcanic materials below the shallow groundwater system and groundwater level trends are shown on Figure 12, Figure 13 and Figure 14.

The younger volcanic materials infill topographic depressions in the surface of the andesite rock body in which the open pit and underground mines are constructed.

Groundwater level change and the associated consolidation of the varying thickness of these relatively compressible younger volcanic materials are considered to be responsible for much of the settlement and for the settlement patterns around the Martha and Favona Mines, noting that dewatering of the deep andesites is also contributing to general settlement across Waihi.

The dewatering pattern in the younger volcanics around Martha Mine indicates drainage towards the open pit. The limited groundwater discharge at the contact of the younger volcanic materials with the underlying andesite in the pit (see Figure 12 & Figure 13) suggests drainage is affected by features other than the contact (which defines a paleo-valley in the andesite). The most likely additional drain point is a substantial block cave evident in the pit wall. This block cave, referred to as the Milking Cow, was active during historical (pre-1950’s) underground operations and resulted in substantial settlement of the ground surface, down-folding of fill and younger volcanic strata, and close fracturing of the welded ignimbrite layers.

Prior to the start of dewatering at Martha Mine, groundwater levels in all rock units were similar. With the onset of mine dewatering, water levels in the veins and historic workings were drawn down. Groundwater levels in the various rock units below the shallow aquifer showed increasing vertical separation until the mid to late 1990’s. Thereafter, the water levels (other than in the veins and workings) stabilised and have remained stable since. This pattern is demonstrated in the monitoring wells at site P2, with piezometer P2-1 following the vein water levels until the water level dropped below the piezometer tip. P2-2 measures the upper andesite water levels, P2-3, the younger volcanic rock water levels and P2-4 the alluvium (shallow aquifer) water levels.

No notable changes can be seen in younger volcanics piezometric levels since dewatering below 700 mRL commenced.

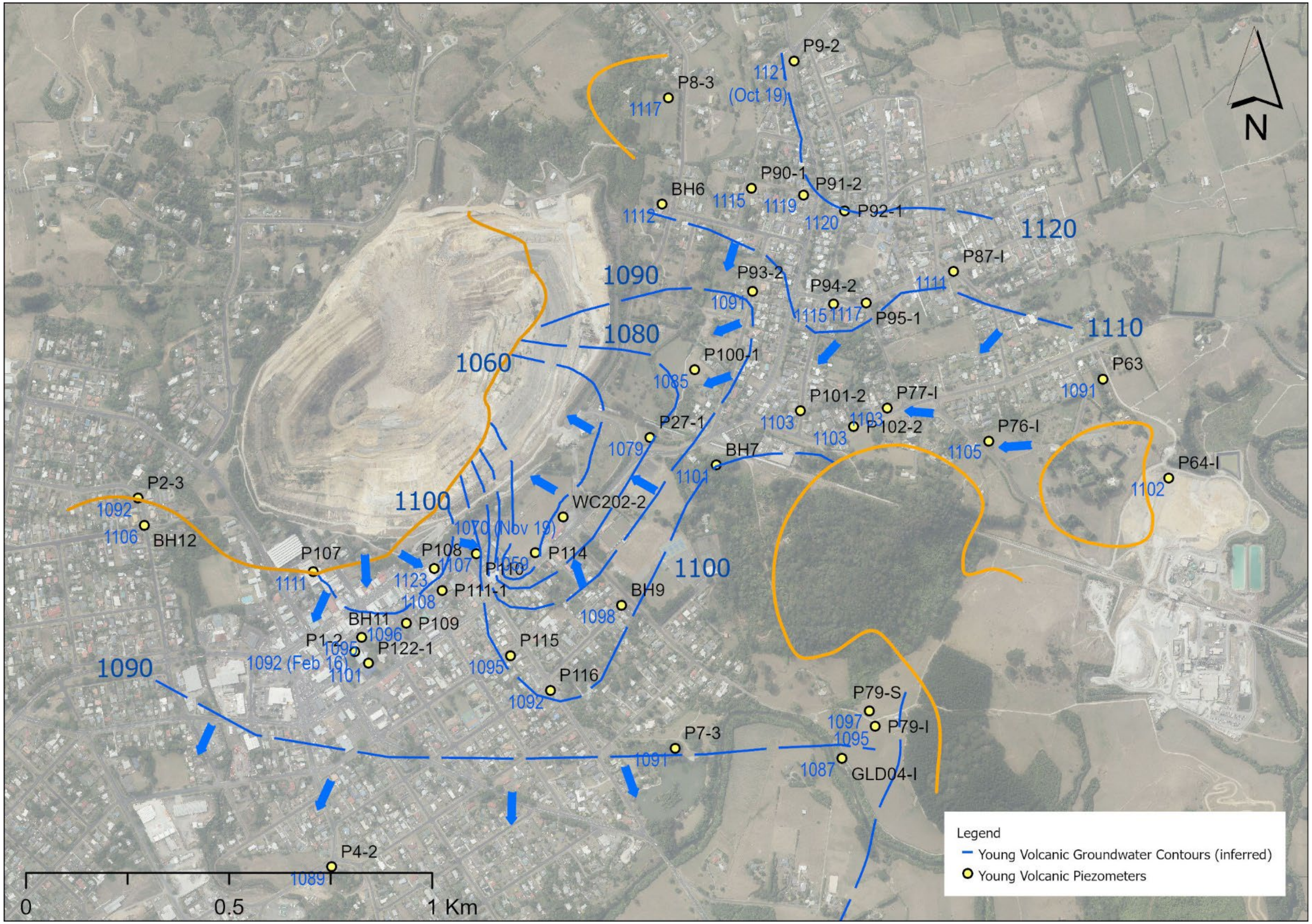

Figure 12: Deeper younger volcanic water level contours

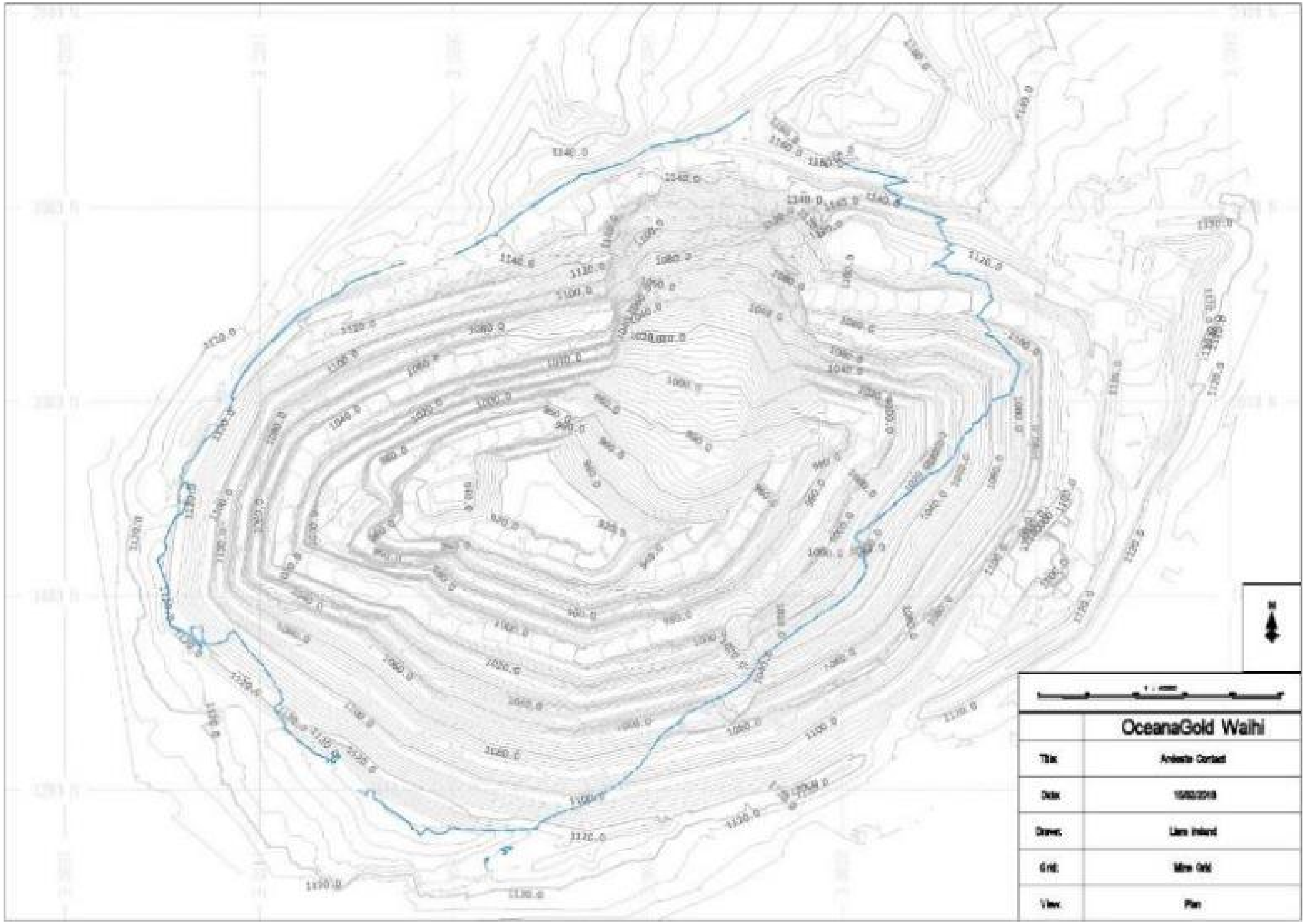

Figure 13: Groundwater level trends – deeper younger volcanic materials

Note: blue line indicates contact of the younger volcanics with the underlying andesite where seepage at the base of the younger volcanics would occur.

