



# DEWATERING AND SETTLEMENT REPORT

## 2021

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# DEWATERING & SETTLEMENT MONITORING REPORT 2021

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>6</b>
<b>1 INTRODUCTION .....</b>	<b>8</b>
<b>2 GEOLOGICAL SETTING .....</b>	<b>9</b>
<b>3 MINING ACTIVITIES .....</b>	<b>11</b>
<b>4 DEWATERING .....</b>	<b>16</b>
<b>5 GROUNDWATER MONITORING .....</b>	<b>21</b>
<b>6 SETTLEMENT MONITORING .....</b>	<b>46</b>
<b>7 TILT .....</b>	<b>61</b>
<b>8 COMPLAINTS .....</b>	<b>70</b>
<b>9 CONTINGENCY ACTIONS AND FUTURE IMPACTS .....</b>	<b>71</b>
<b>10 UNDERGROUND WATER QUALITY .....</b>	<b>71</b>
<b>11 IMPROVEMENT ACTIVITIES .....</b>	<b>76</b>
<b>12 PEER REVIEW RECOMMENDATIONS 2021 .....</b>	<b>76</b>
<b>13 RESOURCE CONSENT EVALUATION .....</b>	<b>79</b>
<b>14 CONCLUSION.....</b>	<b>90</b>
<b>15 REFERENCES .....</b>	<b>91</b>

## LIST OF APPENDICES

Appendix A	Relevant Consent Conditions
Appendix B	Surveyor Reports
Appendix C	Plans of Settlement Marks & Contours
Appendix D	Trend Plots of Settlement Zones
Appendix E	Pit/Underground & Pit Wall Runoff – Water Quality 2021

## LIST OF FIGURES

Figure 1: Geological map and cross section of the Waihi area showing the distribution of quartz veining and dominant geological rock units .....	10
Figure 2: Current workings and boundaries .....	12
Figure 3: Oblique view of Correnso showing completed development and stoping activities. View is looking north east from above.....	13
Figure 4: Oblique view of Martha showing completed development and stoping activities. View looking north east.....	14
Figure 5: a) Martha Mine/Correnso dewatering rates, and b) Dewatering water level and rainfall .....	17
Figure 6: a) Project Martha dewatering bore locations, and b) 2021 dewatering bore water levels .....	18
Figure 7: Correnso, Trio and Favona Pumping Schematic December 2021 .....	19
Figure 8: Martha Underground Pumping Schematic December 2021 .....	20
Figure 9: Waihi Piezometer Network 2021 .....	26
Figure 10: Alluvium water level contours.....	27
Figure 11: Groundwater Level Trends – Shallow Groundwater (Alluvium & Weathered Contact of Young Volcanics).....	28
Figure 12: Deeper Younger Volcanic Water Level Contours .....	30
Figure 13: Groundwater Level Trends - Deeper Younger Volcanic Materials .....	31
Figure 14: Andesite Younger Volcanic Materials Contact.....	32
Figure 15: Andesite water level contours .....	35
Figure 16: Andesite Water Level Trends (excl. VW piezometers).....	36
Figure 17: Waihi South Piezometer Levels .....	38
Figure 18: P111 Vibrating Wire Piezometer .....	38
Figure 19: P112 Vibrating Wire Piezometer .....	39
Figure 20: P90 Vibrating Wire Piezometer .....	41
Figure 21: P91 Vibrating Wire Piezometer .....	41
Figure 22: P92 Vibrating Wire Piezometer .....	41
Figure 23: P93 Vibrating Wire Piezometer .....	42
Figure 24: P94 Vibrating Wire Piezometer .....	42
Figure 25: P95 Vibrating Wire Piezometer .....	43
Figure 26: P100 Vibrating Wire Piezometer .....	43
Figure 27: P101 Vibrating Wire Piezometer including daily rainfall.....	43
Figure 28: P102 Vibrating Wire Piezometer .....	44
Figure 29: Private bore water levels.....	45



Figure 30: Total Settlement Contours Nov 2021 .....	48
Figure 31: Settlement Marker Location Plan & Hazard Zones .....	49
Figure 32: Favona Settlement Nov 2021 .....	50
Figure 33: Triggered settlement marks Nov 2021 .....	51
Figure 34: Zone 1 Waihi Whangamata Road .....	54
Figure 35: Zone 1 Waihi South .....	54
Figure 36: Zone 1 West of Waihi .....	55
Figure 37: Zone 1 North of Waihi .....	55
Figure 38: Favona Settlement Profile .....	64
Figure 39: Favona Settlement marks and workings .....	65
Figure 40: Correnso Tilts and Underground Workings .....	67
Figure 41: Underground sample sites – Key Chemistry .....	73
Figure 42: Underground Dewatering Piper Diagram .....	73
Figure 43: Correnso Underground Piper Trilinear Diagram .....	74
Figure 44: Favona Underground Piper Trilinear Diagram .....	74
Figure 45: Underground Comparison Water Piper Trilinear Diagram .....	75
Figure 46: Treated Water Piper Trilinear Diagram .....	75

## EXECUTIVE SUMMARY

This Annual Dewatering and Settlement Monitoring Report is a requirement of the consent conditions for the Martha, Favona, Trio, Correnso and Project Martha mining projects, Waihi, New Zealand. Compliance monitoring and assessment of groundwater and settlement trends is reported for the period 1 January to 31 December 2021 and is in accordance with the current Dewatering and Settlement Monitoring Plan submitted to the Hauraki District and Waikato Regional Councils in May 2019.

On 16 July 2017, the Correnso groundwater take permit 124860 was replaced by the Project Martha groundwater take permit 139551. This allows dewatering to a lower level (500 mRL cf. 700 mRL).

New settlement triggers were applied during 2020 following the approval of Project Martha consents. Settlement survey results indicated that 97% (392/403) of marks graphed were within the predicted settlement ranges, based on the settlement resulting from mining activities. 11 marks triggered further investigation. Four settlement marks triggered were above the Favona mining area. The other seven triggered marks are located in the wider Waihi area. No effects were observed at surface near these locations and nearby shallow piezometers have not displayed any associated affect. This is considered an acceptable number of marks triggered.

### Martha Open Pit

Dewatering from the Martha Pit was discontinued on 04 May 2015 after a slip in the pit when access and power supply to the dewatering pumps became limited. Dewatering from within the Correnso underground mine was initiated on 18 May 2015. The Martha, Trio, Correnso and SUPA groundwater systems are hydraulically linked, and water levels are controlled by Correnso underground dewatering.

No drawdown effects caused by mine dewatering were indicated in monitoring bores and no tilt trends have developed during 2021 that can be attributed to dewatering operations.

The analysis of data has indicated that most settlement around Martha Pit had developed by the mid to late 1990s, but widespread small magnitude settlement has been ongoing and is likely to be related to dewatering of deeper structures within the andesite rock mass. Groundwater monitoring data does not show any widespread or significant dewatering of alluvium; of the upper portions of the younger volcanic materials; or dewatering of the upper layers of the andesite rock body which could lead to a greater magnitude of settlement.

No property damage complaints attributable to mine dewatering or settlement in response to mine dewatering were reported during 2021. Compliance was achieved with the consent conditions granted for the Martha Extended Project.

### Favona

At the Favona mine, piezometer levels indicate continued dewatering of the vein system, with the water level maintained at approximately 800mRL mine datum by the end of 2021. Water levels in the country rock surrounding the vein system stand higher and are either not responding or responding slowly to dewatering.

During 2019, a separate flow meter to measure dewatering flow from Favona was installed.

Four Favona marks exceeded settlement prediction, the same as in 2020.

A settlement trend exists over a 150 m wide area above the underground workings with a maximum total settlement of 354 mm (F18), of which up to 305 mm can be attributed to Favona mining activity. This is greater than the 80 mm initially predicted by URS (2002 Technical Report) to be due to dewatering. Settlement is attributed to a combination of depressurisation stress (primary consolidation) associated with drawdown in the andesite rock and relaxation of the country rock as mining proceeded. Primary consolidation (the first time a mine is dewatered) is greater than a second

cycle (subsequent dewatering activities). The Favona mine is outside of the Martha groundwater system; the Martha system was historically dewatered for a longer period and to greater depth and is currently undergoing a second period of dewatering.

Five tilt gradients attributable to Favona mining activity remain steeper than 1:1000; these are on farmland owned by the company and south of the residential area along Barry Road and have all been recorded in previous surveying events.

The previous trigger levels applied to Favona piezometers have been removed. These have been superseded by the Waihi wide triggers introduced as part of the Correnso dewatering consent. The trigger is a 15m water level change within a month. No Favona piezometer had such an increase or decrease. Compliance with the conditions of the Favona consents and Monitoring Plan was achieved.

## **Trio**

Water levels were controlled by Correnso dewatering.

## **Correnso**

The Correnso underground mine was granted consent and operations began on 20 December 2013.

Waikato Regional Council consents were granted in 2019 permitting the development of the Martha underground mine (Project Martha) and allowing groundwater levels to be lowered beyond the lowest level allowed for the mining of Trio. The Correnso water take permit was activated in July 2017, allowing dewatering to lower the groundwater down to 700 mRL (124860, Schedule One – General Conditions, Condition 1). At the end of 2021 the water level was at approximately 705 mRL.

New settlement trigger levels for Correnso were applied in 2017 and Project Martha superseded these in 2020. During 2021, no settlement mark in the Correnso Extensions Project Area (CEPA) displayed dewatering related settlement and no consent related groundwater trigger was activated. Compliance was achieved with the consent conditions granted for the Correnso Project.

## **SUPA**

The Slevin Underground Project Area is essentially an extension of the Correnso mining area. Mining within the SUPA area began January 16, 2017. No new Waikato Regional Council consents were required for the activity which is covered by the existing WRC consent conditions. The HDC dewatering and settlement related conditions are similar to the WRC conditions for Correnso. No new monitoring or reporting is required as the existing networks adequately encompass SUPA.

## **MDDP**

The Martha Drill Drives Project (MDDP) was granted consent on August 9, 2017. Mining in the MDDP began August 17, 2017 and was completed during 2019. The project involved the construction of two underground drill drives from the SUPA area towards Martha Pit. No specific HDC conditions relate to dewatering and settlement, rather it is covered by the existing WRC Correnso consent conditions. No new monitoring or reporting is required as the existing networks adequately encompass MDDP.

## **Project Martha**

Consents for Project Martha were granted on 01 February 2019. Joint HDC and WRC consents were activated on July 27, 2019 when blasting began in the project area. The WRC dewatering consent which allows dewatering below 700 mRL for Project Martha was activated on the 1st of January 2020. New dewatering bores were installed during 2020 to progressively lower the water level to enable Project Martha activities.

## 1 INTRODUCTION

This report is submitted to meet the requirements of various consents held by OGNZL related to Dewatering and Settlement. New consents have been issued for different projects as mining has progressed at Waihi with many having conditions and reporting requirements in common. A full list of conditions pertaining to Dewatering and Settlement are included in Appendix A. Consents for Martha, Favona, Trio, Correnso, SUPA, MDDP and Project Martha all require a Dewatering and Settlement Monitoring Plan. Below is a summary of the current consent requirements common to those consents:

The report shall, as a minimum, provide the following information:

- a) The volume of groundwater abstracted;
- b) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;
- c) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, predictions of the 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, this analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;
- d) Any contingency actions that may have been taken during the year; and
- e) Comment on compliance with [any conditions] of this schedule including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.
- f) The report shall be forwarded in a form acceptable to the Councils.

### **Changes to this year's monitoring report:**

Peer review comments received from the 2020 Dewatering and Settlement report suggest the hydrographs were too cluttered. To rectify this the Y axes have been narrowed and some historic dry wells have been removed from the charts.

Hydrographs have also been updated to utilise vibrating wire piezometric data. However due to congestion the andesite vibrating wire levels have been excluded from the hydrograph.

A new section has been included "Peer Review Recommendations". This will allow tracking of recommendation actions (see Section 12).

## 2 GEOLOGICAL SETTING

The mineralised veins of the Martha, Favona, Trio and Correnso gold deposits in Waihi are developed within Miocene age lava flows, intrusives and volcanoclastics of predominantly andesitic and minor dacitic composition (Figure 1). 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 that cover much of the Waihi township. The ignimbrites drape over an eroded andesitic graben and horst landscape resulting in a volcanoclastic 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, resistant, 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 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 host rock type. In Waihi the strongly clay altered zones are usually concentrated within close proximity to the veins or faults (eg within the hanging wall of Favona) and within the vein zones themselves (eg 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 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, hydrogeologically, 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 (Figure 1). 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 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 hydrogeological connectivity between the Martha system with the Favona system, shown by a lack of mutual response in the measured ground 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, both of which are north to northeast trending and have a perceived strike extent exceeding 1km

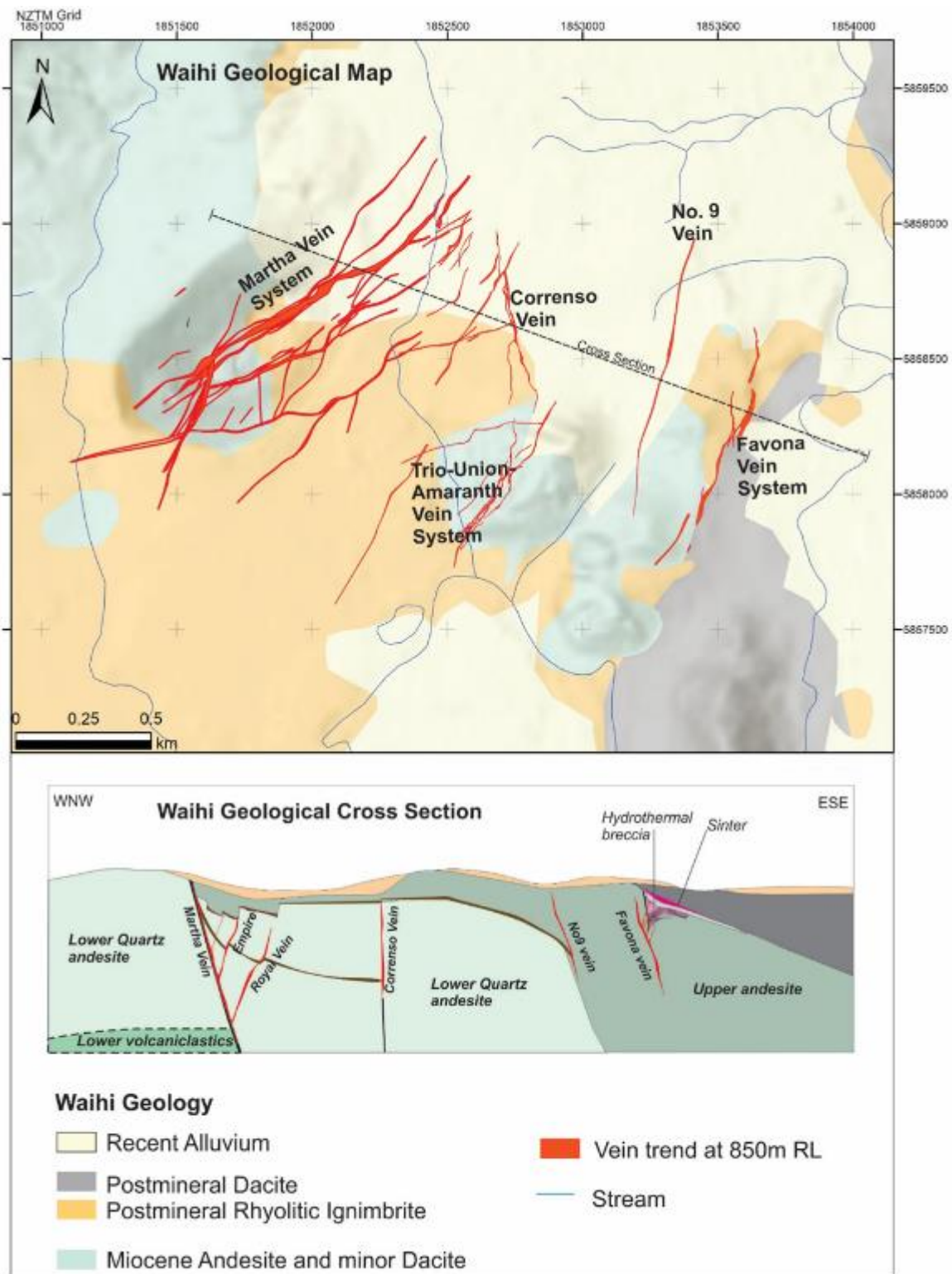


Figure 1: Geological map and cross section of the Waihi area showing the distribution of quartz veining and dominant geological rock units

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 considered to be compressible and 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 and the magnitude of dewatering in these materials.



### **3 MINING ACTIVITIES**

The main features of the mining activities during 2021 (in relation to dewatering and settlement) are described in the following sections.

#### **3.1 Martha Open Pit**

Access to Martha Pit during 2021 has been restricted due to the North Wall slip. No works were undertaken in the pit during 2021. The pit remains in care and maintenance.

#### **3.2 Underground**

##### **3.2.1 Development**

2021 saw development in the Correnso Upper, and Martha mining areas (Figure 3 & Figure 4), consisting mainly of declines, accesses and ore drives in Martha. Throughout 2022 a total of 9,872m of development was completed with the vast majority in Martha with only 386m being in Upper Correnso.

2021 saw approximately a total of 287,428t of ore extracted from both stopes and development.

##### **3.2.2 Future Mining Activities**

Production will be focussed in Martha with ore drives and stopes being focussed on the Rex, Edward, and Royal West mining areas. Minor amount of narrow vein production will be carried out in the upper portions of Correnso (approx. 950mRL). For a full breakdown of the activities planned refer to the Annual Work Programme.

##### **3.2.3 Waste rock management**

Waste rock is managed in two ways; underground stockpiling and backfilling into stopes and placement on temporary stockpiles on the surface.

On the surface, a short-term stockpile is maintained immediately behind the mill area, enabling easy access for backloading. Larger or longer-term volumes may be stored at the Favona 'Polishing Pond' Stockpile (near the water treatment plant polishing pond). Waste rock placement at this stockpile started in early February 2007 and the site has also been utilised for interim placement of Martha ore. Before undertaking stockpile construction, the Favona Underground Mine Settlement, Dewatering and Water Quality Monitoring Plan was prepared, and approved by Waikato Regional Council (WRC). A separate Favona Water Quality Monitoring Report is prepared mid-year and submitted to WRC.



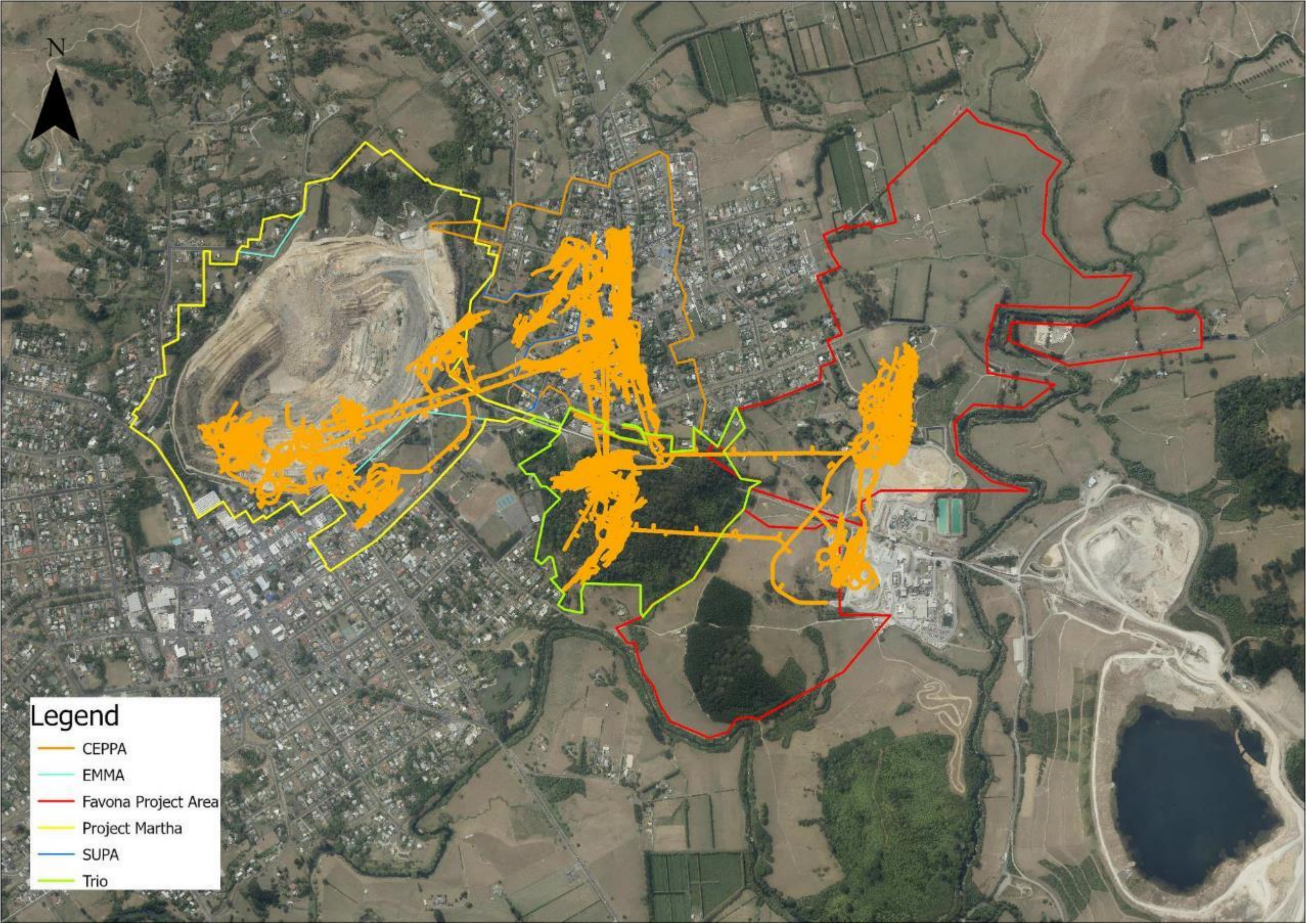


Figure 2: Current workings and boundaries



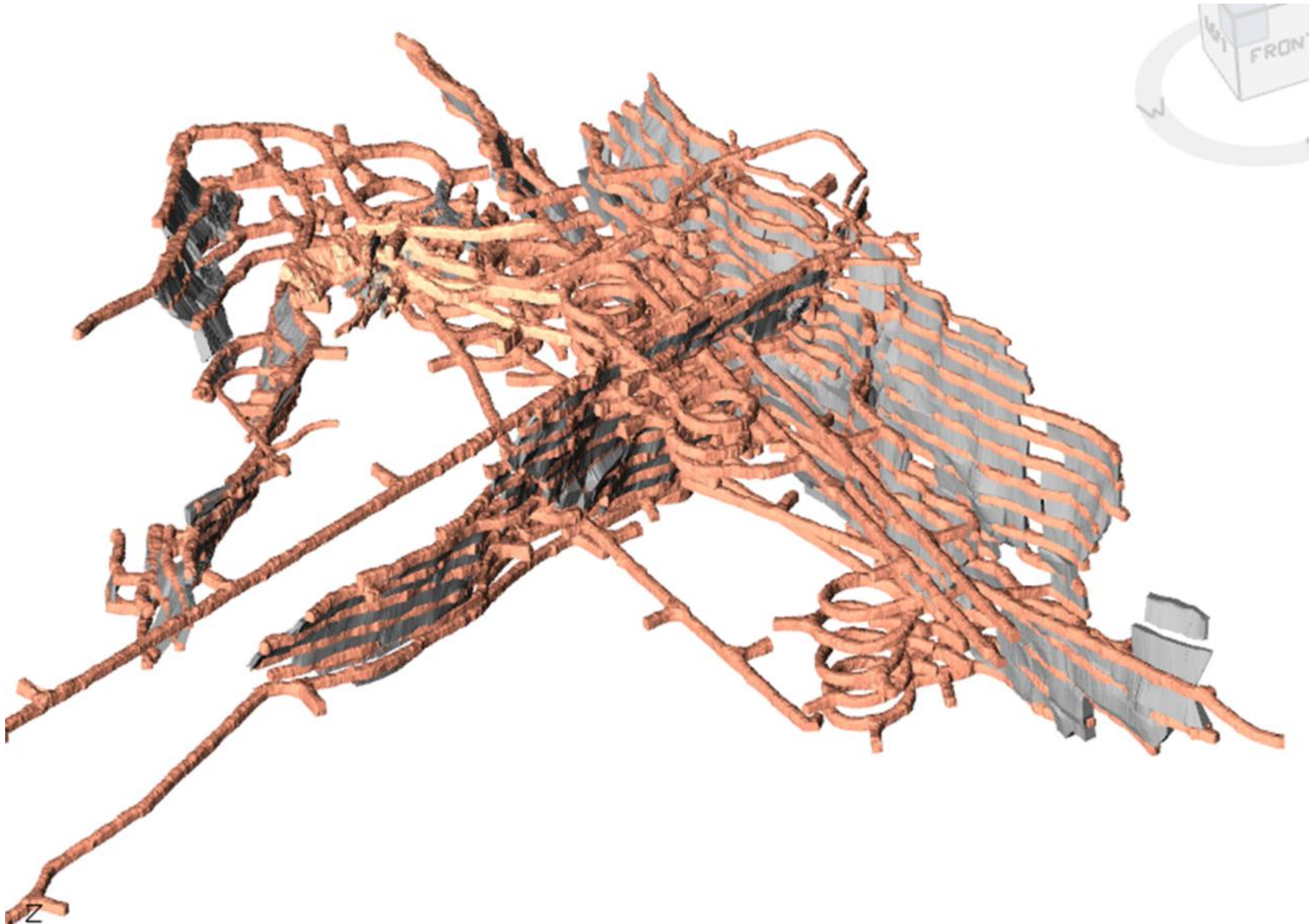


Figure 3: Oblique view of Correnso showing completed development and stopping activities. View is looking north east from above.

