Martha Shallow and Deep Aquifer Report

2019

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MARTHA SHALLOW AND DEEP AQUIFER REPORT 2019

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Approvals

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HSE Manager	Daniel Calderwood	Mr		05/06/2019
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Revision History

Date	Revision No.	Issued for	By
28/05/2019	1.0	OceanaGold New Zealand Waihi Operations	Cassie Craig

EXECUTIVE SUMMARY

This Martha Shallow and Deep Aquifer Report is a requirement of the consent conditions for the Project Martha mining project, Waihi, New Zealand. This report is provided prior to the commencement of Project Martha activities and provides an overview of the current state of the shallow and deep aquifers under the Martha pit and immediate surrounds.

On 01 February 2019, Project Martha Groundwater Take Consent 139551 was granted by Waikato Regional Council. This consent allows the taking of groundwater associated with the dewatering of Martha Pit and associated underground workings to a level no lower than 500mRL.

Groundwater chemistry samples are currently collected as a combined sample from Favona, Martha, Correnso and Trio dewatering water. During the reporting period, pH and EC averaged 7.5 and 264 g/m^3 respectively. Sulphates averaged 1496 g/m^3. Fe and Mn are at levels above receiving water criteria. Other metals are at low concentrations.

Two areas of wetland in the surrounds of Martha Pit have been identified as being reliant on groundwater contribution. These areas are located north east of Martha Pit and south east of Martha Pit, near Union Hill and Black Hill.

1 INTRODUCTION

In 2019 the Waikato Regional Council (WRC) granted consent (No. 139551) to take groundwater to dewater the Martha Pit and associated underground workings to a level no lower than 500mRL.

Condition 9 of the consent requires that upon commencement of the consent holder 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.

Dewatering from the Martha Pit was discontinued on 04 May 2015 after a slip in the pit. As a result, access and power supply to the dewatering pumps became limited. Dewatering from within the Correnso area was initiated on 18 May 2015. The Martha, Trio, Correnso and SUPA groundwater systems are hydraulically linked and water levels are currently controlled by Correnso underground dewatering. Levels are currently being maintained at 700mRL. When dewatering occurs below this level, consent 139551 will be activated.

2 GEOLOGICAL SETTING

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

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

The mineralised vein deposits of the Martha, Favona, Trio and Correnso zones are hosted by altered andesitic lava flows, breccias and tuffs (Figure 1a). The host andesites of Miocene age extend to depths greater than 600m and are extensively modified in places by weathering and hydrothermal alteration. Paleo-weathering and hydrothermal alteration have created an extensive low-permeability clay-rich cap within the upper part of the andesite sequence. This cap generally separates the andesites hydrogeologically from a younger overlying sequence of rhyolitic ignimbrite flows and alluvial boulder beds and prevents the younger volcanic deposits from being fully dewatered. Exposure of the altered andesite in the southern wall of the Martha Pit indicates that the weathered clay cap may extend up to 30 metres in thickness. Dewatering of the andesites is considered to contribute little to the development of settlement around the mine site due to the stiffness of these rocks.

Groundwater levels in the andesite are controlled in the vicinity of the Martha Pit by old underground mine workings and shafts as well as the structural controls of faults and veins in the area. The old mine workings extend mainly in a SW-NE orientation following the Martha lode (Figure 1b). The historical mine workings act as effective conduits allowing groundwater inflow of water from an area surrounding the current mine pit. Investigation drilling at Union Hill has identified similar water levels in permeable vein systems to those in the historical workings, with water levels at higher elevations in less permeable ground. This pattern of groundwater depressurisation is consistent through the older andesites in the vicinity of Martha Mine (Figure 1c).

Davies (2002) defined district-scale northeast trending grabens based on general stratigraphic patterns and fault data. The western margin of one of these, informally referred to as the Waihi Graben, hosts the Martha-Favona epithermal system. This system has developed on the graben boundary faults dominated by the Waihi and Martha faults. A mantle of younger ignimbrite cover means that the actual dimensions of the Waihi Graben remain unknown (Davies, 2004).

Principal veins and faults at both Martha and Favona dip to the south-east while the Correnso vein that strikes north-north-west with an easterly dip connects the Martha and Union systems. Subsidiary splay veins dip back to the north-west and west, defining a mine-scale horst-graben geometry in which veins coincide with the graben margins. Union and Amaranth veins are located on a paleotopographic high, informally referred to as the Union

Horst that separates the Martha graben from the smaller-scale Favona-Moonlight graben. Davies identified north-trending veins and faults such as Trio, which links the Union and Amaranth veins, as structural fault relays. At district scale, the north-trending Favona fault-vein system may represent a structural relay between northeast-trending boundary faults of the Waihi graben. Relays represent domains of strain transfer between fault segments (e.g. between the Union and Amaranth faults) that may or may not be physically linked. These relay systems are important from a mineralization point of view as they represent areas that were foci for hydrothermal fluid flow. From a hydrogeological perspective today, these areas may store significant quantities of groundwater. During underground mining at Favona, dewatering rates increased for a time when access drives cut across the fault-fracture zones which drain more freely than the country rock.

The upstanding Union Horst block probably acts as a barrier between the more structurally permeable areas of the Martha Graben and Favona-Moonlight fault system. The hydrogeological connectivity of the Martha Graben faults, facilitated by the connecting Correnso structure, was demonstrated by the rise and fall of water levels in the Union Hill shaft in unison with the rise and fall of water levels in the Martha Pit. The connectivity of the Martha system with the Favona fault system, however, is very weak as shown by the lack of response in measured water levels. The zone of separation of 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 (Figure 1d), both of which are north to northeast trending and have been observed in drilling to extend over one kilometre in strike. The Favona footwall fault is observed as a broken quartz gouge zone encountered 30 m west of the main vein system at Favona, where it occasionally has strong inflows of water (P. Keall, pers comm.) and the No 9 fault is located further again to the west. However, some aquitards and associated pressurisation are also present in some sections of the underground workings.

Under the Waihi East residential area the Union Horst may be more responsive to the Martha groundwater system as indicated by water level increases in wells in conjunction with a rise in pit water levels in 2007. Nevertheless, some early Favona dewatering effect is evident in monitoring data. Faults associated with the Martha and Favona vein systems may intersect in the Waihi East area although their potential connectivity is not well understood, due to a lack of drilling data.

The andesites are overlain by a series of younger rhyolitic volcanics, which are highly variable in thickness and composition. These deposits draped an eroded graben-horst landscape. The younger volcanics consist of rhyolitic tephras and ignimbrites in the form of flows, breccias and tuffs. Paleosols (buried soils) and sedimentary deposits such as alluvium and boulder alluvium mark the top of successive eruption sequences. The ignimbrite deposits underlie much of Waihi township and outcrop to the east and south of the mine pit.

Groundwater inflow is, predominantly, controlled by infiltration from overlying layers and through outcrops of welded ignimbrite in the beds of streams and at the ground surface. The rhyolitic sequence is considered to be compressible, in parts, and to give rise to much of the dewatering induced settlement around the mine site. This is indicated by settlement magnitude generally corresponding to the thickness of and the magnitude of dewatering in these materials.

The uppermost layer of alluvium is discontinuous beneath Waihi township (Figure 1a) and is located in areas where old streams and river channels are cut into the top of the ignimbrites, rhyolitic tephras and andesite. Alluvial deposits are extensive east of Waihi where they are associated with the drainage systems of the Ohinemuri River catchment. Groundwater in the alluvial formation (and the upper weathered contact of the younger volcanics) is monitored to depths of less than 10m.

Figure 1 - Summary of Geology - Maps 1(a)-(d)

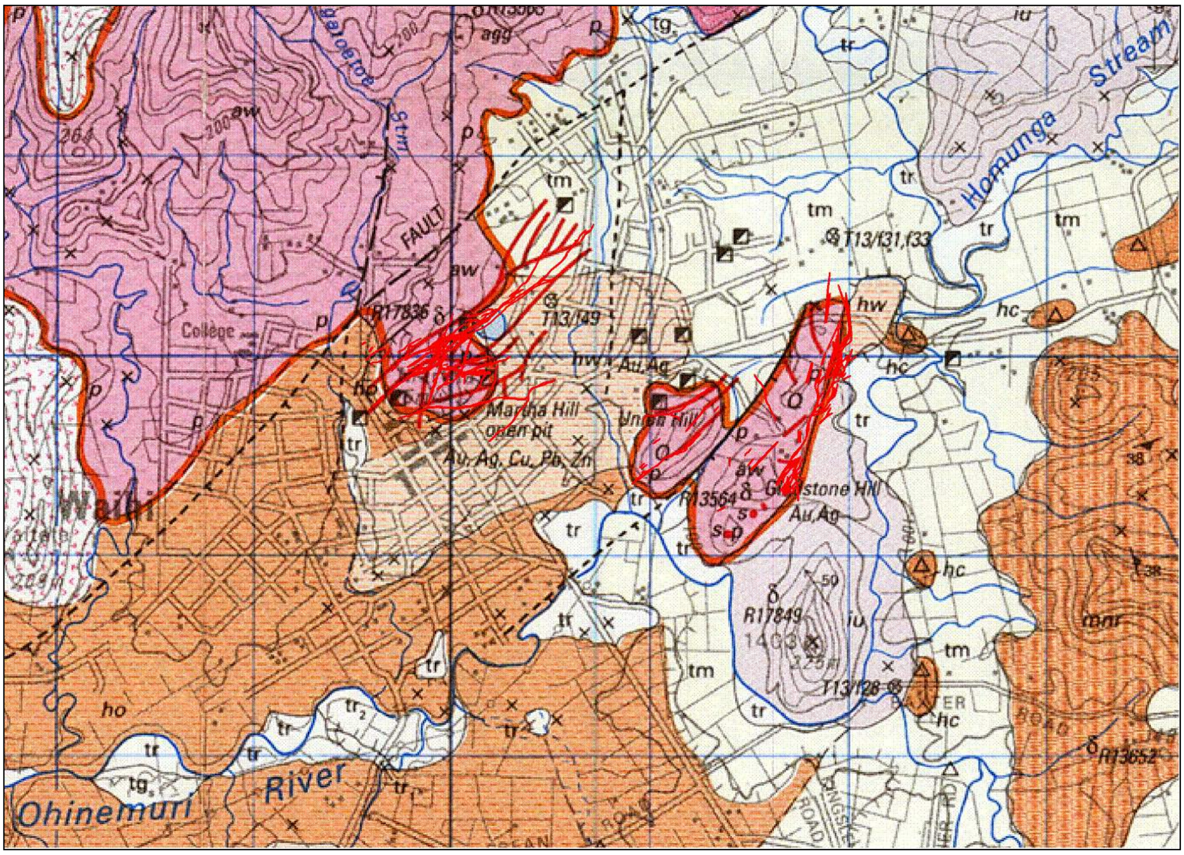

Figure 1(a) Geology Map of Waihi showing distribution of andesite (aw), younger volcanics (ho & hw) and alluvium (tm & tr). The Martha and Favona vein systems (Gladstone Hill area) are defined as fine red lines (derived by exploration and mining surveys).

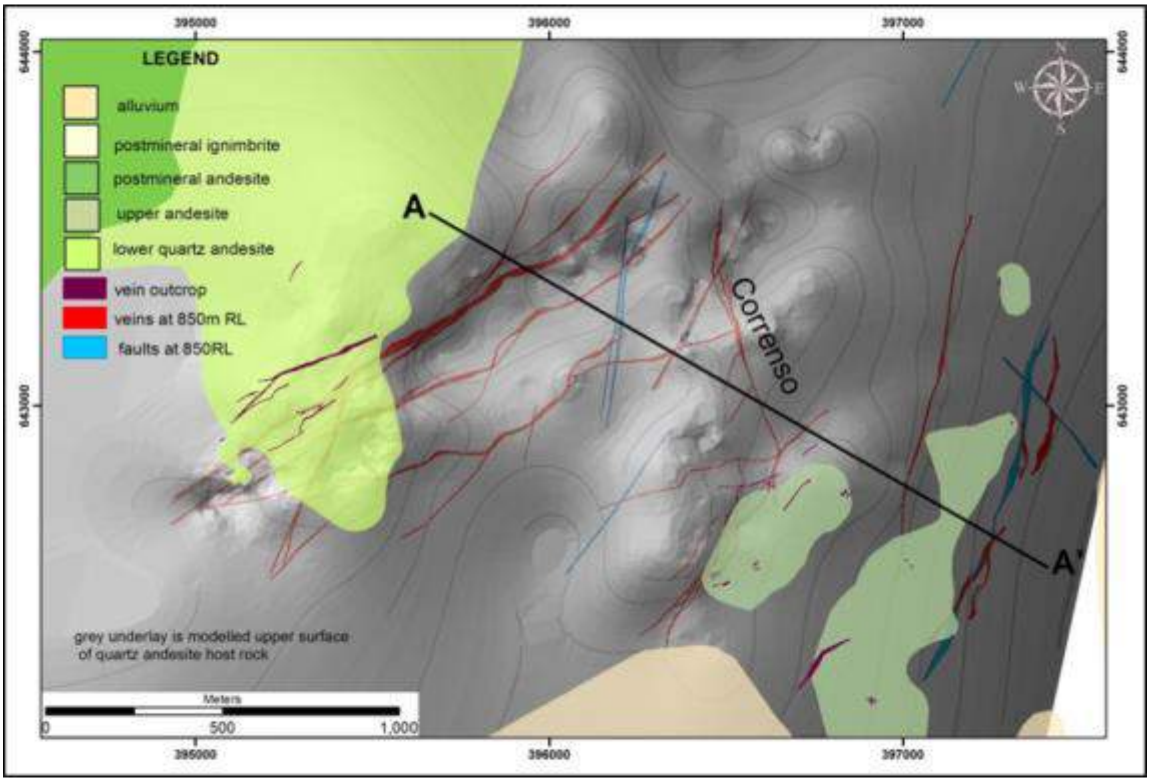

Figure 1(b) Veins and faults from around Martha & Favona mines, showing projected Correnso (J Hobbins, OGNZL Exploration Dept.).