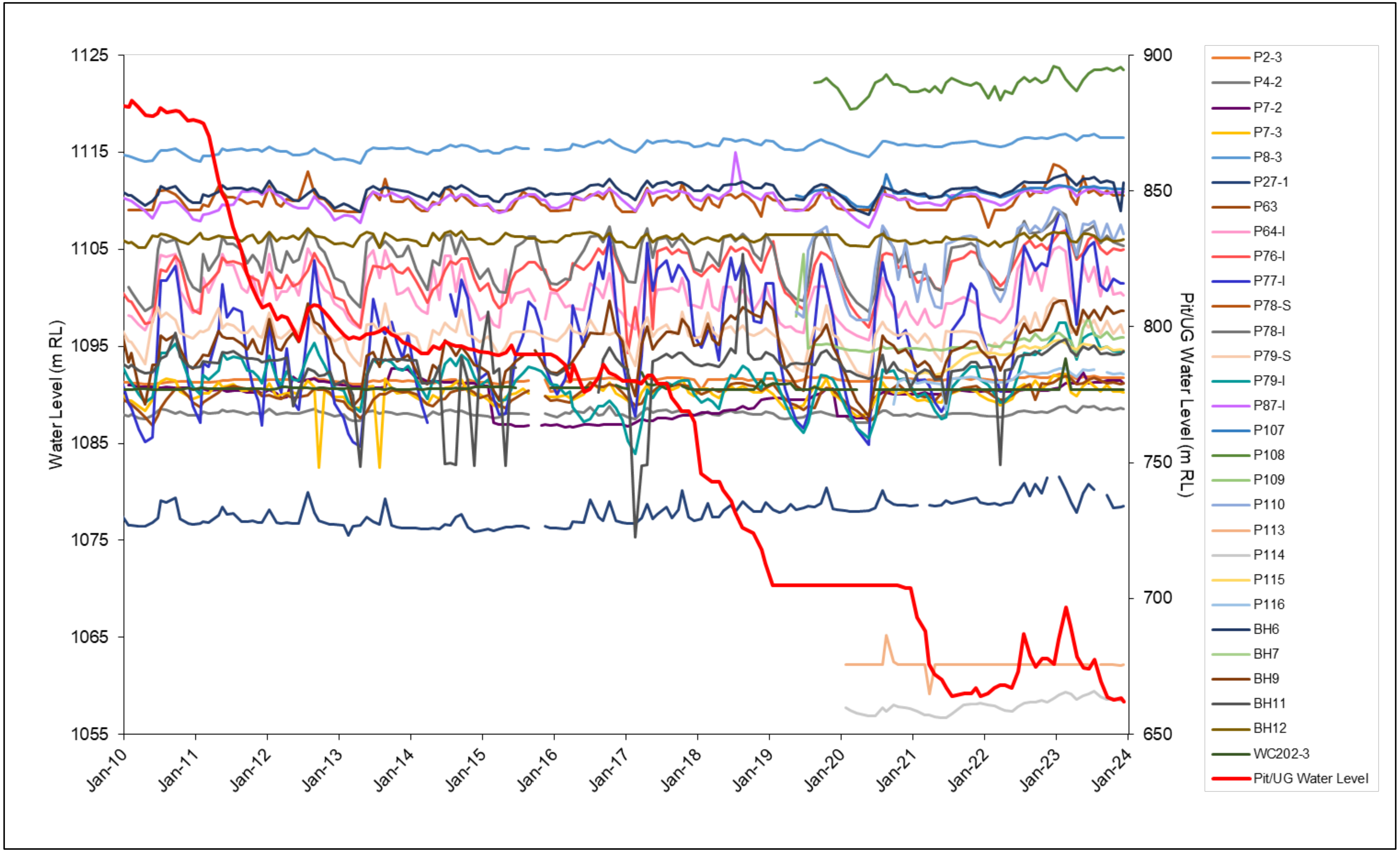

Figure 14: Groundwater level trends – deeper younger volcanics near underlying andesite contact

4.2.3 Andesite

Andesite rock forms the local basement rock body for the Waihi area and hosts the mineralisation which was being mined at Martha Pit and is currently mined in the Underground.

Figure 15 shows the scope of the dewatering effects in the andesite rock body as a result of dewatering. Data from the vibrating wire piezometer units have been included. Figure 16 provides the water level trends in the andesite rock body. While groundwater level data is available for the vein systems and the shallower andesite rock, no monitoring data is available for intermediate depths within the andesite rock mass outside of development areas. Hence, groundwater levels between the vein and the shallow rock mass have been interpolated.

Groundwater levels in the andesite vein systems have responded rapidly and substantially to mine dewatering along the strike of the Martha vein system, Trio vein system (beneath Union Hill), and Favona/Moonlight vein systems (Figure 15). An area of dewatering, indicated between Martha Mine and Trio/Correnso vein systems, suggests a relatively close linkage. Outside of these structures, the dewatering effect in the andesite rock is attenuated or absent. This is illustrated by the different responses shown on Figure 16.

The Martha Mine dewatering effect continues to be abruptly attenuated to the north of the mine and also to the west of the mine. This is considered to be the result of faulting which truncates the veining. A lobe of dewatering extends to the southwest of Martha Mine and this is considered to be due to the drainage effect along the north-south Edward lode structure. Dewatering is shown to reduce eastwards along the Martha system but may extend further at depth as the host rocks are more deeply buried in that direction and no deep monitoring wells are available for confirmation.

Figure 15 also indicates the dewatering centralised on the Favona system with the restriction of connection between Favona and the Union systems. The geological model in Section 3 indicates an up-thrown block (Union Horst, Figure 15) between the Union and Favona systems. This structural hiatus is likely to account for the restricted groundwater interconnection between the Martha-Union and Favona systems.

No changes are apparent in andesite piezometric levels since dewatering below 700 mRL occurred.