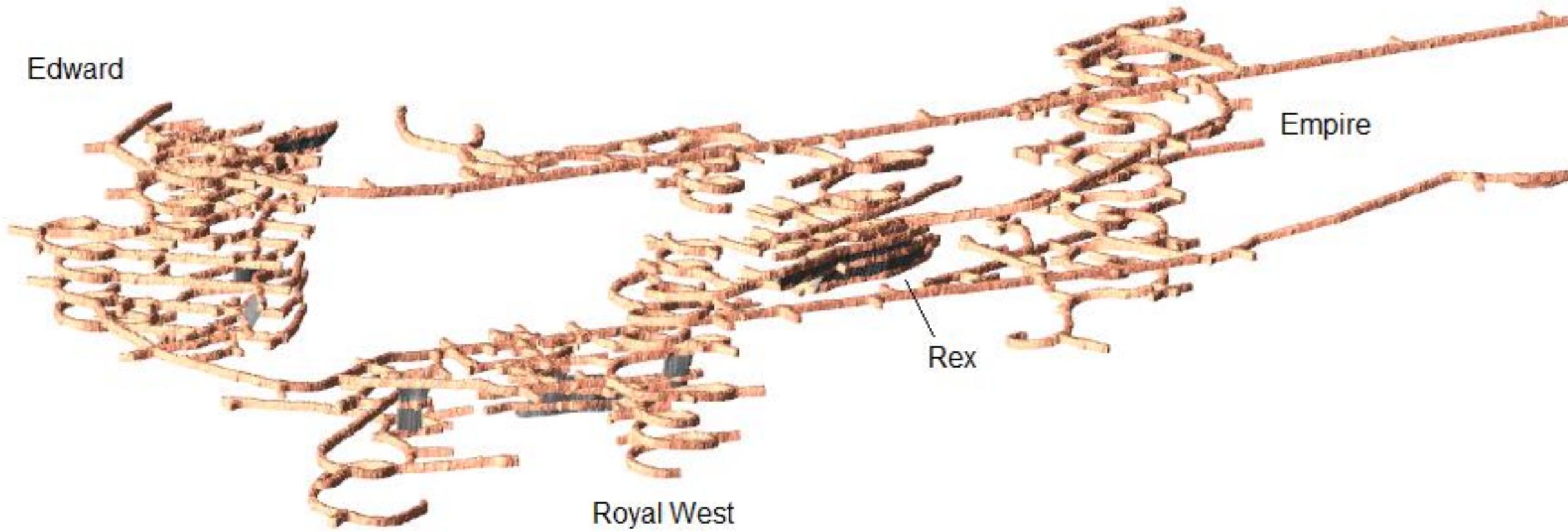


Figure 4: Oblique view of Martha showing completed development and stoping activities. View looking north east





## 4 DEWATERING

Table 1 shows the annual combined abstraction rate from Martha, Favona, Correnso and Trio. Figure 5 shows groundwater take rates and water levels and Figure 6 and Figure 8 show the current pump arrangement for underground dewatering.

During 2020, four dewatering pumps in two bores (800 PC1 and 800 PC2) were installed from the 800 mRL level to lower water levels for Project Martha development. Dewatering to 500 mRL is permitted under the Project Martha consent. Dewatering water from these bores is connected to the existing Correnso dewatering line. Water levels began to be drawn down using these pumps during 2021. At the end of year levels were PC1 667 mRL and PC2 664 mRL (Figure 6).

Table 1 - Martha, Favona, Trio & Correnso Mines Annual Dewatering Volumes and Rates

Year	Total mine take (m <sup>3</sup> )	Average pump rate (m <sup>3</sup> /day)	Service water pumped underground (m <sup>3</sup> )	Total Mine take minus Service Water (m <sup>3</sup> )
2015 (May 18 <sup>th</sup> onwards)	1,338,760	5,871	60,727 (23 Sep onwards)	1,278,033
2016	2,911,046	7,954	181,466	2,729,580
2017	3,637,734	9,996	219,198	3,418,536
2018	4,285,048	11,511	262,227	4,022,821
2019	3,153,288	8,639	254,859	2,898,429
2020	2,687,124	7,342	173,290	2,513,834
2021	3,379,568	9,259	182,803	3,196,765

At the request of a peer reviewer, a standalone flow meter for the Favona dewatering line was installed in December 2019, abstraction rates from Favona are shown in Table 2.

Table 2 - Favona Mine Annual Dewatering Volumes and Rates

Year	Favona Mine take (m <sup>3</sup> )	Average pump rate (m <sup>3</sup> /day)
2019	1,637 (first reading 12 December 2019)	125
2020	14,313	39
2021	14,539	39

*Note: for continuity, Favona abstraction volumes are also included in 'Total mine take' numbers reported in Table 1.*

### 4.1 Future Dewatering

The Project Martha dewatering consent, which allows dewatering to no lower than 500 mRL. Underground water levels were drawn to ~665 mRL in 2021. They will be progressively lowered during 2022. The target pumping rate is 37 L/s at each of the four pumps. Water levels are projected to be lowered by an additional 40 m in 2022. Water levels in the dewatering bores are currently being measured approximately weekly using a water level dip meter. Pressure transducers will be installed during 2022 to collect continuous water level readings.

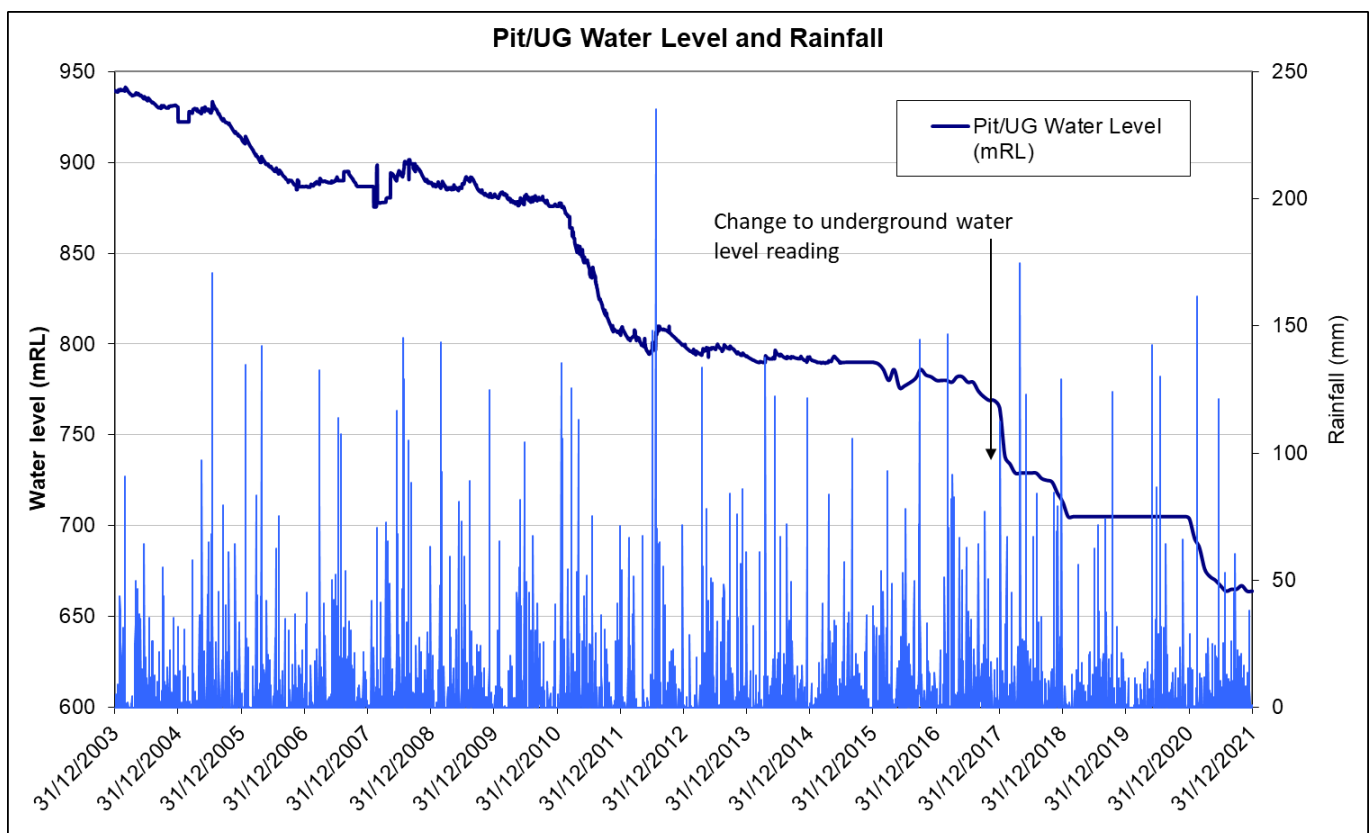
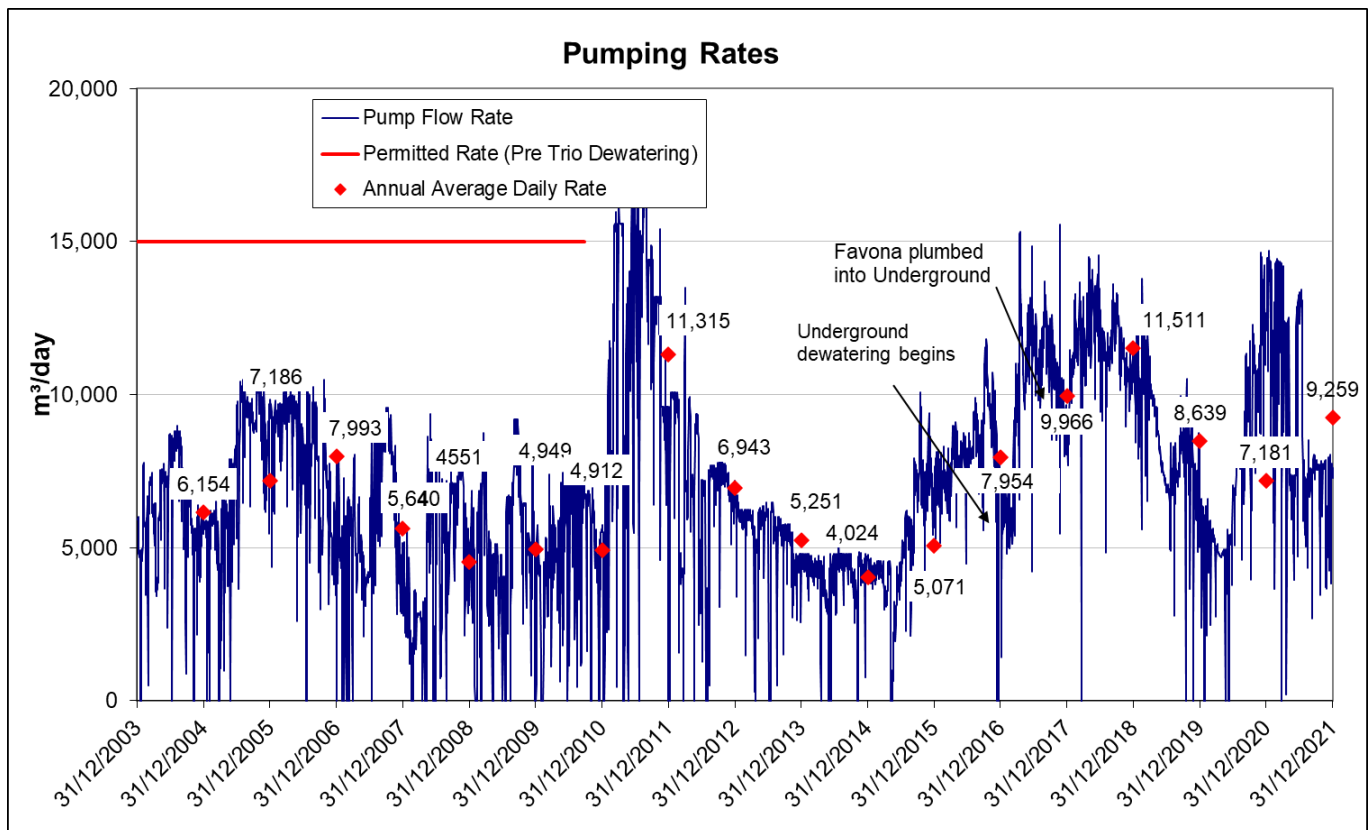


Figure 5: a) Martha Mine/Correnso dewatering rates, and b) Dewatering water level and rainfall

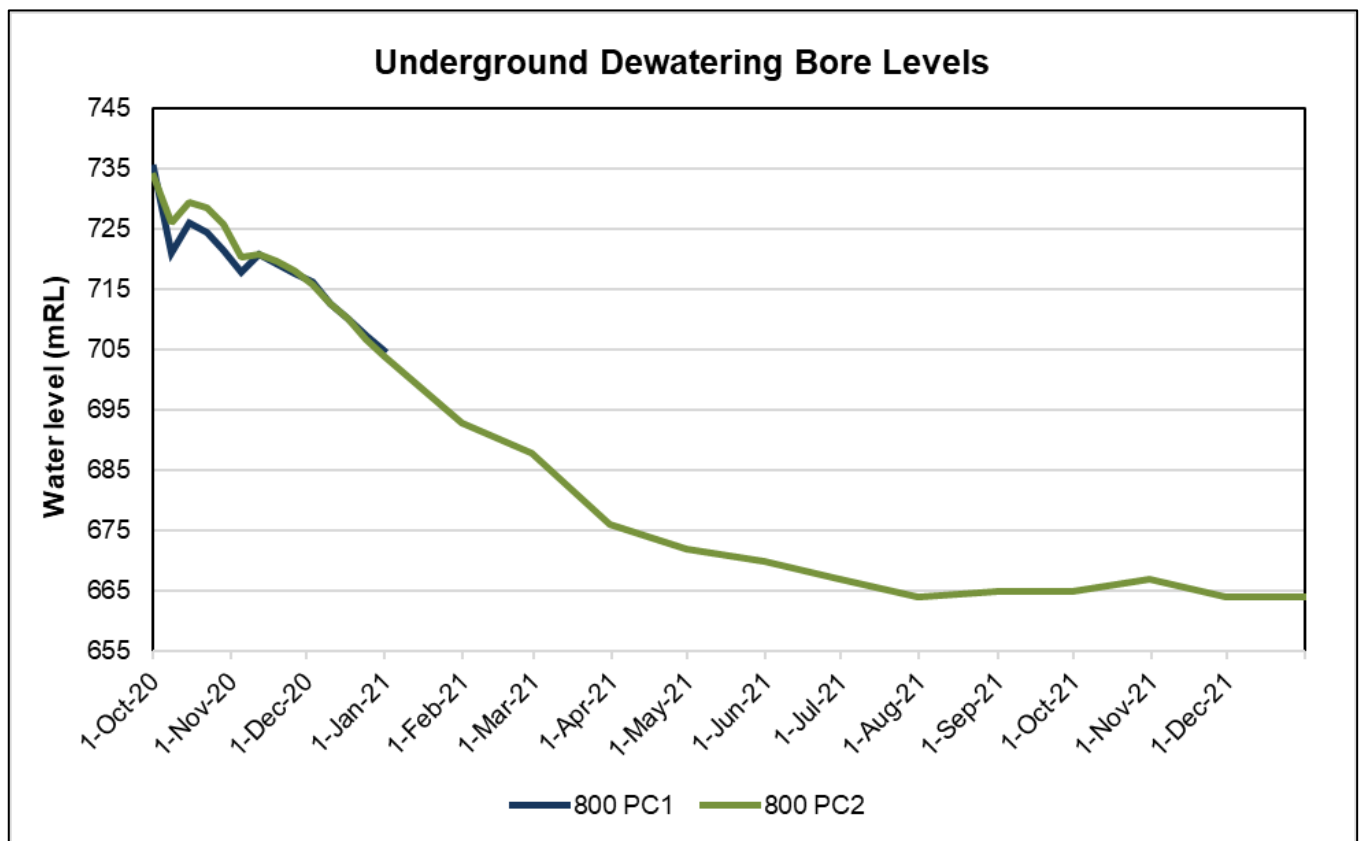
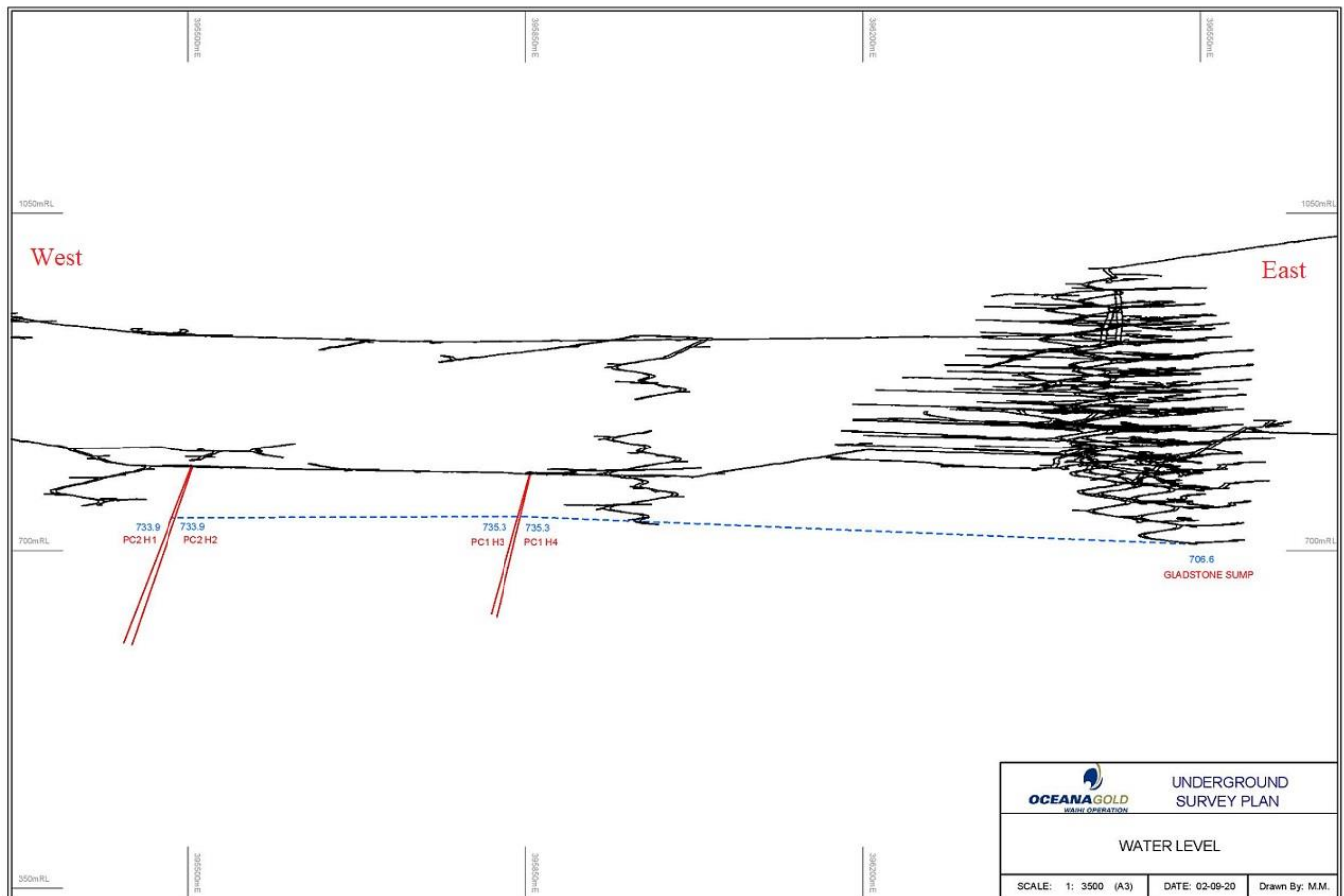


Figure 6: a) Project Martha dewatering bore locations, and b) 2021 dewatering bore water levels

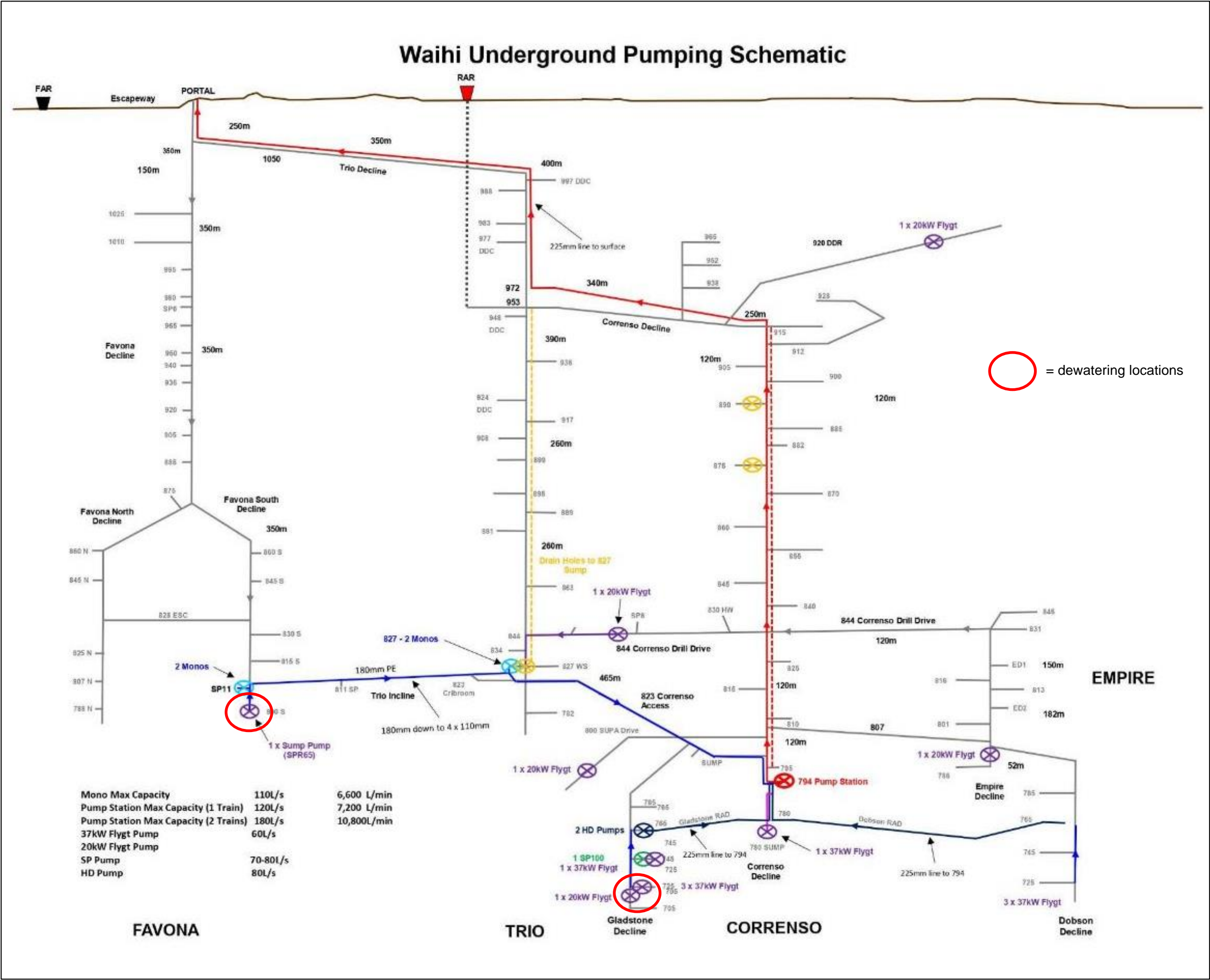


Figure 7: Correnso, Trio and Favona Pumping Schematic December 2021

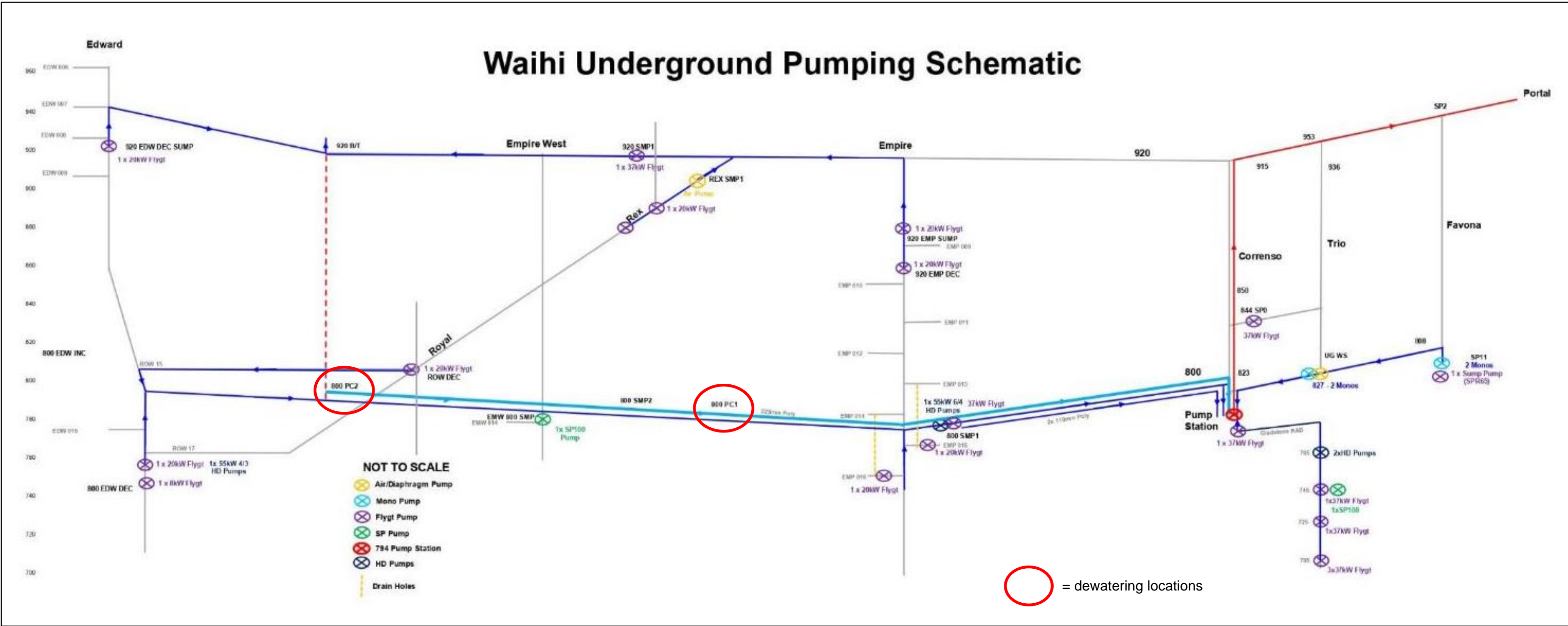


Figure 8: Martha Underground Pumping Schematic December 2021



## **5 GROUNDWATER MONITORING**

This section is provided to meet Conditions 13 a, b and c of the Martha consent, Conditions 2a, 4b, and 4c Schedule 2 of the Favona consent, Conditions 6(ii) and (iii) of the Trio Development consent (referred to by the Trio Underground Mine Consent 6.1.1), Condition 35 of the Correnso Underground Mine Consent and Condition 29 of the SUPA Consent. It includes:

- Data from monitoring undertaken during the previous year including groundwater contour plans (derived from the data) in respect of the piezometer network.
- Identification and interpretation of any environmentally important trends in dewatering behaviour or groundwater profile. Existing trends identified prior to end of 2020 will not be discussed in depth unless there has been a significant change or trigger reached.