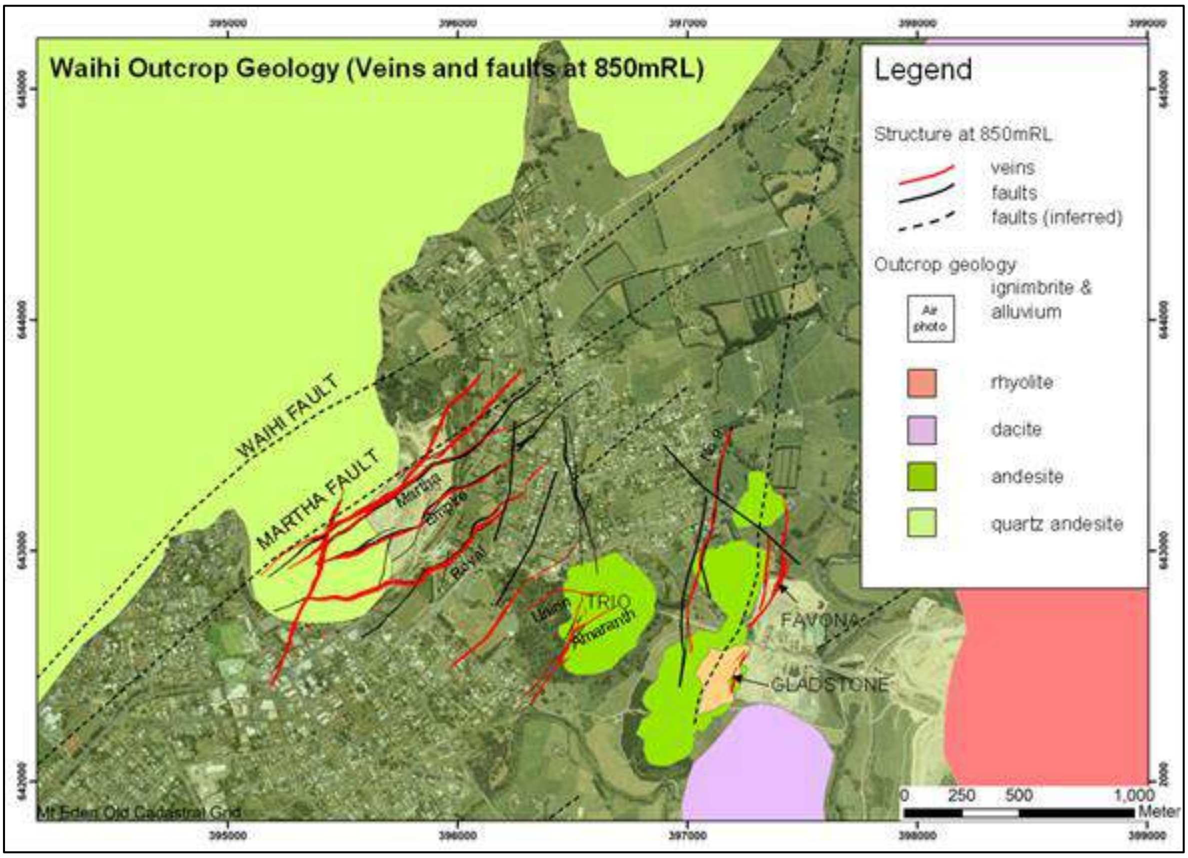

Figure 1(c) Faults and geology at 850 m RL showing main structural elements

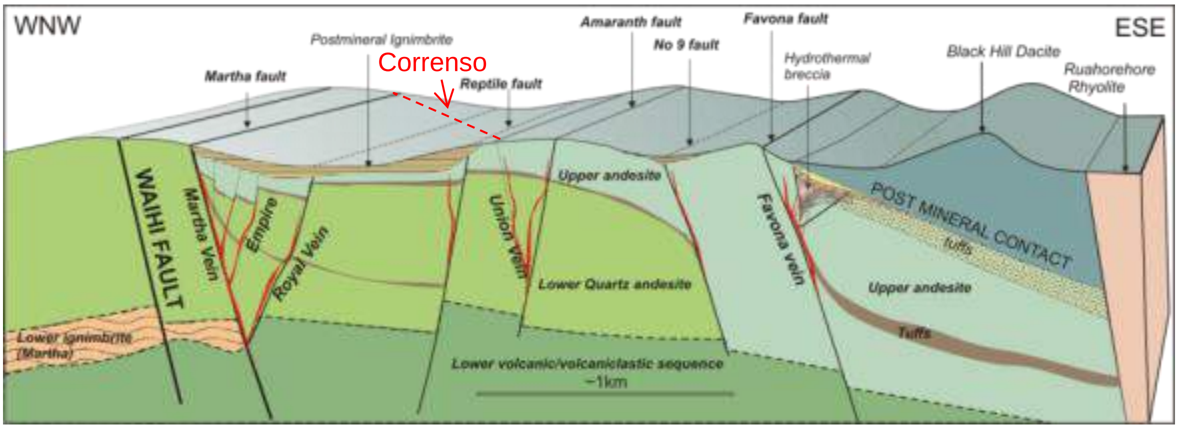

Figure 1(d) Schematic cross section illustrating key elements of fault structures in the Waihi area, including projected surface trace of Correnso.

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3 GROUNDWATER CHEMISTRY

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

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

While access to the pit is restricted and dewatering of the pit occurs from underground, the most representative sample of Martha groundwater currently available is the combined underground dewatering water. This is a composite of Favona, Correnso, Trio and Martha water. Underground dewatering water quality results from 01 January 2018 to 08 March 2019 are included as Appendix B. During this period, pH and EC have remained stable, averaging 7.5 and 264 g/m^3 respectively. Sulphates averaged 1496 g/m^3. Fe and Mn are at levels above receiving water criteria. Other metals are at low concentrations.

4 GROUNDWATER LEVELS

This section is provided to meet Condition 9 c of the Project Martha 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.

OGNZL has maintained a piezometer network within and around Martha Mine since 1987. Additional Correnso/SUPA piezometers were installed in 2011, 2014 and 2016. Table 1 lists the piezometers currently operational that are assigned to each of the three main geological units.

Table 1 - Current Waihi Piezometer Network

Alluvium	Depth (mRL)	Younger Volcanics	Depth (mRL)	Martha Andesite	Depth (mRL)	Favona Andesite	Depth (mRL)
~~DM21-1 dry~~	~~1103~~	BH6-1	1052	BH11	1074	~~P60 ** dry~~	~~1075~~
~~DM31-1~~	~~1112~~	BH7-1	1078	BH12	1090	P61	1076
~~DM81-1~~	~~1117~~	~~BH8-1 dry~~	~~1048~~	~~P1-1 dry~~	~~1065~~	P64-D dry	1062
~~DM82-1~~	~~1114~~	BH9-1	1073	P2-1 dry	974	P75	979
~~DM83-1~~	~~1116~~	~~P1-2~~	~~1091~~	P2-2	1034	P76-D	1055
~~DM85-1~~	~~1115~~	P2-3	1073	~~P4-1~~	~~994~~	P77-D	1031
P2-4	1111	P4-2	1047	P7-1	988	P78-D	1052
~~P4-3*~~	~~1093~~	P7-2	1039	P8-2	1044	P79-D	1047
P8-4	1113	P7-3	1080	P8-1	975	P87-D	1024
~~P9-3~~	~~1108~~	P8-3	1092	P9-1	1036		
P63-S*	1111	~~P9-2~~	~~1084~~	~~P62 dry~~	~~1021~~		
P76-S*	1109	P27-1	1073	P69-S	1114		
P77-S*	1110	P63-1	1070	P69-D	1063		
P78-S	1103	P64-I	1086	WC201-1	1058		
P87-S	1110	P76-I	1072	WC201-2	1077		
WC201-4	1103	P77-I and	1045	WC201-3	1096		
WC201-5	1109	P77-I2	1051	WC202-1	1031		
~~WC202-4 dry~~	~~1099~~	P78-I	1066	P90-3	982		
~~WC202-5 dry~~	~~1112~~	P79-I	1061	P91-4	970		
P90-1	1096	P79-S	1090	P92-3	965		
P91-1	1105	P87-I	1069	P93-4	974		

P92-1	1114	~~WC202-2~~	~~1048~~	P94-4	976		
P93-1	1102	P90-2	1019	P95-3	1000		
P94-1	1108	P91-2	1096	P100-3	981		
P101-1	1102	P91-3	1010	P100-4	956		
P102-1	1108	P92-2	1000	P101-4	1037		
		~~P93-2~~	~~1091~~	P102-4	1026		
		P93-3	1014	P106-1	1100		
		P94-2	1094	P106-2	1060		
		P94-3	1016	P106-3	1010		
		P95-1	1090	P106-4	974		
		P95-2	1030				
		P100-1	1066				
		P100-2	996				
		P101-2	1083				
		P101-3	1068				
		P102-2	1078				
		P102-3	1054				

* - at or just below the contact with weathered young volcanics
** - collapsed piezometer
WC – Pneumatic piezos
~~P93~~ – Strikethrough indicates failed or lost piezometer

All piezometers are monitored on a monthly basis as required by Waikato Regional Council Correnso Dewatering Consent 124860. The water levels are translated to the mine datum reference level to enable comparison between bores or areas.

4.1 Groundwater Monitoring Results

The Waihi town piezometer network currently has 41 dipped piezometers and six pneumatic piezometers. Additional vibrating wire piezometers are installed at 10 locations around Waihi East, with up to four piezometers at each location. On the north east side of the pit, seven real time loggers are installed in wells (Figure 2). Groundwater contour plans have been included for the three principal geological units: alluvium (plus shallow groundwater in weathered younger volcanic materials); younger volcanics (including ignimbrite); and andesite. The groundwater plans are presented in Figure 3, Figure 5 and Figure 8 respectively. Discussion of results for each unit follows.

Only the andesite contour map includes data from the vibrating wire piezometers. Alluvium and younger volcanics contour maps have not included vibrating wire piezometers as the vertical gradients evident do not provide a unique water level.

Figure 2: Piezometer Location Plan

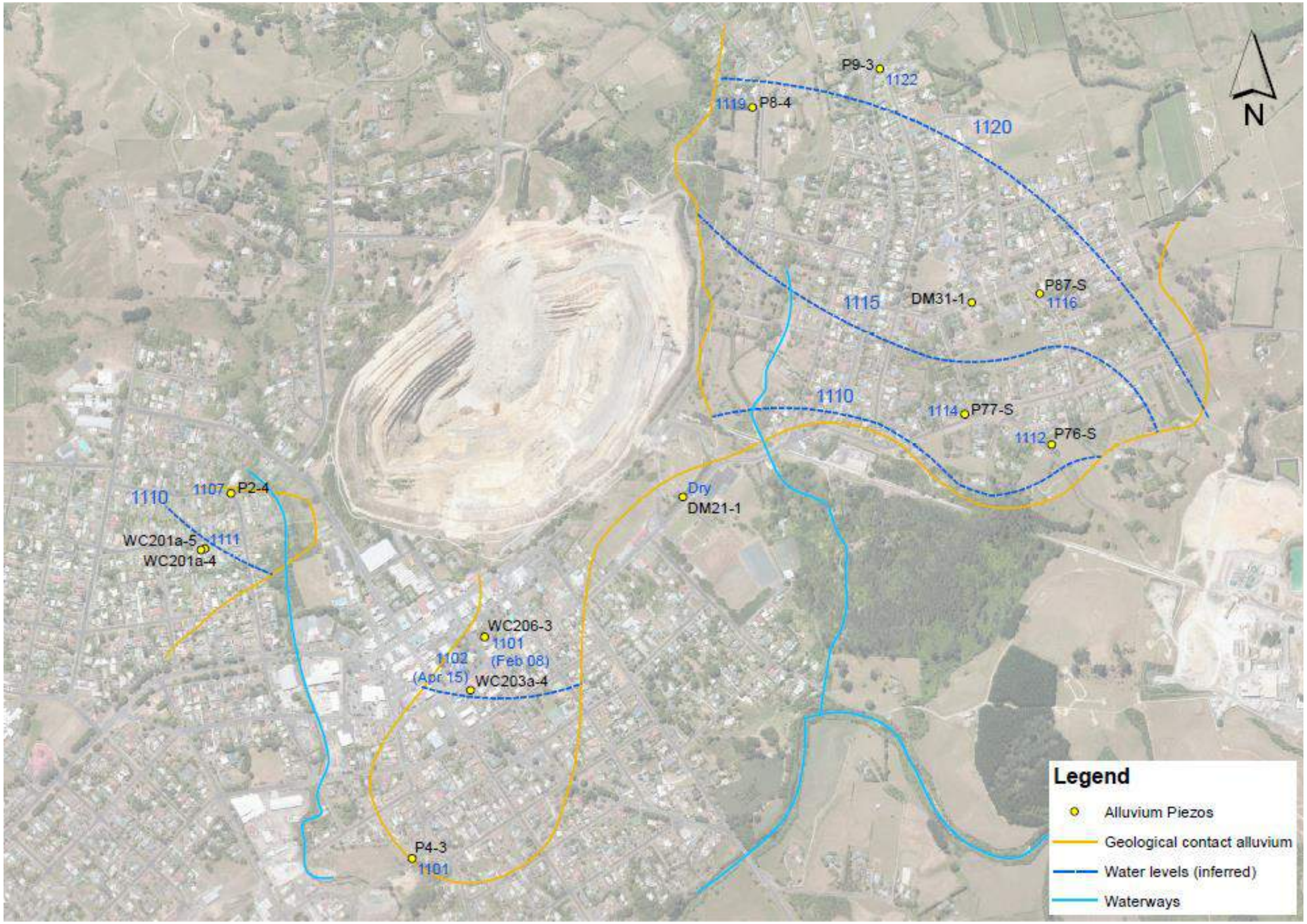

Figure 3: Alluvium Water Level Contours

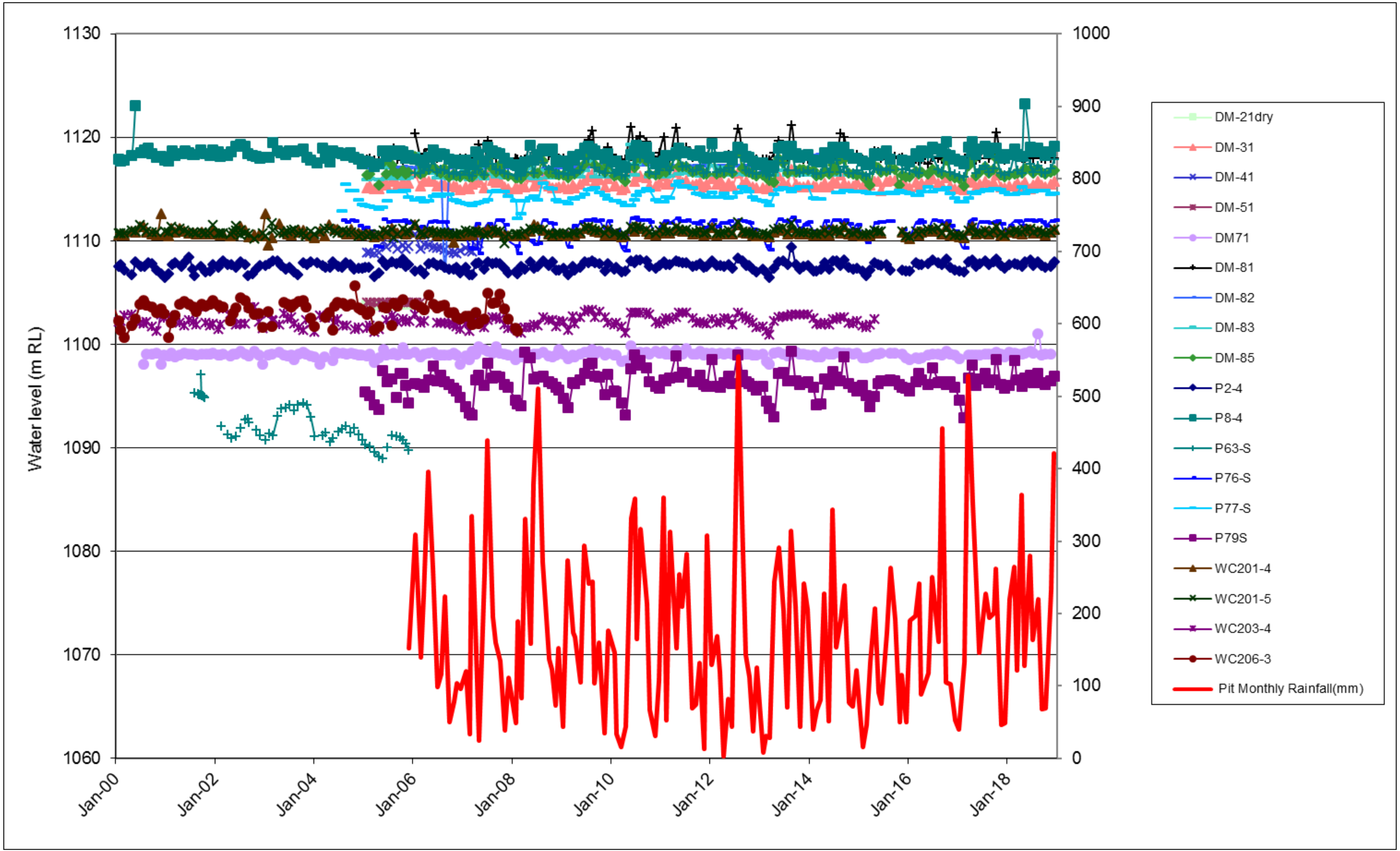

Figure 4: Groundwater Level Trends – Shallow Groundwater (Alluvium & Weathered Contact of Young Volcanics

4.1.1 *Shallow Groundwater*

Figure 3 shows the inferred contours for shallow groundwater in alluvium and in weathered younger volcanic materials and Figure 4 shows the water level trends over time. The overall contour pattern and the trend plots demonstrate 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 lobe southwest of Martha Mine (Figure 3) 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 has remained the same as in previous years.