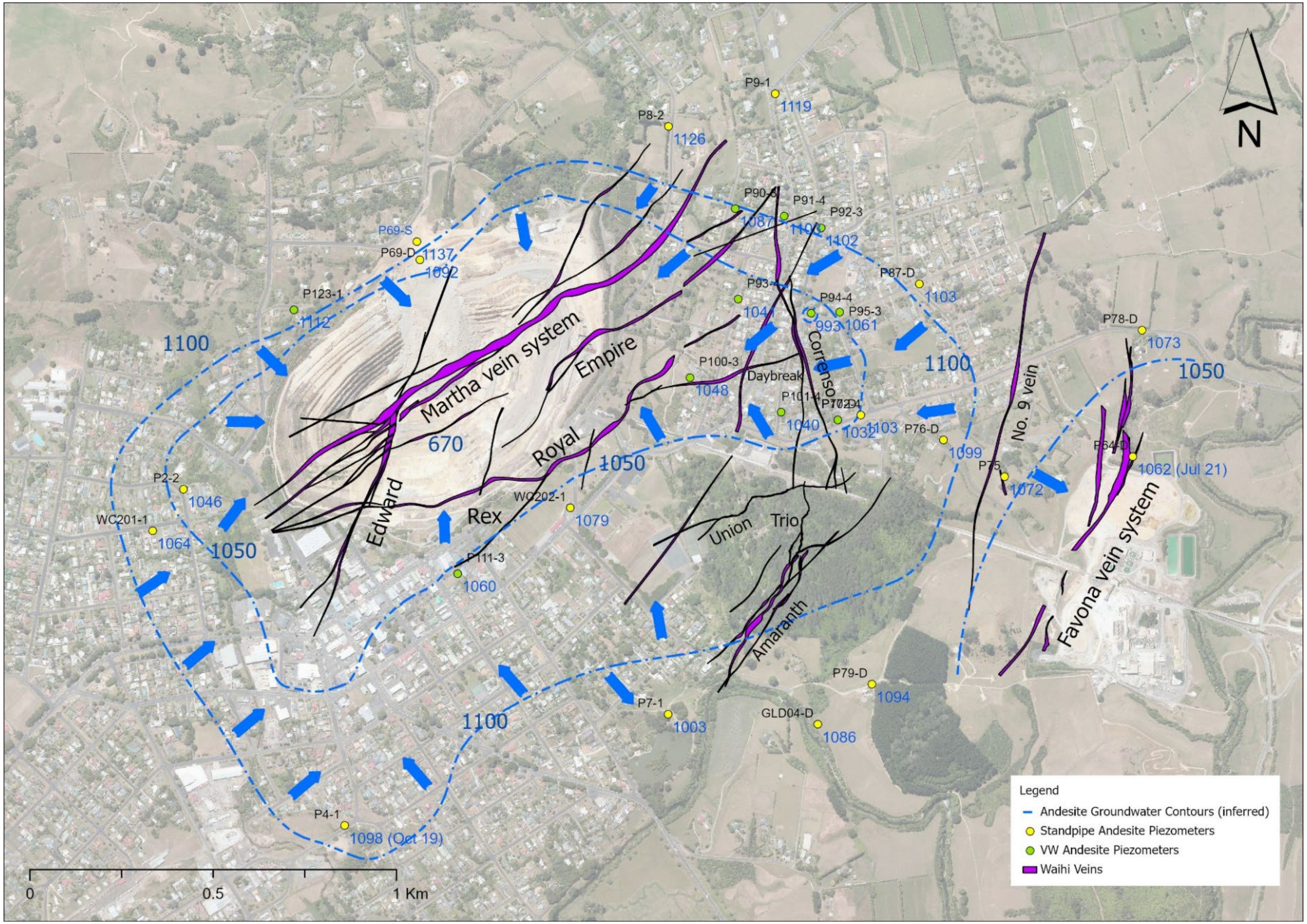

Figure 15: Upper andesite water level contours

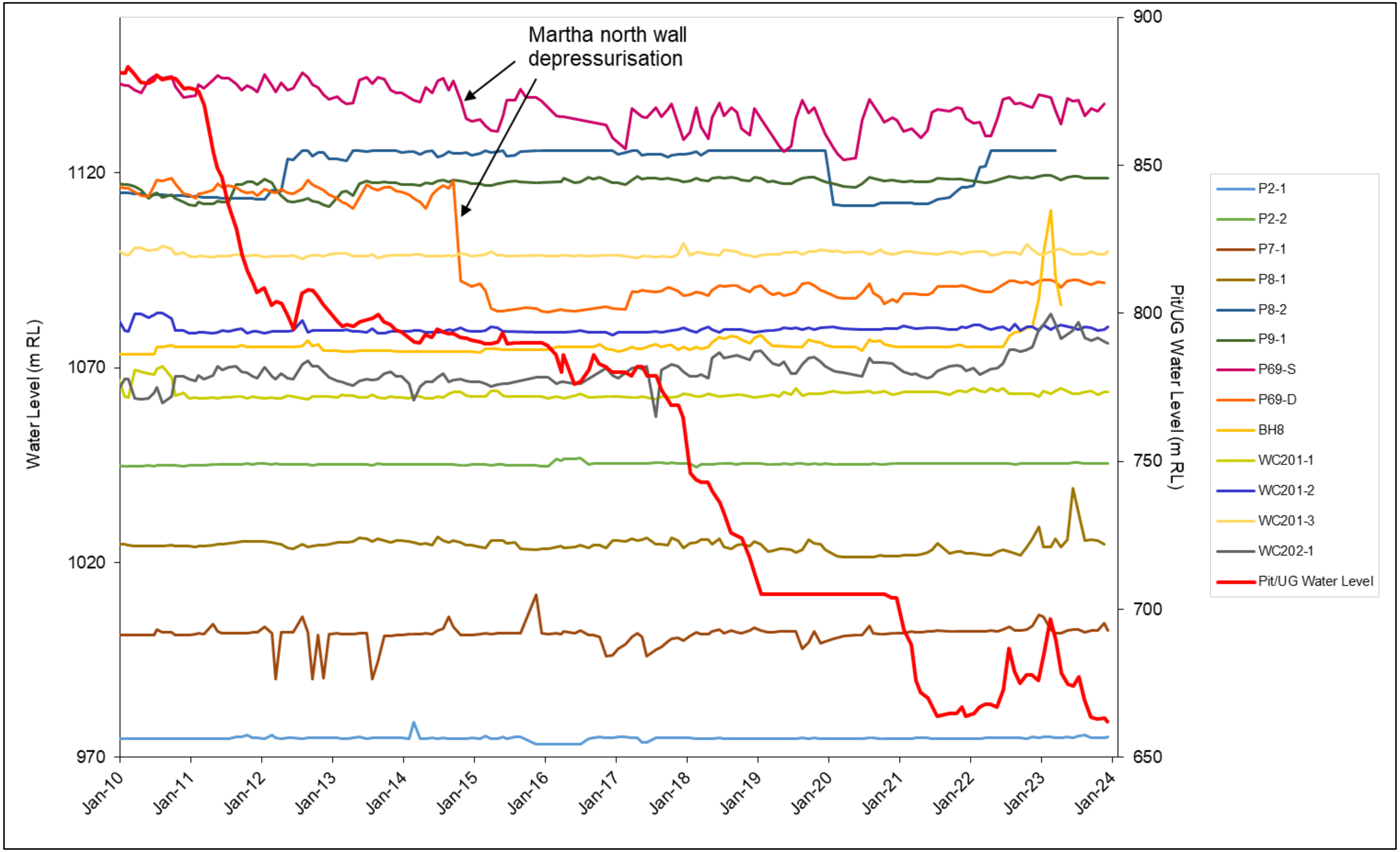

Figure 16: Andesite water level trends

5 WETLANDS AND ECOLOGICAL VALUES

This section is provided to meet Condition 9 c of the consent:

- *Provide details of any wetland areas and any other known aquatic ecological values that are dependent on the surface contribution of shallow and deep groundwater outflows.*

Two distinct areas of wetland in the surrounds of Martha Pit have been identified by GWS as being dependant on the surface contribution of shallow groundwater outflows. No wetlands fully or partially supported by a deep groundwater source were identified. A memorandum outlining GWS's assessment of groundwater fed wetlands is included as Appendix C.

The first is located northeast of Martha Pit and is referred to hereafter as the Northern Area. The second area is located in the Union Hill, Winner Hill and Black Hill surrounds and is referred to as the Southern Area (Figure 17).

Figure 17: Northern and Southern Wetland Area

5.1 Northern Area

The Northern Area is located to the north of Martha Pit where younger volcanics/alluvium are located near the surface. Two separate areas of springs located between Williams Street and Bulltown Road drain southeast into a wetland alongside the Pit Rim Walkway before joining the Eastern Stream The area of wetland immediately northeast of the pit and the riparian margins of the Eastern Stream near the pit are maintained by OGNZL (Figure 18 and Figure 19).

Figure 18: Map of the Northern Area showing wetland boundary (green), flow direction (blue), photo point location (A), and proposed staff gauge location (A)

Figure 19: Northern Area Wetland view from photo point A in Figure 19 . A) Upstream view from pit rim walkway B) Downstream view from pit rim walkway

No changes have been apparent in this wetland since dewatering below 700 mRL commenced.

A staff gauge will be installed in the wetland this reporting period to allow for more accurate monitoring of temporal changes in wetland water level. The proposed location is shown in Figure 18, point A.

5.2 Southern Area

The groundwater system near Gladstone Hill consists of shallow groundwater in younger volcanic and alluvium deposits and a deeper system within the andesite rockmass. The systems are separated locally through the presence of a low permeability weathered layer. The Southern Area wetland is supported by the shallow groundwater system in this location.

The Southern Area wetland consists of a collection of ephemeral springs that flow after heavy or prolonged rainfall (Figure 20, points C). When flowing, the springs run through two gullies planted in native vegetation and maintained by OGNZL, before eventually joining the main Gladstone wetland where standing water occurs throughout the year. The estimated wetland boundary is shown in green in Figure 20 and photos from Figure 20, point B are shown in Figure 21. From here, water from the wetland flows towards the Ohinemuri River and discharges to the river via two culverts that maintain the wetland water level in low flows (Figure 20, point A).

Figure 20: Map of Gladstone wetland boundary (green), flow direction (blue), with culvert and proposed staff gauge location (A), photo point location (B), and spring locations (C)

Quarterly flow gauging and photo monitoring of this wetland has been undertaken throughout the reporting period. Increased water levels in the wetland and outflow through the culvert occur after periods of heavy rain, with lower water levels and outflow during extended dry periods, however, no long-term changes have been apparent in this wetland since dewatering below 700 mRL commenced.

A staff gauge will be installed in the wetland this reporting period to allow for more accurate monitoring of temporal changes in wetland water level.

Figure 21: Gladstone wetland from Point B, Figure 21. A) view southeast and B) view of standing water from northern side of walkway

6 CONCLUSIONS

Since dewatering below 700 mRL has commenced, no new trends have been noted in groundwater levels in the shallow and deep aquifers surrounding the Martha Pit. Similarly, no changes to the two areas of wetlands identified as being fed by shallow groundwater have been noted during the reporting period.

Whilst water quality sampling from the shallow and deep aquifers has commenced, additional data is required to better characterise water quality. This will be collected in the next reporting period and presented in the next version of this report.

Staff gauges will be installed in two wetlands during this reporting period to improve the ability to monitor water levels within the wetlands.

Overall, OGNZL believes it is in compliance with conditions of consent 139551 related to the Shallow and Deep Aquifer Report.

APPENDIX A

GWS Technical Memo: MUG Groundwater Quality Baseline 2023

TECHNICAL MEMO

10th May 2023

To: Mark Burroughs

From: Chris Simpson

Subject: MUG Groundwater Quality Baseline Monitoring

1. Background

The Project Martha Underground dewatering consent has a condition that requires the following:

Project Martha Consent 139551 within Groundwater Take Permit section - Condition 6 - Monitoring of the shallow and deep aquifers part (b) requires "comment on the chemistry in shallow and deep aquifers".

Project Martha Consent 139551 Condition 22 (c) include the phrase "predictions of future impacts that may arise as a result of any trends that have been identified including review of the predicted post closure effects based on actual monitoring data, and what contingency actions, if any, the consent holder proposes to take in response to those predictions".

In summary, our interpretation is that the condition seeks to characterise the groundwater quality prior to site closure occurring such that any subsequent changes in quality can be detected.

This memo provides a review that identifies piezometers suitable for baseline water chemistry sampling of the shallow and deep aquifers in the mine area and, where necessary, make recommendations for new piezometers to fill critical spatial data gaps. The approach assumes representative water quality samples are required for each hydrogeologic unit and that seasonal variation in quality will be characterised.

2. Existing Piezometer Network

A detailed review of the MUG groundwater monitoring network was undertaken by GWS (April 2022) to identify gaps in the network and provide recommendations for additional monitoring locations. Further information about the network can be found in that memo. The existing groundwater monitoring network surrounding the Marth Underground consists of a series of standpipe and vibrating wire piezometers constructed at various times during the life of modern mining. Given the objective of needing to collect groundwater samples, only standpipe piezometers can be considered as being useful for that purpose. Applying that filter halves the number of existing monitoring points available for sampling. The table presented at the end of this memo includes all of the monitoring wells that can be sampled separated by geologic unit.