### **5.1 Method**

OGNZL has maintained a piezometer network within and around Martha Mine since 1987 and Favona Mine since 2004. Additional Correnso/SUPA piezometers were installed in 2011, 2014 and 2016. P106 was drilled and four vibrating wire piezometers installed in that drill hole during 2017. It is located to the north west of Martha Pit (Figure 9). Seven Project Martha piezometers were added to the network during 2019 and a further three were completed during 2020. The current piezometer network, well depths and average 2021 water depths are in Table 3.

Table 3: Current Waihi Piezometer Network

<b>ALLUVIUM</b>				
<b>Well ID</b>	<b>Depth (mRL)</b>	<b>2021 GWL (m RL)</b>	<b>Water Depth (m)</b>	<b>Type</b>
P2-4	1101	1107	6	Standpipe
P8-4	1113	1118	5	Standpipe
P76-S*	1109	1111	2	Standpipe
P77-S*	1110	1114	4	Standpipe
P87-S	1110	1115	5	Standpipe
WC201-4	1103	1111	8	Standpipe
WC201-5	1109	1111	2	Standpipe
P91-1	1113	1119	6	VWP
P93-1	1105	1116	11	VWP
P94-1	1114	1115	1	VWP
P101-1	1102	1108	6	VWP
P102-1	1108	1114	6	VWP
P63-S*	1113	1116	3	Standpipe
GLD004S	1080	1085	5	Standpipe
<b>YOUNG VOLCANIC</b>				
<b>Well ID</b>	<b>Depth (mRL)</b>	<b>2021 GWL (m RL)</b>	<b>Water Depth (m)</b>	<b>Type</b>
BH6-1	1052	1111	59	Standpipe
BH9-1	1073	1095	22	Standpipe
BH11	1074	1093	19	Standpipe
BH12	1090	1106	16	Standpipe
P2-3	1073	1092	19	Standpipe
P4-2	1047	1088	41	Standpipe
P7-2	1039	1090	51	Standpipe
P7-3	1080	1090	10	Standpipe
P8-3	1092	1116	24	Standpipe
P63-I	1070	1091	21	Standpipe
P76-I	1072	1104	32	Standpipe
P77-I and P77-I2	1045	1097	52	Standpipe
P79-I	1061	1092	31	Standpipe
P79-S	1091	1096	5	Standpipe
P87-I	1070	1110	40	Standpipe
WC202-2	1049	1065	16	Pneumatic
WC202-3	1090	1090	0	Pneumatic
P90-1	1100	1113	13	VWP
P90-2	1020	1102	82	VWP

P91-2	1097	1117	20	VWP
P91-3	1011	1112	101	VWP
P92-1	1096	1118	22	VWP
P92-2	1000	1107	107	VWP
P93-2	1015	1088	73	VWP
P94-2	1094	1112	18	VWP
P94-3	1016	1100	84	VWP
P95-1	1091	1114	23	VWP
P95-2	1031	1101	70	VWP
P100-1	1066	1075	9	VWP
P100-2	996	1050	54	VWP
P101-2	1083	1094	11	VWP
P101-3	1068	1085	17	VWP
P102-2	1078	1089	11	VWP
P102-3	1054	1085	31	VWP
P107	1089	1111	22	Standpipe
P108	1115	1122	7	Standpipe
P109	1090	1095	5	Standpipe
P110	1097	1104	7	Standpipe
P111-1	1100	1107	7	VWP
P112-1	1058	1059	1	VWP
P114	1054	1058	4	Standpipe
P115	1072	1094	22	Standpipe
P116	1045	1092	47	Standpipe
P64-I	1086	1098	12	Standpipe
P78-I	1051	1103	52	Standpipe
P27-1	1073	1075	2	Standpipe
BH7-1	1078	1092	14	Standpipe
GLD004I	1065	1085	20	Standpipe
P113	1063	1063	0	Standpipe
<b>ANDESITE</b>				
<b>Well ID</b>	<b>Depth (mRL)</b>	<b>2021 GWL (m RL)</b>	<b>Water Depth (m)</b>	<b>Type</b>
P2-2	1034	1045	11	Standpipe
P7-1	988	1002	14	Standpipe
P8-1	975	1022	47	Standpipe
P8-2	1044	1116	72	Standpipe
P9-1	1036	1118	82	Standpipe
P69-S	1114	1134	20	Standpipe
P69-D	1063	1091	28	Standpipe
WC201-1	1058	1064	6	Pneumatic

WC201-2	1077	1080	3	Pneumatic
WC201-3	1096	1100	4	Pneumatic
WC202-1	1031	1069	38	Pneumatic
P90-3	982	1085	103	VWP
P91-4	970	1100	130	VWP
P92-3	965	1100	135	VWP
P93-4	974	1038	64	VWP
P94-4	976	991	15	VWP
P95-3	1000	1060	60	VWP
P100-3	981	1043	62	VWP
P100-4	956	990	34	VWP
P101-4	1036	1036	0	VWP
P102-4	1026	1032	6	VWP
P75	979	1067	88	Standpipe
P76-D	1055	1098	43	Standpipe
P77-D	1031	1097	66	Standpipe
P78-D	1052	1072	20	Standpipe
P79-D	1047	1088	41	Standpipe
P87-D	1024	1102	78	Standpipe
P106-1	1100	1100	0	VWP
P106-2	1060	1060	0	VWP
P106-3	1010	1010	0	VWP
P106-4	974	974	0	VWP
P111-2	1088	1088	0	VWP
P111-3	1055	1059	4	VWP
P112-2	1035	1035	0	VWP
P112-3	997	999	2	VWP
BH8	1075	1075	0	Standpipe
P1-1	1065	1065	0	Standpipe
P4-1	994	1098	3	Standpipe
GLD004D	1020	1085	65	Standpipe

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.

## 5.2 Inspection and Maintenance

The piezometer dip-meter is maintained in good working condition. A calibration of the dip-meter tape against a reference tape is carried out annually by Hydrologic NZ Ltd. The dip-meter tape is replaced if the difference against the reference tape is more than 0.1%. The dip-meter was calibrated in January 2021.

The consent conditions require an inspection of the piezometer installations and appraisal of the piezometer network every two years. In effect, inspections of the piezometer network are undertaken

more frequently, with the piezometer monitoring procedure requiring 6-monthly sounding to the bottom of all standpipe piezometers to identify any with excess silt and mud.

The piezometer designs have screens which allow water inflow into the pipe. Piezometers that are most impacted by sediment are on a flushing schedule, with flushing of silted boreholes occurring in November of 2019. Piezometers P4-1, P4-3, P8-2, P9-2, and P9-3 have showed little change after multiple flushing attempts and are no longer monitored.

### **5.3 Groundwater Results**

The Waihi town piezometer network currently has 52 dipped piezometers and six pneumatic piezometers. An additional 12 data loggers connected to 41 vibrating wire piezometers are also included in monitoring Waihi East and south of Martha Pit (Figure 9). On the north east side of the pit, seven real time data loggers are installed in wells, these were installed to investigate the source of a seepage and data collection is ongoing. 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. The groundwater plans are presented in Figure 10, Figure 12 and Figure 15 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.

#### **5.3.1 Changes to monitoring network 2021**

- No new piezometer locations were added to the network during 2021.
- P8-2 responded to flushing in 2019 but has again increased in water level.
- P64-D (Favona network) developed a blockage and/or collapse. Monitoring has been discontinued.
- Recently installed P109 (Young volcanics, Project Martha) was tar sealed over by Hauraki District Council contractors. It was able to be uncovered early 2022.
- Martha pit seep investigation loggers were removed as enough data had been gathered. These piezometers were not part of the dewatering monitoring network and monitoring has been discontinued.





Figure 9: Waihi Piezometer Network 2021





Figure 10: Alluvium water level contours

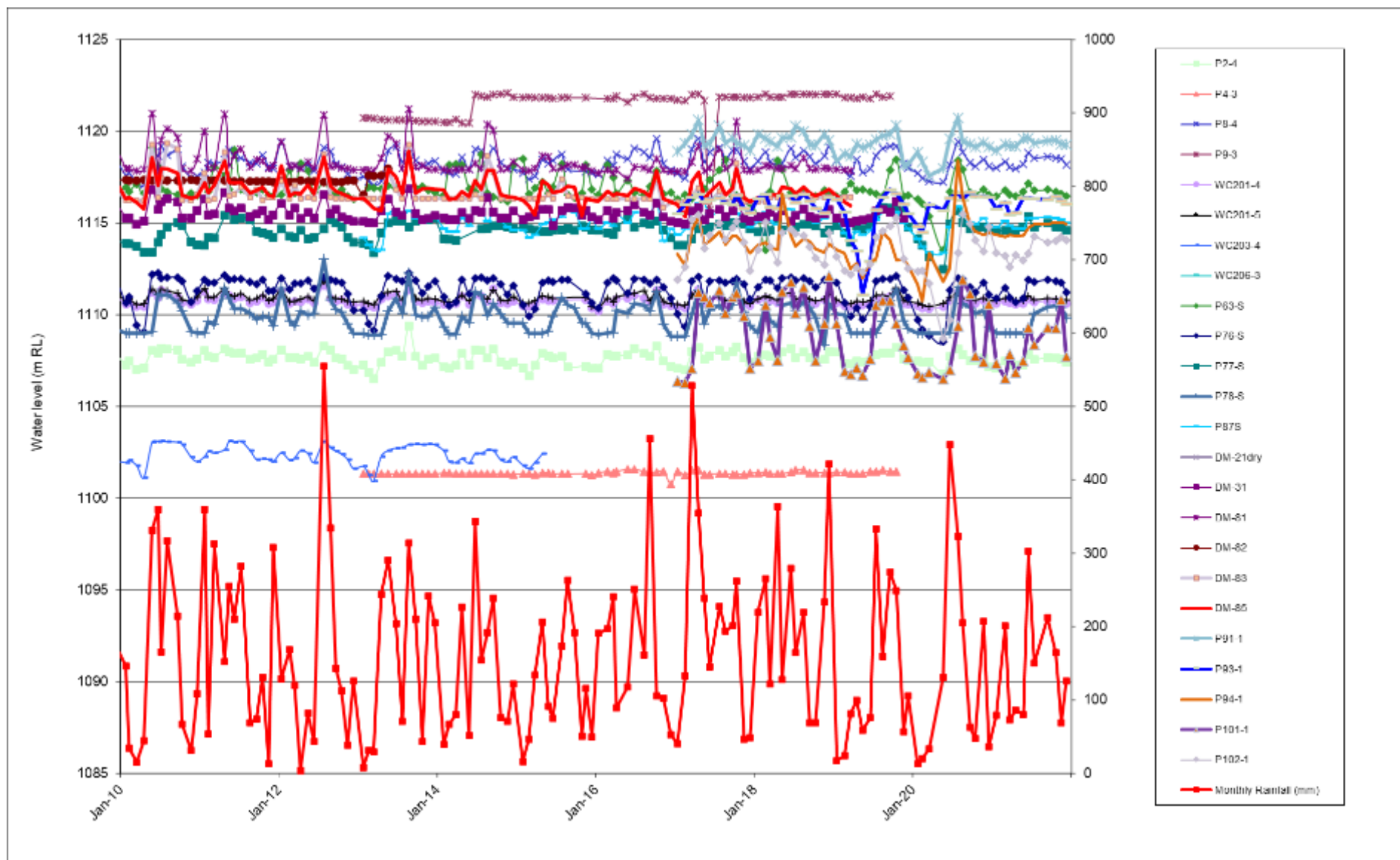


Figure 11: Groundwater Level Trends – Shallow Groundwater (Alluvium & Weathered Contact of Young Volcanics)



### **5.3.2 Shallow Groundwater**

Figure 10 shows the inferred contours for shallow groundwater in alluvium and in weathered younger volcanic materials and 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 10) 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.

A request at peer review 2021 was made to include the Waihi East vibrating wire (VW) alluvium piezometer information in the alluvium hydrograph. P91, P93, P94, P101 and P102 have VW tips located in alluvium. These have been included in Figure 10.

### **5.3.3 Younger Volcanics**

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

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 12 and 12) 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 15).

Piezometers P1-1 and P1-2 were lost in early 2016 due to public carpark resurfacing.

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.

BH11 and BH12 have been included in the young volcanics hydrograph. These were historically listed as andesite piezometers. The piezometers are currently under review by GWS Limited as part of a wider assessment of the Waihi piezometer network. Findings of the review will be after this report's submission to regulators.

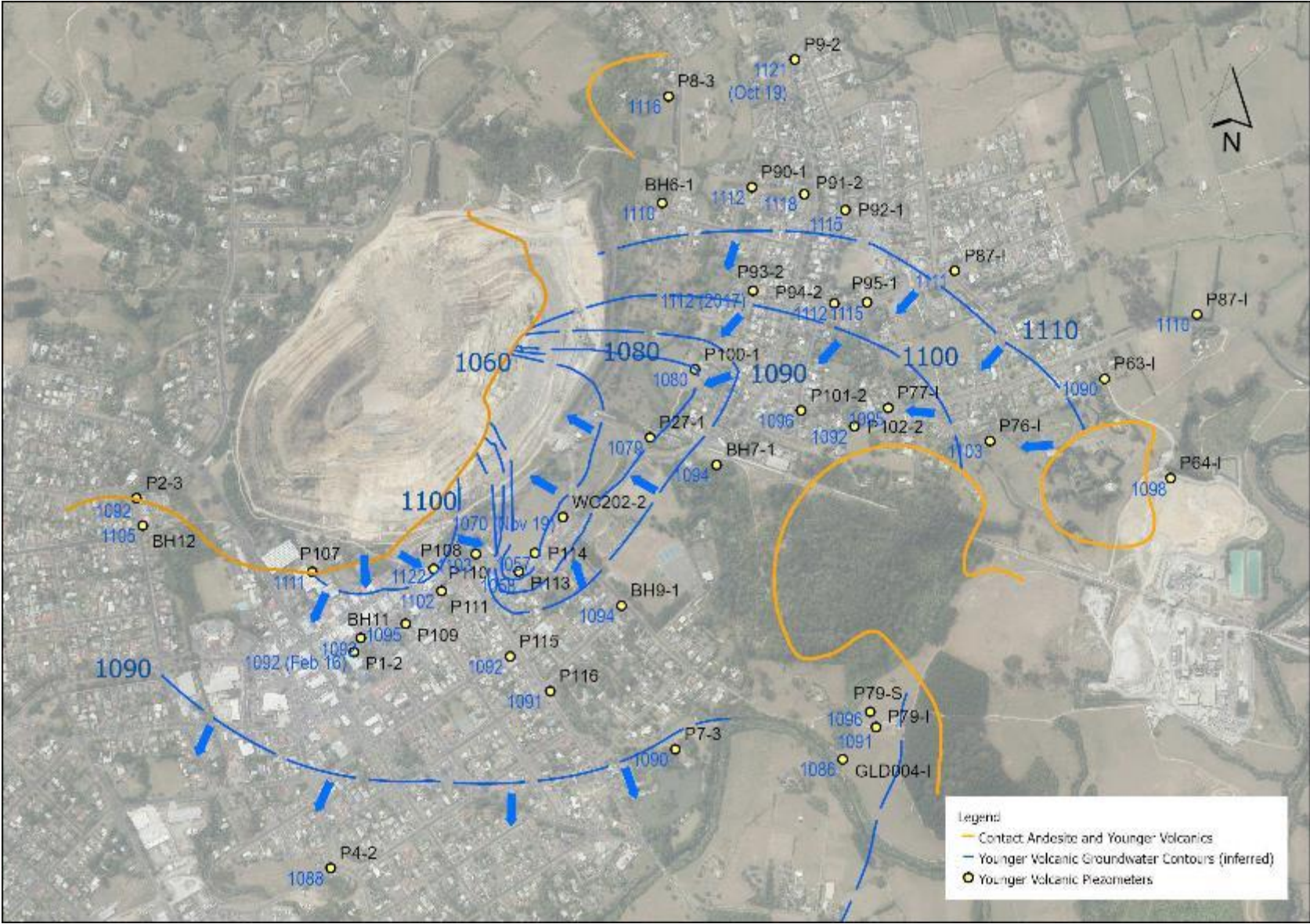


Figure 12: Deeper Younger Volcanic Water Level Contours



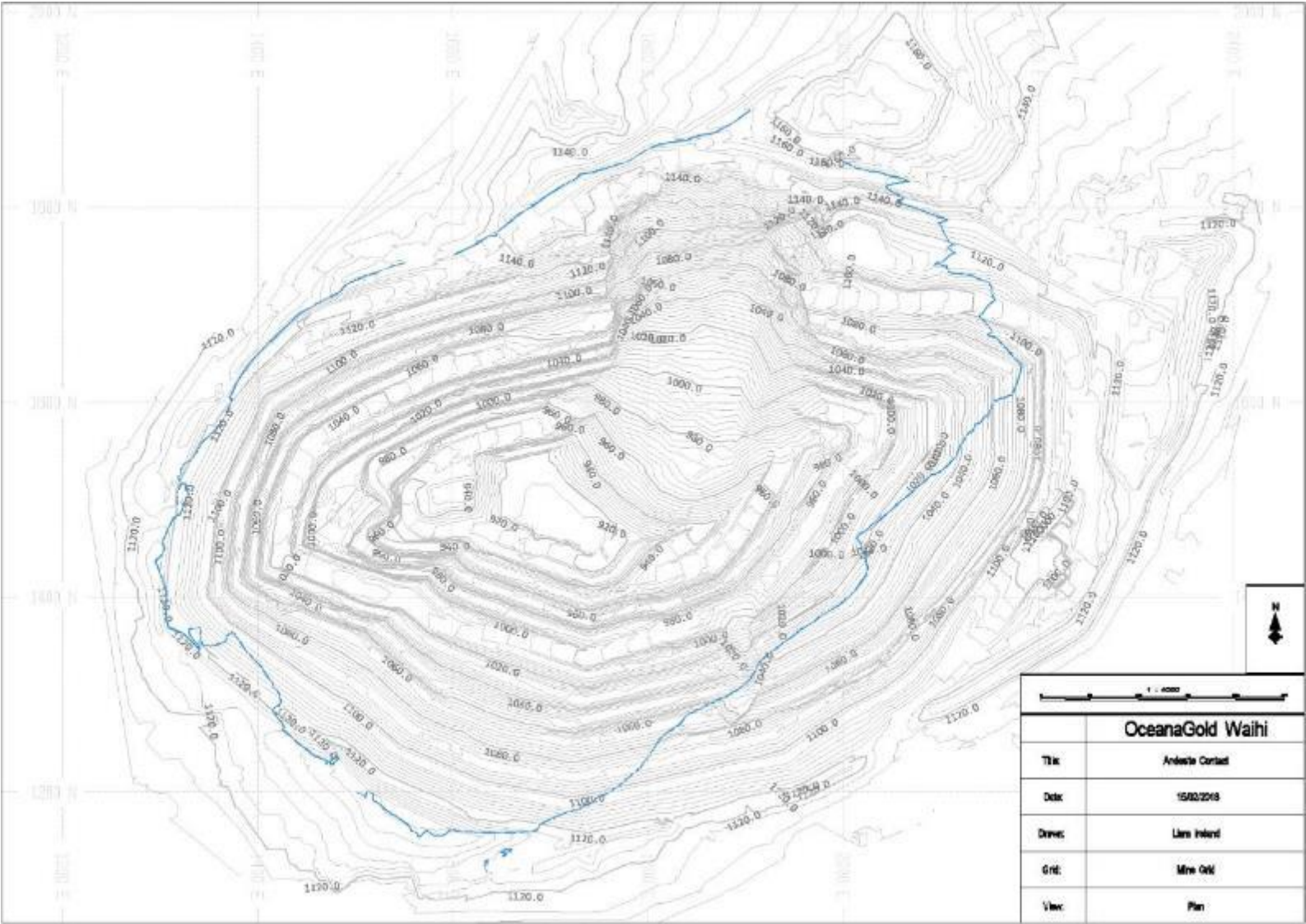


Figure 13: Groundwater Level Trends - Deeper Younger Volcanic Materials

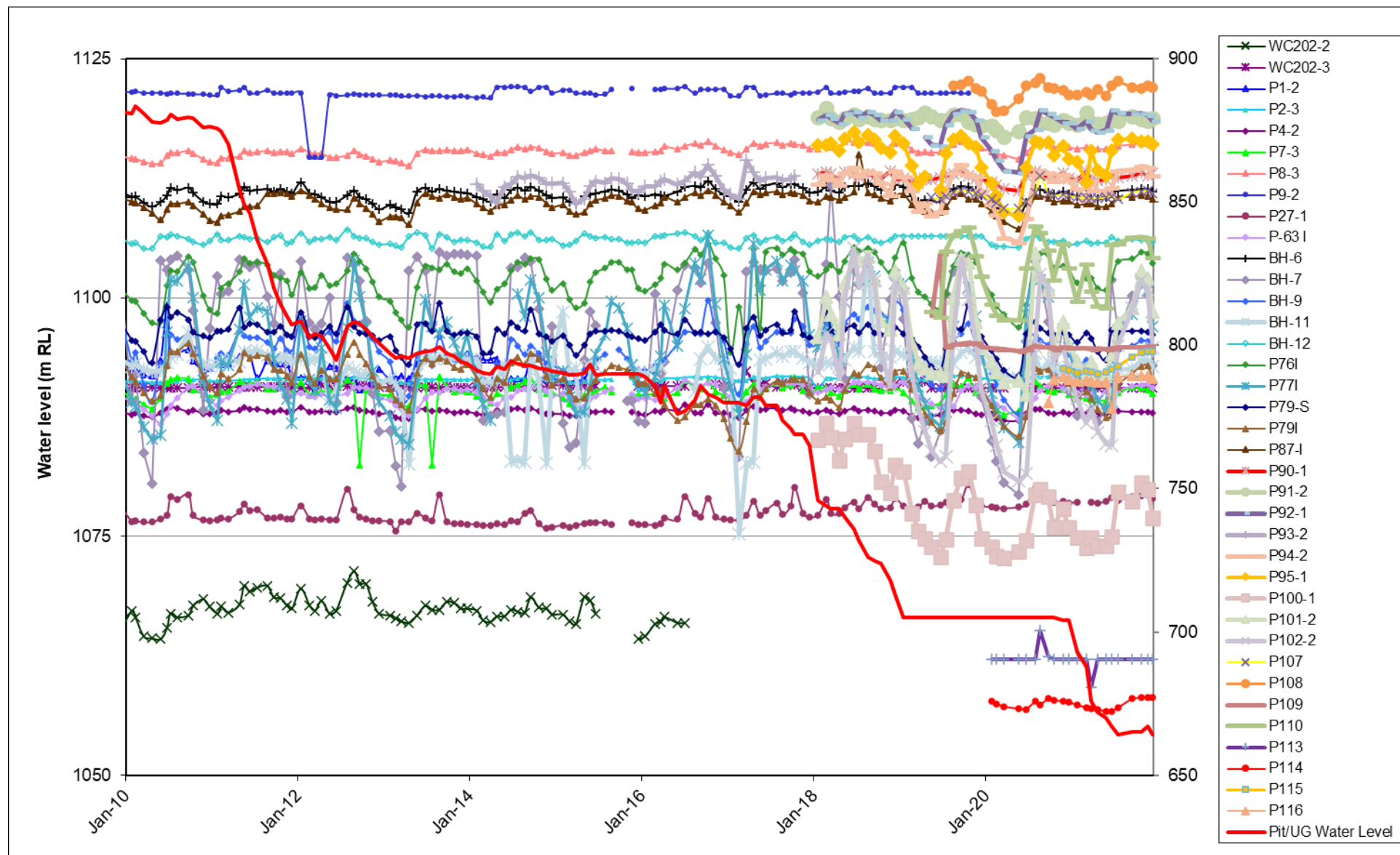


Figure 14: Andesite Younger Volcanic Materials Contact



#### **5.3.4 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 15 shows the scope of the dewatering effects in the andesite rock body as a result of dewatering. Data from the Waihi East 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 rockmass outside of development areas. Hence, groundwater levels between the vein and the shallow rockmass 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, along the strike of the Trio vein system beneath Union Hill, and also along the strike of the 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 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 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.