4.1.2 *Younger Volcanics*

Groundwater contours in the deeper portions of the younger volcanic materials below the shallow groundwater system are shown on Figure 5 and trends are graphed on Figure 6.

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 weak younger volcanic materials is considered to be responsible for much of the settlement and for the settlement patterns around Martha and Favona mines.

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 5) suggests drainage is affected by features other than the contact (which defines a paleovalley 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 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 about the mid to late 1990’s. Thereafter, the water levels (in other than the veins and workings) stabilised and have remained stable since. This pattern is demonstrated in monitoring wells at site P2. With piezometer P2-1 following the vein water levels until water level dropped below the piezometer tip, P2-2 the upper andesite water levels P2-3, younger volcanic rock water levels and P4-2 alluvium (shallow aquifer) (Figure 6).

The development of the settlement pattern has shown a similar behaviour with an initial higher rate of settlement followed by a much-reduced rate of settlement once groundwater levels in the upper rock layers stabilised. These patterns are discussed in the following sections.

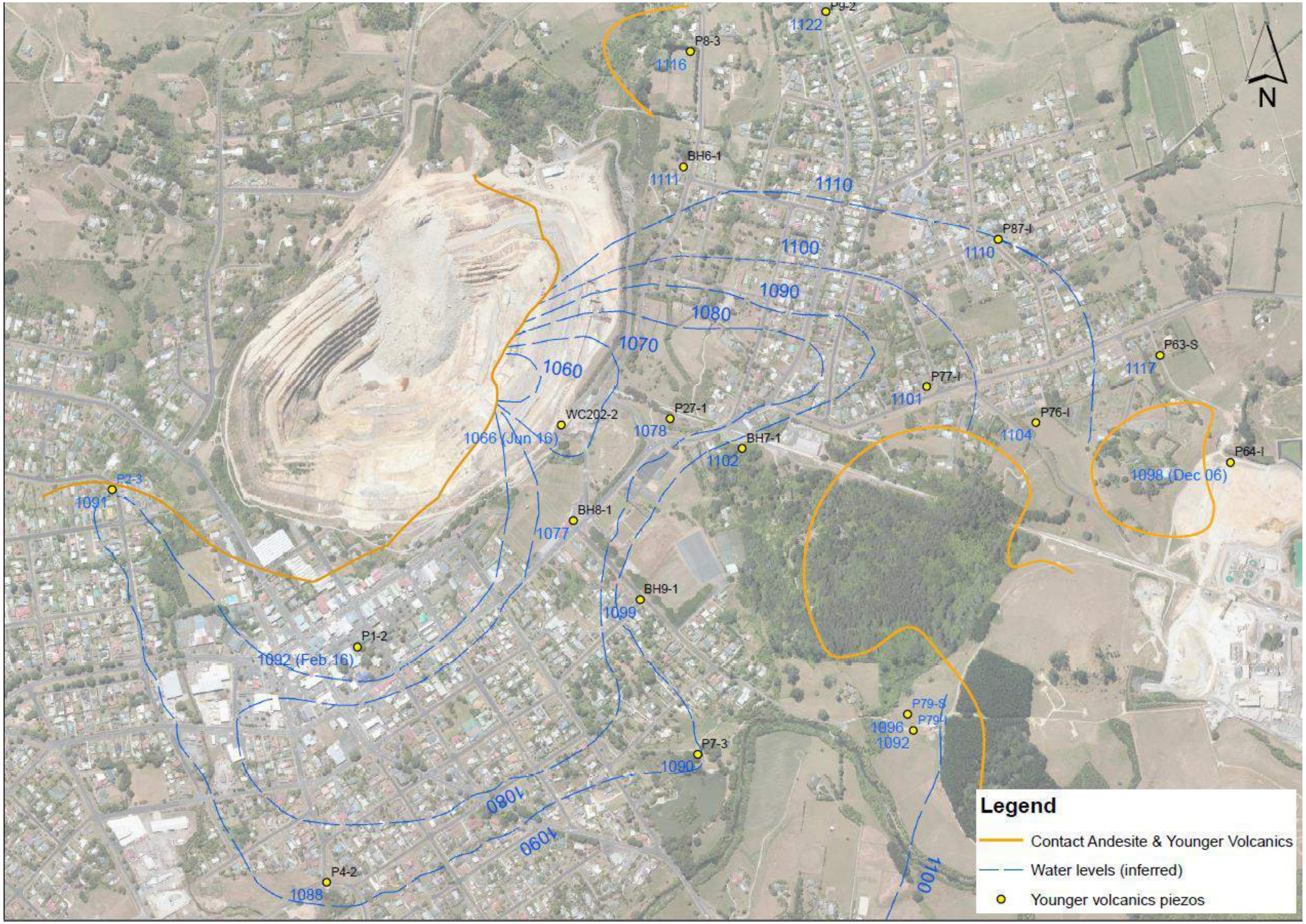

Figure 5: Deeper Younger Volcanic Water Level Contours

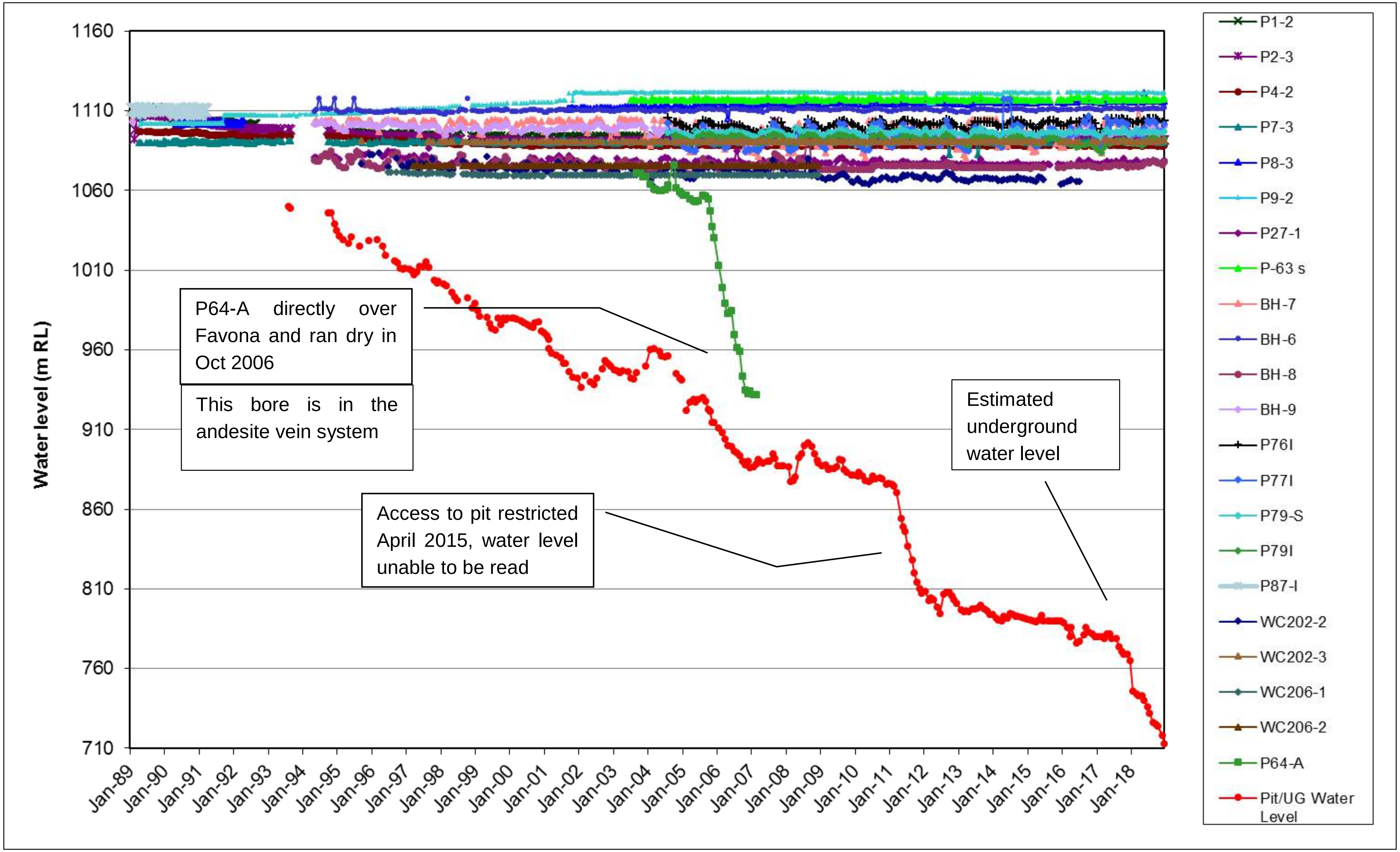

Figure 6: Groundwater Level Trends - Deeper Younger Volcanic Materials

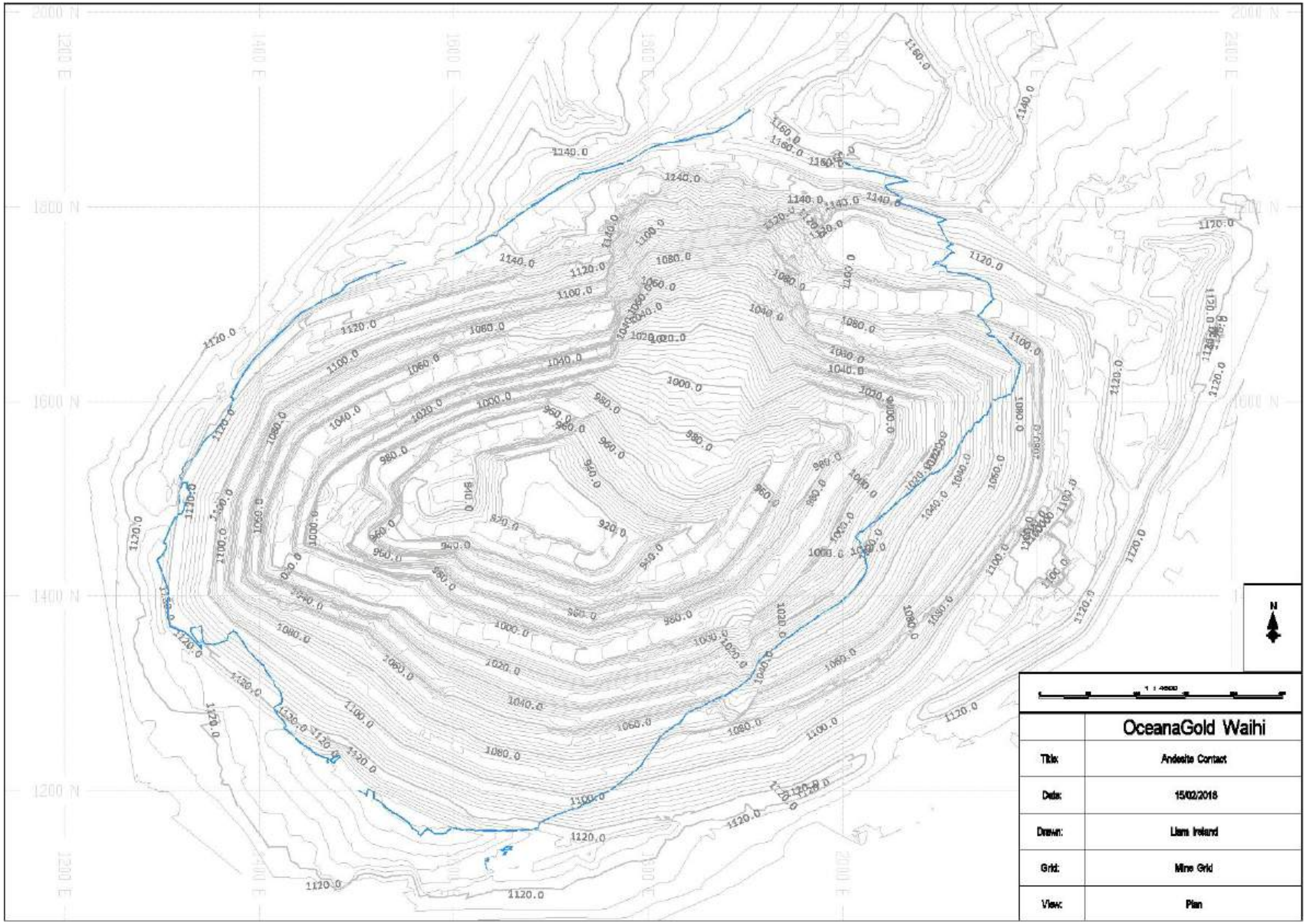

Figure 7: Andesite Younger Volcanic Materials Contact in Martha Pit

4.1.3 *Andesite*

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

Figure 8 shows the scope of the dewatering effects in the andesite rock body as a result of dewatering to date. Data from the Waihi East vibrating wire piezometer units has been included. Figure 9 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 rockmass outside of development areas. Hence, groundwater levels between the vein and the shallow rockmass has 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, along the strike of the Trio vein system beneath Union Hill, and also along the strike of the Favona/Moonlight vein systems. 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 9.

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 N-S 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 8 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 1 indicates an up-thrown block (Union Horst Figure 1d and Figure 8) 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.