3. Proposed Groundwater Monitoring Locations

While there are clearly a number of monitoring wells that could be sampled, we have identified a selection that provide reasonable spatial coverage around the underground operations. These are discussed by hydrogeologic unit as follows.

Level 1/320 Ti Rakau Dr
East Tamaki
Auckland 2013

Phone: 09 576 0093
Email: GWS@xtra.co.nz
Web Page: www.gwsconsulting.co.nz

Alluvium

We recommend that groundwater samples are collected from each of the areas where alluvium is present at the surface namely: P2-4, P77-S, P8-4 and at a new well next to P122 and BH11. These locations are highlighted green on Figure 1 below.

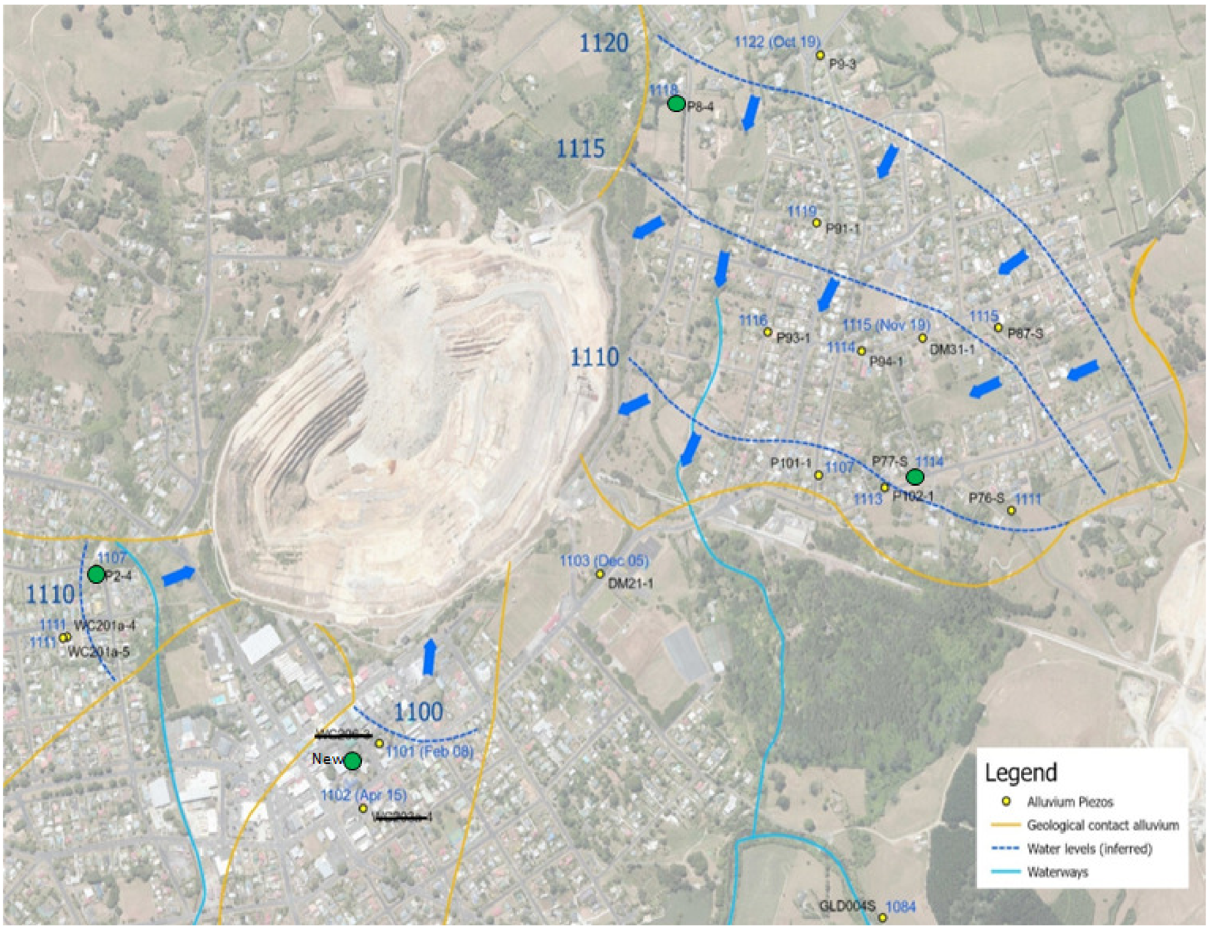

Figure 1 Recommended Alluvium Water Quality Sampling Locations

Level 1/320 Ti Rakau Dr
East Tamaki
Auckland 2013
Phone: 09 576 0093
Email: GWS@xtra.co.nz
Web Page: www.gwsconsulting.co.nz

Young Volcanics

Young Volcanics are present dominantly on the eastern side of the Martha Underground. We recommend monitoring groundwater quality at BH6, BH7, BH9, BH11 and BH12 which provides a general spatial representation of the aquifer. These are highlighted green on Figure 2 below.

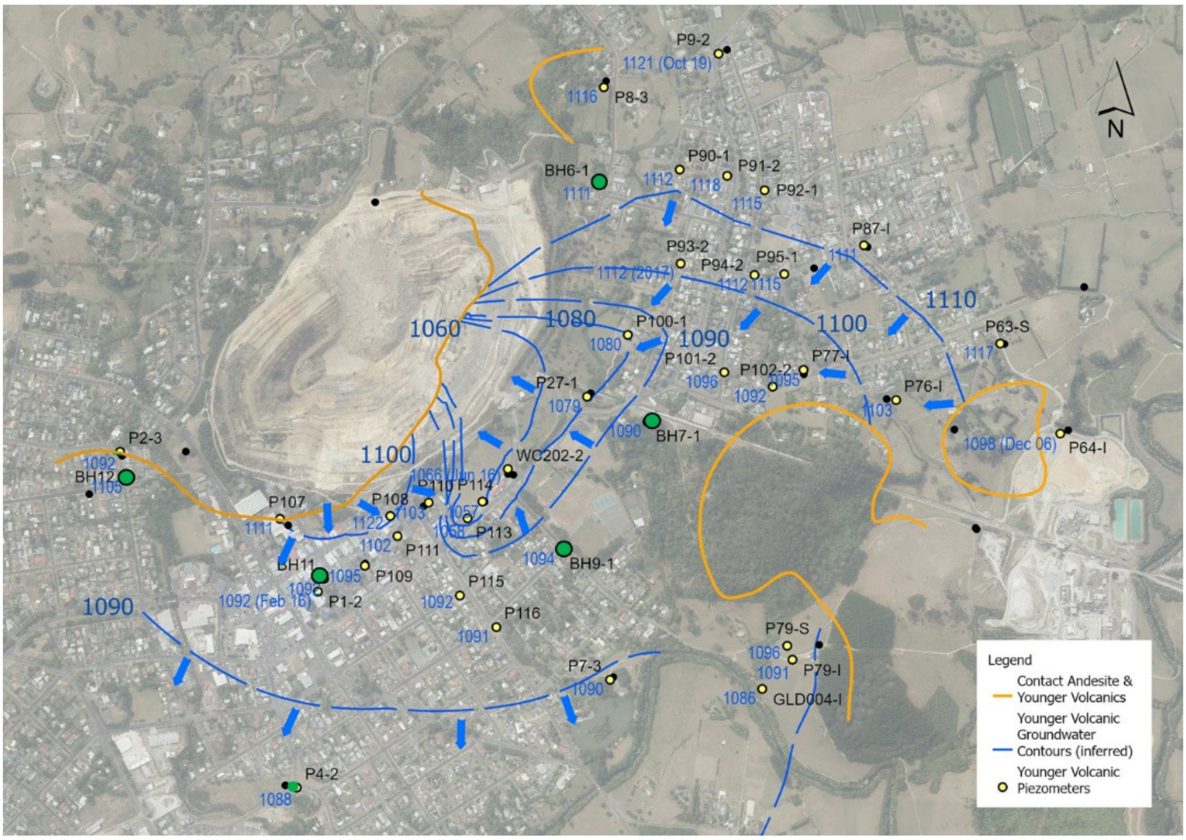

Figure 2 **Recommended Young Volcanics Water Quality Sampling Locations**

Andesite

Andesite rock encompasses the entire Martha Underground. We recommend monitoring groundwater quality at P2-2, P77-D, P8-2 which provides a general spatial representation of the aquifer These locations are highlighted green on Figure 3 below.