The andesite hydrograph (Figure 16) is congested so the vibrating wire piezometers have been excluded. VW hydrographs are presented in Figures 18 – 28.



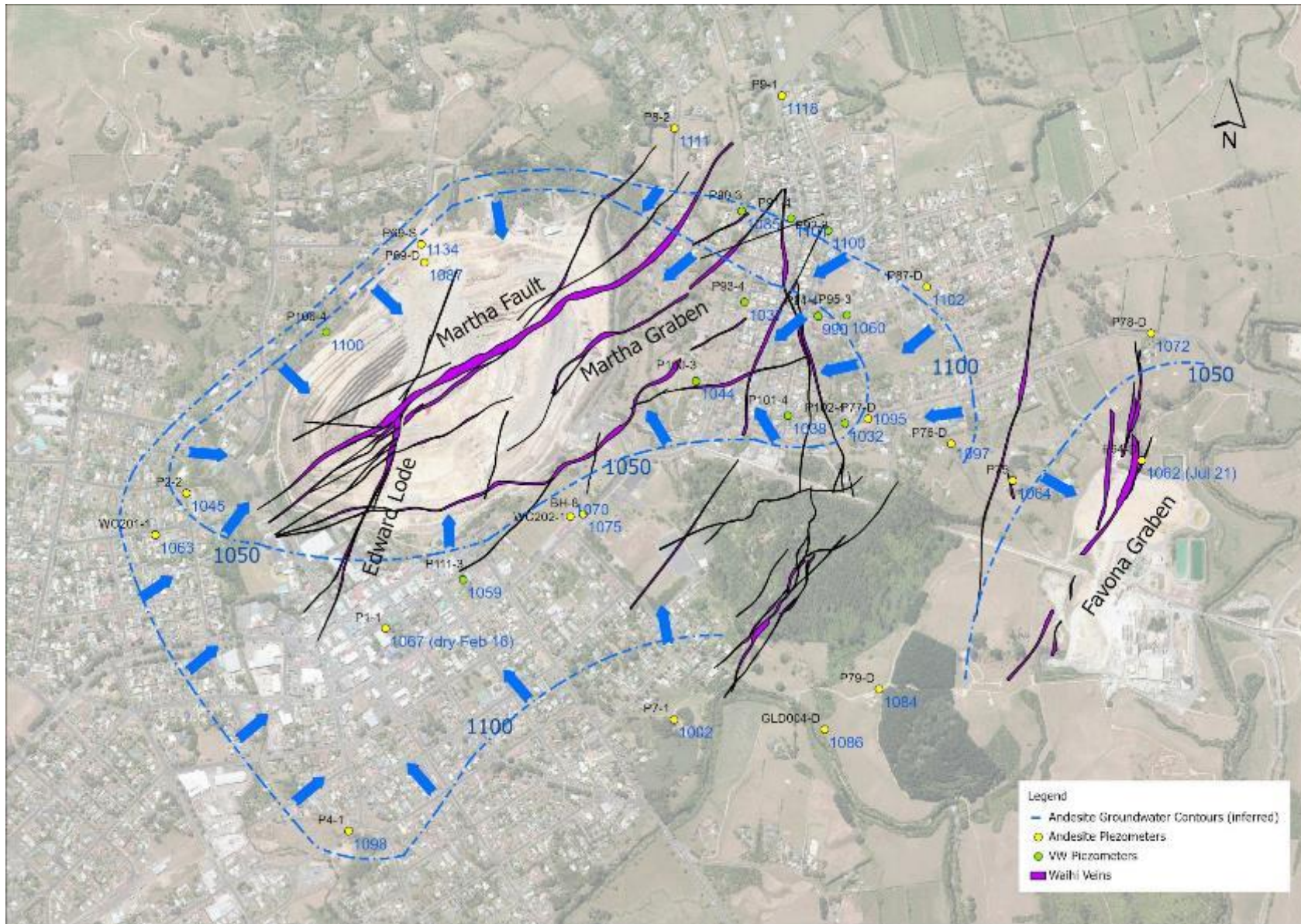


Figure 15: Andesite water level contours

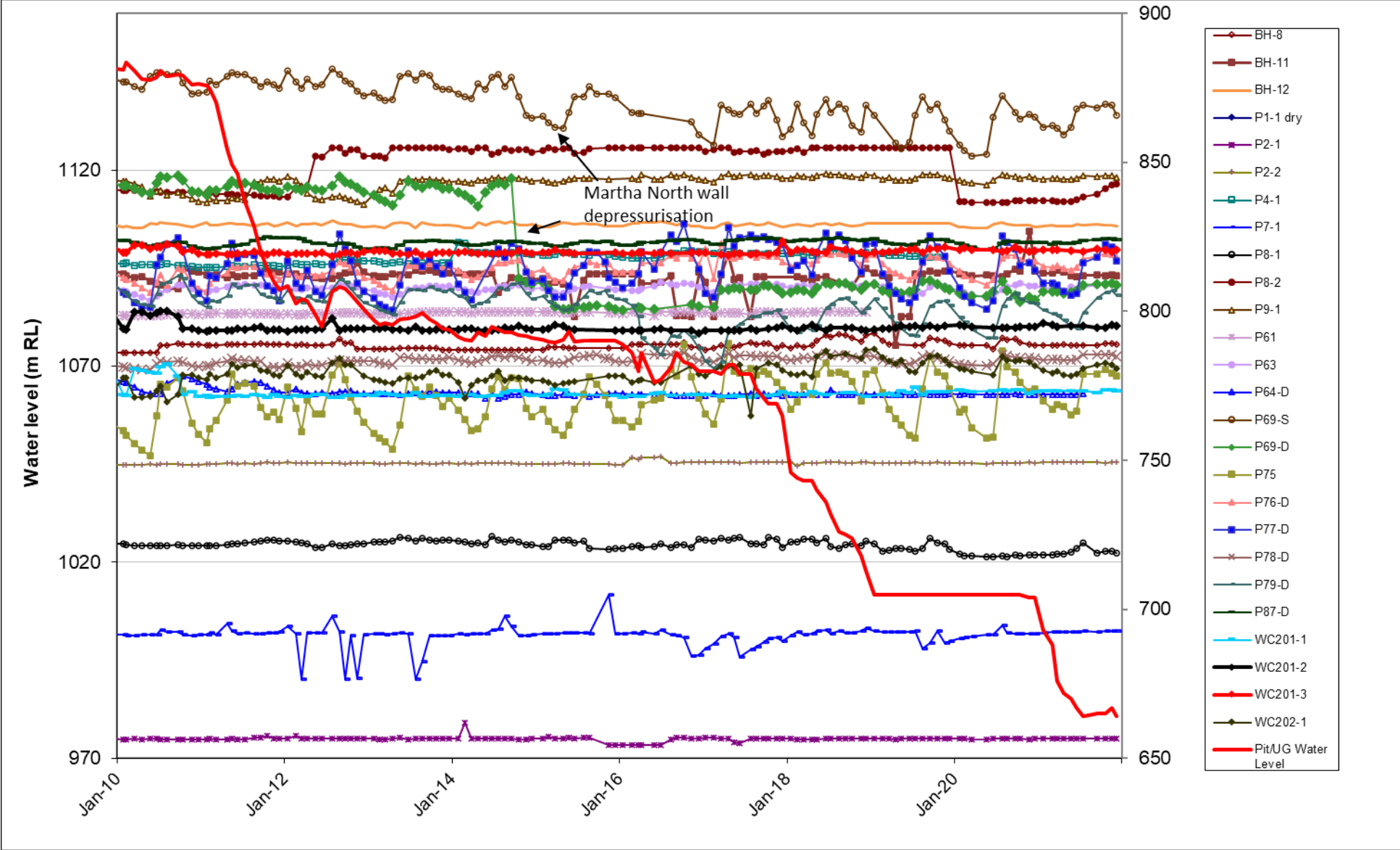


Figure 16: Andesite Water Level Trends (excl. VW piezometers)



### 5.3.5 Martha groundwater assessment

Martha groundwater remained stable during the reporting period (Figure 16). No triggers were breached, or trends of concern developed.

10 new wells were installed in 2019 and 2020 (Table 4).

Table 4: Project Martha piezometer depths

Bore	Young Volcanics		Andesite			
	Depth (m)	Piezo Tip (mRL)	Depth (m)		Piezo Tip (mRL)	
P107	30	1089				
P108	9.8	1116				
P109	22	1091				
P110	16.8	1097				
P111	13	1100	25	58	1088	1055
P112	50	1057	72	110	1035	995
P113	46	1058				
P114	55	1054				
P115	30.8	1103				
P116	53.3	1098				

Project Martha piezometers P107 to P110 and P113 to P116 are standpipes installed at varying ground elevations. Figure 17 shows water levels have remained fairly settled. Some initial changes to P109 and P110 are likely due to well flushing after installation. Newly drilled standpipe P113 has remained dry.

Vibrating wire piezometer P111 (Figure 18) was installed with three tips, one in the young volcanics and two in the andesite layer. The younger volcanic piezometer is measuring some water pressure at 1102mRL. The upper andesite piezometer appears to be dry with levels recorded below the tip level (1087mRL cf. 1088mRL), indicating this area may be previously affected by dewatering. The lower andesite piezometer is measuring around 4m of water pressure above the tip, at 1059mRL.

P112 is also a vibrating wire design installed with three tips: one in the young volcanics and two in the andesite layer. Water levels have remained stable in all three piezometers since installation in July 2020 (Figure 19).

A peer recommendation was to identify lithology zones on the vibrating wire hydrographs. The key to the zone shading is shown in Table 5.

Table 5: Lithology shading

Lithology	
Alluvium	
Young Volcanics	
Andesite	

Additionally, a concern was raised at peer review that the P111 and P112 andesite piezometers could be too shallow. OGNZL are currently looking into options for better deeper groundwater resolution in this area.

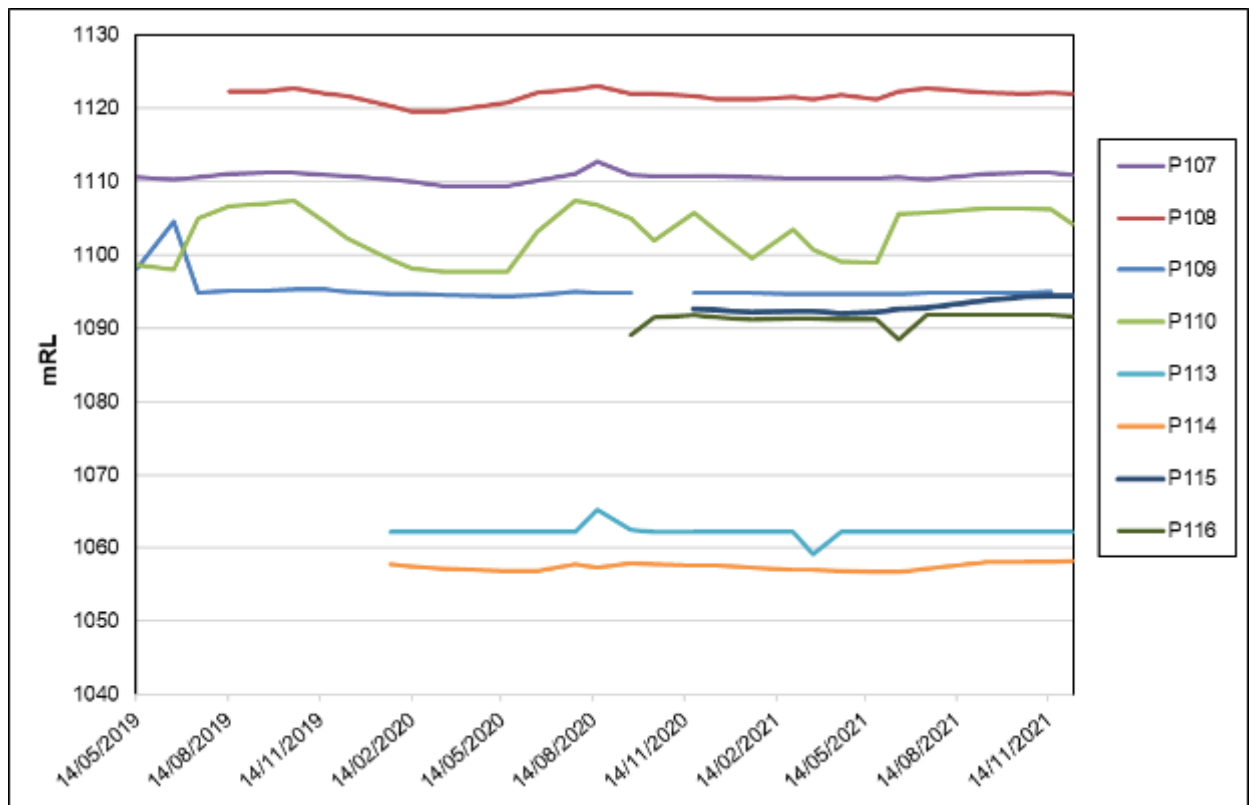


Figure 17: Waihi South Piezometer Levels

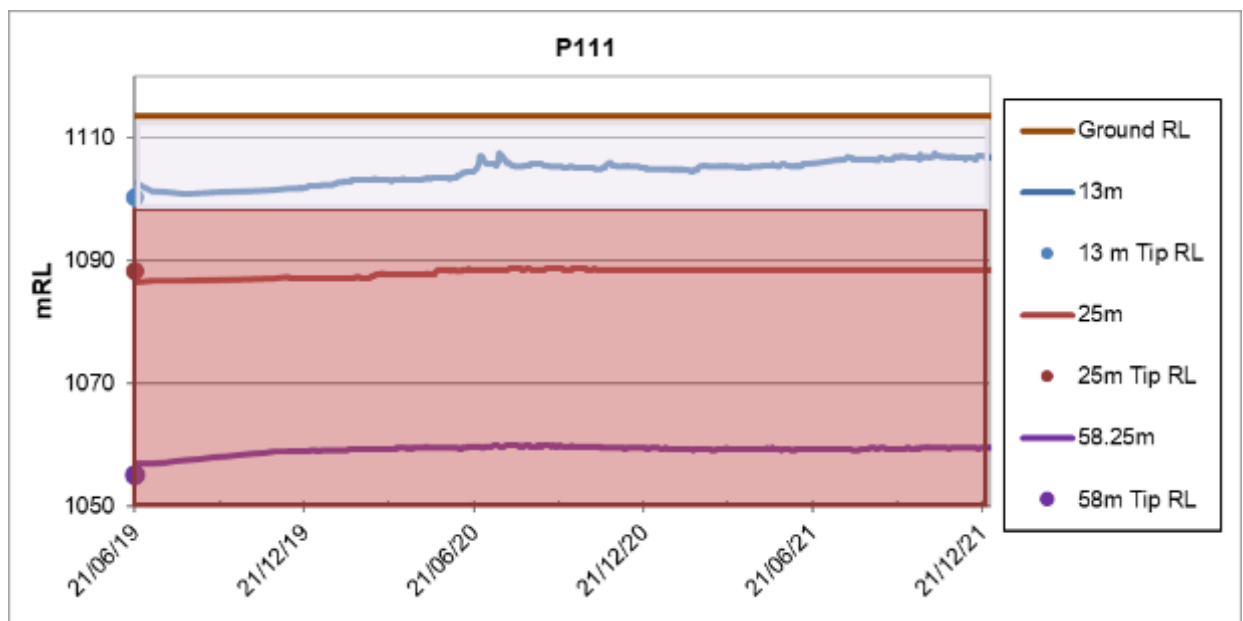


Figure 18: P111 Vibrating Wire Piezometer

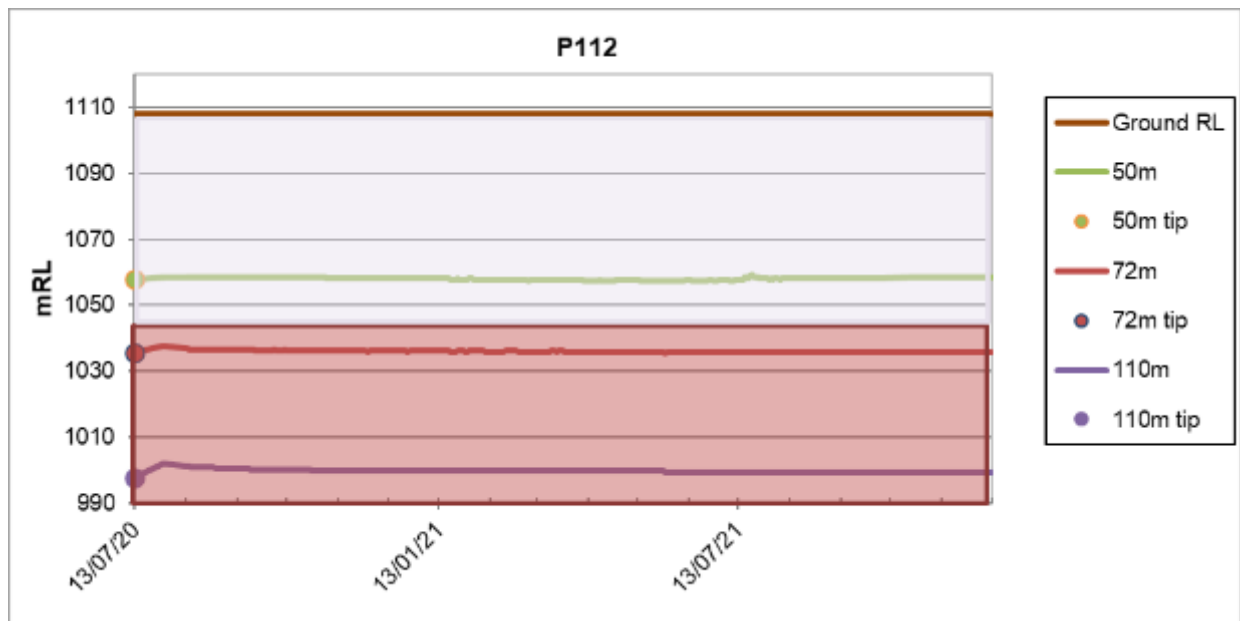


Figure 19: P112 Vibrating Wire Piezometer

### 5.3.6 Favona groundwater assessment

Favona groundwater gathers at the 800 level and this is the assumed groundwater level in the Favona mine. However, mine development links Favona to Trio and Correnso, both part of the Martha groundwater system. Figure 16 shows how most Favona wells are influenced seasonally and not by Martha/Underground dewatering. The Favona wells used to have individual triggers applied to them as part of the Favona mine compliance, however these have now been superseded by the general Correnso trigger of a 15m change in water level in one month. No well had a 15m decrease during the reporting period.

### 5.3.7 Waihi East – CEPA

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 and 39 additional settlement markers 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 9). The piezometers were constructed to intercept the shallow aquifer, younger volcanics, and andesite rock (Table 6).

Table 6: 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 20 to 28 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. Exceptions are discussed below.