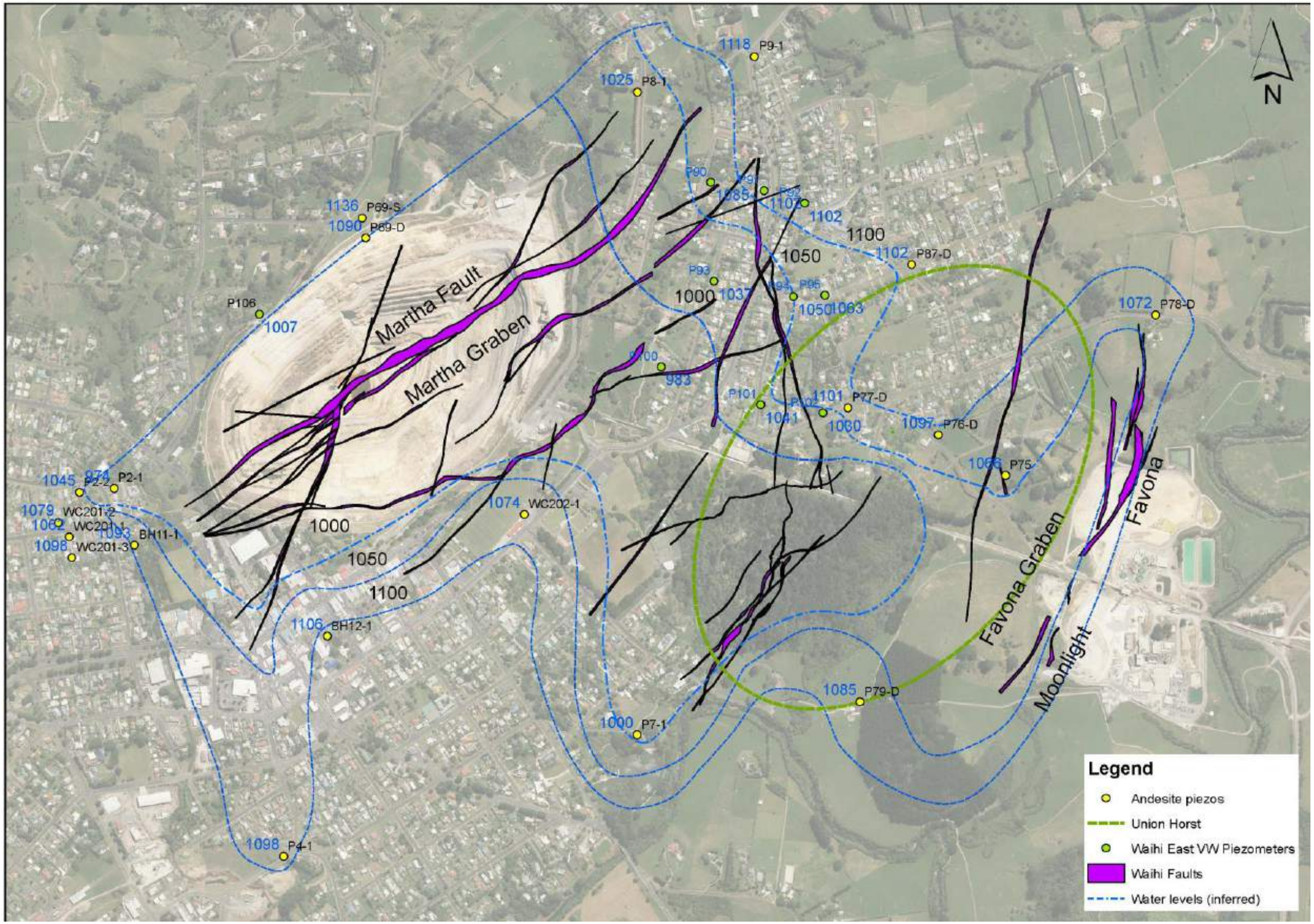

Figure 8: Andesite Water Level Contours

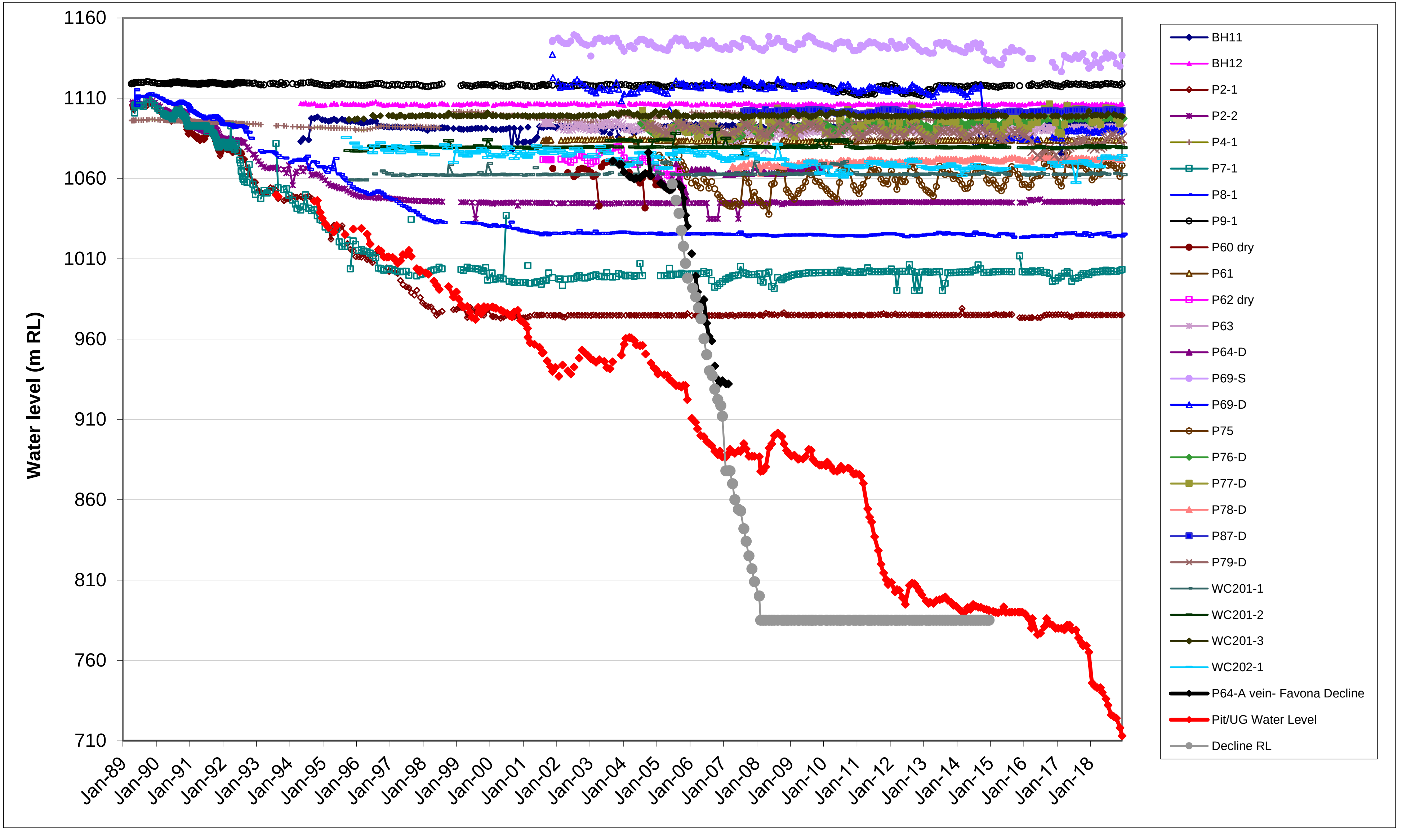

Figure 9: Groundwater Level Trends – Andesite

4.1.1 *Waihi East*

Six groundwater monitoring boreholes were installed between July – September 2011. They are located east of the Martha Pit to provide improved groundwater information in an area with few existing wells and in the vicinity of the Correnso Project. Two additional vibrating wire piezometer boreholes were installed in early 2014. One further borehole was installed in 2016 for monitoring related to the Daybreak/SUPA orebody.

The piezometers were located across and perpendicular to the Correnso vein system in three lines (P90, P91 and P92 forming one line, P93, P94 and P95 a second line and P100, P101 and P102 the third). Separation distance between the northern and southern lines is some 500m (Figure 2). The piezometers were constructed to intercept the shallow aquifer, younger volcanics, and andesite rock (Table 2).

Table 2: Geological Units and Depths P90-P95, P100-P102 Piezometers

Bore	Shallow	Younger Volcanics		Andesite	
		Upper	Basal Zone		
P90	-	20	100	137	
P91	9.3	25.5	111.3	151.3	
P92	-	23.3	121.3	156.3	
P93	12.3	26	100	143	
P94	6	25	104	144	
P95	-	35	90	120	
P100	-	50	120	135	160
P101	12.8	32	47	78	
P102	8	38	62	90	

Figures 10 to 18 provide the records from the piezometers expressed as mRL. The charts also display the depth of the piezometer tips. Separation between the shallow and deeper piezometers is evident in the records. The nine groundwater monitoring boreholes have indicated stable water levels in Waihi East.

Note: Gaps in the data are due to either brief logger malfunction issues or flat batteries in the unit