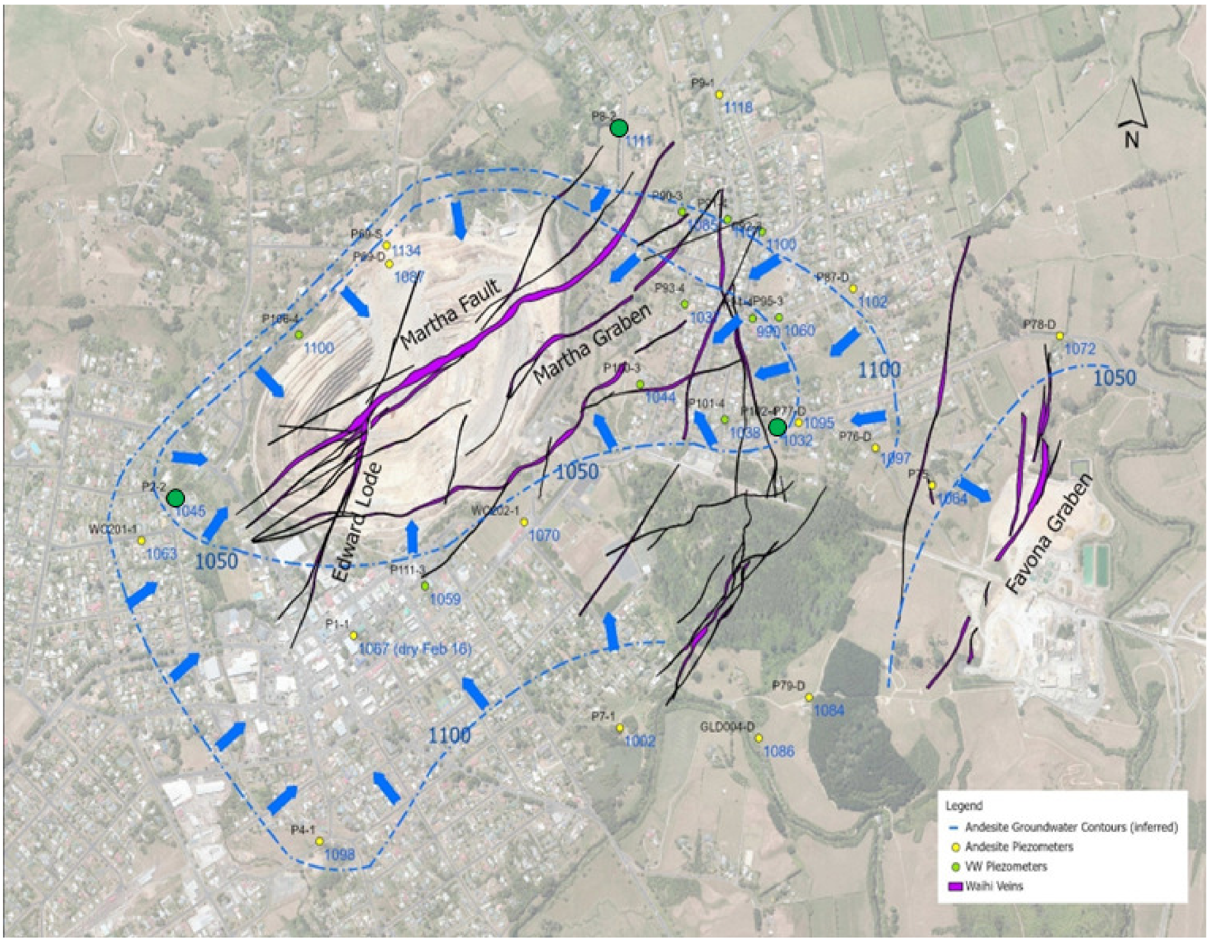

Figure 3 Recommended Andesite Water Quality Sampling Locations

Summary of Monitoring Locations

Table 1 provides a summary of those monitoring well identified as suitable for groundwater quality monitoring.

Table 1 Recommended Groundwater Monitoring Locations

Alluvium	Young Volcanics	Andesite
P2-4	BH6	P2-2
P77-S	BH7	P77-D
P8-4	BH9	P8-2
New	BH11	
	BH12	

We recommend that OGL review and ground truth the list of recommended monitoring wells for suitability for water quality sampling. If not considered suitable, other existing alternative monitoring locations can be considered. We understand that the main issue associated with most of the existing monitoring wells is that they are relatively small diameter (25 mm) and as such there are limitations as to what sampling equipment may be suitable.

Sampling Frequency

We recommend groundwater samples are collected bi-annually at the beginning of April and October of each year to understand the seasonal changes in groundwater chemistry.

Sampling Methodology

The groundwater sampling methodology should be consistent with that already undertaken by OGL at the TSF's and Favona Stockpiles. An alternative sampling methodology may need to be considered where the water level in the wells is very deep. Any methodology should be consistent with the National Protocol for State of the Environment Groundwater Sampling in New Zealand (GNS, 2006).

Groundwater Quality Analytical Suite

The groundwater quality samples from all wells should be sent to an external laboratory for the Code 40 analysis suite set (i.e. same suite as for Favona groundwater samples).

Once a full analytical baseline has been established, it may be appropriate to reduce monitoring to only pH and EC with trigger levels set that initial full suite sampling (as per the Favona groundwater quality monitoring).

APPENDIX B
Groundwater Quality Results

Date	Data Point	FLS Comments	FLS EC (mS/m)	FLS pH	FLS Temp	FLS Vol. Purge (L)	Acidity (ph 8.3)(g/m3 as CaCO3)	Acidity (pH 3.7)	Alk-Bicarb	Alk-T	AlA	AlS	SbA	SbS	AsA	AsS	Bicarb	CdA	CdS	CaSO	COD	Cl	CrA	CrS	Cr6col
29/05/2024	800 PC2																								
29/05/2024	800 PC1																								
21/02/2024	800 PC1							1	152	152		0.006		0.0011		0.04	185		0.00044	580	6	11		0.001	0.01
21/02/2024	800 PC2							1	93	93		0.015		0.0005		0.002	113		0.0025	570	6	10		0.001	0.01
12/12/2023	800 PC2							1	80	81		0.012		0.0004		0.002	98		0.0031	480	6	12		0.001	0.01
12/12/2023	800 PC1							1	144	144		0.006		0.0007		0.005	176		0.0001	510	6	13		0.001	0.01
30/05/2023	800 PC2							1	48	48		0.17		0.0004		0.002	59		0.0049	450	6	10		0.001	0.01
30/05/2023	800 PC1							1	147	148		0.006		0.0011		0.01	180		0.0025	530	7	12		0.001	0.01
2/02/2023	800 PC1							1	1	1		13.9		0.0002		0.0013	1		0.039	370	7	7		0.0034	0.01
2/02/2023	800 PC2							1	1	1		11.3		0.0002		0.001	1		0.0165	340	6	7		0.0028	0.01
13/09/2022	800 PC1							1	89	89		0.033		0.0006		0.001	108		0.0069	520	6	9		0.0005	0.01
13/09/2022	800 PC2							1	59	59		0.008		0.0002		0.001	72		0.005	530	6	9		0.0005	0.01
3/05/2022	800 PC1							1	145	146		0.003		0.0003		0.001	177		5.00E-05	510	6	11		0.0005	0.01
3/05/2022	800 PC2							1	28	28		0.003		0.0002		0.001	34		0.00113	500	10	12		0.0005	0.01
10/02/2022	800 PC1							1	116	116		0.003		0.0002		0.0019	142		0.00067	410	6	8		0.0005	0.01
10/02/2022	800 PC2							1	48	48		0.087		0.0003		0.001	58		0.0106	440	6	8		0.0005	0.01
5/10/2021	800 PC1							1	18.7	18.7		0.006		0.0004		0.002	23		0.0001	480	7	11		0.001	0.01
5/10/2021	800 PC2							1	113	113		0.006		0.0005		0.002	137		0.0048	530	6	11		0.001	0.01
19/09/2021	800 PC1	Sample taken but pump not running.						1	160	160		0.003		0.0002		0.0057	195		5.00E-05	540	6	9		0.0005	0.01
19/09/2021	800 PC2	Sample taken but pump not running.						1	89	89		0.037		0.0004		0.001	108		0.0092	540	6	8		0.0005	0.01
22/03/2021	800 PC1							1	142	142		0.006		0.0005		0.022	173		0.00121	550	6	12		0.001	0.01
22/09/2020	800 PC1							1	1	1	14	13.5	0.0004	0.0004	0.002	0.002	1	0.0195	0.02	440		9	0.003	0.003	0.001