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



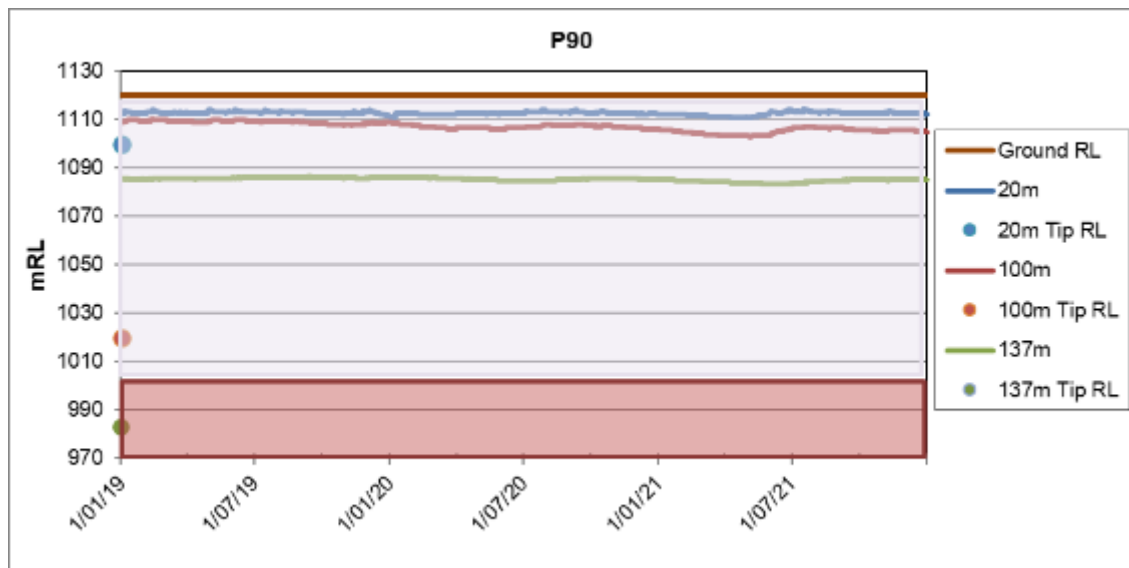


Figure 20: P90 Vibrating Wire Piezometer

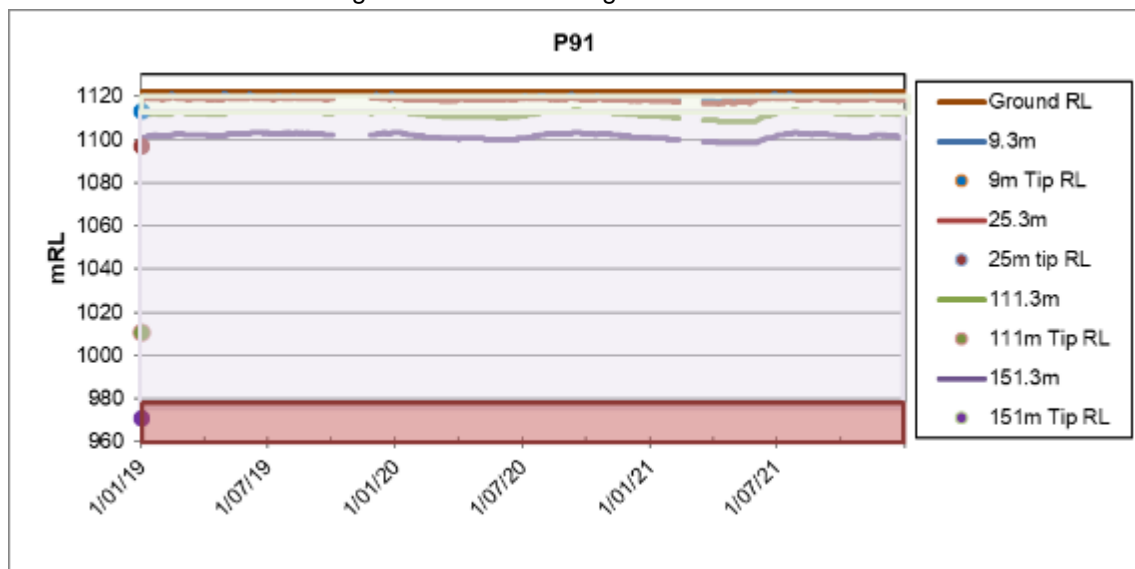


Figure 21: P91 Vibrating Wire Piezometer

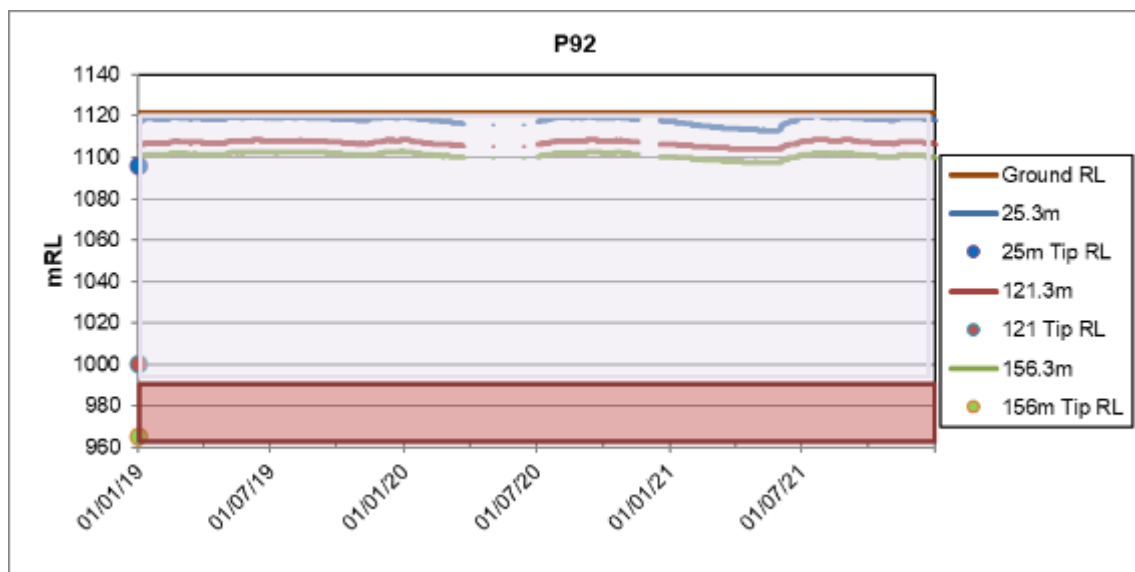


Figure 22: P92 Vibrating Wire Piezometer

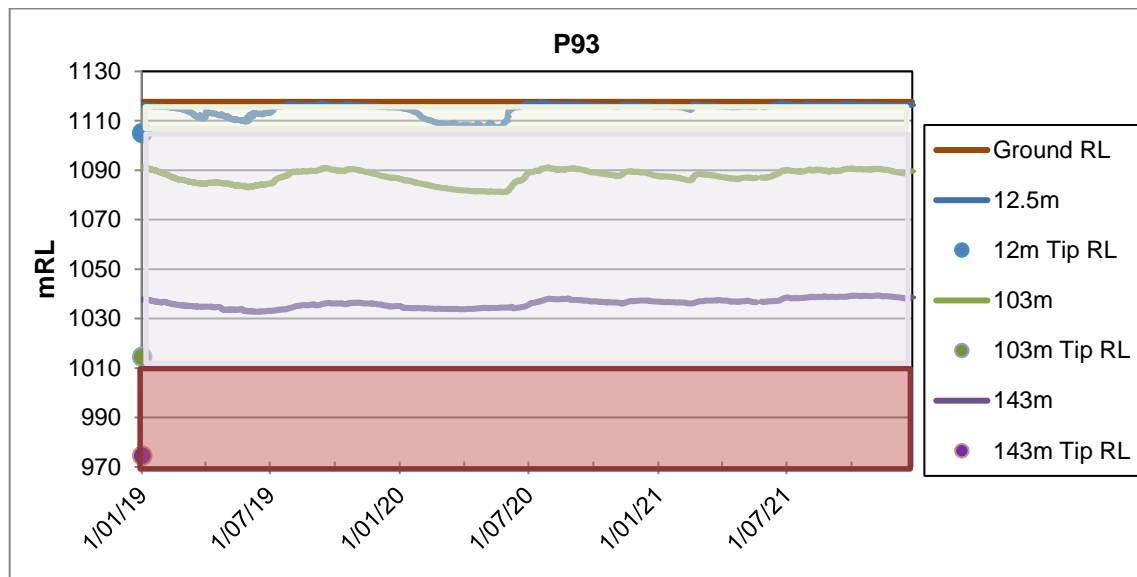


Figure 23: P93 Vibrating Wire Piezometer

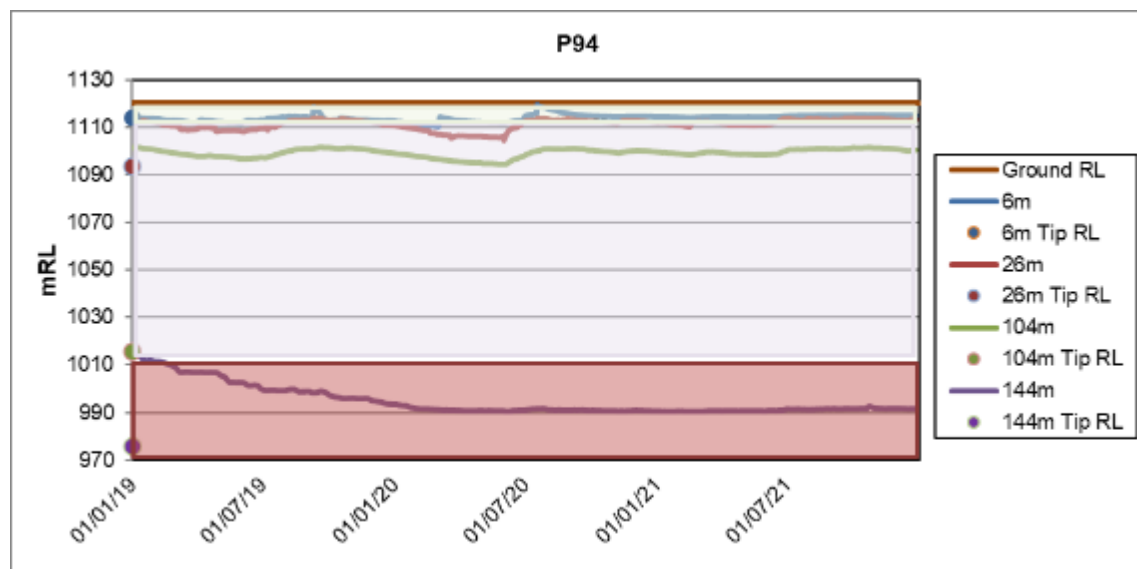


Figure 24: P94 Vibrating Wire Piezometer

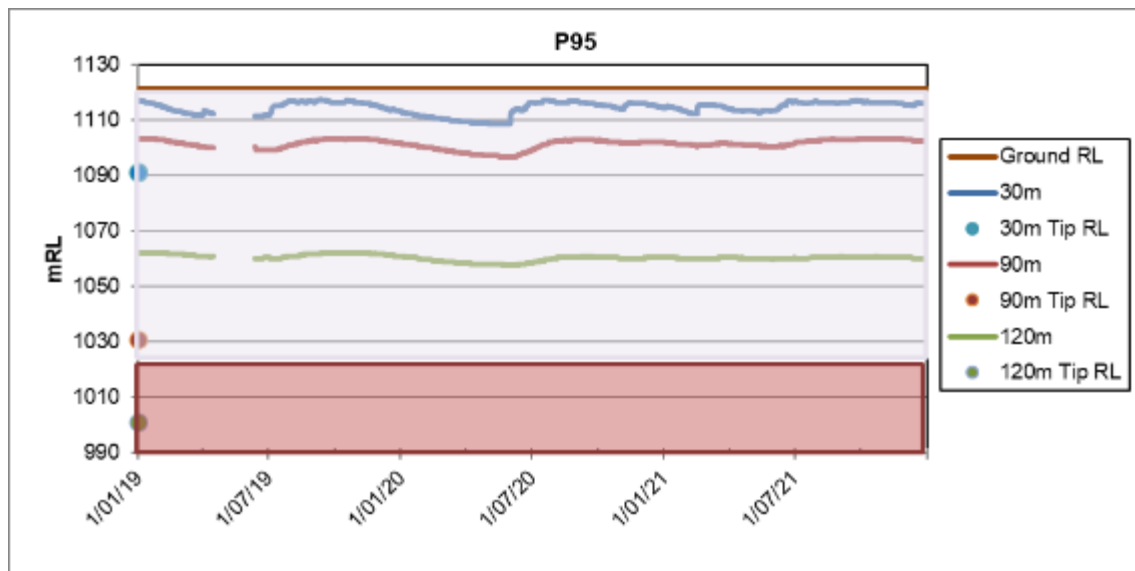


Figure 25: P95 Vibrating Wire Piezometer

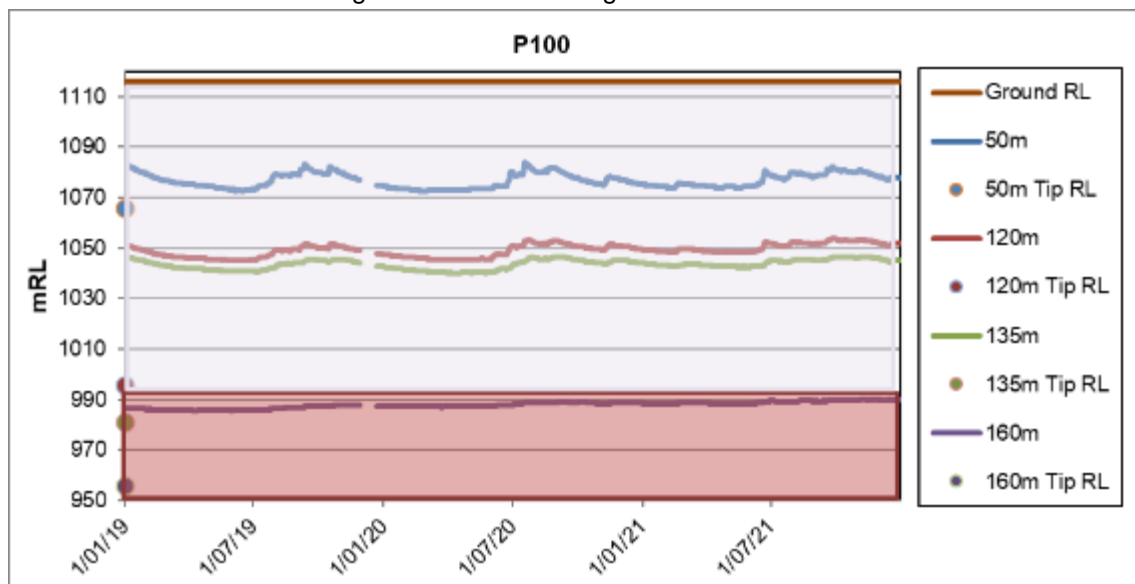


Figure 26: P100 Vibrating Wire Piezometer

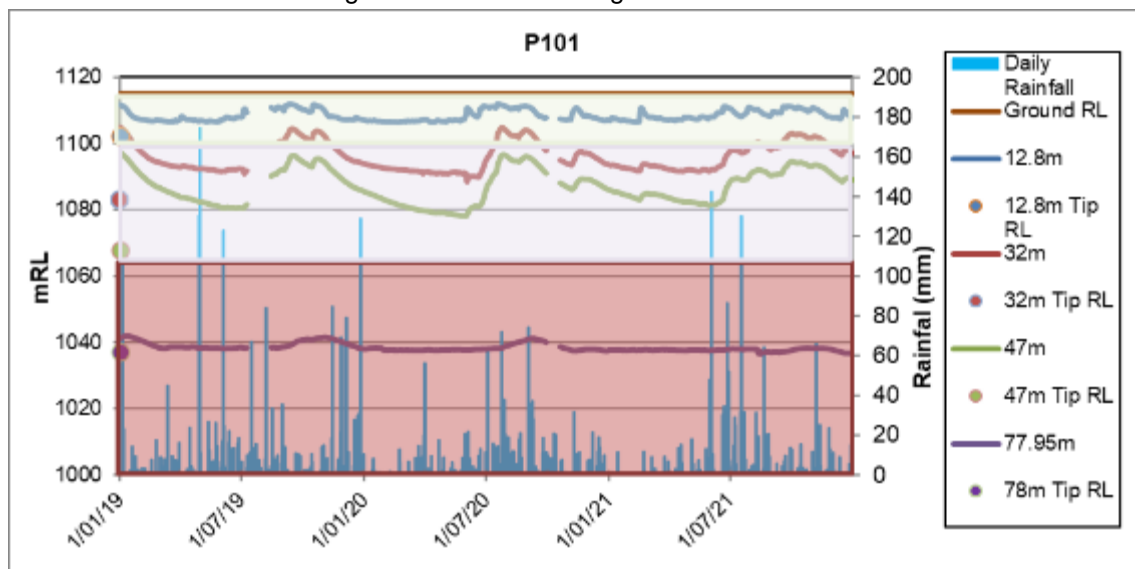


Figure 27: P101 Vibrating Wire Piezometer including daily rainfall

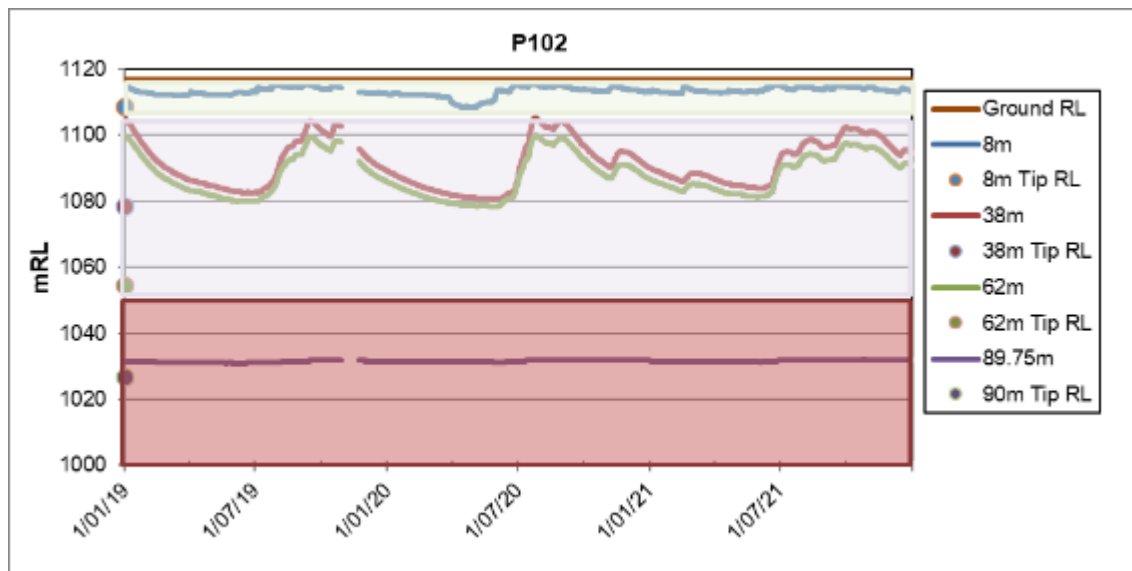


Figure 28: P102 Vibrating Wire Piezometer

Piezometric levels in the Younger Volcanics have continued to show some dependence on rainfall. This is particularly evident with P100, P101 and P102. This ongoing fluctuation does not appear to have any significant effect on ground surface settlement.

During 2018 and 2019, the 975 mRL piezometer in well P94 showed a drop in pressure believed to be a result of nearby mining causing relaxation in the country rock surrounding the piezometer tip. The pressure has stabilised through 2021 with water levels remaining at around 990mRL. The shallower piezometers at this location have not displayed any unusual drop in pressure and there have been no anomalous trends in nearby settlement markers (BM24, MATAURA1, 24F) identified.

P101-4, an andesite piezometer, appears to have little water pressure (Figure 27). The tip is at ~1037 mRL and at the end of the 2021 monitoring period water pressures gradually lowered from 1037.71 to 1036.59 mRL. The three piezometers above show no such gradual decline and are reactive to wet and dry periods. OGNZL will continue to monitor P101 monthly and note any trends in 2022.

### 5.3.8 Private Wells

The private wells are bores mainly used for water supply (Figure 9). They show seasonal fluctuations in groundwater levels and these levels can also be influenced by landowners using the bore. The Whangamata Rd and Mataura Rd bores can no longer be accessed due to health and safety concerns. There is no indication of any influence in the bores from mine dewatering (Figure 29).



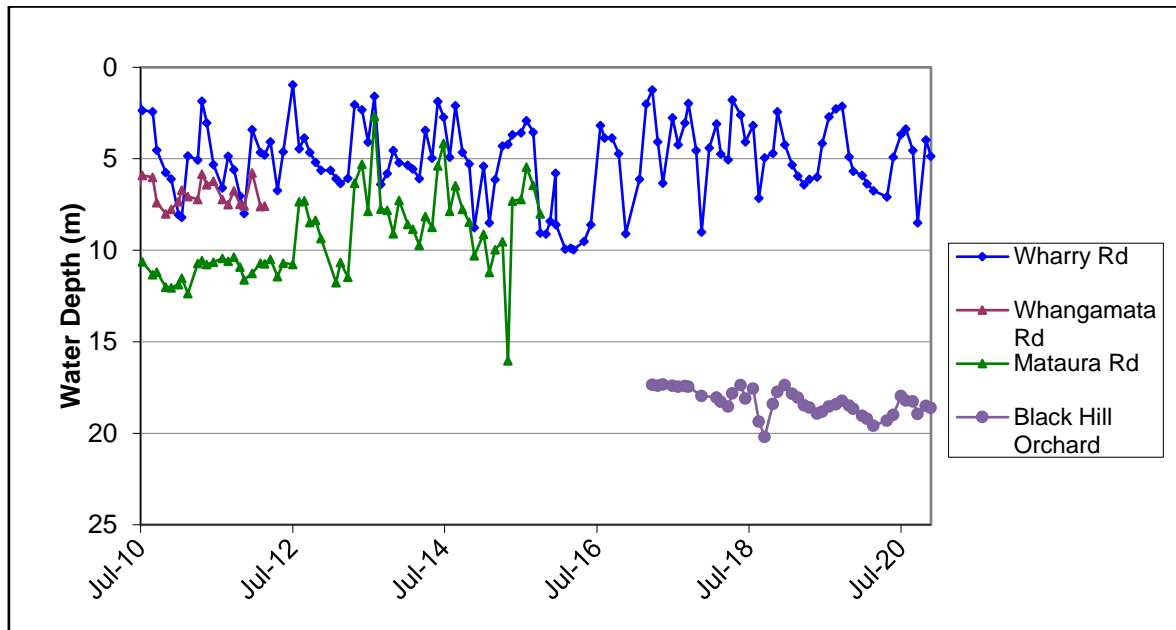


Figure 29: Private bore water levels

## 6 SETTLEMENT MONITORING

Condition 13b of the Extended Martha Mine consent requires the identification of any environmentally important trends in settlement behaviour. Condition 13d of the same consent requires that a comparison of the settlement survey data with that predicted for the consent.

A reassessment for the settlement prediction was conducted for the Trio Development Project (Engineering Geology, June 2010). This review assessed the effect of pumping from the Martha pit to draw down the groundwater level progressively to 755mRL, which would also dewater the connected Trio system.

Another reassessment was conducted for the Correnso Underground project (Engineering Geology, 2012). The report recommended new trigger levels for settlement based on additional depressurisation of the andesite layer.

Further reassessment was undertaken for Project Martha with dewatering to below 700 mRL authorised. New triggers were applied during the 2020 reporting period (Table 7).

A review of the settlement marker network was undertaken during 2019 by GWS Ltd. This resulted in the removal of erroneous and high-density settlement markers for settlement plotting and trigger assessments.

Seven settlements zones were defined around the Martha Mine pit in 1999, extending to the outskirts of Waihi. The zones were established based on the first ten years (pre-extension) of settlement history having regard to the then current knowledge of the thickness and composition of compressible materials (such as ash-soils, alluvium, lake sediments, and unconsolidated younger volcanic deposits) and the expected effect from Martha Mine dewatering. Table 7 provides the most recent update of the Settlement Zone trigger levels, approved in 2019 and applied following the commencement of Project Martha in 2020, to reflect the changed mining and dewatering conditions. Figure 30 shows the predicted settlement zones. These have also been updated with the commencement of Project Martha.

Table 7 - Table of Predicted Settlement with Project Martha Trigger Levels

Zone	New Trigger Levels (mm) Project Martha (2020)
Settlement Zone 1	55
Settlement Zone 2	65
Settlement Zone 3	95
Settlement Zone 4	160
Settlement Zone 5	260
Settlement Zone 6	340
Settlement Zone 7	540

The settlement measured is an accumulation of all causes of settlement. Generally, this is considered to be the result of mine dewatering, but close to the mines and (in the case of Favona) overlying the mine areas, additional settlement may be the result of primary consolidation settlement (as opposed to reconsolidation settlement which is the process in the Martha groundwater system where historic dewatering resulted in groundwater levels dropping to lower elevations for a longer time period than is proposed for current mining activity). Nevertheless, it is the total settlement that is discussed in this report as settlement due to dewatering alone cannot be separated from other causes.

Comment is provided in relation to the predicted settlements given in Table 7 and these comments are expanded on where monitoring data show exceedance of the trigger values.

## 6.1 Method

The initial settlement survey network was established in 1980 during the exploration phase of the project and has been regularly monitored since December 1987. Over the course of the project, settlement survey marks have been added, removed or replaced, as required, to extend the network or to compensate for damaged sites.

Figure 31 shows the location of settlement marks monitored by OGNZL up to the end of 2021. Also, included on Figure 31 are the defined subsidence hazard zones related to historical underground mine stopes and shafts (IGNS, 2002). Figure 32 provides the settlement monitoring marks across the Favona Mine and shows the locations of the Favona Mine workings in relation to the marks. Figure 33 provides the marks identified as triggered during the November 2021 survey.

Settlement monitoring was undertaken in May/June and November/December 2021 across the settlement network surrounding Waihi Township (refer Appendix C) and also along the Favona network which is an extension of the Martha mine survey network. Appendix B presents the two summary settlement monitoring reports. For simplicity this report refers to surveys as May and November 2021.

The raw data provided by the surveyors has been graphed and where changes in the record are apparent as a result of mark relocation or replacement, corrections have been applied using graphical projection so that total settlement over the life of mining can be determined for each location. The correction process applied was as follows:

- Updating the time-history graph for all data from settlement markers with data up to 1/11/2021.
- Where changes in the time-history graph identified a datum change, a correction was arrived at by projecting the initial data visually on the graph to the time of the new datum and a correction calculated. A smooth settlement curve resulting after the correction was applied and similarity of curve shape to those of adjacent marks was taken as indicating an acceptable correction.
- Where marks were installed in May 1999, the previously determined settlement for that location from 1988 to 1999 was applied as a correction.
- Where marks were installed or changed other than in May 1999, the previously assessed settlement at the location as of May 1999 was used with a best fit trend line of settlement in time to correct the values to be consistent with the May 1999 value.
- For Favona marks, settlement values as at 1/12/2005 were assessed for each location and used to correct the new marks to account for settlement from 1988 to 2005.
- The corrected data has then been used to generate:
  - Settlement-time trend graphs for each zone.
  - Plans of total settlement.
  - Contours of total settlement.
  - Calculation of tilt.
  - Settlement-time trend graphs of specific areas.
- Where Favona development has affected settlement, a projection of the pre-Favona mine settlement trend has been made as a means to estimate the current Martha Mine settlement and this settlement value has been subtracted from the total measured settlement to provide an estimate of the settlement due to the Favona Mine development.