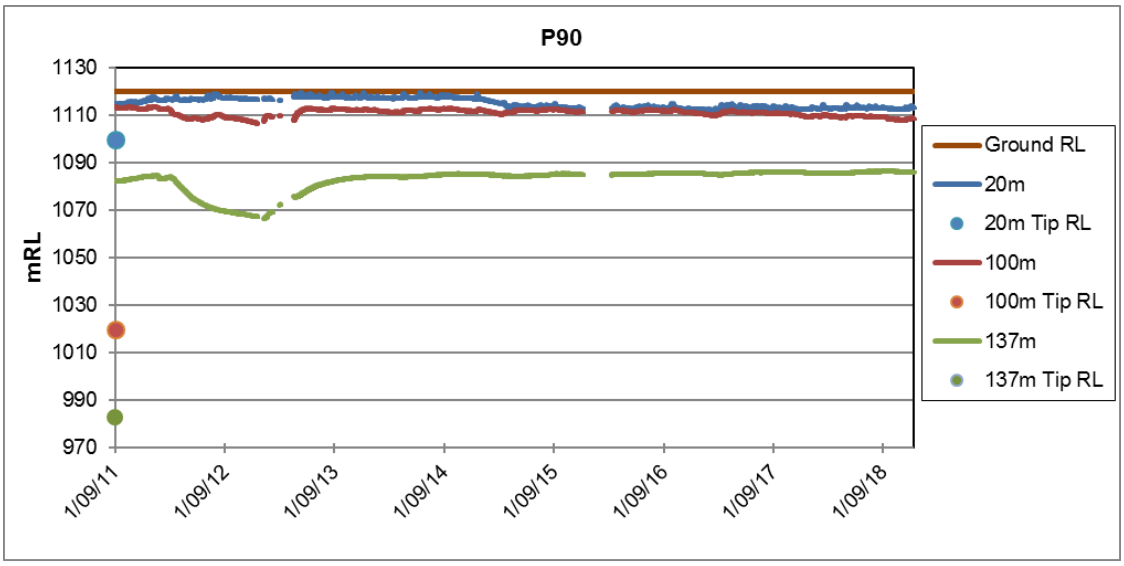

Figure 10: P90 Vibrating Wire Piezometer

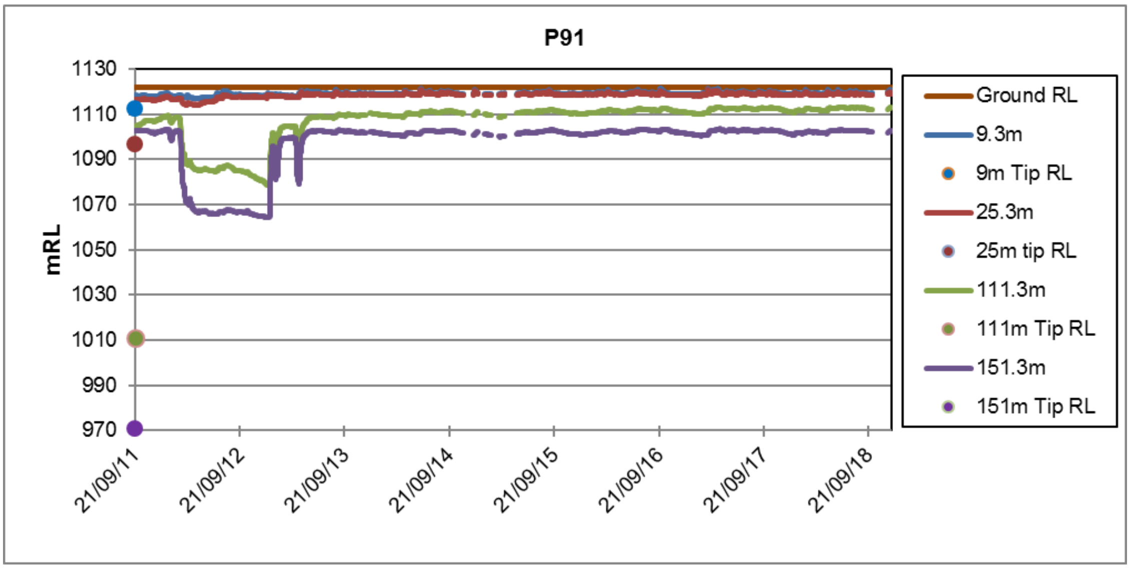

Figure 11: P91 Vibrating Wire Piezometer

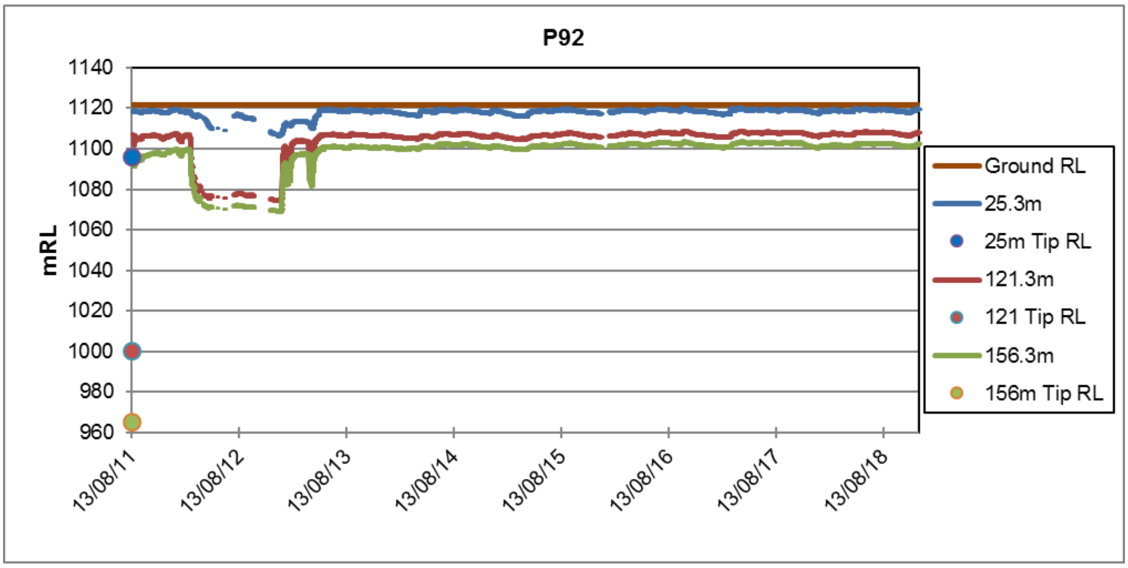

Figure 12: P92 Vibrating Wire Piezometer

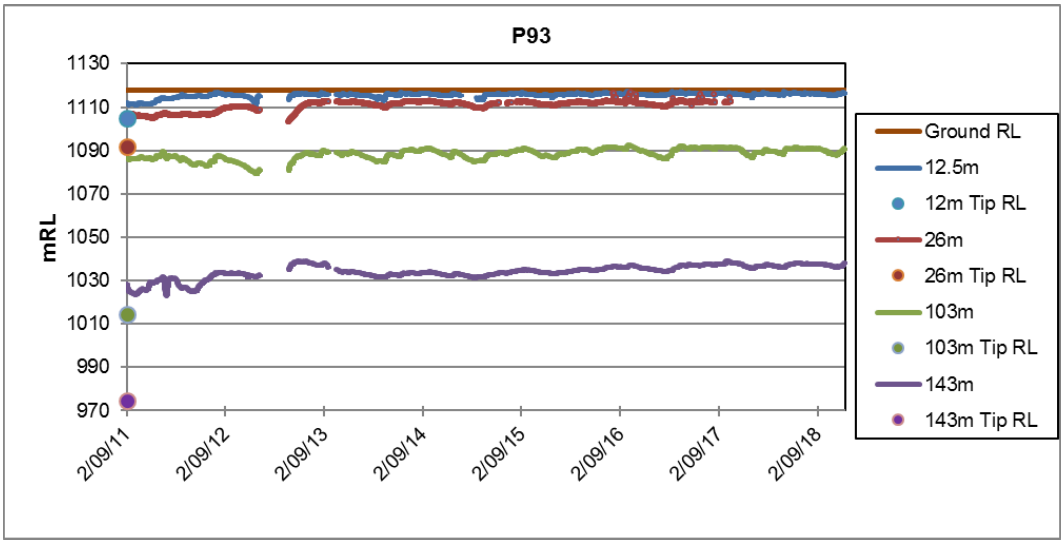

Figure 13: P93 Vibrating Wire Piezometer

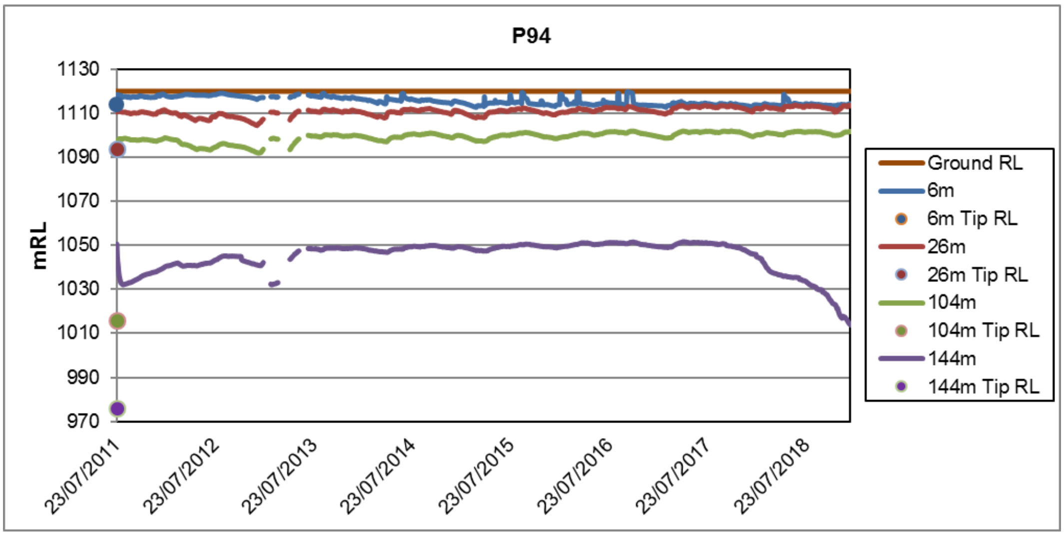

Figure 14: P94 Vibrating Wire Piezometer

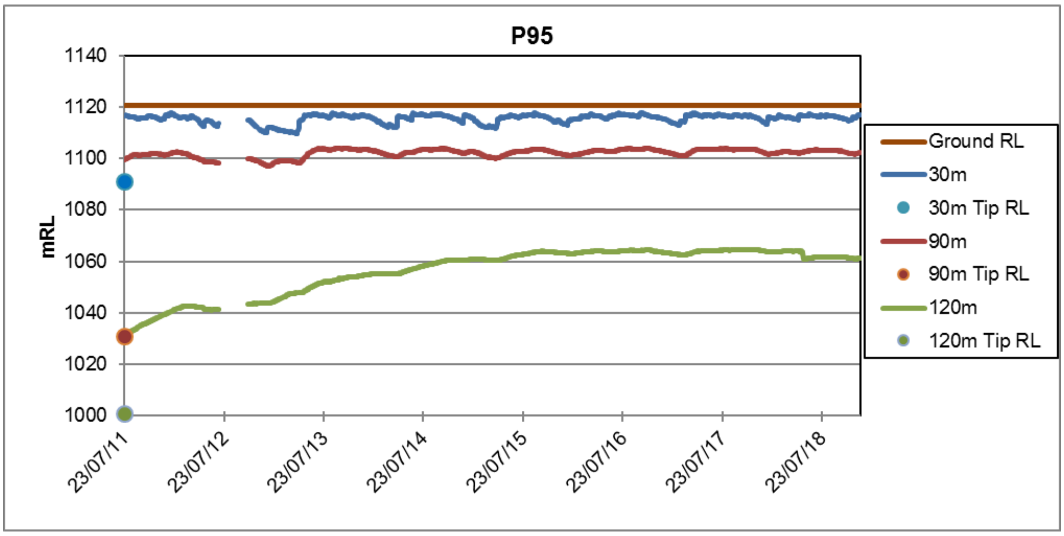

Figure 15: P95 Vibrating Wire Piezometer

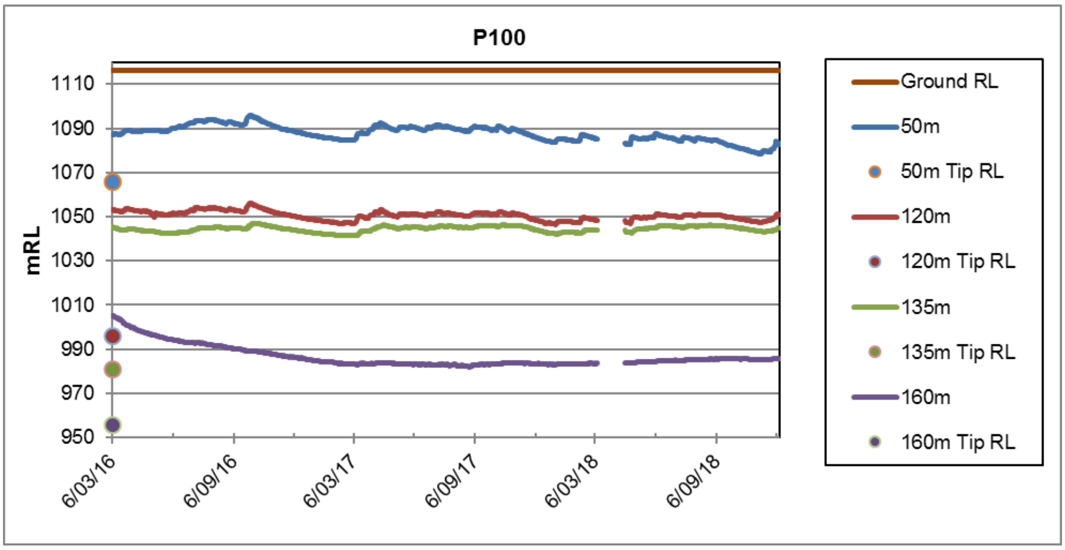

Figure 16: P100 Vibrating Wire Piezometer

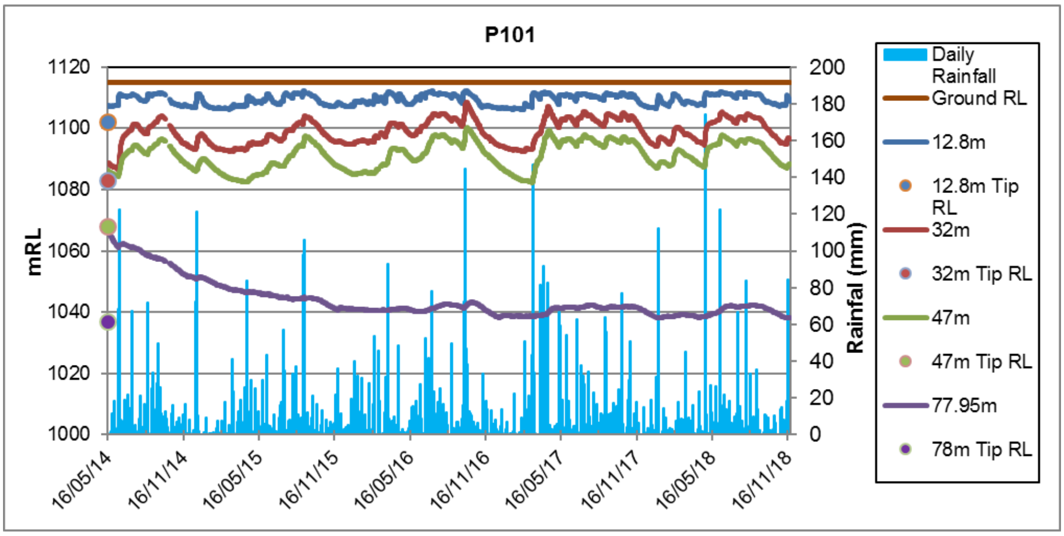

Figure 17: P101 Vibrating Wire Piezometer including daily rainfall

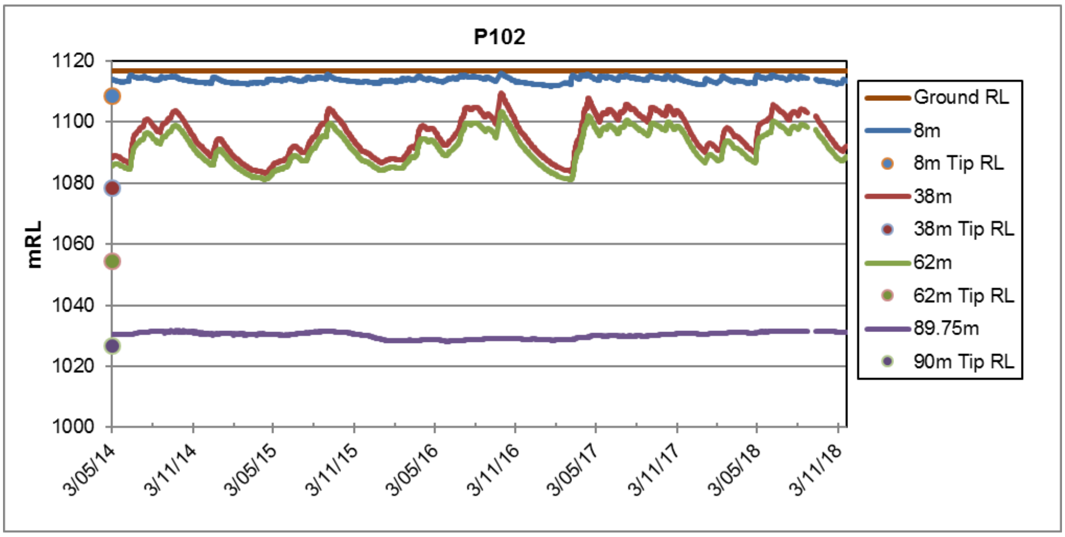

Figure 18: P102 Vibrating Wire Piezometer

.

Water levels were disrupted during 2012 to 2013 in P90, P91 and P92 by leakage down an incompletely sealed drill hole annulus. Pressures returned to normal after comprehensive effort to seal the leakage pathway.

During 2018, the 1050mRL piezometer in well P94 showed a drop in pressure believed to be a result of nearby mining causing relaxation in the country rock host rock surrounding the piezometer tip. The shallower piezometers at this location have not displayed any corresponding drop in pressure (Figure 14). The depressurisation is expected to stabilise once mining has passed the area.

4.1.2 *Martha Pit Piezometers*

P69D & P69S were installed in 2001 and are located close to the rim of the North Wall of Martha Pit. They were considered control bores and previously uninfluenced by dewatering. Geotechnical stability work in the North Wall was undertaken in October 2014, partly due to excessive water. Drainage holes were drilled into the lower wall. Localised drainage of the wall resulted, and the water levels in P69D and P69S declined. By March 2015 the piezometers had stabilized with P69D and P69S declined by 32m and 12m respectively (Figure 19). With the large North Wall slip in April 2016, access to the piezometers was briefly restricted. Real time loggers were installed in mid-2017 and are currently programmed to record hourly.

In September 2017, a piezometer hole (well P106) was drilled on the north-west side of Martha Pit (Figure 2). Four piezometers were installed to depths between 37 and 163m. The piezometers tips are in dewatered andesite and results indicate the majority of the rockmass is dry with little or no water pressure.

In mid-2018, five real time loggers recording hourly were installed in new wells (wells P117 – P121) to investigate the source of an area of seepage on the north wall of the pit (Figure 2). Water levels in well P119 appear to fluctuate with rainfall while in wells P 120 and P 121, levels follow long term seasonal trends within the andesite (Figure 20). These will continue to be monitored in 2019.