Date	Data Point	FLS Comments	CoA	CoS	CuA	CuS	CNTOT	EC (mS/m)	F-	NH3	AuS	Hard	FeA	FeS	FeT	PbA	PbS	MgSO	MnA	MnS	HgA	HgS	HgT	NiA	NiS	NO3-N	NOxN	NO2-N	NH4N	pH	PTO	KSO
29/05/2024	800 PC2																															
29/05/2024	800 PC1																															
21/02/2024	800 PC1			0.007		0.001	0.02	268		0.0002	0.0006	1890	0.54		0.59		0.0002	105		9.5	8.00E-05		8.00E-05		0.0087	0.1	0.1	0.1	0.055	7.2	0.013	9.3
21/02/2024	800 PC2			0.0165		0.0053	0.02	289		2.30E-05	0.0006	2100	0.58		0.63		0.021	162		12.6	8.00E-05		8.00E-05		0.045	1.15	1.17	0.1	0.036	6.4	0.004	12.4
12/12/2023	800 PC2			0.022		0.0032	0.02	281		1.00E-05	0.0006	1770	1.45		1.6		0.0005	140		11	8.00E-05		8.00E-05		0.067	1.25	1.25	0.1	0.021	6.3	0.017	11.5
12/12/2023	800 PC1			0.0073		0.001	0.02	268		9.00E-05	0.0006	1690	7.8		8.3		0.0002	101		8.9	8.00E-05		8.00E-05		0.0119	0.1	0.1	0.1	0.035	7.1	0.012	9.4
30/05/2023	800 PC2			0.054		0.046	0.02	270		1.20E-05	0.0006	1770	0.27		0.38		0.0112	154		15.7	8.00E-05		8.00E-05		0.146	1.24	1.24	0.1	0.048	6	0.003	9.8
30/05/2023	800 PC1			0.0138		0.0023	0.02	285		0.0002	0.0006	1810	0.36		0.44		0.0018	116		10.5	8.00E-05		8.00E-05		0.023	0.14	0.15	0.1	0.041	7.3	0.017	9.2
2/02/2023	800 PC1			0.196		0.64	0.02	201		1.00E-05	0.0006	1290	1.16		1.09		0.28	87		14.3	8.00E-05		8.00E-05		0.48	0.22	0.22	0.1	0.08	3.8	0.004	5.5
2/02/2023	800 PC2			0.148		0.24	0.02	189.6		1.00E-05	0.0006	1180	0.97		0.9		0.109	81		14.7	8.00E-05		8.00E-05		0.37	0.28	0.29	0.1	0.051	3.9	0.003	5.5
13/09/2022	800 PC1			0.041		0.036	0.02	297		3.50E-05	0.0006	1910	0.23		0.24		0.024	147		14.9	8.00E-05		8.00E-05		0.115	0.13	0.13	0.1	0.03	6.7	0.017	10.1
13/09/2022	800 PC2			0.055		0.001	0.02	318		9.00E-05	0.0006	2100	24		28		0.0001	194		20	8.00E-05		8.00E-05		0.147	0.1	0.1	0.1	0.14	6.5	0.004	11.9
3/05/2022	800 PC1			0.0077		0.0005	0.02	277		2.00E-05	0.0006	1740	22		21		0.0001	115		9.8	8.00E-05		8.00E-05		0.0123	0.1	0.1	0.1	0.01	6.9	0.007	9.8
3/05/2022	800 PC2			0.049		0.0005	0.02	304		7.00E-05	0.0006	1910	73		71		0.0001	158		17.5	8.00E-05		8.00E-05		0.106	0.1	0.1	0.1	0.1	6.4	0.005	11.2
10/02/2022	800 PC1			0.0119		0.0005	0.02	273		4.00E-05	0.0006	1500	29		28		0.0001	116		16.5	8.00E-05		8.00E-05		0.0193	0.1	0.1	0.1	0.01	7.1	0.003	9.4
10/02/2022	800 PC2			0.105		0.155	0.02	289		5.50E-05	0.0006	1590	0.29		0.33		0.035	119		19.6	8.00E-05		8.00E-05		0.23	0.98	0.99	0.1	0.107	6.4	0.002	9.9
5/10/2021	800 PC1			0.0067		0.001	0.02	296		1.00E-05	0.0006	1830	79		82		0.0002	155		14.3	8.00E-05		8.00E-05		0.0098	0.1	0.1	0.1	0.02	6.1	0.007	11.4
5/10/2021	800 PC2			0.058		0.001	0.02	307		0.000107	0.0006	1950	7.4		8.4		0.0002	151		18	8.00E-05		8.00E-05		0.1	0.1	0.1	0.1	0.069	6.8	0.002	11.7
19/09/2021	800 PC1	Sample taken but pump not running.		0.0041		0.0005	0.02	288		0.00014	0.0006	1870	41		42		0.0001	124		12.2	8.00E-05		8.00E-05		0.0048	0.1	0.1	0.1	0.1	6.8	0.01	9.8
19/09/2021	800 PC2	Sample taken but pump not running.		0.082		0.0144	0.02	298		3.20E-05	0.0006	1990	2		2.1		0.0037	158		22	8.00E-05		8.00E-05		0.164	0.15	0.16	0.1	0.062	6.4	0.002	10.8
22/03/2021	800 PC1			0.031		0.001	0.02	300		0.00011	0.0006	1980	1.33		1.47		0.0019	146		17.8	8.00E-05		8.00E-05		0.046	0.1	0.1	0.1	0.03	7.2	0.004	10.4
22/09/2020	800 PC1		0.24	0.27	0.25	0.27	0.02	287	0.74	1.00E-05		1760	0.93	0.89		0.63	0.63	162	33	35		8.00E-05	8.00E-05	0.51	0.59	0.18	0.19	0.1	0.145	3.8	0.004	10

Date	Data Point	FLS Comments	DRP	SeA	SeS	SeT	SI	AgA	AgS	NaSO	NaT	SO4	Sum Anion	Sum Cation	TiA	TiS	TKN	SeTR	TSS	UA	US	CNWAD	ZnA	ZnS
29/05/2024	800 PC2																							
29/05/2024	800 PC1																							
21/02/2024	800 PC1		0.004		0.002	0.0021	39		0.0002	57		1680	38	41			0.13		3			0.02		0.51
21/02/2024	800 PC2		0.004		0.002	0.0021	38		0.0002	51		1900	42	45			0.22		3			0.02		0.97
12/12/2023	800 PC2		0.004		0.002	0.0021	39		0.0002	41		1970	43	38			0.1		41			0.02		1.3
12/12/2023	800 PC1		0.004		0.002	0.0021	37		0.0002	51		1730	39	37			0.1		11			0.02		0.25
30/05/2023	800 PC2		0.004		0.002	0.0021	40		0.0002	36		1750	38	38			0.1		8			0.02		2
30/05/2023	800 PC1		0.004		0.002	0.0021	37		0.0002	52		1790	40	39			0.13		3			0.02		1.08
2/02/2023	800 PC1		0.004		0.0026	0.0024	44		0.0001	16.9		1260	27	29			0.18		5			0.02		19.2
2/02/2023	800 PC2		0.004		0.0016	0.0014	47		0.0001	15.4		1160	24	27			0.13		6			0.02		7.7
13/09/2022	800 PC1		0.04		0.001	0.0021	38		0.0001	44		1950	43	41			0.1		6			0.02		3.3
13/09/2022	800 PC2		0.04		0.001	0.0011	28		0.0001	46		2200	47	45			0.13		43			0.02		2.6
3/05/2022	800 PC1		0.004		0.001	0.0011	18.8		0.0001	49		1760	40	37			0.13		51			0.02		0.36
3/05/2022	800 PC2		0.004		0.001	0.0011	27		0.0001	42		2100	44	41			0.11		110			0.02		1.22
10/02/2022	800 PC1		0.004		0.001	0.0011	14		0.0001	38		1770	39	33			0.12		33			0.02		0.183
10/02/2022	800 PC2		0.004		0.001	0.0021	44		0.0001	43		1970	42	35			0.11		6			0.02		4.1
5/10/2021	800 PC1		0.004		0.002	0.0011	13.3		0.0002	48		1960	41	39			0.1		160			0.02		0.156
5/10/2021	800 PC2		0.004		0.002	0.0011	37		0.0002	51		1950	43	42			0.1		15			0.02		3.5
19/09/2021	800 PC1	Sample taken but pump not running.	0.004		0.001	0.0011	22		0.0001	51		1810	41	40			0.1		70			0.02		0.078
19/09/2021	800 PC2	Sample taken but pump not running.	0.04		0.001	0.0011	41		0.0001	45		2000	44	43			0.1		12			0.02		3.6
22/03/2021	800 PC1		0.004		0.002	0.0021	37		0.0002	48		1790	40	43			0.14		9			0.02		1.1
22/09/2020	800 PC1			0.002	0.003		57	0.0002	0.0002	30		1980	42	40	0.00184	0.00183	0.17		3	0.00105	0.00106	0.02	9.6	9.4

Date	Data Point	FLS Comments	FLS EC (mS/m)	FLS pH	FLS Temp
27/03/2024	P2-4	purged using waterra pump, fast recharge, grey sediment , used bailer for sample perristeltic pipe catching on inside of bore need to investigate	23.78	7.51	20.2
27/03/2024	P8-4	purged using waterra pump, grey colour sediment ,used bailer for sample cloudy, not enough for feild reading			
27/03/2024	BH6	Purged using waterra pump, organic /brown coloured sediment ,earthy smell needs well cap,and to be purged properly with monsoon pump . sampled using bailer mostly clear some floating organic particles	15.74	6.77	18.1
27/03/2024	P77S	purged using stainless bailer till dry, heavy grey/brown sediment, previous bore depth 5.68 now 5.98, previous swl 3.14 very slow to recharge, not enough to sample			
30/04/2024	BH12	for sample cloudy some organic sediment no smell, purged previous day brown heavy sediment, slow to recharge	22.94	7.18	17.8
30/04/2024	BH9	for sample clear no smell, purged previous day brown heavy sediment quick to recharge	6.87	5.26	

Date	Data Point	FLS Water Level (m)	FLS Vol. Purge (L)	Acidity (pH 3.7)	Alk-Bicarb	Alk-T	AlS	SbA	SbS	AsS	Bicarb	CdS	CaSO	Cl	CrS	CoS	CuS	EC (mS/m)	F-	NH3	Hard	FeS	PbS	MgSO	MnS	HgA	HgS	NiS
27/03/2024	P2-4	2.41	30	1	104	104	0.028	0.0002	0.0003	0.0024	127	5.00E-05	24	10	0.0007	0.0002	0.002	23.2	0.05	7.00E-05	81	0.02	0.00039	5.1	0.077	8.00E-05	8.00E-05	0.0006
27/03/2024	P8-4	8.03	25	1	59	59	0.096	0.0002	0.0002	0.0037	72	7.00E-05	10.6	10	0.0006	0.0018	0.0007	14.6	0.05	9.50E-05	44	2.7	0.00038	4.3	0.64	8.00E-05	8.00E-05	0.0052
27/03/2024	BH6	6.9	30	1	57	57	0.004	0.0002	0.0002	0.004	70	5.00E-05	8.1	9	0.0005	0.0005	0.0005	14.6	0.09	6.70E-05	32	0.1	0.0001	2.8	0.55	8.00E-05	8.00E-05	0.0005
27/03/2024	P77S	5.81	5																									
30/04/2024	BH12	4.25	55	1	74	74	0.02	0.0002	0.0002	0.001	90	5.00E-05	28	9	0.0006	0.0002	0.0005	21.4	0.05	0.00147	84	0.02	0.0001	3.7	0.083	8.00E-05	8.00E-05	0.001
30/04/2024	BH9	11.18	65	1	6.3	6.3	0.019	0.001	0.0004	0.001	7.7	9.00E-05	2.1	9	0.0005	0.0002	0.0013	6.5	0.05	1.00E-05	9.6	0.02	0.00046	1.07	0.057	8.00E-05	8.00E-05	0.0007