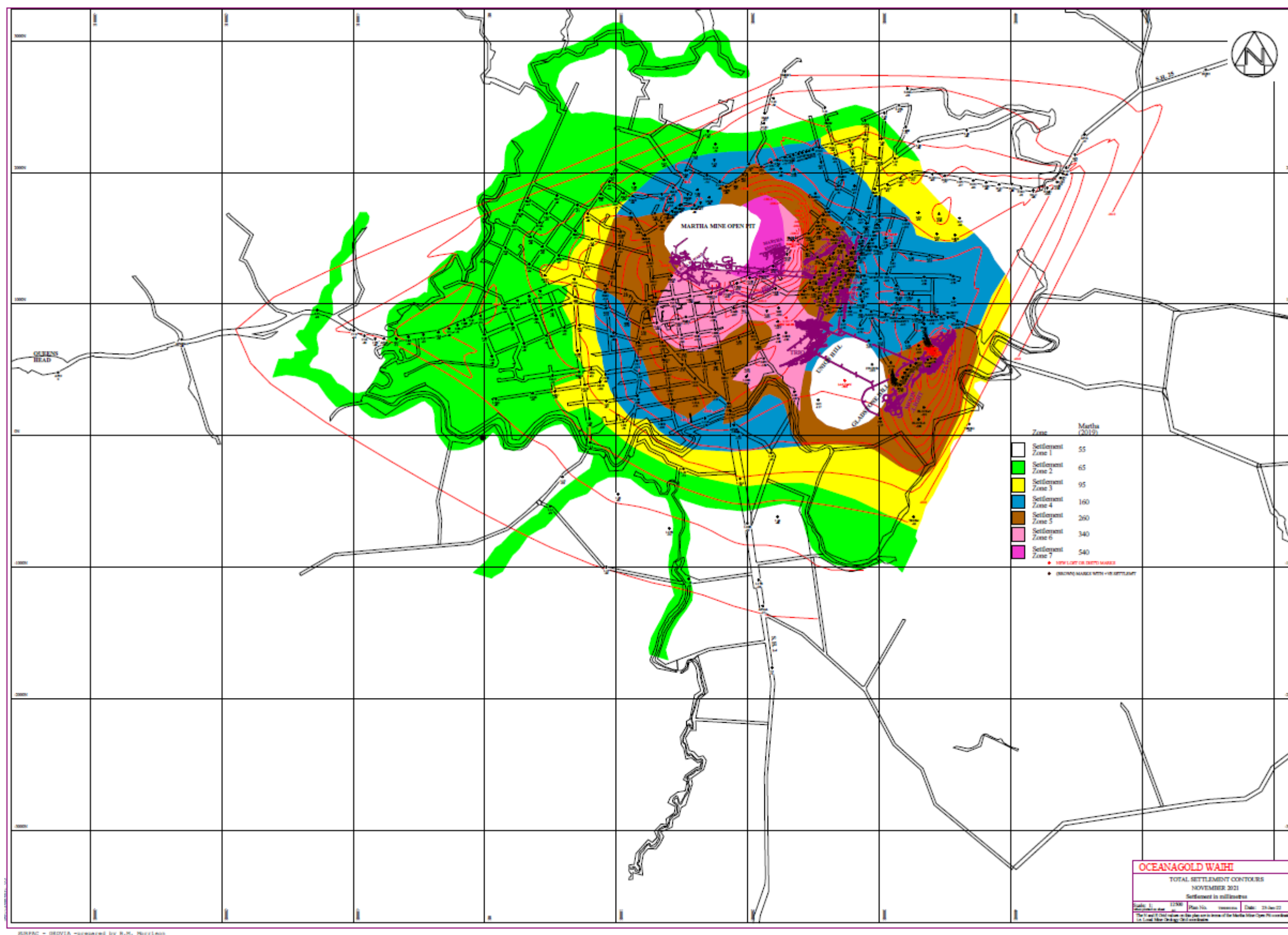


Figure 30: Total Settlement Contours Nov 2021



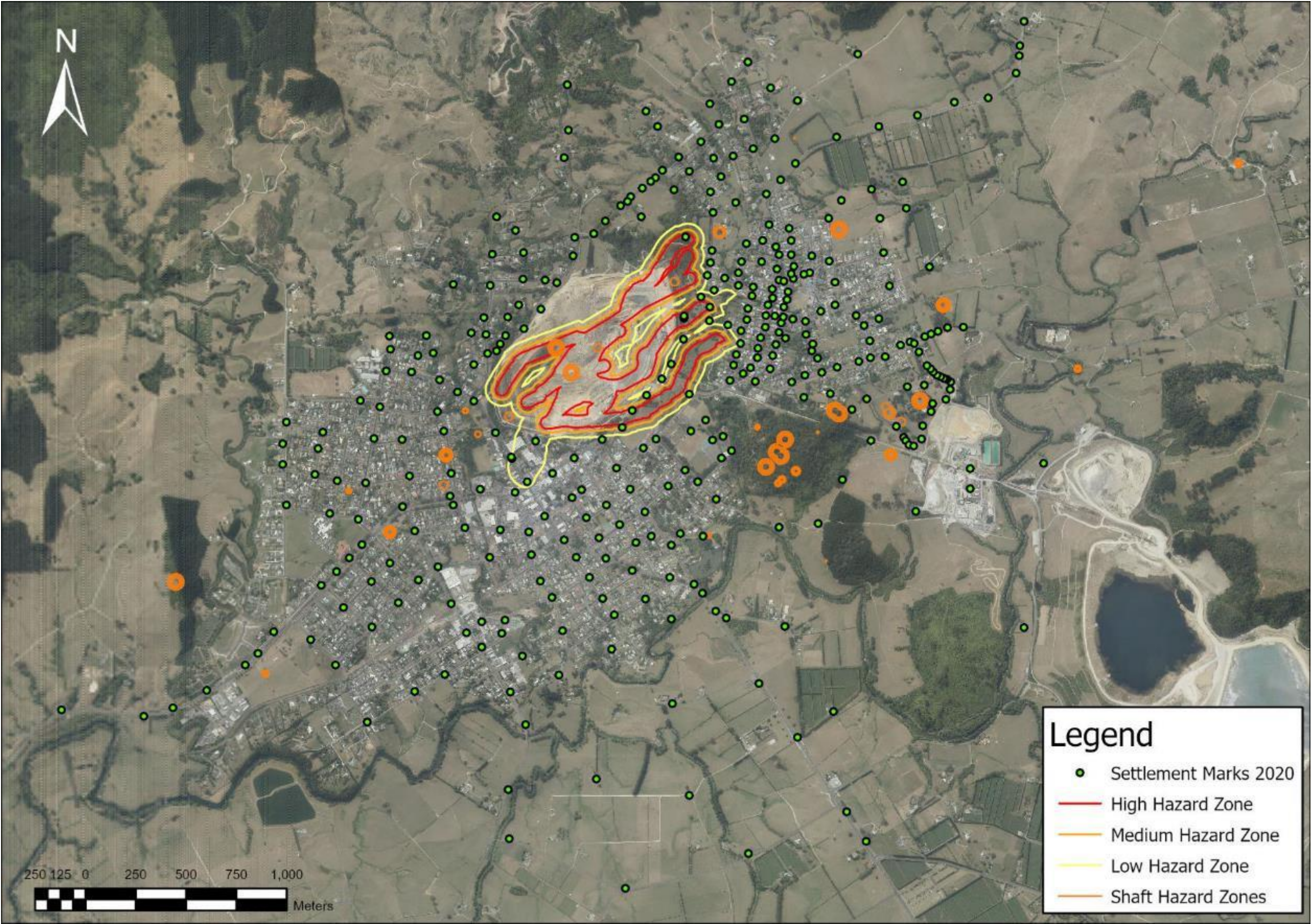


Figure 31: Settlement Marker Location Plan & Hazard Zones



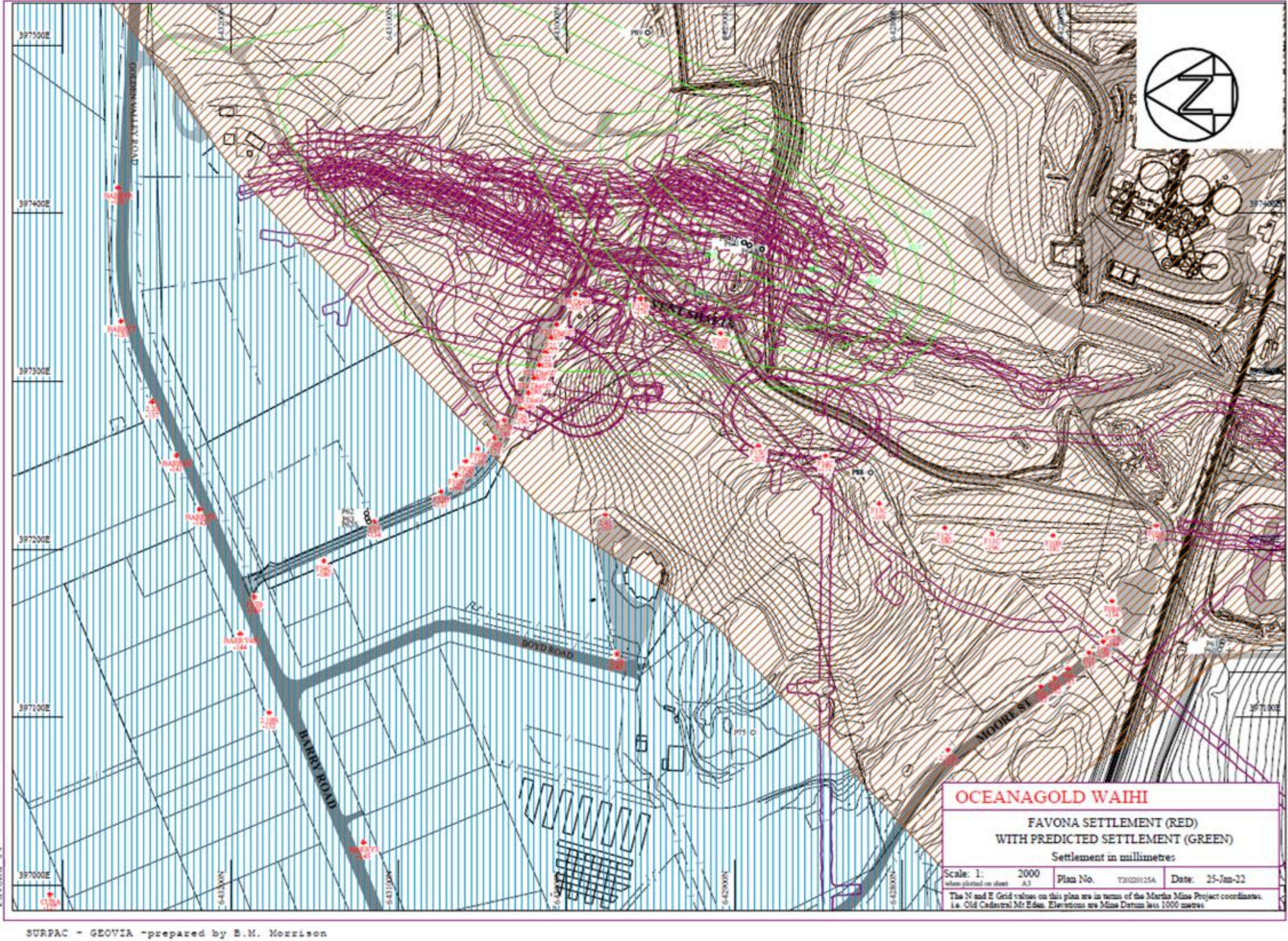


Figure 32: Favona Settlement Nov 2021





Figure 33: Triggered settlement marks Nov 2021



## 6.2 Results

Appendix C presents plans showing settlement marks, settlement values and settlement contours.

Time-history plots of settlement survey data for each zone are presented in Appendix D. The plots also depict the zone settlement predictions (for the Martha Extended Project, Trio Development, Correnso Project and Project Martha) shown as horizontal lines on each set of graphs.

The projected trends and the maximum settlements are provided on the graphs in Appendix D. Key trends are described below.

97% (392/403) of the marks did not exceed the settlement trigger levels; 11 marks were triggered. This number is similar to 2020. Figure 33 displays the seven settlement marks from the November 2021 survey outside the influence of the Favona Underground that exceeded the trigger limits. The other four marks that exceeded the trigger limits are located above the Favona Underground.

Some points in the time-history plots of settlement in Appendix D for May 2021 show greater settlement compared to the general trends. This is due to a larger than normal survey mis-close associated with the change to new survey staff in May 2021. This is generally most notable to the north and east extents of the survey. The reason for this larger than normal mis-close was able to be identified and corrected for the November 2021 survey. The November 2021 results follow the general settlement trends prior to the May 2021 survey. The May 2021 survey data can be reprocessed to remove the May 2021 mis-close. This reprocessing will be done for future reports.

### 6.2.1 ZONE 1 – Trigger 55mm

The Zone 1 time-history plot (Appendix D) shows three groupings, one showing a small but steady ongoing settlement after about 1999), another with little settlement until November 2015 and then a small ongoing settlement and another group with no settlement evident. To show these observations the marks for Zone 1 were re-plotted as groups namely:

- Zone 1 along Waihi Whangamata Road has had a small steady ongoing settlement since 1999 which has reached between 15 and 40 mm (Figure 34)
- Zone 1 south of Waihi has had a small steady ongoing settlement since 1999 which has reached between 15 and 50 mm (Figure 35)
- Zone 1 west of Waihi has had a very small amount of settlement (less than 12 mm) up to 2015 following which the settlement rate increased to a small steady ongoing settlement which has reached between 10 to 20 mm (Figure 36)
- Zone 1 north of Waihi which has had no measurable settlement (Figure 37)

This grouping shows that the marks in Zone 1 with a slow ongoing settlement trend are located along Waihi Whangamata Road to the east of Waihi and to the south of Waihi. A steady increase in settlement rate from about 1999 is also be observed in most marks in Zones 2 to 6, suggesting that there is a small and widespread effect occurring at depth. Two of the three settlement marks in Zone 1 to the west show little settlement until 2015 and then a small steady on-going settlement showing the widespread effects at depth have reached these markers (Figure 37).

These observations suggest the following:

- The widespread 10 to 50 mm settlement observed from about 1999 at many Zone 1 marks and also the increasing settlement in Zones 2 to 6 marks is a response to the ongoing dewatering of the deeper structures in the andesite rock body (fracture depressurisation) as a result of mine dewatering. This is a broad effect and has negligible influence on differential tilt between marks.



The stable water levels in the wells monitoring the deeper younger volcanic materials and the upper andesite layers (Figure 14) indicate that the observed settlement behaviour is not related to on-going consolidation of these materials at these locations as no on-going dewatering is evident at these locations.

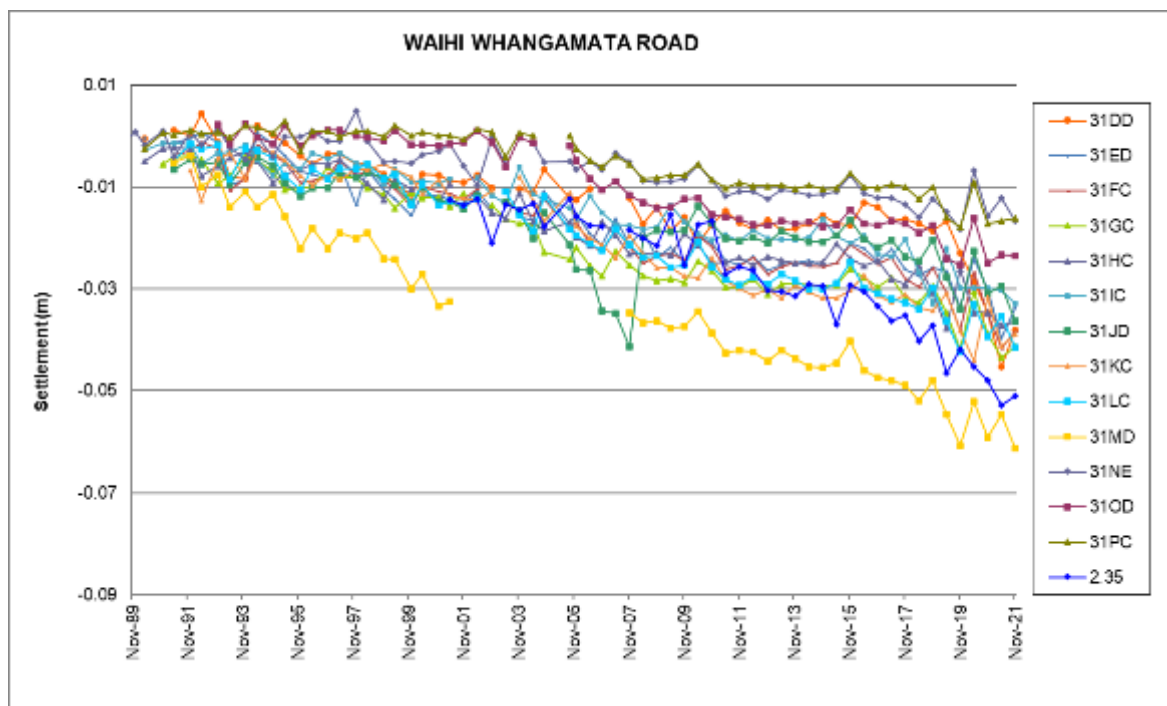


Figure 34: Zone 1 Waihi Whangamata Road

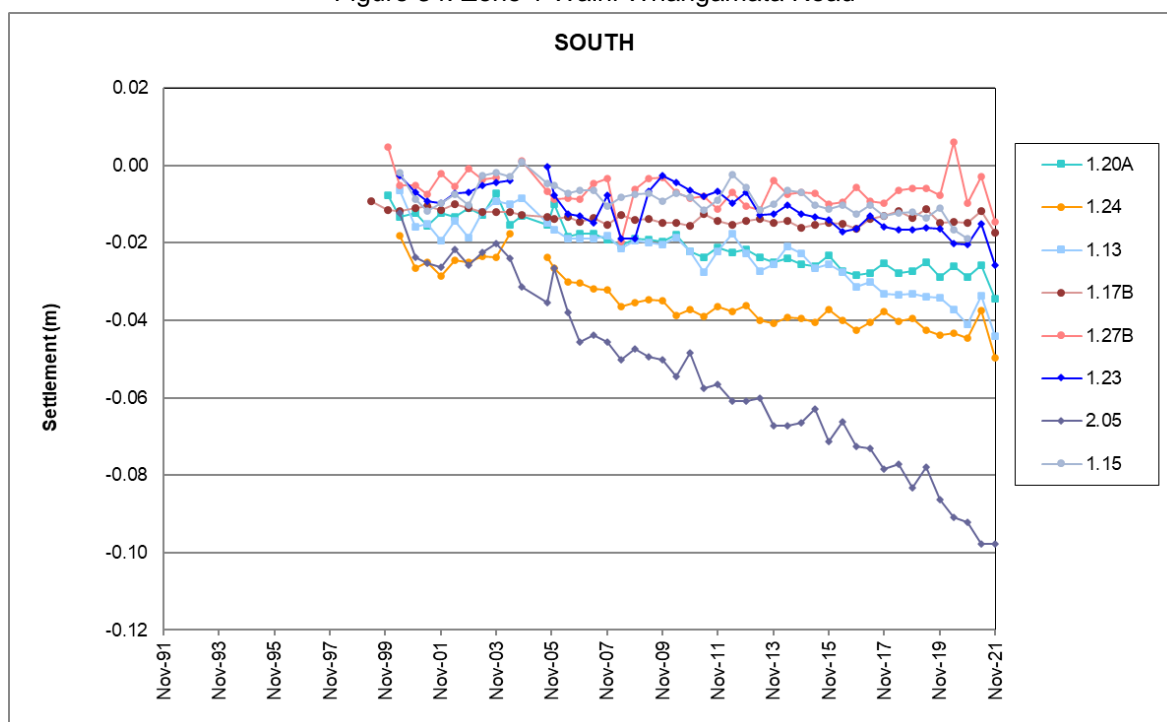


Figure 35: Zone 1 Waihi South

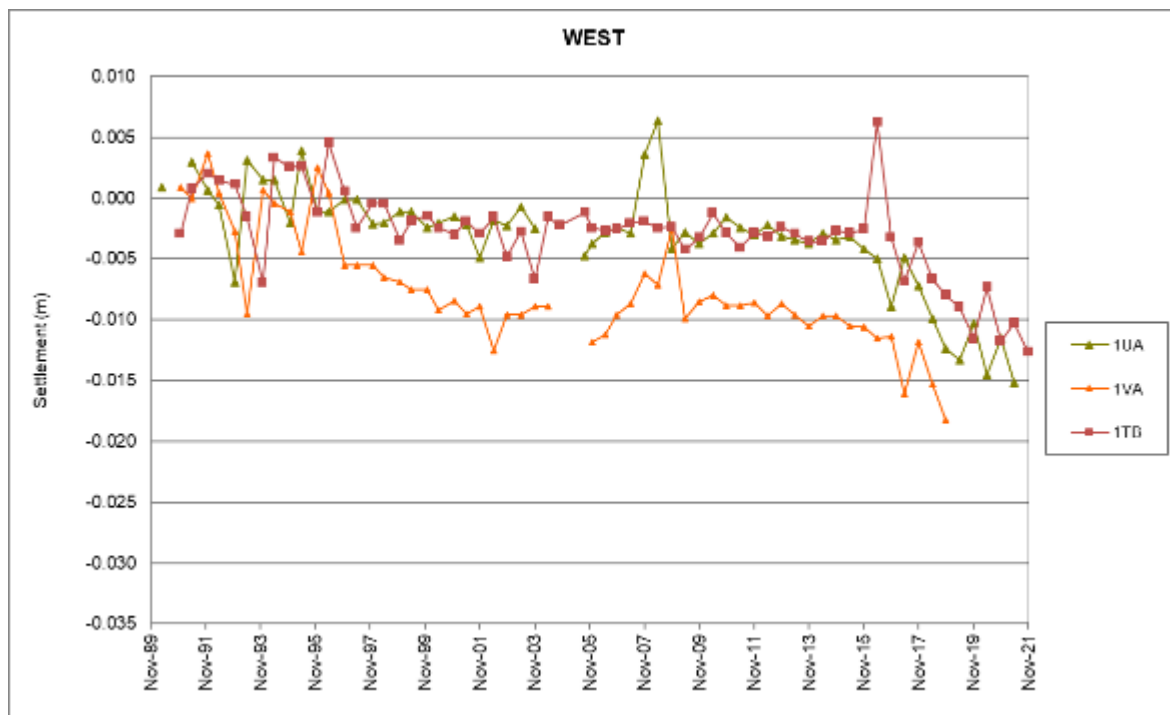


Figure 36: Zone 1 West of Waihi

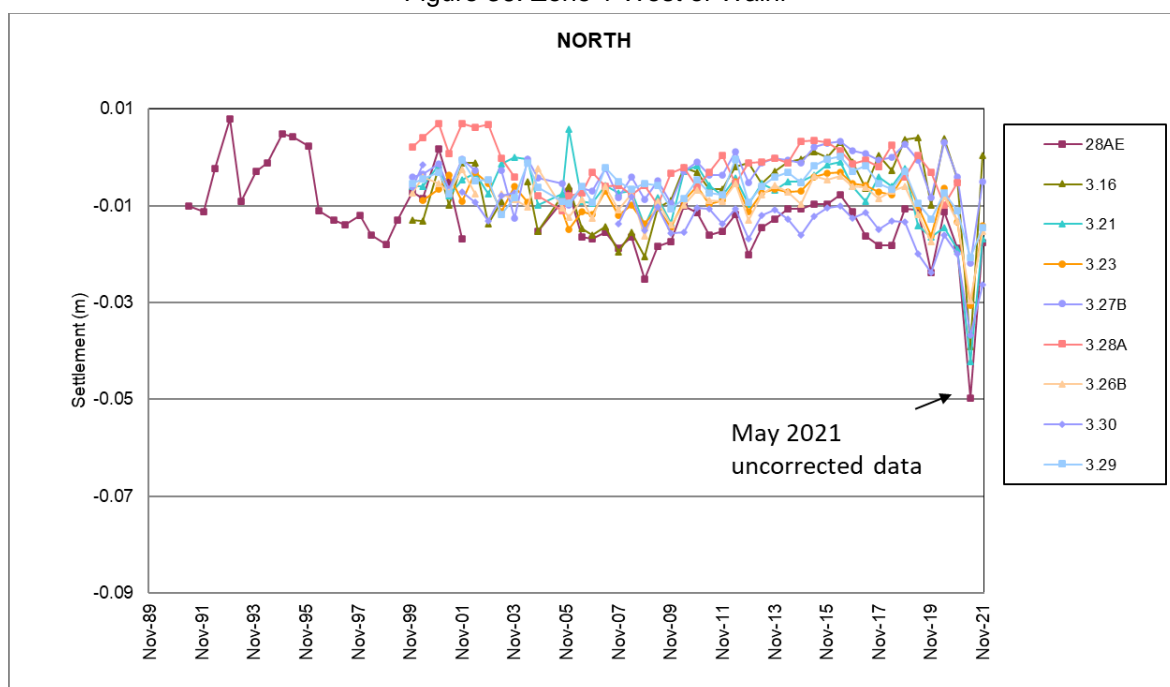


Figure 37: Zone 1 North of Waihi

Results exceeding the trigger levels shown on the Zone 1 time – history plot are discussed below.

Three marks in Zone 1 showed settlement greater than the trigger levels: 31MD, 2.05 and 2.44

Mark 31MD is located along the Waihi to Whangamata Road and showed a period of greater settlement than nearby marks during the early 1990s. More recent recorded ongoing settlement is similar to nearby marks. This mark may be influenced by its proximity to the banks of the Ohinemuri River (Figure 33).

Mark 2.05 is near Winner Hill and was included in Zone 1 because it was an andesite outcrop. Dewatering of the andesite was originally thought to contribute less to settlements. Like other marks

to the south of Waihi Mark 2.05 indicates ongoing settlement after 2003 due to deeper and more extensive dewatering of the andesite. Mark 2.05 is more representative of Zone 4 settlements.

Mark 2.44 has been investigated in the past and the cause has been attributed to some localised surficial slope movement. This mark is listed as disturbed by the surveyor.



### **6.2.2 ZONE 2 – Trigger 65mm**

This zone encompasses the western outskirts of Waihi township and some marks to the north and south of Waihi. The time-history plot for Zone 2 (Appendix D) shows all but one of the Zone 2 marks to be tracking less than the settlement trigger level. As with Zone 1 most of the marks have small settlements. Total settlements to date are generally between 10 to 65 mm with settlements of between 10 to 40 mm since 1999. Movements exceeding trigger levels are discussed below

Mark 1.12 exceeds the Zone 2 trigger level by 4mm. On review the settlements at this mark, Mark 1.04, Mark 1.02D, and Mark 1.03D in Zone 2 in this area of town, the settlement rate increased in 2020. This is likely associated with the ongoing dewatering for MUG and likely shows effect the deep dewatering in the andesite is having. The piezometer borehole P4 in the south area of Waihi indicates the overlying younger volcanics have not been dewatered. The settlements are relatively small and with negligible tilt and are not of concern. Mark 1.12 will continue to be reviewed with subsequent monitoring surveys where over the trigger level of 65mm.

### **6.2.3 ZONE 3 – Trigger 95mm**

This zone includes areas to the east, south and west of Waihi town.

Inspection of the time-history plot for Zone 3 shows, as with Zones 1 and 2, most marks display ongoing steady settlement. The measured total settlements are small and generally between 20 to 90 mm with settlements since 1999 of between about 10 to 50 mm. Tilts between adjacent marks are well within acceptable limits.

One mark (2CE) has moved more than the settlement trigger level for the zone. Mark 2CE is located to the west of Waihi township and has showed an increased rate of settlement compared to nearby marks between 1991 and 1995. Thereafter, it has settled at a similar rate to nearby marks. This settlement pattern is similar to point 2BC in Zone 5. This increase settlement rate in the early 1990's is associated with dewatering/depressurisation effects due to the development of Martha Pit. Steady ongoing settlements similar to the surrounding points indicates settlement associated with dewatering of the deeper andesite. This mark will continue to be reviewed however settlements are explainable and tilts are small, so not of concern.

### **6.2.4 ZONE 4 – Trigger 160mm**

Zone 4 time-history plots (Appendix D) show relatively steady ongoing settlement since 1995 in response to dewatering effects. The measured total settlements are relatively small and generally between 20 to 140 mm. Settlements since 1999 are generally between 10 to 80 mm. Tilts between adjacent marks are well within acceptable limits.

One mark, 23C, exceeded the predicted maximum settlement for this zone in May 2021. This mark showed a sharp increase in settlement in the May 2020 survey. The settlement in the subsequent November 2020 survey was similar to nearby marks. This mark is located near a drain and may have been affected by the dry summer and autumn during 2019/2020 or been influenced by recent drainage works nearby. No effects on surrounding land are visible, and nearby piezometers have not shown any unusual changes.

### **6.2.5 ZONE 5 – Trigger 260mm**

The data for the Zone 5 marks are provided in the time-history plot in Appendix D. Marks show a steady increase in settlement with time and total settlements are generally between 30 and 150 mm. Settlements since 1999 are generally between 15 to 85 mm. No marks in Zone 5, outside of the area over Favona Underground, exceeded the predicted maximum settlement for the zone.

### **6.2.6 ZONE 6 – Trigger 340mm**

The settlement in this zone is shown on the Zone 6 time-history plot in Appendix D. This zone extends through the centre of the Waihi commercial area. Marks show steady ongoing settlement with time and total settlements are generally between 70 to 280 mm. Settlements since 1999 are generally between 50 to 190 mm. One mark in this zone exceeded the maximum predicted settlement for the zone. This mark (mark BM20) has been noted as disturbed by the surveyor (Appendix B), however the settlement has been accumulated at a relatively constant rate. The larger settlements at BM20 (compared to the rest of Zone 6) are likely due to the local ground conditions and there is no private property in this area. This point will continue to be monitored and reviewed.