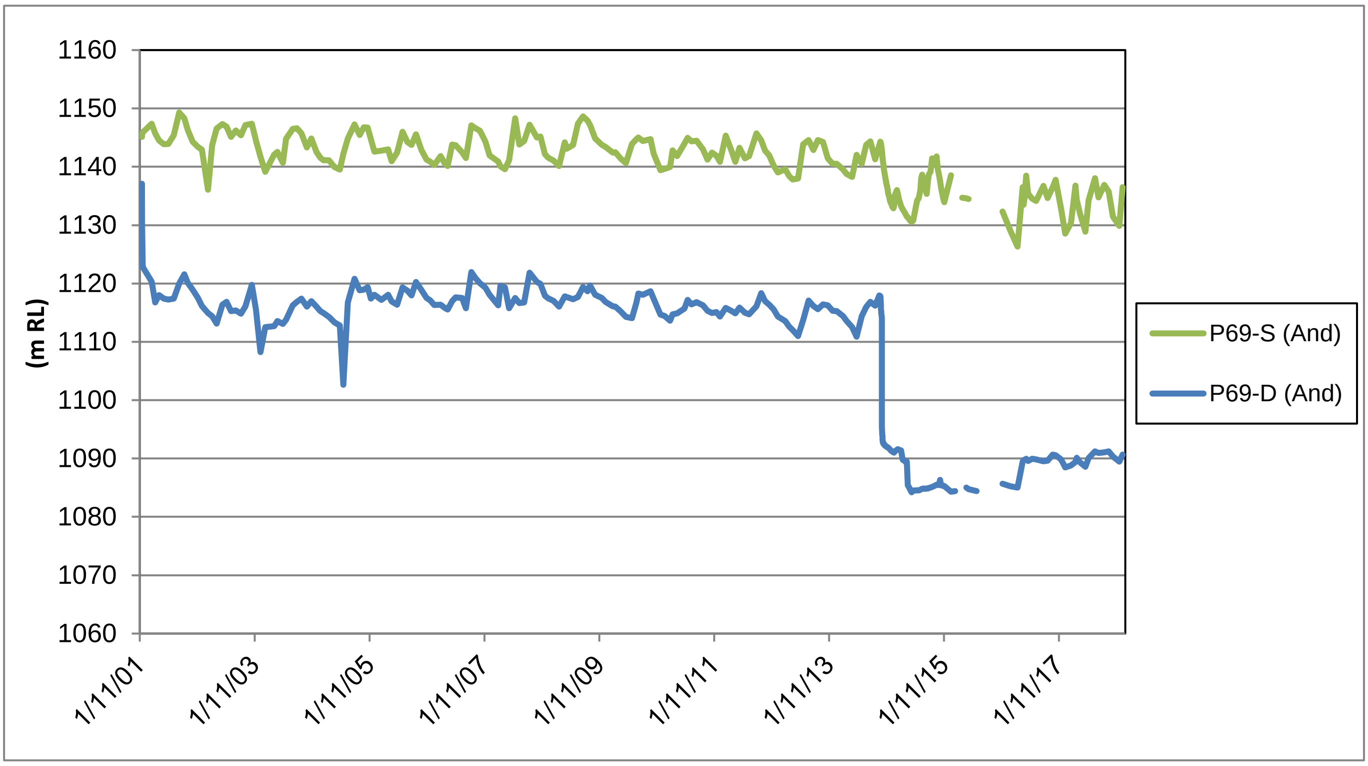

Figure 19: Water Levels P69 Pit North Wall

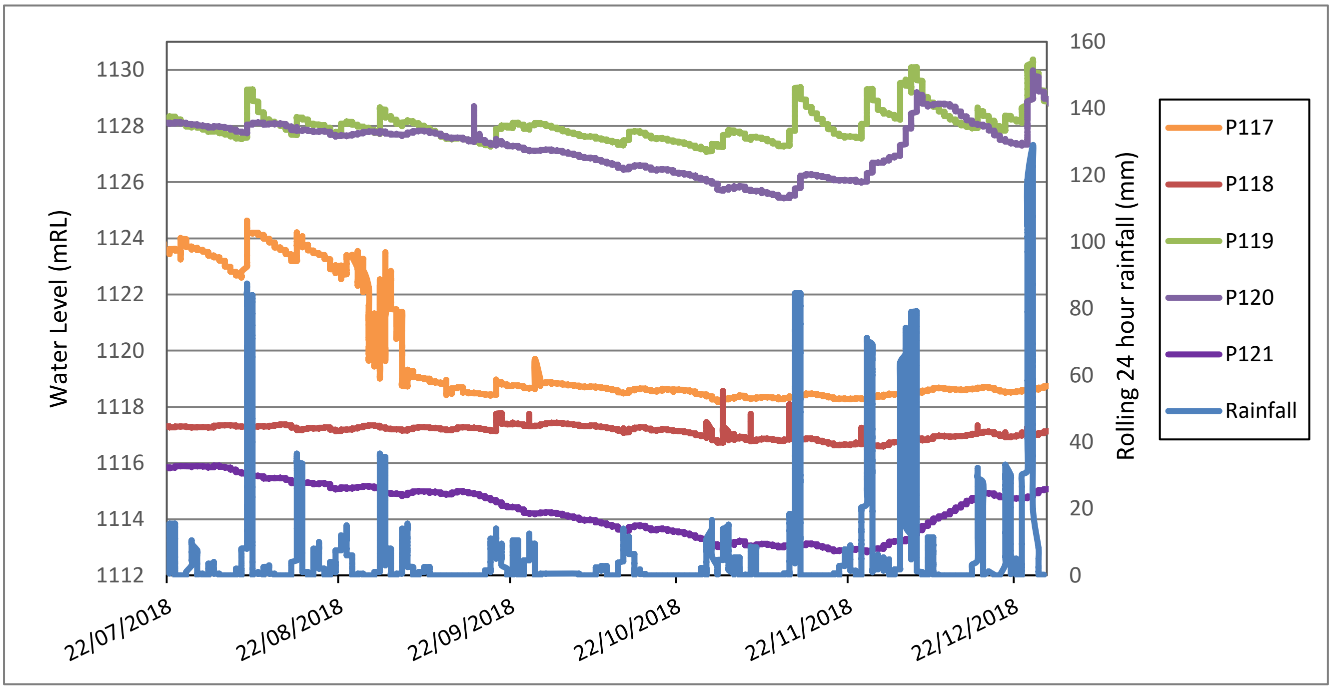

Figure 20: Water Levels in North Wall Piezometers

4.1.3 *Project Martha Piezometers*

During 2019, three dipped and three vibrating wire piezometers were added to the piezometer network to measure groundwater levels on the southern edge of the pit. Data collection from these piezometers is yet to begin. A further five may be added later in 2019.

5 WETLANDS AND ECOLOGICAL VALUES

This section is provided to meet Condition 9 e of the Project Martha 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 as possibly being dependant on the surface contribution of shallow groundwater outflows by GWS. A memorandum outlining GWS's assessment of groundwater fed wetlands is included as Appendix C.

The first is located north 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 21).

Figure 21: 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 south east 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. No flow monitoring of this location has been undertaken in the past, however baseline flow monitoring further downstream on the Eastern Stream has begun at sampling point ES04 Weir (Figure 22).

5.2 Southern Area

The Southern Area consists of a collection of ephemeral springs that flow during winter or after heavy rainfall. Up to four separate springs flow from the south eastern side of Winner Hill (Figure 23). The springs run through a gully planted in natives and maintained by OGNZL, before eventually joining the Ohinemuri River. Flows from the springs are typically low and consequently, collecting flow rates at the springs themselves has not been possible. Collection of baseline flow data has instead commenced at TB4, where the springs join the Ohinemuri River (Figure 23). Initial monitoring has shown TB4 does not flow in summer.

A further possible groundwater fed wetland identified by GWS is located south of Union Hill. Preliminary observations have shown this area is usually dry, however further monitoring is required in winter to confirm if it is in fact groundwater fed, or if the channel only accommodates storm water flows following rainfall.

Water quality samples have sporadically been taken from the springs and TB4 when possible. Water quality data is attached as Appendix D.

Figure 22: Northern Area Wetland

Figure 23: Southern Area Wetlands

6 CONCLUSION

As dewatering below 700 mRL has not yet occurred, there are currently no effects as a result of dewatering associated with Project Martha. Effects of dewatering associated with previous dewatering consents is addressed in the Dewatering and Settlement Report 2018. Further comment on the effects of dewatering related to Project Martha activities will be included in subsequent reports.

APPENDIX A –

CONSENT CONDITIONS

Extract from conditions of Waikato Regional Council Consent 139551

MONITORING OF THE SHALLOW AND DEEP AQUIFERS
9 The consent holder shall upon commencement of this consent and at five yearly intervals thereafter, provide a report to the Waikato Regional Council commenting on the effect the groundwater take and dewatering activity is having on the deep and shallow aquifers under the Martha Pit and immediate surrounds. The report shall as a minimum, provide the following information:

(a) The nature of the geology under the Martha Pit and immediate surrounds;

(b) Comment on the existing groundwater chemistry for the deep and shallow aquifers;

(c) Comment on the groundwater levels in the deep and shallow aquifers; and

(e) 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.

Taking into account all of this information (and any other relevant data) the consent holder shall provide comment on the effects the dewatering activity is having on the shallow and deep aquifers under the Martha Pit and immediate surrounds.

APPENDIX B –

UNDERGROUND DEWATERING WATER QUALITY

Date	Data Point	FLS pH	FLS EC (mS/m)	FLS Temp	Acidity (ph 8.3)(g/m3 as CaCO3)	Acidity (pH 3.7)	Alk-Bicarb	Alk-T	Alkalinity (pH4.5)(g/m3 as CaCO3)	AlS	SbS
25/01/2018	Underground Dewatering	7.3	324	24.8		1	300	300		0.008	0.0067
27/02/2018	Underground Dewatering	7.05	233.2	28.4	1				206		
14/03/2018	Underground Dewatering				1				169		
26/04/2018	Underground Dewatering	7	283.6	27.4	1				188		
18/05/2018	Underground Dewatering					1	193	193		0.012	0.0041
17/07/2018	Underground Dewatering				1				536		
6/08/2018	Underground Dewatering	7.24	33.7	29.7		1	490	490		0.013	0.0139
19/09/2018	Underground Dewatering	7.08	33.5	28.4	1				192		
10/10/2018	Underground Dewatering				1				184		
7/11/2018	Underground Dewatering				1				163		
11/12/2018	Underground Dewatering					1	330	330		0.021	0.0093
9/01/2019	Underground Dewatering				1				164		
8/02/2019	Underground Dewatering					1	200	200		0.018	0.0069
8/03/2019	Underground Dewatering				1				276		

Date	Data Point	AsS	Bicarb	CdS	CaSO	COD	Cl	CrS	Cr6col	CoS	CuS	CNTOT	EC (mS/m)	NH3	AuS	Hard	FeA	FeT	PbS	MgSO
25/01/2018	Underground Dewatering	0.034	360	0.0001	540	32	15.8	0.001	0.01	0.0053	0.001	0.057	276	0.024	0.0006	1610	2.3	8.4	0.0008	63
27/02/2018	Underground Dewatering				594		13						273			1800	3.5			73
14/03/2018	Underground Dewatering				540		13						270			1700	7.2			76
26/04/2018	Underground Dewatering				539		13.7						258			1600	5.1			70
18/05/2018	Underground Dewatering	0.01	230	0.00083	510	6	14	0.001	0.01	0.022	0.001	0.0029	269	0.01	0.0006	1590	6.3	13.5	0.0002	74
17/07/2018	Underground Dewatering				447		16						255			1400	16			70
6/08/2018	Underground Dewatering	0.04	600	0.0001	490	35	12	0.001	0.01	0.0028	0.001	0.03	269	0.028	0.0006	1480	3.2	30	0.005	60
19/09/2018	Underground Dewatering				595		11.2						275			1800	3.7			86
10/10/2018	Underground Dewatering				520		14						261			1600	3.6			67
7/11/2018	Underground Dewatering				494		13						257			2200	6.4			70
11/12/2018	Underground Dewatering	0.013	400	0.00019	470	62	20	0.001	0.01	0.0068	0.004	0.02	258	0.081	0.0006	1390	3.9	38	0.0044	52
9/01/2019	Underground Dewatering				539		10.9						258.2			1700	2.2			75
8/02/2019	Underground Dewatering	0.018	250	0.00023	500	6	12	0.001	0.01	0.0068	0.001	0.02	265	0.0057	0.0006	1540	4.2	23	0.0005	72
8/03/2019	Underground Dewatering				504		12.4						255			1500	5.2			66

Date	Data Point	MnA	MnS	HgA	HgT	NiS	NO3-N	NOxN	NO2-N	NH4N	pH	PTO	KSO	DRP	SeS	SeT	SI	AgS	NaSO	SO4
25/01/2018	Underground Dewatering		7.1	8.00E-05	8.00E-05	0.0085	5.8	6.1	0.29	4.6	7.4	1.03	10.8	0.004	0.003	0.004	37	0.0002	71	1350
27/02/2018	Underground Dewatering	10									7.5		9		0.0094				59	1720
14/03/2018	Underground Dewatering	9.9									7.3		8.1		0.0094				56	1670
26/04/2018	Underground Dewatering	9.6									7.3		7.7		0.0094				61	1550
18/05/2018	Underground Dewatering		9	8.00E-05	8.00E-05	0.028	1.41	1.53	0.11	1.1	7.4	0.22	9.1	0.004	0.002	0.0029	47	0.0002	59	1630
17/07/2018	Underground Dewatering	11									7.4		9.3		0.0094				48	660
6/08/2018	Underground Dewatering		7	8.00E-05	0.00018	0.01	4.9	5	0.12	3.4	7.6	0.57	9.4	0.004	0.002	0.0035	42	0.0002	59	1660
19/09/2018	Underground Dewatering	8.9									7.6		8.6		0.0094				55	1780
10/10/2018	Underground Dewatering	8.2									7.5		7.3		0.0094				53	1490
7/11/2018	Underground Dewatering	8.1									7.3		7.6		0.0094				58	1460
11/12/2018	Underground Dewatering		4.4	8.00E-05	0.00029	0.0116	8.2	9	0.79	5.6	7.8	0.68	13.9	0.004	0.004	0.0055	33	0.0002	75	1500
9/01/2019	Underground Dewatering	7.5									7.7		8.5		0.0094				47	1380
8/02/2019	Underground Dewatering		7.6	8.00E-05	8.00E-05	0.013	0.85	1.01	0.16	0.54	7.7	0.23	8.4	0.004	0.002	0.0021	42	0.0002	61	1590
8/03/2019	Underground Dewatering	10									7.6		7.3		0.0094				55	1510

Date	Data Point	Sum Anion	Sum Cation	TKN	SeTR	TSS	CNWAD	ZnS
25/01/2018	Underground Dewatering	35	36	5.9		2600	0.0189	0.058
27/02/2018	Underground Dewatering				0.0094	420		
14/03/2018	Underground Dewatering				0.0094	410		
26/04/2018	Underground Dewatering				0.0094	370		
18/05/2018	Underground Dewatering	38	35	1.2		780	0.0028	0.49
17/07/2018	Underground Dewatering				0.016	8000		
6/08/2018	Underground Dewatering	45	33	4.8		2200	0.02	0.055
19/09/2018	Underground Dewatering				0.0094	530		
10/10/2018	Underground Dewatering				0.0094	430		
7/11/2018	Underground Dewatering				0.0094	570		
11/12/2018	Underground Dewatering	39	32	6.8		3800	0.02	0.1
9/01/2019	Underground Dewatering				0.0094	300		
8/02/2019	Underground Dewatering	38	34	0.77		850	0.02	0.174
8/03/2019	Underground Dewatering				0.0094	1400		

APPENDIX C –

GWS SPRINGFED WETLANDS MEMO

MEMO

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.