Date	Data Point	NO3-N	NOxN	NO2-N	NH4N	pH	KSO	SeA	SeS	SI	AgS	NaSO	SO4	Sum Anion	Sum Cation	TiS	TSS	US	CNWAD	ZnS
27/03/2024	P2-4	0.1	0.1	0.1	0.01	7.5	2.7	0.001	0.001	40	0.0001	18.9	6	2.5	2.5	5.00E-05	990	0.00014	0.02	0.0019
27/03/2024	P8-4	0.12	0.12	0.1	0.062	6.8	3.1	0.001	0.001	48	0.0001	14.4	4	1.56	1.73	5.00E-05	580	3.00E-05	0.02	0.0151
27/03/2024	BH6	0.1	0.11	0.1	0.052	6.8	4.5	0.001	0.001	86	0.0001	18.4	2	1.44	1.58	5.00E-05	20	0.00018	0.02	0.0018
27/03/2024	P77S																			
30/04/2024	BH12	0.57	0.57	0.1	0.185	7.5	2.7	0.001	0.001	13.6	0.0001	12.1	19	2.2	2.3	5.00E-05	53	2.00E-05	0.02	0.0039
30/04/2024	BH9	0.66	0.66	0.1	0.01	6	2.2	0.001	0.001	24	0.0001	7.6	6	0.56	0.58	7.00E-05	11	4.00E-05	0.02	0.03

APPENDIX C
GWS Technical Memo: Assessment of Groundwater Fed Wetlands

MEMO

GWS Limited

30th May 2019

To: Mark Burroughs

From: Chris Simpson

Subject: Waihi Spring Fed Wetlands

This memo provides a summary of our understanding of the likely remaining locations in Waihi where remaining spring fed wetland areas are expected to exits.

This review has started with a figure (Figure 1 attached) generated by Woodward-Clyde in 1996 that identified relic mining features, areas of fill and locations of "swampy ground" based on a 1942 aerial photograph (refer Figures 2). We have interpreted these swampy areas as potentially being wetlands. This pre-modern mining plan has been lain over a recent aerial photograph to show where the areas of potential wetlands may still exist (Figure 3). In summary, it appears most of the potential wetland areas within the township, particularly in the east, have been infilled and developed into residential properties. Wetland areas to the north presently still remain, as do the areas to the south surrounding Union Hill, Black Hill and adjacent to the Ohinemuri River.

To assess the likelihood of these potential areas being spring fed, a map of the geology of Waihi (Figure 4), a topographic map (Figure 5) and high resolution historic aerial photographs have been used to make an interpretation as to whether springs are expected to occur in these locations or not based on the hydrogeologic setting.

The geology to the north of the Martha Pit in Waihi is dominated by a large massive body of quartz andesite at the surface which is largely devoid of springs. There is one area, however, where young volcanics/alluvium are present at the near surface where contact springs can occur. This area is some 400 to 500 m due north of the Martha Pit wall in between Williams St and Bulltown Rd (Figure 6). Review of the aerial photographs clearly shows what are likely to be springs forming two reaches that flow eastward to wetland areas that drain to the south.

The geology to the south of Waihi consist of volcanics/alluvium at the surface and there are two exposures of andesite that protrude though the sediments that form the Union and Black Hills (Figure 7). This older andesite is weathered in the near surface which has allowed the development of a soil regolith cover. This regolith allows the surface infiltration of water into the soil profile, which then allows the soil moisture to move under gravity to form spring, usually at a change in slope or where it meets the contact with the volcanics/alluvium. As shown on Figure 7 there are two locations adjacent to Domain Rd where springs are indicated to be discharging into wetland areas before entering the Ohinemuri River.

In summary, it is our interpretation that there are two main locations in Waihi where spring fed wetlands still exist. These springs occur due to shallow groundwater discharging from volcanics/alluvium or from weathered andesite and we understand they are ephemeral, essentially drying up during summer months. These springs existed prior to modern mining and still exist now. As these features relate to shallow groundwater movement, dewatering associated with mining operations has not affected the spring flow to any significant degree. This observation is consistent with 30 years of shallow groundwater level monitoring as demonstrated in annual monitoring reports that shows a water table is maintained in the weathered andesite and young volcanics/ alluvium despite deeper dewatering of the andesite rockmass.