### **6.2.7 ZONE 7 – Trigger 540mm**

Zone 7 settlements are all within the predicted maximum settlement (Zone 7 time-history plot, Appendix D). Total settlements are about 290 mm. Settlements since 1999 are about 160 mm. Ongoing settlements are relatively constant matching the ongoing dewatering at depth in the andesite. No new trends are indicated.

## **6.3 Favona Settlement**

Settlement in the vicinity of the Favona Mine has a component of settlement due to Martha Mine dewatering as well as settlement related to Favona Mine dewatering.

A separation of total settlement into Martha and Favona settlement components has been undertaken by projecting the settlement evident before the commencement of the Favona Mine and accepting these projected settlements as Martha settlements. The difference between the projected (Martha) settlement and total measured settlement has been taken as the Favona component of settlement. Table 8 sets out the total settlement, the settlement attributed to Martha dewatering and the settlement attributed to Favona Mine dewatering as assessed for the Favona Mine settlement markers.

Table 8 - Separation of Settlement – Favona Marks (Nov 2021)

Mark	Total Settlement (mm)	Martha Settlement (mm)	Favona Settlement (mm)
F02	103	50	53
F03	106	46	60
F04	108	44	64
F05	110	46	64
F06	110	40	70
F07*	112	42	70
F08A	121	44	77
F09A	124	38	86
F10B	131	44	87
F11C	157	42	115
F12C	134	39	95
F13C	131	55	76
F14C	131	60	71
F15C	167	55	112
F16B	163	55	108
F17B	280	55	225
F18	354	49	305
F20	303	44	259
F21	274	43	231
F22	255	42	213
F23	235	49	186
F24	220	42	178
F25	214	49	165
F26	192	45	147
F27B	178	50	128
F28B	168	49	119
F29B	157	48	109
F30B	156	52	104
F31B	140	55	85
F32B	126	49	77
F33	115	52	63
F34C	115	58	57
F35B	106	61	45

\* Disturbed by 40+mm

The largest settlement at Favona Mine occurs where the markers overlies mine workings (marks F16B to F26). The maximum predicted settlement over the workings from dewatering was assessed as 80 mm for earlier projects, with mine dewatering related settlement not extending into the urbanised area. The actual total settlement and the extent of settlement exceeded the predictions for the dewatering settlement. The difference between the predictions and measured settlement was considered to reflect depressurisation and consolidation of the andesite rock body, which was not considered in the initial predictions. Andesite rock was considered to be a stiff material with negligible consolidation characteristics, but the long-term settlement observed in response to Martha Mine dewatering (in Zones 1 to 6, discussed above) suggests that some minor consolidation of the deeper andesite rock is occurring, possibly as a response to fracture depressurisation. In addition, some further relaxation of the rockmass towards the mine workings may be occurring, and this may be providing further volume reduction of the andesite rockmass in the vicinity of the mine.

Another potential influence is that the Favona andesite has been undergoing primary consolidation, as current water level monitoring data suggests that the Favona system was not dewatered to the

same extent as the Martha groundwater system during historical mining in the early 1900's. Consolidation predictions for Favona were made based on Martha's second dewatering consolidation data. The amount of primary consolidation is greater for the first time of dewatering compared to the second or subsequent times of dewatering. This is because the first cycle of dewatering results in preconsolidation and an increase in the stiffness of the ground, and subsequent re-watering does not result in full rebound of levels to their original levels.

Settlement predictions for Project Martha have been updated for the zone encompassing Favona marks to reflect the effects outlined above. Four Favona marks exceeded the maximum predicted settlement in the November 2021 survey: F17B, F18, F20 and F21. All are located above underground workings, on company owned land. Marks F18 and F20 are noted by the surveyor as being disturbed (Figure 32, Appendix B **Error! Reference source not found.**).

#### 6.4 Trio Underground

The only anomalous result in the vicinity of Trio Underground has been apparent settlement at mark 2.44 (located on a farm track between Union and Black Hill) with pronounced acceleration since the May 2010 survey. This was investigated and determined to be related to a shallow, likely pre-existing surficial landslide. It is now noted by the surveyor as being disturbed. The mark will continue to be monitored on a biennial basis as per other survey marks but will not be included in any settlement profiling.

#### 6.5 Summary

The analysis of the data to the end of 2021 continues to indicate that current slow settlements associated with Martha Mine are likely to be related to dewatering of the deeper structures within the andesite rock mass. Groundwater monitoring data does not show any widespread or significant ongoing dewatering of alluvium, younger volcanic materials or the upper layers of the andesite rock body.

Settlement triggers include modification to Martha Mine Extended pit associated with the cutback projects; the extended duration of dewatering at Martha Mine; assumptions made in the Favona settlement predictions (fracture depressurisation, secondary rather than primary consolidation); and localised natural, induced and historic effects.

The area around Martha Mine of greatest settlement is adjacent to the eastern pit wall where the weaker younger volcanic rocks are thickest and dewatering of this geological unit is greatest. This is also an area that has historic underground workings that have not been backfilled.

The main area of settlement at Favona overlies the workings, is directly under farmland and within the area of Company owned land. Outside the Favona workings area, settlement is notably lower. The conditions giving rise to settlement at Favona differ from those in the Martha Groundwater System as the latter has been dewatered to a greater extent for a longer time than the current dewatering while the former has not been previously dewatered. While settlement has exceeded initial estimates at Favona, those estimates were based on Martha settlement data which was responding to reconsolidation rather than primary consolidation.

In relation to Trio, Correnso and SUPA mines, these are located in the dewatered Martha Groundwater System and settlement as described in this document has already been developing in those areas in response to Martha Mine dewatering. Also, as these are linked to the Martha system, settlement will be based on additional consolidation and did not include settlement due to dewatering of the andesites.



## 7 TILT

As noted earlier, a full review of the Waihi settlement marker network and database was undertaken by GWS Limited in 2019. The review resulted in the removal of erroneous and high-density settlement marks and an updated settlement database with revised settlement marker corrections where appropriate. Marks proposed for removal have been included in tilt calculations until their removal is approved by Hauraki District and Waikato Regional Councils. Revised settlement marker corrections have been applied in this reporting period.

Assessments have been grouped into five areas: Favona, Martha (incl. North Wall), Correnso, Correnso South and SUPA. There is some crossover of marks between Mining Permit boundaries. The assessment of tilt between adjacent settlement marks is summarised in Table 9.

Table 9: Tilt Calculations November 2021 Survey

Mark	x	y	Distance (m)	Nov 2021 (m)	Abs	Δh (m)	Tilt (1:X)
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### Favona

F02	3097.60	490.00		-0.1029	0.1029		
F06	3126.97	430.49	66.36	-0.1099	0.1099	0.0070	6510
F10B	3176.88	446.75	52.49	-0.1315	0.1315	0.0216	3232
F12C	3207.32	503.82	64.69	-0.1344	0.1344	0.0029	22374
F14C	3275.29	551.31	82.91	-0.1310	0.1310	0.0034	24632
F15C	3297.17	585.32	40.44	-0.1672	0.1672	0.0362	1117
F16B	3367.38	578.70	70.52	-0.1627	0.1627	0.0045	15596
F17B	3405.48	613.91	51.88	-0.2804	0.2804	0.1177	441
F18	3423.83	648.30	38.98	-0.3543	0.3543	0.0738	528
F21	3405.99	672.00	29.66	-0.2742	0.2742	0.0801	370
F24	3388.13	690.85	25.97	-0.2199	0.2199	0.0542	479
F32B	3348.78	769.10	87.59	-0.1265	0.1265	0.0935	937
F34C	3339.49	849.57	81.00	-0.1146	0.1146	0.0118	6838
F35B	3336.68	896.06	46.58	-0.1060	0.1060	0.0086	5416

### Martha

20BB	2533.26	1622.29		-0.1217	0.1217		
20AC	2461.04	1536.91	111.83	-0.1255	0.1255	0.0039	28886
BM20A	2345.50	1484.90	126.71	-0.2421	0.2421	0.1165	1087
20D	2482.07	1473.48	137.05	-0.1506	0.1506	0.0914	1499
19CB	2296.71	1381.40	206.97	-0.2843	0.2843	0.1337	1548
19BB	2191.56	1292.02	138.00	-0.2972	0.2972	0.0129	10702
BM19B	2117.17	1244.36	88.35	-0.2975	0.2975	0.0002	372363
17CB	2014.23	1201.01	111.70	-0.3004	0.3004	0.0029	38434
17BB	1919.52	1160.79	102.90	-0.2181	0.2181	0.0823	1251
17AB	1841.32	1104.80	96.18	-0.1898	0.1898	0.0283	3398
BM17A	1724.44	1088.92	117.95	-0.0992	0.0992	0.0906	1302

### North Wall

27AB	2009.08	2064.33		-0.0101	0.0101		
26Q	1963.00	1982.71	93.73	-0.0339	0.0339	0.0237	3948
26PB	1834.84	1893.11	156.38	-0.0503	0.0503	0.0164	9529
26OB	1706.93	1812.27	151.31	-0.0042	0.0042	0.0461	3285

26NC	1641.16	1772.40	228.22	-0.0435	0.0435	0.0393	5810
26MB	1593.46	1750.66	122.11	-0.0449	0.0449	0.0133	9174
26JB	1495.71	1756.55	93.74	-0.0387	0.0387	0.0045	20949
BM26	1542.45	1837.81	100.98	-0.0342	0.0342	0.0107	9447
3.09	1618.51	1870.17	217.54	-0.0316	0.0316	0.0274	7935

**Correnso**

25E	2472.35	1162.01		-0.1572	0.1572		
25B	2497.67	1105.83	61.63	-0.1337	0.1337	0.0235	2619
25I	2537.20	1045.04	72.51	-0.1214	0.1214	0.0123	5890
24H	2630.70	1072.28	97.39	-0.1096	0.1096	0.0118	8266
24B	2667.67	1126.40	65.54	-0.1134	0.1134	0.0038	17453
24G	2705.96	1170.46	58.38	-0.1238	0.1238	0.0104	5602
24L	2761.67	1181.33	56.76	-0.1256	0.1256	0.0018	31210
24AC	2743.58	1218.90	41.70	-0.1280	0.1280	0.0024	17440
24F	2772.80	1257.27	48.23	-0.1219	0.1219	0.0061	7874
BM24	2794.55	1279.36	31.00	-0.1128	0.1128	0.0091	3413
24E	2758.43	1303.23	43.29	-0.1185	0.1185	0.0057	7564
24DC	2718.29	1323.13	44.80	-0.1184	0.1184	0.0001	401372
24I	2692.57	1269.71	59.29	-0.1313	0.1313	0.0129	4583
25H	2648.48	1232.96	57.40	-0.1347	0.1347	0.0033	17175
25CB	2615.91	1190.50	53.51	-0.1346	0.1346	0.0001	632001
25G	2594.60	1149.42	46.28	-0.1354	0.1354	0.0008	60071
25F	2542.53	1116.24	61.74	-0.1376	0.1376	0.0023	27346
25B	2497.67	1105.83	46.06	-0.1337	0.1337	0.0039	11751
BM25	2424.91	1100.25	72.97	-0.1469	0.1469	0.0132	5531
25E	2472.35	1162.01	77.88	-0.1572	0.1572	0.0103	7532
25A	2505.13	1203.77	53.09	-0.1552	0.1552	0.0021	25590
25D	2547.05	1248.02	60.95	-0.1565	0.1565	0.0014	44038
21DC	2573.96	1304.15	62.25	-0.1456	0.1456	0.0109	5713
21N	2623.25	1342.44	62.41	-0.1109	0.1109	0.0348	1796
21C	2651.57	1389.82	55.20	-0.1182	0.1182	0.0073	7583
21M	2694.90	1439.65	66.03	-0.1058	0.1058	0.0124	5335
21BC	2719.27	1477.80	45.27	-0.0910	0.0910	0.0148	3061
21EB	2799.95	1429.09	94.24	-0.0934	0.0934	0.0024	39943
24K	2783.89	1387.72	44.38	-0.1095	0.1095	0.0161	2753
24J	2749.39	1365.76	40.89	-0.0848	0.0848	0.0247	1657
24DC	2718.29	1323.13	52.77	-0.1184	0.1184	0.0336	1571
22F	2815.91	1325.41	97.65	-0.1175	0.1175	0.0009	104892
22C	2846.39	1352.54	40.80	-0.1350	0.1350	0.0176	2322
22GB	2862.88	1387.97	39.08	-0.1079	0.1079	0.0272	1438
22BC	2916.75	1435.77	72.02	-0.0940	0.0940	0.0139	5177
22I	2918.98	1461.37	25.69	-0.0923	0.0923	0.0017	15351
22H	2869.25	1441.80	53.44	-0.0811	0.0811	0.0112	4769
21P	2849.17	1456.90	25.13	-0.0839	0.0839	0.0028	8819
21FB	2861.65	1512.21	56.70	-0.0657	0.0657	0.0182	3110
21Q	2899.60	1571.32	70.24	-0.0672	0.0672	0.0015	47393
21GC	2901.12	1614.05	42.76	-0.0699	0.0699	0.0027	15899
22KB	2985.12	1610.91	84.06	-0.0594	0.0594	0.0105	8002
2.29B	2955.27	1547.42	70.16	-0.0860	0.0860	0.0267	2630
22J	2944.47	1489.76	58.66	-0.0740	0.0740	0.0120	4892
22I	2918.98	1461.37	38.16	-0.0923	0.0923	0.0182	2092
22H	2869.25	1441.80	53.44	-0.0811	0.0811	0.0112	4769

21EB	2799.95	1429.09	70.46	-0.0934	0.0934	0.0123	5730
21BC	2719.27	1477.80	94.24	-0.0910	0.0910	0.0024	39943
BM21	2654.80	1515.40	74.63	-0.0987	0.0987	0.0077	9660
20F	2605.79	1575.98	77.92	-0.1077	0.1077	0.0090	8645
20E	2535.65	1542.67	77.65	-0.1656	0.1656	0.0578	1342
21C	2651.57	1389.82	191.84	-0.1182	0.1182	0.0474	4045

### Correnso South

23F	2700.77	968.79		-0.1161	0.1161		
2.13	2725.42	874.95	97.03	-0.1075	0.1075	0.0086	11250
23E	2774.82	972.51	74.14	-0.1195	0.1195	0.0034	21492
2.14A	2853.28	838.67	132.91	-0.1168	0.1168	0.0093	14253
23B	2856.49	949.79	84.77	-0.1211	0.1211	0.0016	54321
BANK1	2866.21	1023.25	74.10	-0.1066	0.1066	0.0145	5122
23C	2856.14	1068.01	45.88	-0.1688	0.1688	0.0622	738
2.25	2874.51	1097.26	34.54	-0.1141	0.1141	0.0547	632
23D	2861.42	1154.89	59.09	-0.1196	0.1196	0.0055	10711
2.24	2885.91	1215.47	65.35	-0.1230	0.1230	0.0034	19298
MATAURA1	2831.84	1250.81	64.60	-0.1106	0.1106	0.0124	5227
BM24	2794.55	1279.36	46.96	-0.1128	0.1128	0.0021	21893

### SUPA

Mark	x	y	Distance (m)	Nov 2021 (m)	Abs	Δh (m)	Tilt (1:X)
BM25	2424.91	1100.25		-0.1469	0.1469		
34H	2233.59	970.56	231.13	-0.1274	0.1274	0.0195	11841
2.10	2143.92	950.39	91.91	-0.1432	0.1432	0.0158	5800
34C	1968.90	982.67	177.97	-0.1146	0.1146	0.0286	6228
34GC	2211.33	1119.52	278.39	-0.2074	0.2074	0.0927	3002
19BB	2191.56	1292.02	173.63	-0.2972	0.2972	0.0898	1933
19CB	2296.71	1381.40	138.00	-0.2843	0.2843	0.0129	10702
21O	2527.37	1356.34	232.01	-0.1497	0.1497	0.1346	1724
20C	2450.61	1413.86	95.92	-0.1734	0.1734	0.0237	4049
20D	2482.07	1473.48	67.41	-0.1506	0.1506	0.0228	2962
BM20A	2345.50	1484.90	137.05	-0.2421	0.2421	0.0914	1499

	Above mine workings
	Tilt greater than 1:1000

## 7.1 Favona

Locations surveyed in 2021 with tilt values steeper than the 1:1000 criterion between adjacent marks are listed in Table 9. The locations of the marks in relation to the Favona mine workings are shown in Figure 38 and Figure 39.

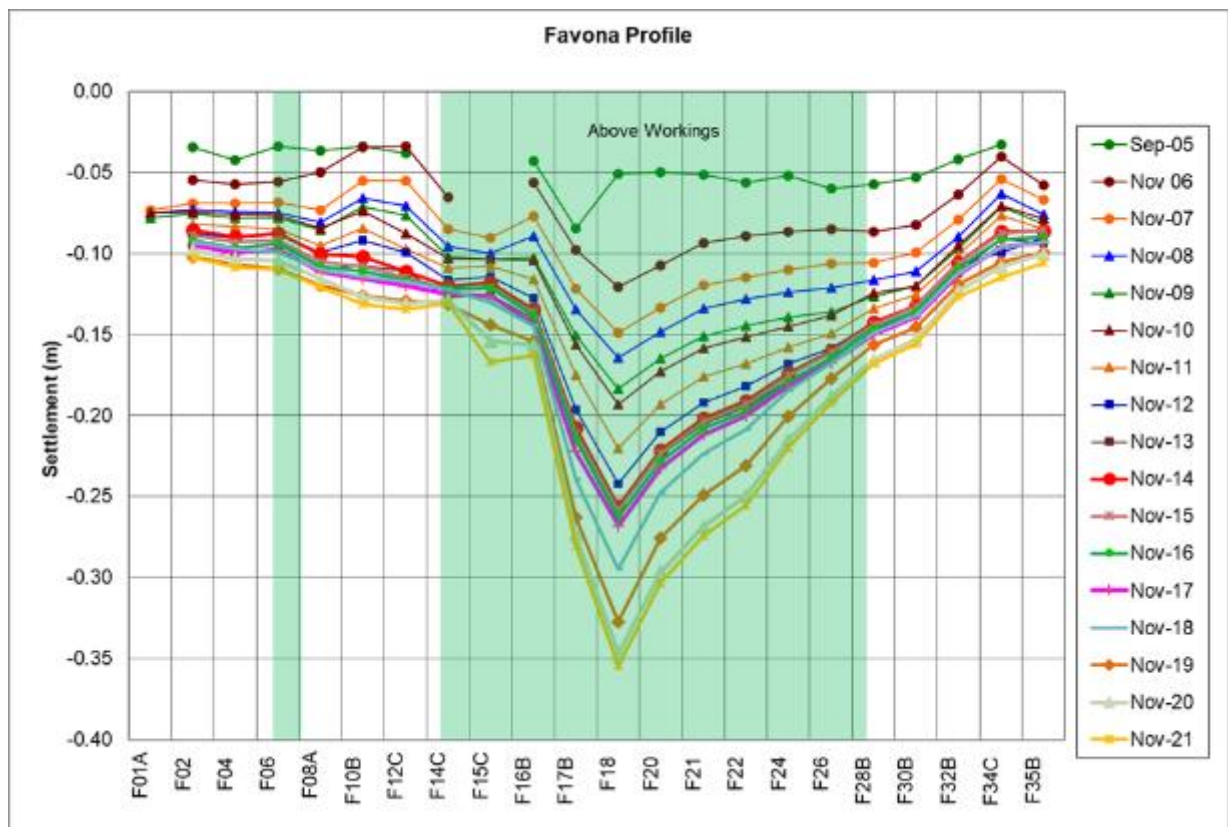


Figure 38: Favona Settlement Profile



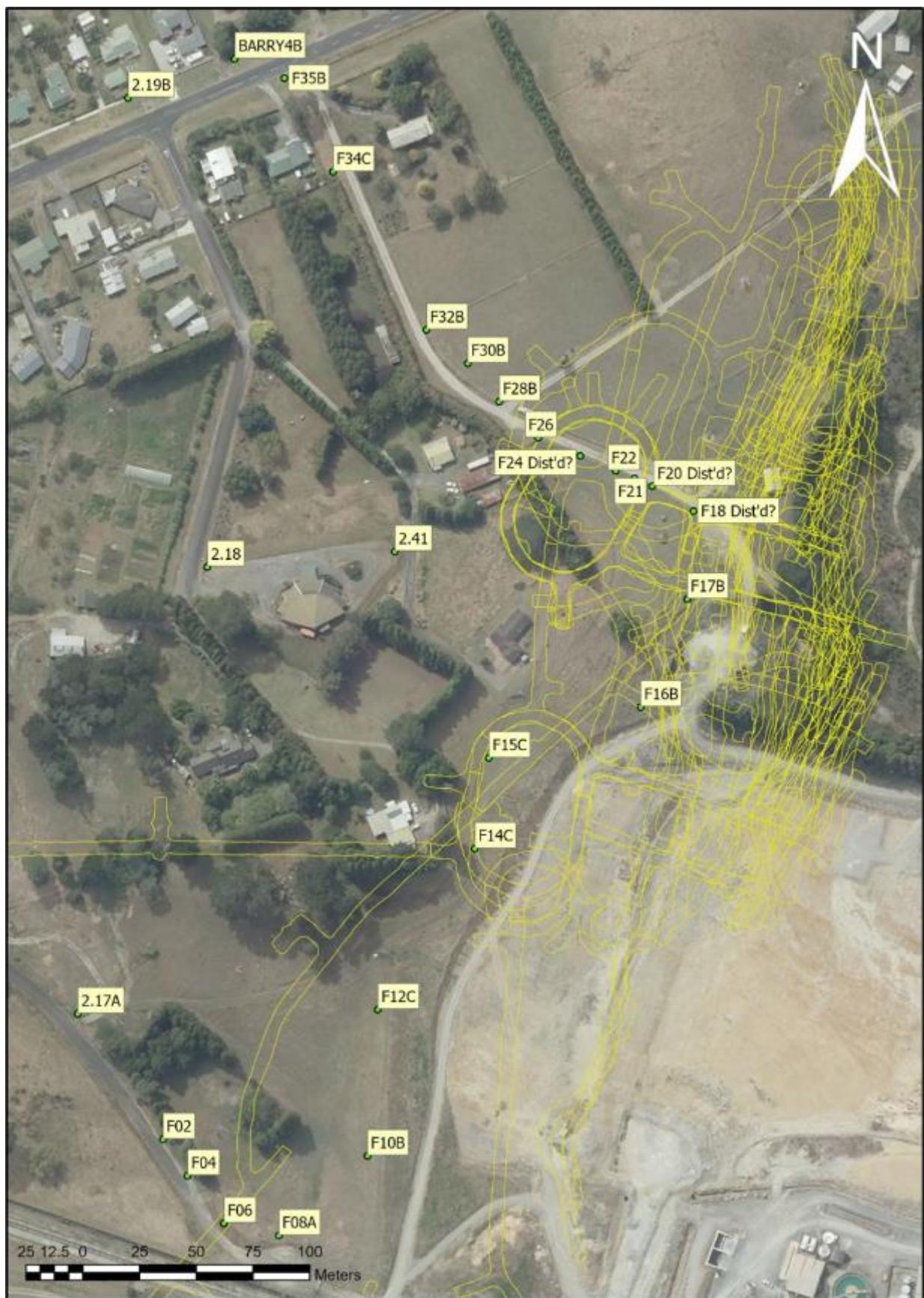


Figure 39: Favona Settlement marks and workings

## Discussion

### Favona Tilt

The results for Favona indicate no new trends compared with recent surveys. No new tilt measurements in excess of 1:1000 has been recorded since the November 2020 survey.

All Favona marks showed more settlement than the November 2020 survey, continuing the trend of slow settlement over time at this location.

Tilt calculations greater than 1:1000 were determined in five locations (F16B/F17B, F17B/F18, F18/F21, F21/F24 and F24/26). These are all located over or near underground workings. Tilt in this area has changed little since 2005, with small increases in tilt as the dewatered underground workings adjust compared to the adjacent land. These locations are on farmland owned by the company; are over 100m south of any non-company residences; and are not considered to be an issue. Monitoring will continue, and this will determine any anomalous results that need to be addressed.

Note 1: The Favona tilt calculation is calculated from the total settlement at each mark, without separation of any Martha effect. While the calculated tilt may not precisely reflect the tilt due to Favona alone, the discrepancy is considered to be minor.

Note 2: Not all Favona settlement markers are included in tilt calculations due to some being too close to one another for accurate tilt calculations. The minimum distance between marks included in tilt calculation is 25m.

### 7.2 Martha/North Wall Tilt

No tilt calculations greater than 1:1000 in the Martha/North Wall area have been identified during the November 2021 survey.

Although no tilts have been identified in Slevin Park, the area is swampy, historically infilled with poor material and with previous slumping/subsidence. Therefore, close monitoring of this area will continue. We understand that HDC is also undertaking regular monitoring of this area.

### 7.3 Correnso

Two tilt calculations greater than 1:000 in the Correnso South area were identified during the May 2020 survey and remain in the November 2021 survey. The tilts are between marks 23C/2.25 and 23C/BANK1 (Figure 40). Both tilts are due to a sharp increase in settlement of mark 23C in the May 2020 survey. The rate of settlement recorded at 23C in subsequent survey events has been similar to nearby marks. The mark is noted by the surveyor as being near a watercourse. The mark may have been influenced by improved drainage nearby or may have been disturbed.





Figure 40: Correnso Tilts and Underground Workings

#### 7.4 SUPA

No tilts in the SUPA area have been identified.

#### 7.5 Historic comparisons

Marks are compared with the three previous surveys to help assess any trends (Table 2). It should be noted that tilt assessments vary depending on the separation distance of the markers. If marks have little tilt, large numbers can sometimes be generated. Additionally, marks can be reviewed which can result in revised corrections. This will modify tilt calculations.