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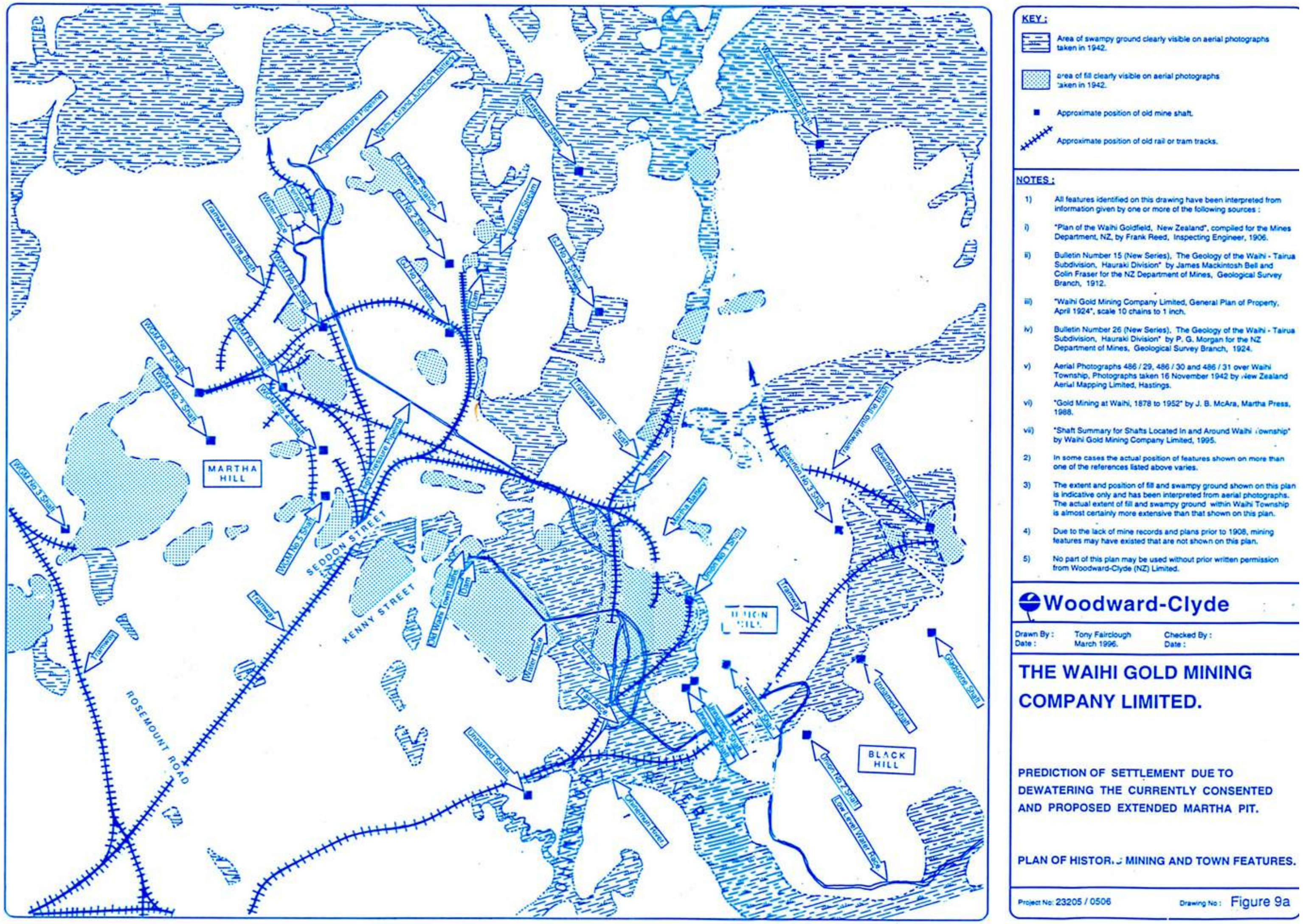

Figure 1 WWC (1996) Plan of Mining Features, Areas of Fill and Swamy Ground

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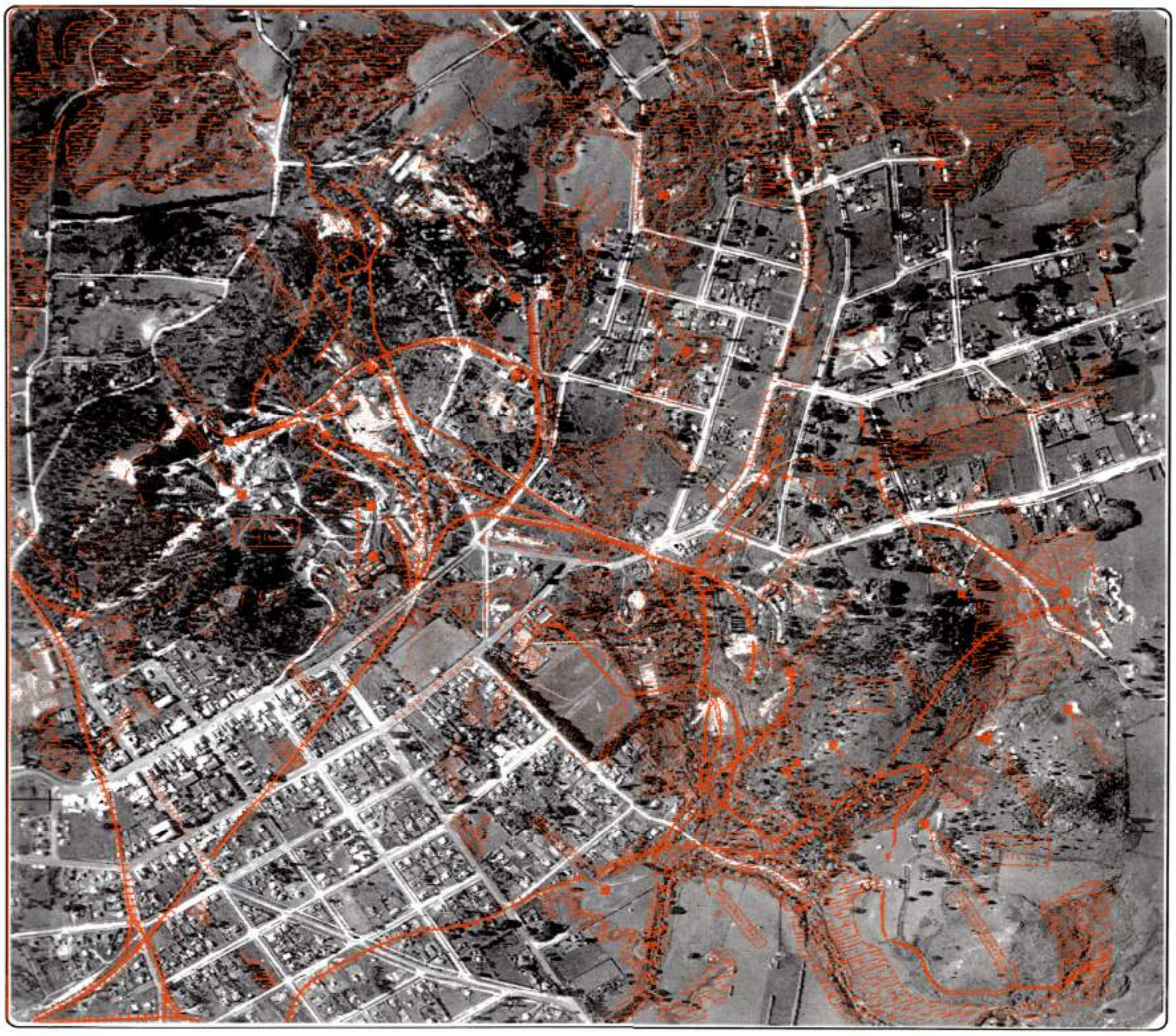

Figure 2 Swampy Areas Identified from 1942 Aerial Photographs

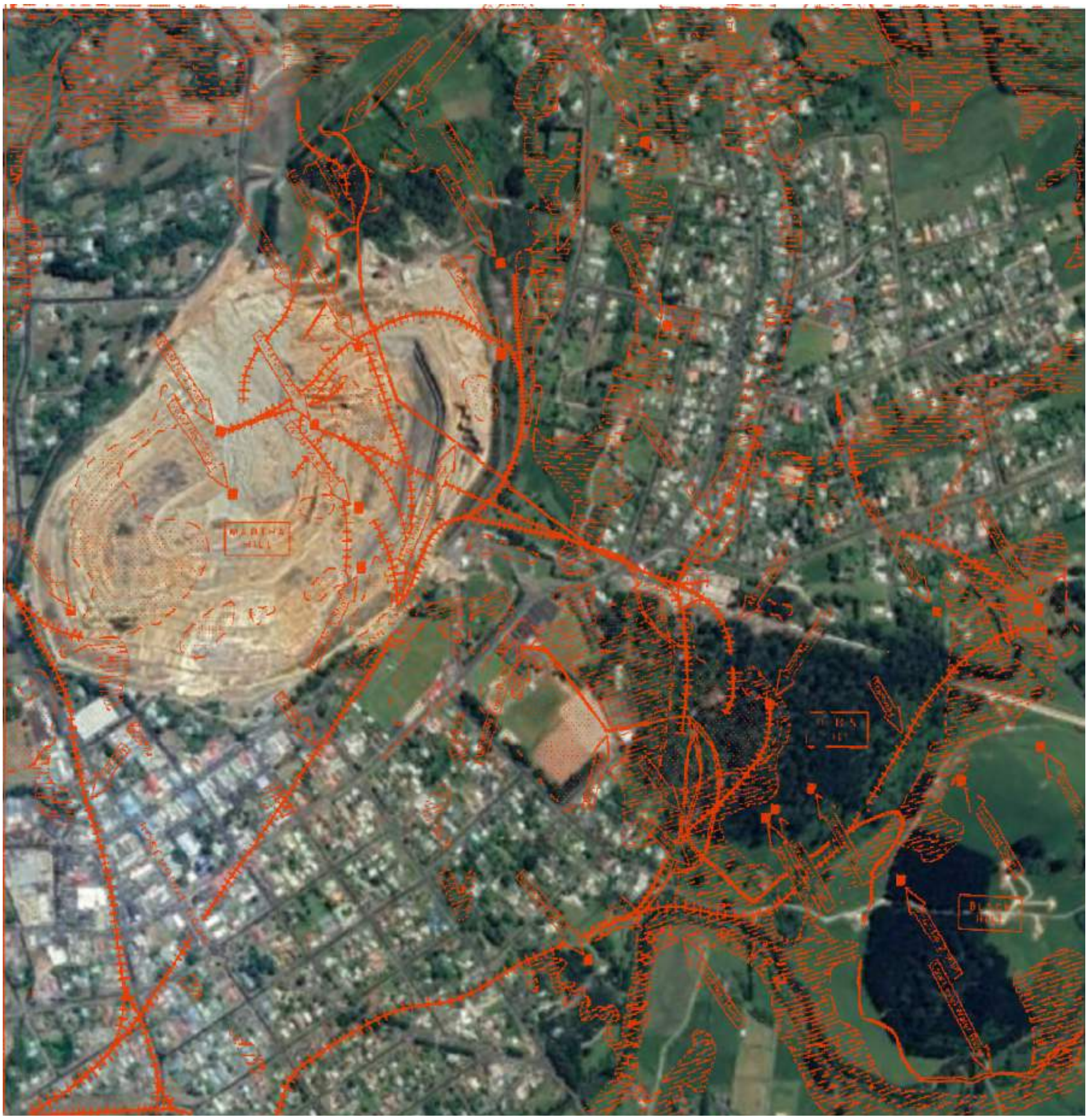

Figure 3 Swampy Areas Over Recent Aerial Photographs

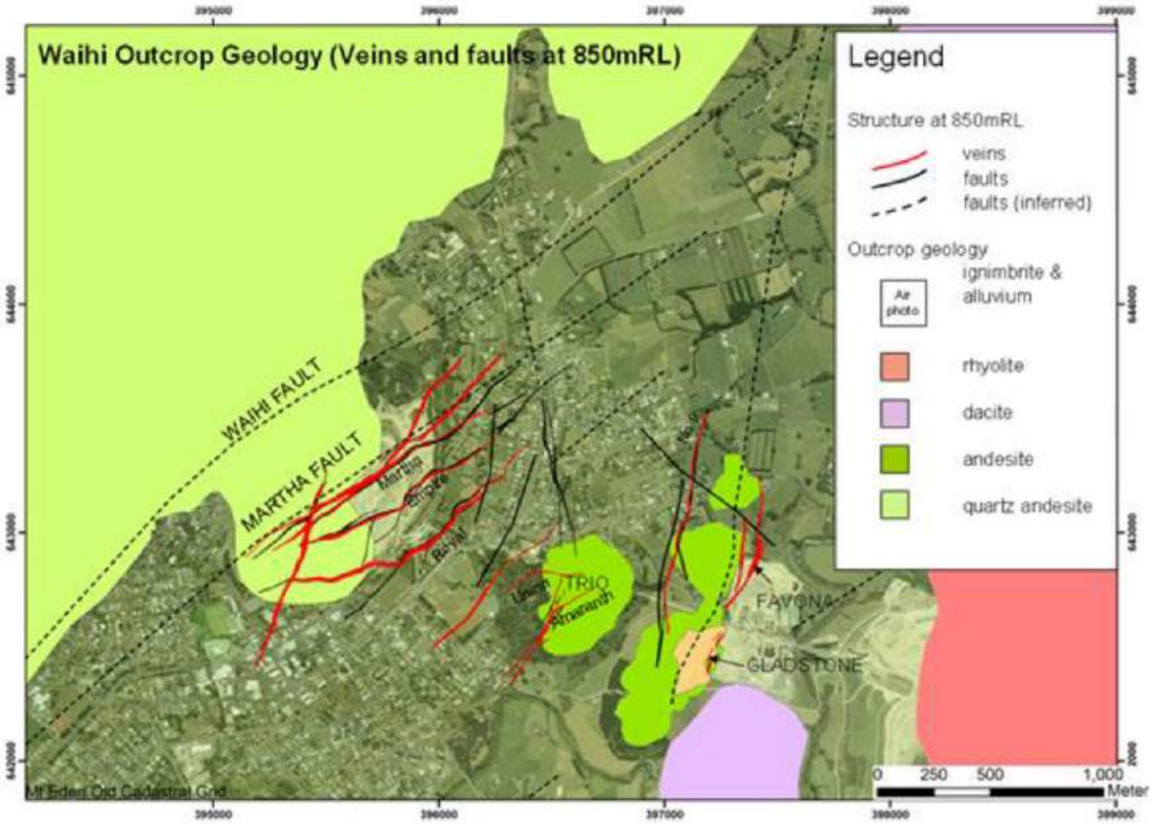

Figure 4 Geology of the Waihi Area

Figure 5 Topography of the Waihi Area

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Figure 6 Northern Area Spring Fed Wetlands

Figure 7 Southern Area Spring Fed Wetlands

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APPENDIX D –

GLAD SPRINGS/TB4 WATER QUALITY

Date	Data Point	FLS Comments	FLS EC (mS/m)	FLS pH	FLS Temp	Acidity (pH 3.7)	Alk-Bicarb	Alk-T	AlA	AlS	SbA	SbS	AsA	AsS	BaS	Bicarb
20/09/2017	Glad spring C	Medium Flow	6.8	6.3	14.9	1	3.8	3.8	0.04	0.025	0.0002	0.0002	0.001	0.001		4.6
20/09/2017	Glad spring A	Low Flow	10.4	6.6	14.6	1	6.9	6.9	0.051	0.031	0.0002	0.0002	0.001	0.001		8.4
20/09/2017	Glad spring B	Trickle Flow	11.2	6.6	14.3	1	4.1	4.1	2.4	0.018	0.0003	0.0002	0.0021	0.001		5
20/09/2017	Glad spring D	Medium Flow	8.5	6.3	13.9	1	9.6	9.6	0.037	0.036	0.0002	0.0002	0.001	0.001		11.7
20/09/2017	TB4	Fast Flow	6.8	7	13.1	1	7.9	7.9	0.035	0.034	0.0002	0.0002	0.001	0.001		9.6
20/09/2017	Glad ABC combined	Medium Flow	7.1	6.5	13.1	1	7.2	7.2	0.042	0.042	0.0002	0.0002	0.001	0.001		8.8
14/02/2018	Glad spring C							4.1		0.032		0.0002		0.001	0.033	5
14/02/2018	Glad spring A							5.7		0.051		0.0002		0.001	0.031	6.9
14/02/2018	TB4							7.3		0.073		0.0002		0.001	0.048	8.9
14/02/2018	Glad spring D							7.5		0.067		0.0002		0.001	0.042	9.1
14/02/2018	Glad spring B							5.3		0.044		0.0002		0.001	0.03	6.5
3/05/2018	Glad spring B		11.2	5.1	16.1			4.2		0.042		0.0002		0.001	0.029	5.1
3/05/2018	Glad spring D		10.3	4.8	16.9			6.8		0.094		0.0002		0.001	0.039	8.3
3/05/2018	Glad spring C		9.9	4.94	16.4			3.5		0.03		0.0002		0.001	0.026	4.3
3/05/2018	TB4		9.1	5.19	14.8			6.4		0.071		0.0002		0.001	0.041	7.8
3/05/2018	Glad spring A		12.2	4.95	16.3			5.9		0.028		0.0002		0.001	0.024	7.2
16/08/2018	TB4		7.3	6.6	12.5			9.3		0.07		0.0002		0.001	0.037	11.3
16/08/2018	Glad spring B		9.5	6.25	14.9			5.9		0.013		0.0002		0.001	0.02	7.2
16/08/2018	Glad spring C		7.1	6.5	15			3.6		0.019		0.0002		0.001	0.019	4.4
16/08/2018	Glad spring A		9.8	6	15.1			6.4		0.017		0.0002		0.001	0.019	7.8
16/08/2018	Glad spring D		8.6	6	13.6			8.9		0.079		0.0002		0.001	0.036	10.8
14/10/2018	TB4							19.7		0.041		0.0002		0.001		24
14/01/2019	TB4	Not Enough To Sample														
18/02/2019	Glad spring D	Dry														
18/02/2019	Glad spring C	Dry														
18/02/2019	Glad spring A	Dry														
18/02/2019	Glad spring B	Dry														
21/02/2019	TB4	No flow														
19/03/2019	TB4	No flow														