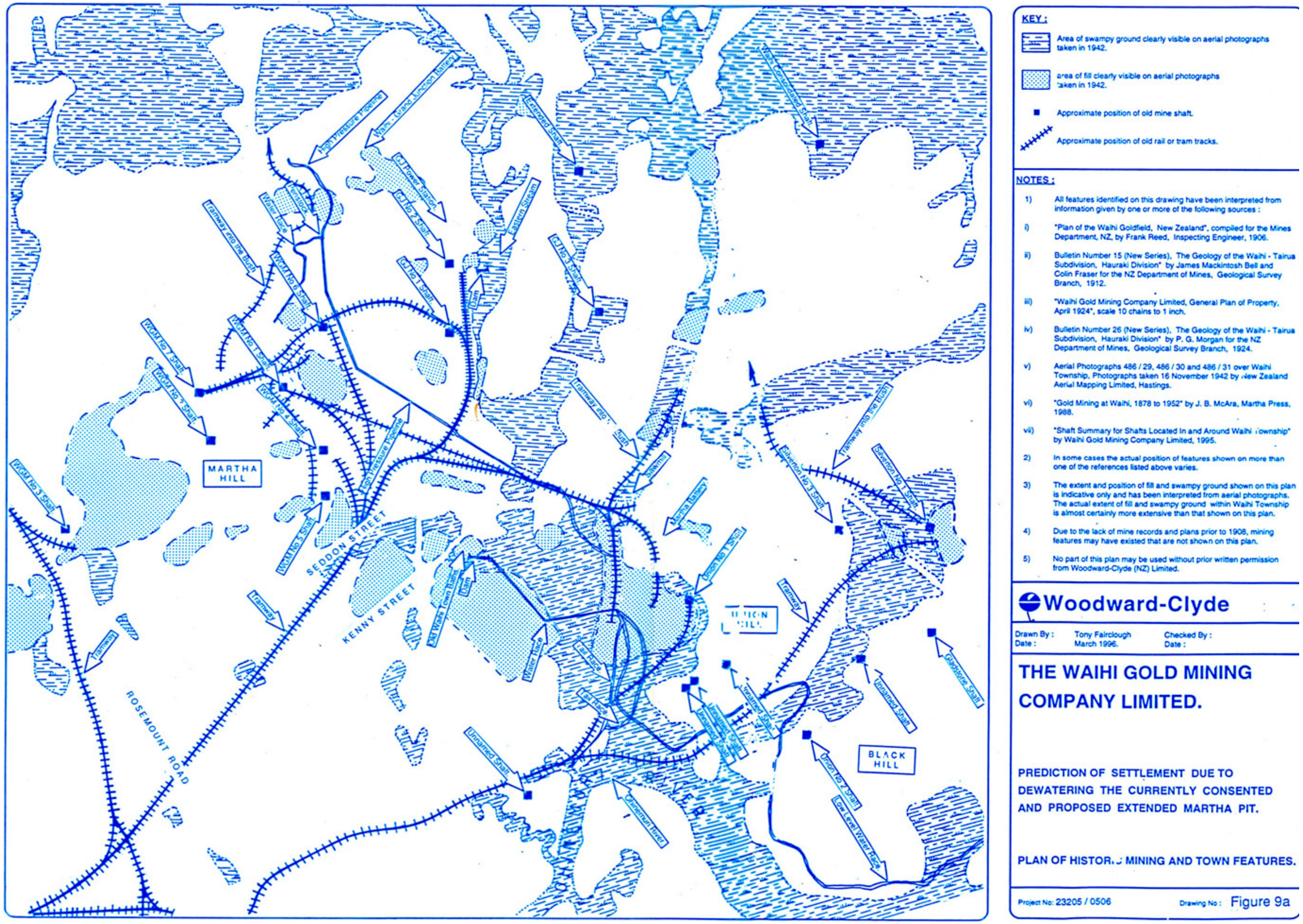

Figure 1 WWC (1996) Plan of Mining Features, Areas of Fill and Swamy Ground

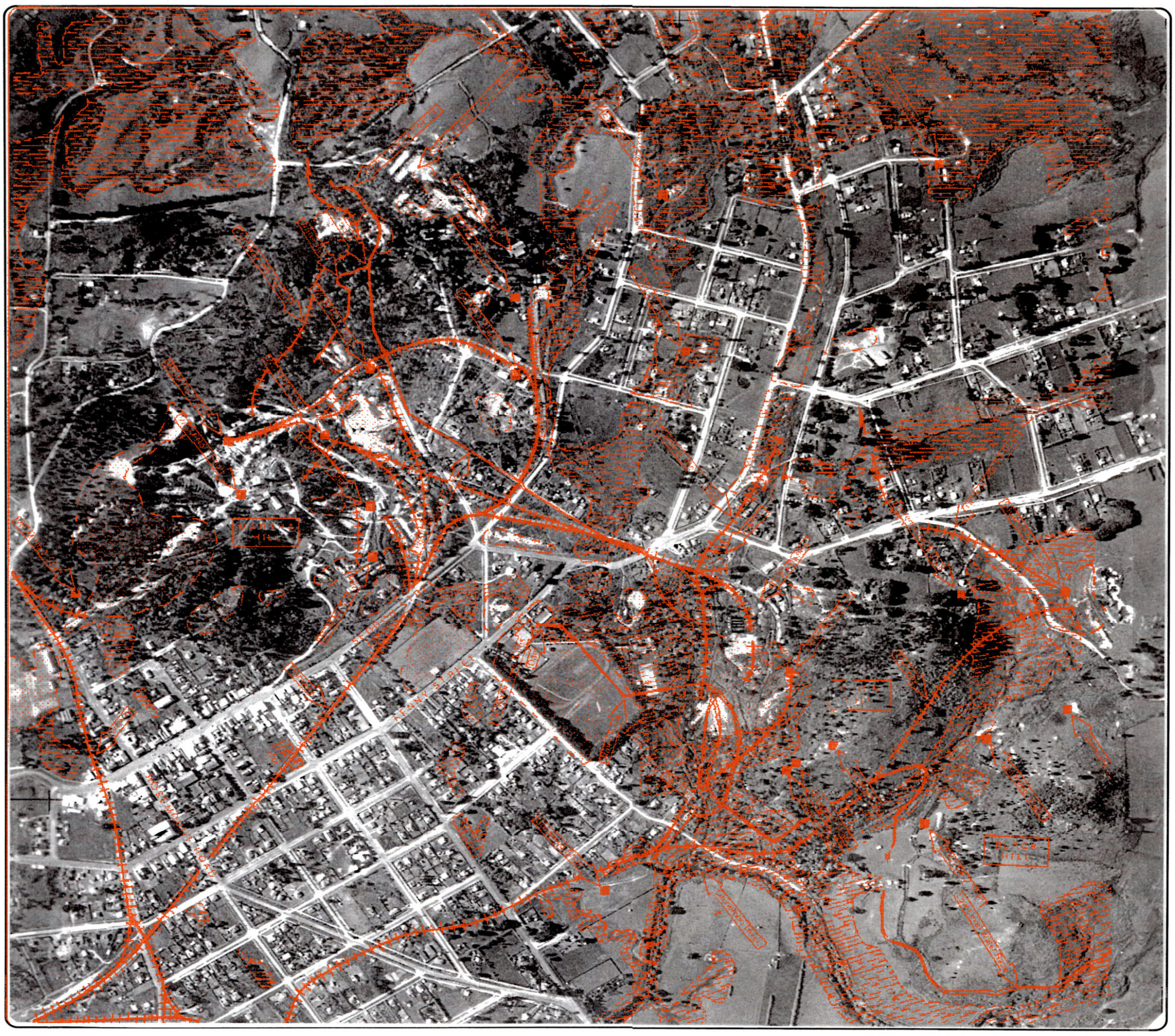

Figure 2 **Swampy Areas Identified from 1942 Aerial Photographs**

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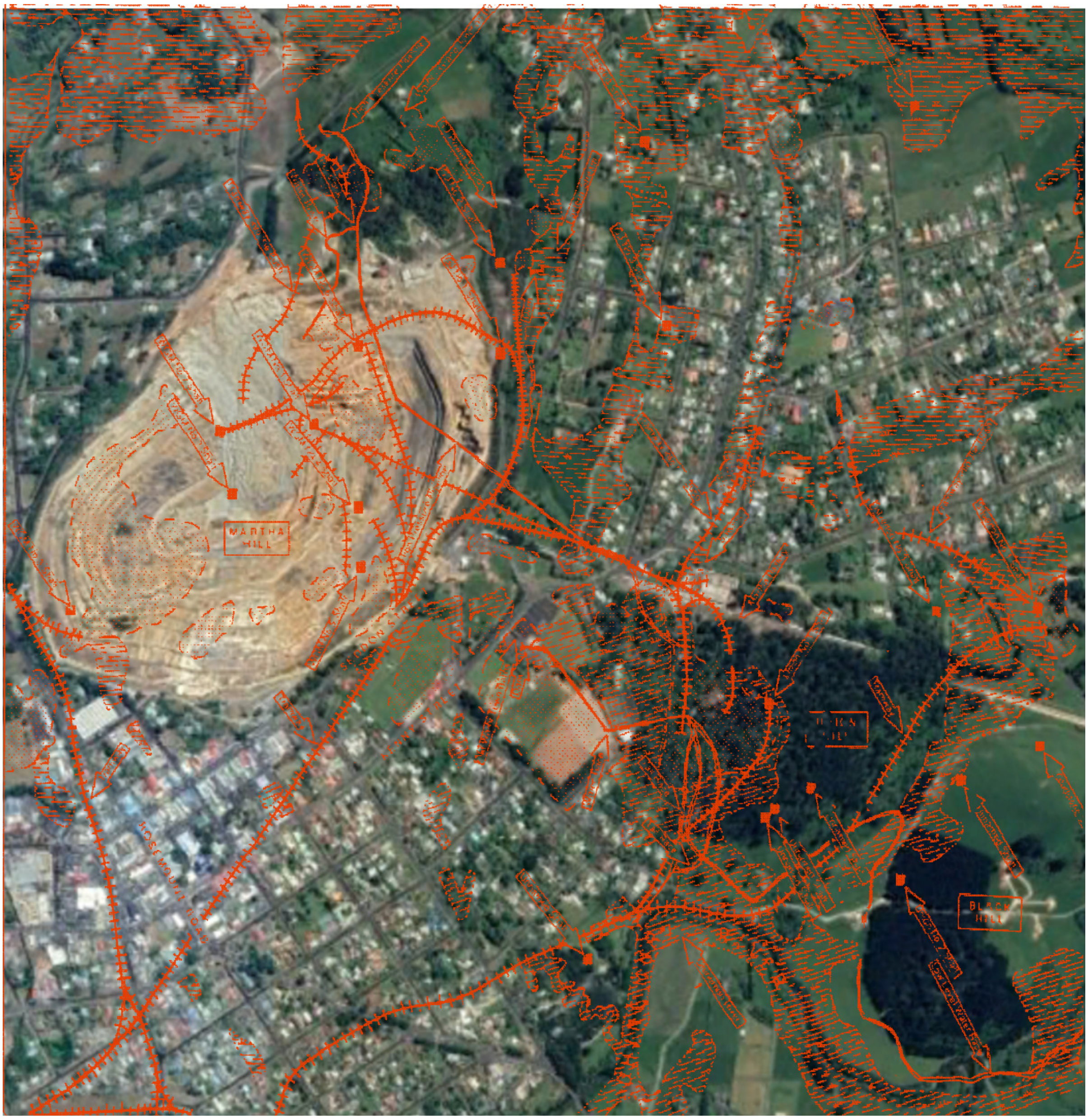

Figure 3 Swampy Areas Over Recent Aerial Photographs

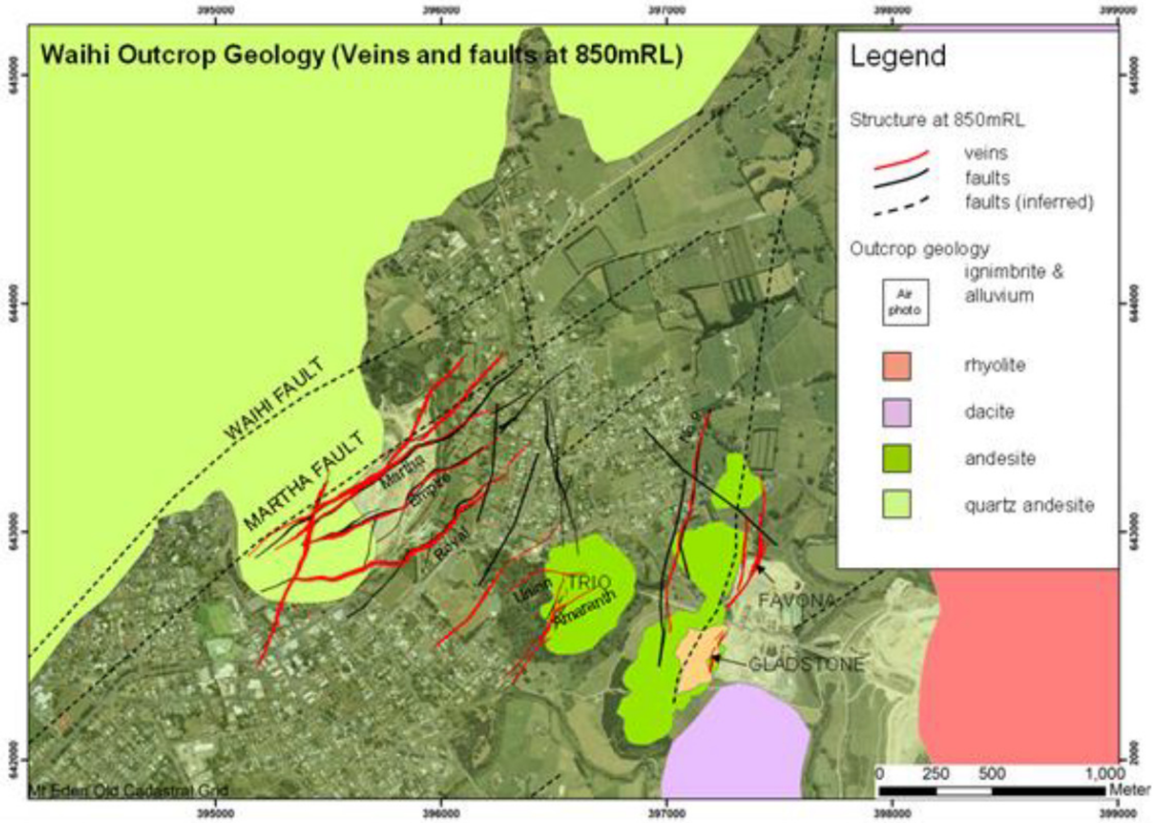

Figure 4 Geology of the Waihi Area

Figure 5 Topography of the Waihi Area

Figure 6 Northern Area Spring Fed Wetlands

Figure 7 Southern Area Spring Fed Wetlands