Date	Data Point	BS	CdA	CdS	CaSO	Carb	COD	Cl	CrA	CrS	Cr6col	Cr-T	CoA	CoS	CuA	CuS	CNTOT	EC (mS/m)	F-	NH3
20/09/2017	Glad spring C		5.00E-05	5.00E-05	2.4	1	6	12.7		0.0005	0.001	0.00053	0.0002	0.0002	0.0005	0.0005	0.001	7.8	0.05	0.01
20/09/2017	Glad spring A		5.00E-05	5.00E-05	7.9	1	6	10.7		0.0005	0.001	0.00053	0.0004	0.0005	0.0005	0.0005	0.001	12.7	0.05	0.01
20/09/2017	Glad spring B		7.00E-05	5.00E-05	5.8	1	6	10.2		0.0005	0.001	0.0024	0.0004	0.0004	0.0023	0.0005	0.001	11	0.05	0.01
20/09/2017	Glad spring D		5.00E-05	5.00E-05	3	1	60	17.2		0.0005	0.001	0.00053	0.0002	0.0002	0.0005	0.0005	0.001	9.7	0.05	0.01
20/09/2017	TB4		5.00E-05	5.00E-05	2.4	1	6	11.2		0.0005	0.001	0.00053	0.0002	0.0002	0.0005	0.0005	0.001	7.4	0.05	0.01
20/09/2017	Glad ABC combined		5.00E-05	5.00E-05	2.1	1	6	10		0.0005	0.001	0.00053	0.0002	0.0002	0.0005	0.0005	0.001	6.8	0.05	0.01
14/02/2018	Glad spring C	0.007		5.00E-05	3.9			15		0.0005				0.0003		0.0005		10.4		
14/02/2018	Glad spring A	0.006		5.00E-05	7.3			13		0.0005				0.0006		0.0005		13.5		
14/02/2018	TB4	0.009		5.00E-05	2.9			16		0.0005				0.0003		0.0005		9.4		
14/02/2018	Glad spring D	0.008		5.00E-05	2.8			16		0.0006				0.0002		0.0005		9.7		
14/02/2018	Glad spring B	0.005		6.00E-05	4.7			14		0.0005				0.0002		0.0005		10.4		
3/05/2018	Glad spring B	0.009		5.00E-05	4.8			14		0.0005				0.0002		0.0005		10.1		
3/05/2018	Glad spring D	0.01		5.00E-05	2.7			16		0.0005				0.0002		0.0005		9.2		
3/05/2018	Glad spring C	0.01		5.00E-05	3.3			14		0.0005				0.0003		0.0005		8.9		
3/05/2018	TB4	0.009		5.00E-05	2.8			14		0.0005				0.0002		0.0005		8.3		
3/05/2018	Glad spring A	0.009		5.00E-05	5.7			14		0.0005				0.0004		0.0005		11		
16/08/2018	TB4	0.007		5.00E-05	2.3			12		0.0005				0.0002		0.0005		7.5		
16/08/2018	Glad spring B	0.009		6.00E-05	5.3			11		0.0005				0.0002		0.0005		10.1		
16/08/2018	Glad spring C	0.009		5.00E-05	2.1			13.2		0.0005				0.0002		0.0005		7.4		
16/08/2018	Glad spring A	0.009		5.00E-05	5.4			11		0.0005				0.0003		0.0005		10.3		
16/08/2018	Glad spring D	0.008		5.00E-05	2.7			15		0.0005				0.0002		0.0005		9.1		
14/10/2018	TB4	0.007		5.00E-05	3.2			11.4		0.0005				0.0015		0.0005		8.3		
14/01/2019	TB4																			
18/02/2019	Glad spring D																			
18/02/2019	Glad spring C																			
18/02/2019	Glad spring A																			
18/02/2019	Glad spring B																			
21/02/2019	TB4																			
19/03/2019	TB4																			

Date	Data Point	Hard	FeA	FeS	FeT	PbA	PbS	MgSO	MnA	MnS	HgA	HgS	HgT	MoS	NiA	NiS	NO3-N	NOxN	NO2-N
20/09/2017	Glad spring C	11.6	0.02	0.02	0.035	0.0001	0.0001	1.38	0.0048	0.0047	8.00E-05	8.00E-05	9.00E-05		0.0005	0.0005	0.9	0.9	0.1
20/09/2017	Glad spring A	32	0.1	0.05	0.09	0.0001	0.0001	3	0.025	0.025	8.00E-05	8.00E-05	8.00E-05		0.0012	0.0011	0.78	0.78	0.1
20/09/2017	Glad spring B	24	1.24	0.2	3	0.0021	0.0001	2.3	0.053	0.042	0.00013	8.00E-05	0.00045		0.0005	0.0005	0.39	0.39	0.1
20/09/2017	Glad spring D	16.7	0.06	0.04	0.084	0.0001	0.0001	2.2	0.0175	0.0155	8.00E-05	8.00E-05	8.00E-05		0.0005	0.0005	0.63	0.63	0.1
20/09/2017	TB4	12.3	0.37	0.23	0.38	0.0001	0.0001	1.55	0.029	0.027	8.00E-05	8.00E-05	8.00E-05		0.0005	0.0005	0.23	0.23	0.1
20/09/2017	Glad ABC combined	10.7	0.36	0.2	0.38	0.0001	0.0001	1.33	0.022	0.0183	8.00E-05	8.00E-05	8.00E-05		0.0005	0.0005	0.15	0.15	0.1
14/02/2018	Glad spring C	17.9		0.02			0.0001	1.94		0.0082	8.00E-05	8.00E-05		0.0002		0.0005		1.59	
14/02/2018	Glad spring A	30		0.02			0.0001	2.8		0.0164	8.00E-05	8.00E-05		0.0002		0.0014		1.65	
14/02/2018	TB4	15		0.27			0.0001	1.89		0.025	8.00E-05	8.00E-05		0.0002		0.0005		0.65	
14/02/2018	Glad spring D	15.4		0.05			0.0001	2		0.0104	8.00E-05	8.00E-05		0.0002		0.0005		0.83	
14/02/2018	Glad spring B	19.9		0.02			0.0001	1.96		0.0147	8.00E-05	8.00E-05		0.0002		0.0005		1.27	
3/05/2018	Glad spring B			0.02			0.0001	1.82		0.0136	8.00E-05	8.00E-05		0.0002		0.0005		1.2	
3/05/2018	Glad spring D			0.05			0.0001	1.96		0.0099	8.00E-05	8.00E-05		0.0002		0.0005		0.87	
3/05/2018	Glad spring C			0.02			0.0001	1.55		0.0075	8.00E-05	8.00E-05		0.0002		0.0005		1.17	
3/05/2018	TB4			0.21			0.0001	1.56		0.028	8.00E-05	8.00E-05		0.0002		0.0005		0.55	
3/05/2018	Glad spring A			0.02			0.0001	2		0.0139	8.00E-05	8.00E-05		0.0002		0.0011		1.02	
16/08/2018	TB4			0.42			0.0001	1.46		0.039	8.00E-05	8.00E-05		0.0002		0.0005		0.33	
16/08/2018	Glad spring B			0.1			0.0001	1.7		0.015	8.00E-05	8.00E-05		0.0002		0.0007		0.54	
16/08/2018	Glad spring C			0.02			0.0001	1.12		0.0036	8.00E-05	8.00E-05		0.0002		0.0005		0.77	
16/08/2018	Glad spring A			0.02			0.0001	1.87		0.0143	8.00E-05	8.00E-05		0.0002		0.0008		0.59	
16/08/2018	Glad spring D			0.04			0.0001	1.91		0.0121	8.00E-05	8.00E-05		0.0002		0.0005		0.68	
14/10/2018	TB4	15.6		2.4			0.0001	1.86		0.33	8.00E-05	8.00E-05		0.0002		0.0005	0.049	0.051	0.003
14/01/2019	TB4																		
18/02/2019	Glad spring D																		
18/02/2019	Glad spring C																		
18/02/2019	Glad spring A																		
18/02/2019	Glad spring B																		
21/02/2019	TB4																		
19/03/2019	TB4																		

Date	Data Point	NH4N	pH	PTO	KSO	DRP	SeA	SeS	SI	AgA	AgS	NaSO	SrS	SO4	Sum Anion	Sum Cation	TiA	TiS	SnS	TDS
20/09/2017	Glad spring C	0.01	5.3	0.004	1.72	0.004	0.001	0.001	11.2	0.0001	0.0001	8.2		8	0.66	0.64	5.00E-05	5.00E-05		55
20/09/2017	Glad spring A	0.01	5.8	0.004	1.74	0.004	0.0012	0.001	14.2	0.0001	0.0001	9.5		30	1.12	1.11	6.00E-05	7.00E-05		84
20/09/2017	Glad spring B	0.012	5.6	0.018	4.3	0.004	0.001	0.001	13	0.0001	0.0001	9.5		27	0.96	1.02	6.00E-05	5.00E-05		78
20/09/2017	Glad spring D	0.01	5.8	0.006	1.77	0.004	0.001	0.001	18.6	0.0001	0.0001	10.5		7	0.87	0.84	5.00E-05	5.00E-05		81
20/09/2017	TB4	0.01	6.7	0.012	1.56	0.004	0.001	0.001	16.1	0.0001	0.0001	8.5		7	0.65	0.67	5.00E-05	5.00E-05		85
20/09/2017	Glad ABC combined	0.01	6.5	0.01	1.07	0.004	0.001	0.001	15.2	0.0001	0.0001	8		8	0.59	0.6	5.00E-05	5.00E-05		48
14/02/2018	Glad spring C	0.01	5.5		2.2			0.001			0.0001	9.9	0.0187	13				6.00E-05	0.0005	
14/02/2018	Glad spring A	0.01	5.5		1.97			0.001			0.0001	10.3	0.03	23				9.00E-05	0.0005	
14/02/2018	TB4	0.015	6		2.3			0.001			0.0001	9.3	0.021	10				5.00E-05	0.0005	
14/02/2018	Glad spring D	0.012	5.5		2.2			0.001			0.0001	10.1	0.022	9				5.00E-05	0.0005	
14/02/2018	Glad spring B	0.01	5.6		1.15			0.001			0.0001	9.5	0.021	15				5.00E-05	0.0005	
3/05/2018	Glad spring B	0.01	6.3		1.37			0.001			0.0001	9.4	0.02	14.8				5.00E-05	0.0005	
3/05/2018	Glad spring D	0.01	5.7		1.89			0.001			0.0001	9.7	0.0191	7.8				5.00E-05	0.0005	
3/05/2018	Glad spring C	0.01	5.9		1.99			0.001			0.0001	8.8	0.0148	11.5				5.00E-05	0.0005	
3/05/2018	TB4	0.017	6.6		1.78			0.001			0.0001	8.6	0.0174	8.9				5.00E-05	0.0005	
3/05/2018	Glad spring A	0.01	5.8		1.83			0.001			0.0001	9.2	0.023	18.7				7.00E-05	0.0005	
16/08/2018	TB4	0.016	6.6		1.44			0.001			0.0001	8.3	0.0163	6				5.00E-05	0.0005	
16/08/2018	Glad spring B	0.019	6.3		1.52			0.001			0.0001	8.9	0.021	17				9.00E-05	0.0005	
16/08/2018	Glad spring C	0.01	6.2		1.48			0.001			0.0001	8.3	0.0112	6.5				5.00E-05	0.0005	
16/08/2018	Glad spring A	0.01	6		1.35			0.001			0.0001	8.8	0.022	18				6.00E-05	0.0005	
16/08/2018	Glad spring D	0.01	6		1.66			0.001			0.0001	10.4	0.019	7				5.00E-05	0.0005	
14/10/2018	TB4		6.7		1.24							8.2		0.9	0.74	0.8			0.0005	
14/01/2019	TB4																			
18/02/2019	Glad spring D																			
18/02/2019	Glad spring C																			
18/02/2019	Glad spring A																			
18/02/2019	Glad spring B																			
21/02/2019	TB4																			
19/03/2019	TB4																			

Date	Data Point	TKN	TSS	UA	US	CNWAD	ZnA	ZnS
20/09/2017	Glad spring C	0.19	35	2.00E-05	2.00E-05	0.001	0.0016	0.0017
20/09/2017	Glad spring A	0.19	19	2.00E-05	2.00E-05	0.001	0.0025	0.0025
20/09/2017	Glad spring B	0.15	43	0.00022	2.00E-05	0.001	0.0046	0.0029
20/09/2017	Glad spring D	0.12	3	2.00E-05	2.00E-05	0.001	0.0024	0.0023
20/09/2017	TB4	0.13	3	2.00E-05	2.00E-05	0.001	0.0043	0.0033
20/09/2017	Glad ABC combined	0.12	3	2.00E-05	2.00E-05	0.001	0.0023	0.0024
14/02/2018	Glad spring C	0.1	3		2.00E-05	0.001		0.0049
14/02/2018	Glad spring A	0.1	3		2.00E-05	0.001		0.0038
14/02/2018	TB4	0.19	5		2.00E-05	0.001		0.004
14/02/2018	Glad spring D	0.23	11		3.00E-05	0.001		0.0024
14/02/2018	Glad spring B	0.32	28		2.00E-05	0.001		0.0031
3/05/2018	Glad spring B	0.6	57		2.00E-05	0.001		0.0037
3/05/2018	Glad spring D	0.22	16		2.00E-05	0.001		0.0024
3/05/2018	Glad spring C	0.37	71		2.00E-05	0.001		0.0025
3/05/2018	TB4	0.2	3		2.00E-05	0.001		0.0105
3/05/2018	Glad spring A	0.18	11		2.00E-05	0.001		0.004
16/08/2018	TB4	0.2	3		2.00E-05	0.003		0.0032
16/08/2018	Glad spring B	0.82	109		4.00E-05	0.002		0.0023
16/08/2018	Glad spring C	0.31	69		2.00E-05	0.002		0.002
16/08/2018	Glad spring A	0.22	40		2.00E-05	0.002		0.0021
16/08/2018	Glad spring D	0.21	10		2.00E-05	0.003		0.0028
14/10/2018	TB4							0.0043
14/01/2019	TB4							
18/02/2019	Glad spring D							
18/02/2019	Glad spring C							
18/02/2019	Glad spring A							
18/02/2019	Glad spring B							
21/02/2019	TB4							
19/03/2019	TB4							