Historic comparisons for Favona marks have not been included prior to the May 2021 reporting period due to the large number of Favona marks which were removed from tilt calculations following the November 2020 survey event, as agreed by Hauraki District and Waikato Regional Councils.

Mark	Tilt (1:X) May 20	Tilt (1:X) Nov 20	Tilt (1:X) May 21	Tilt (1:X) Nov 21
------	----------------------	----------------------	----------------------	----------------------

**Favona**

F02			N/A	N/A
F08A			3222	6510
F10B			3595	3232
F12C			11757	22374
F14C			207249	24632
F15C			1268	1117
F16B			8104	15596
F17B			444	441
F18			512	528
F21			381	370
F24			440	479
F32B			941	937
F34C			5745	6838
F35B			5250	5416

**Martha**

20BB	N/A	N/A	N/A	N/A
20AC	21927	30224	22366	28886
BM20A	1141	1107	1115	1087
20D	1719	1514	1543	1499
19CB	1715	1566	1581	1548
19BB	11405	10952	10534	10702
BM19B	157771	192068	552197	372363
17CB	88647	129878	47329	38434
17BB	1238	1247	1278	1251
17AB	3482	3348	3546	3398
BM17A	1330	1321	1352	1302

**North Wall**

27AB	N/A	N/A	N/A	N/A
26Q	3096	4028	3927	3948
26PB	16121	8987	10784	9529
26OB	3687	3365	3434	3285
26NC	6589	6028	6472	5810
26MB	244214	8307	6822	9174
26JB	21305	12499	7102	20949
BM26	59401	7768	5232	9447
3.09	5811	8750	11847	7935

**Correnso**

25E	N/A	N/A	N/A	N/A
25B	2866	2611	2515	2619
25I	7251	8057	4074	5890
24H	5774	9990	24348	8266
24B	27310	21143	19277	17453
24G	6018	6081	5780	5602
24L	94593	14553	6524	31210
24AC	16039	7868	9065	17440
24F	5742	7308	6184	7874
BM24	3131	3131	3195	3413
24E	6560	6661	7338	7564
24DC	8297	4716	9143	401372
24I	5646	5247	118573	4583
25H	30210	17937	3827	17175
25CB	38223	535124	89187	632001
25G	66119	33059	77139	60071
25F	22865	26842	34298	27346
25B	30704	13546	10012	11751
BM25	6291	5571	5446	5531
25E	7866	7417	7016	7532
25A	21235	18960	26544	25590
25D	55409	87072	43536	44038
21DC	6766	4716	7074	5713
21N	7900	6179	2517	1796
21C	2875	3585	13464	7583
21M	5241	4026	7025	5335
21BC	3353	5204	2830	3061
21EB	10833	42838	34905	39943
24K	2295	2516	2635	2753
24J	6067	12240	3543	1657
24DC	6514	4754	2852	1571
22F	19260	13072	43018	104892
22C	2950	2808	2454	2322
22GB	1613	1528	1420	1438
22BC	3035	4842	5192	5177
22I	32117	6761	64234	15351
22H	4729	6004	3685	4769
21P	3442	17949	2264	8819
21FB	3566	2392	2148	3110
21Q	702402	58534	63855	47393
21GC	8223	17817	17104	15899
22KB	12183	12009	7505	8002
2.29B	3341	2497	2506	2630
22J	6240	5587	4769	4892
22I	1696	2245	1758	2092
22H	3660	6004	3685	4769
21EB	5462	13549	5504	5730
21BC	10833	42838	34905	39943
BM21	8885	8885	10512	9660



20F	9082	9082	9189	8645
20E	1374	1409	1396	1342
21C	4047	4082	4189	4045

**Correnso South**

23F	N/A	N/A	N/A	N/A
2.13	6220	17143	9703	11250
23E	7452	27989	14685	21492
2.14A	221511	28893	19837	14253
23B	15272	241517	17122	54321
BANK1	5789	5182	6798	5122
23C	740	745	736	738
2.25	667	671	603	632
23D	16415	25693	7986	10711
2.24	19802	12101	24203	19298
MATAURA1	4931	5252	4581	5227
BM24	16195	19568	33546	21893

**SUPA**

BM25	N/A	N/A	N/A	N/A
34H	1719	1514	1543	11841
2.10	3511	2996	2944	5800
34C	3998	4031	4484	6228
34GC	1849	1738	1793	3002
19BB	11405	10952	10534	1933
19CB	1973	1927	1919	10702
21O	3687	3053	4370	1724
20C	14469	6666	254246	4049
20D	6565	6339	5930	2962
BM20A	11733	11220	12101	1499

	Above Mine Workings
	Tilt Greater than 1:1000

No anomalous trends were identified. Some marks have shown an overall trend of increasing tilt; however, none are currently of concern.

## 8 COMPLAINTS

The company maintains a complaints database in accordance with consent condition 13f. There were no complaints received during 2021 in relation to dewatering or settlement.

A number of other property damage complaints or enquiries were made during the year, generally in relation to impacts of blast vibration. As a result, some of the properties were inspected to determine likely sources. No evidence was found of land deformation as a consequence of mining activities.

## 9 CONTINGENCY ACTIONS AND FUTURE IMPACTS

No consent or management plan settlement trigger has been activated.

## 10 UNDERGROUND WATER QUALITY

Underground dewatering water is sampled at the Water Treatment Plant. This is a combination of underground water from Favona, Trio, Correnso, SUPA, Martha mines and treated service water, but gives a general indication of underground water quality. Additionally, Environmental staff endeavour to collect quarterly water samples from four locations underground.

The only mine backfilled and considered near its final closure state is the Favona underground mine. Separate sampling of Correnso and Favona underground water from sumps at the lowest accessible points in each mine began during 2018. Sampling from the two Martha Underground bores, PC1 and PC2, began in 2021.

During the reporting period, results from the composite underground dewatering had stable pH and EC values averaging 6.6 units and 291 mS/m respectively. Sulphate values averaged 1930 g/m<sup>3</sup>. Fe averaged 4.9 g/m<sup>3</sup> and Mn 17 g/m<sup>3</sup>. Other metal concentrations were low (Figure 41; Appendix E).

Underground sites were sampled eight times in 2021. These included:

705 level Correnso x2

800 level Favona x1

800 level PC1 bore x3

800 level PC2 bore x2

Some sites were not able to be sampled due to dry sumps, the bore not running, or samples missed during lockdown or access issues. The composite underground mine water was sampled monthly throughout the period

From the sites listed above, the single Favona sample had the highest EC and sulphate (446 mS/m and 3500 g/m<sup>3</sup>). It also had the lowest pH (3.1 pH units) (Figure 41). This could be due to the 800 sump often being dry and results more elevated when the sample was able to be taken. All other samples returned similar results, except for a 3.4 pH recorded in Correnso. The seven samples, excluding the Favona result (only one sample taken), recorded averages of:

EC 300 mS/m

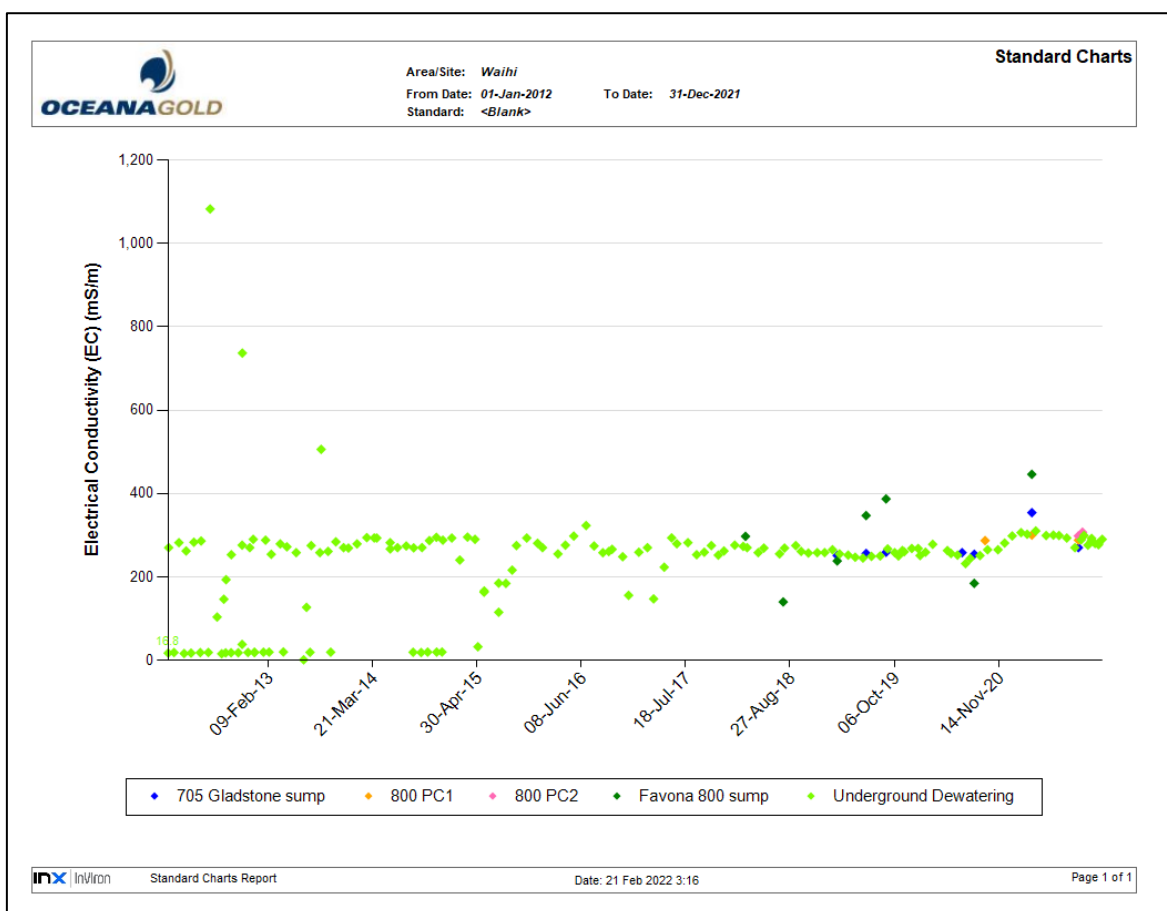
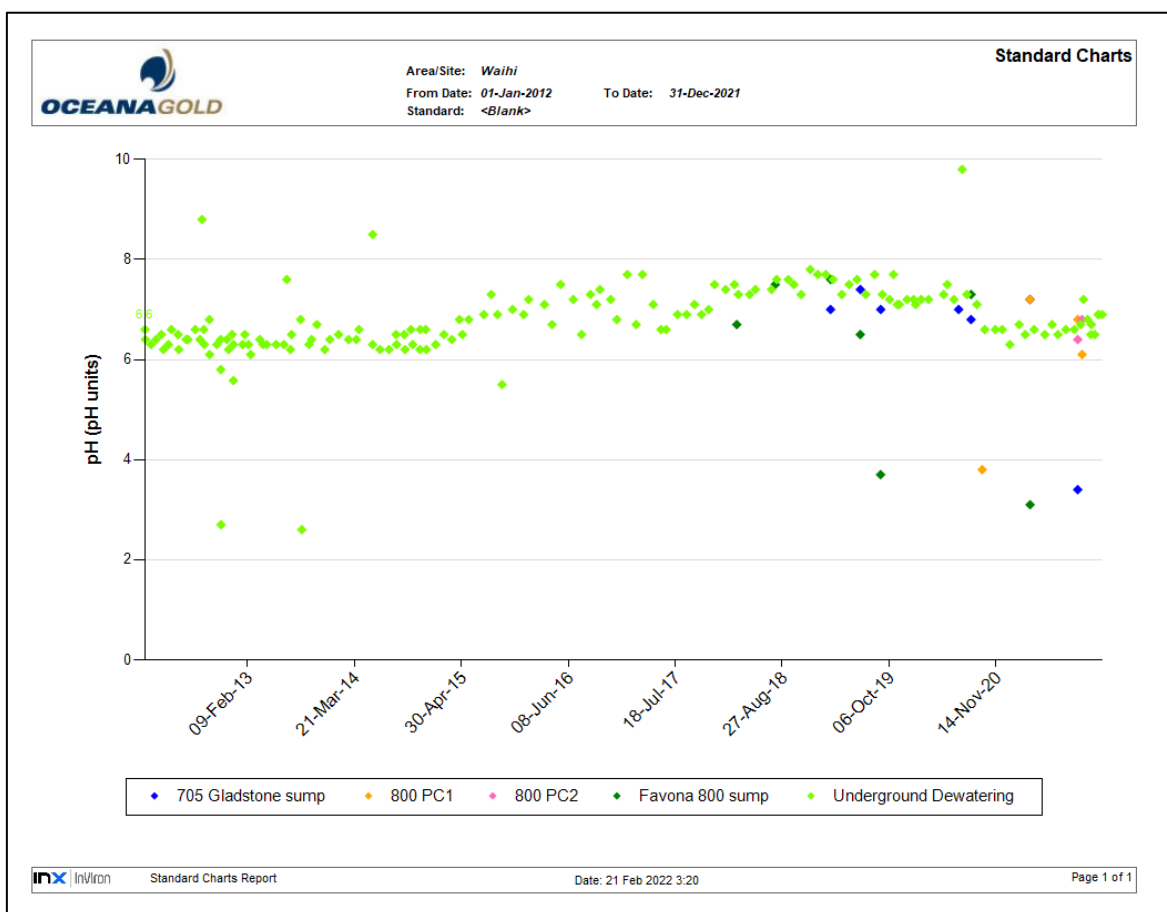
Sulphate 1900 g/m<sup>3</sup>

pH 6.2.

Figures 42 to 45 show Piper Diagrams for the various types of underground water. All water types have a similar make up of cation and anions. UG dewatering and Correnso and at times Favona are calcium sulphate waters and PC01 and at times Favona, are calcium magnesium sulphate waters.

While elevated levels of some metals are noted, all underground water is currently pumped to the Water Treatment Plant.

Figure 46 displays a Piper diagram for treated water. Treated water is used a service water underground, as discussed in Section 4. Treated water quality is extremely consistent as it needs to comply with strict water quality parameters prior to river discharge. In 2021 service water made up 5% of the dewatering volume total and is unlikely to have any effect on groundwater quality. Water quality results are provided in Appendix E.



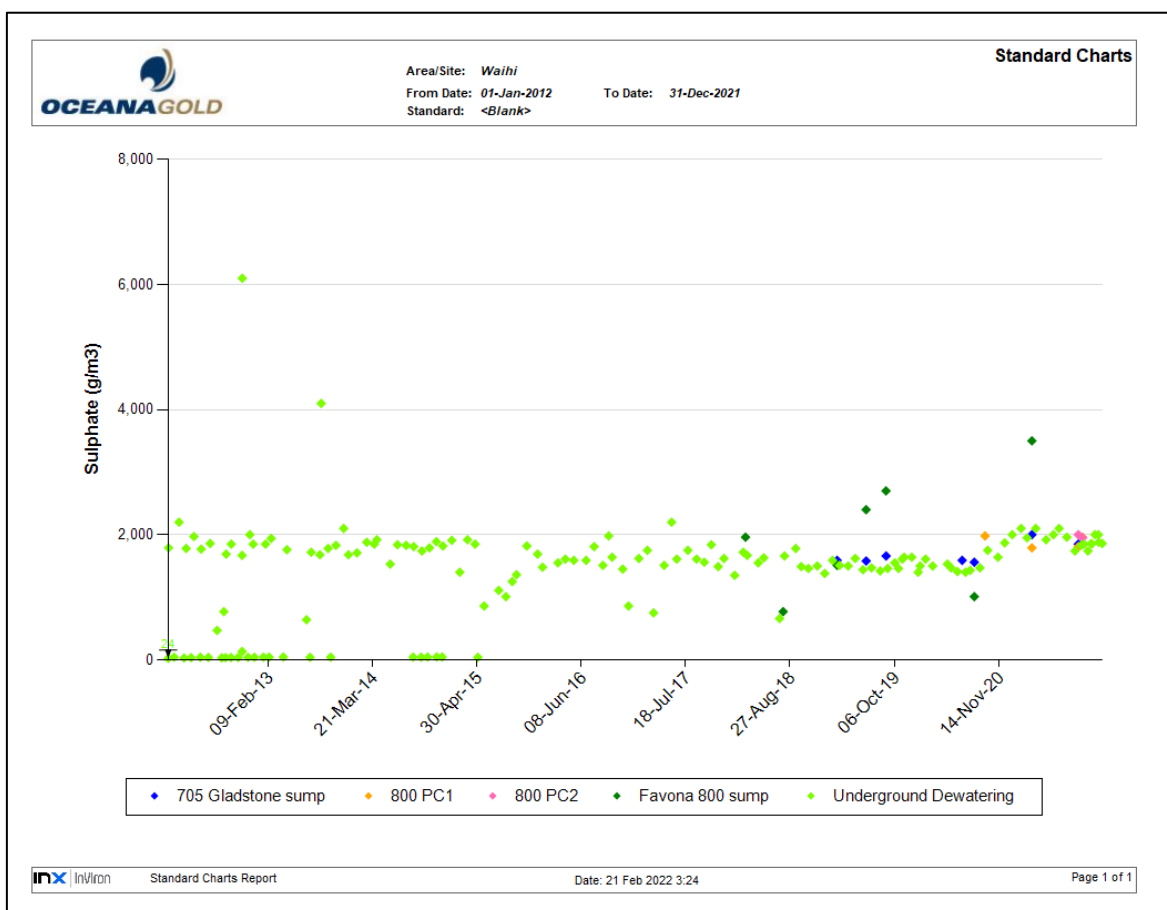


Figure 41: Underground sample sites – Key Chemistry

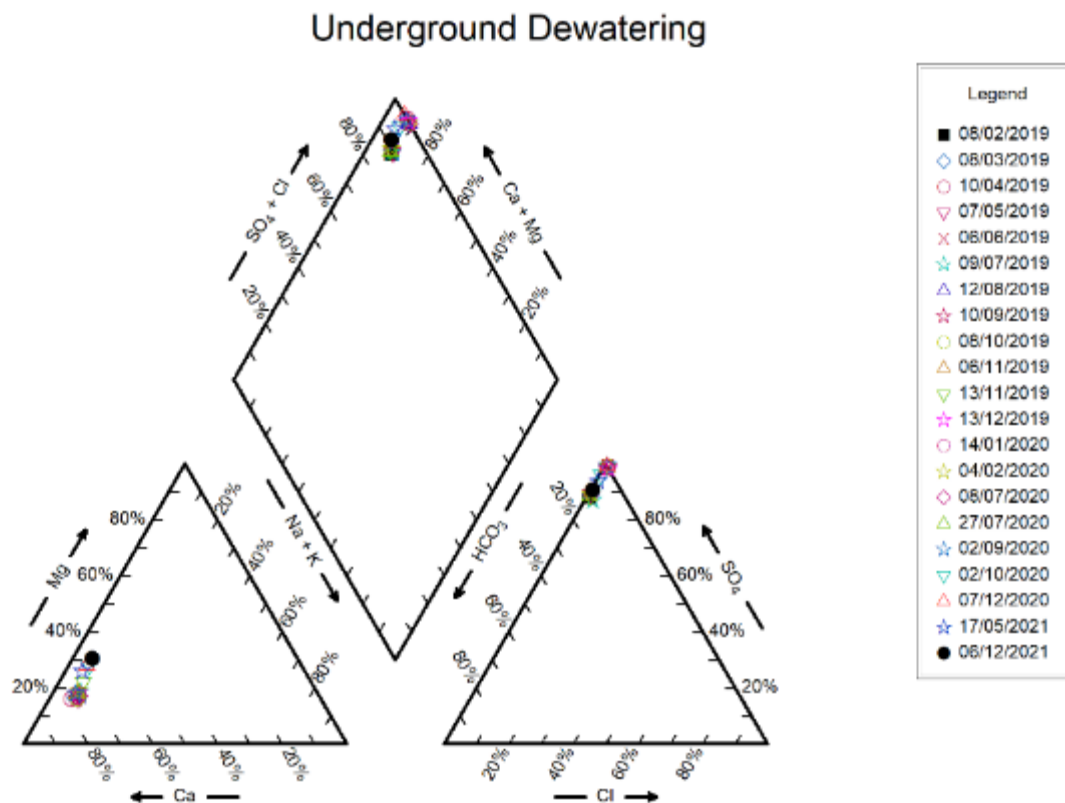


Figure 42: Underground Dewatering Piper Diagram

## Correnso Underground Water

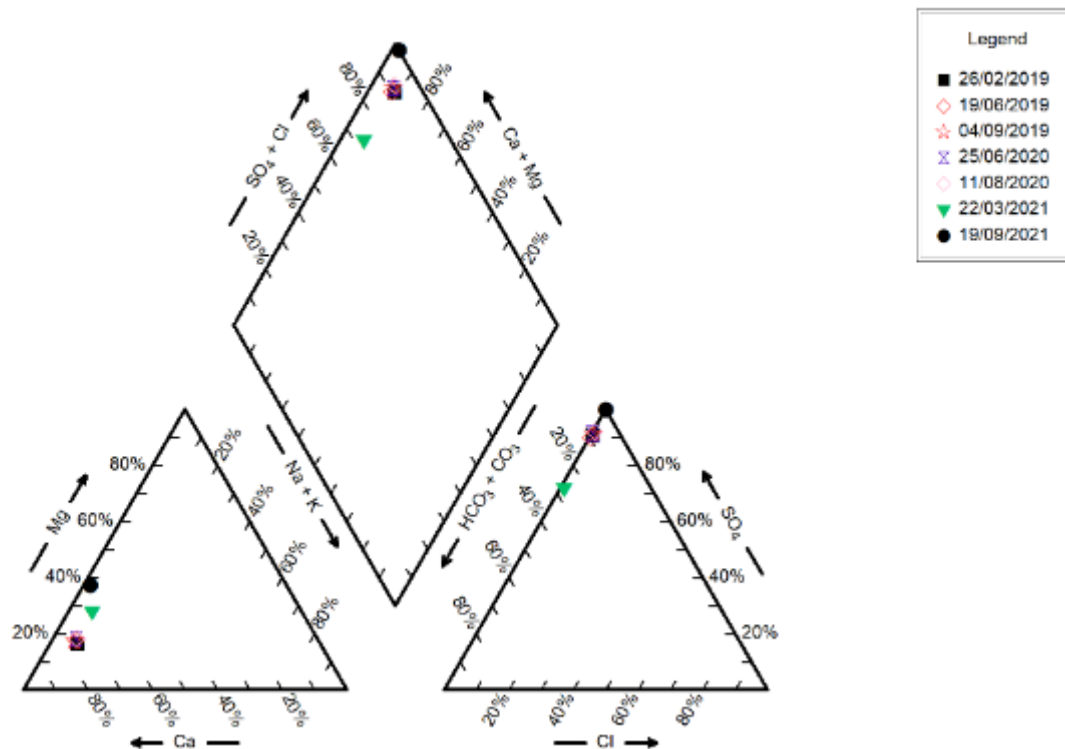


Figure 43: Correnso Underground Piper Trilinear Diagram

## Favona Underground Water



Figure 44: Favona Underground Piper Trilinear Diagram



## Underground mine sites - comparison

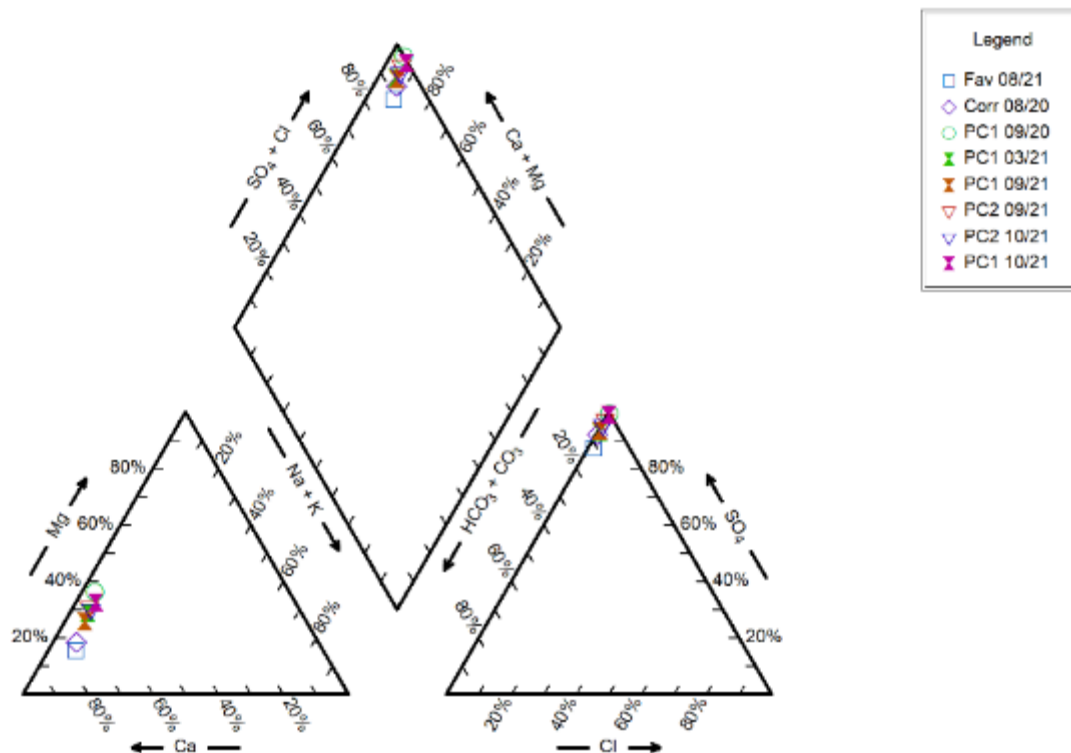


Figure 45: Underground Comparison Water Piper Trilinear Diagram

## Treated Water

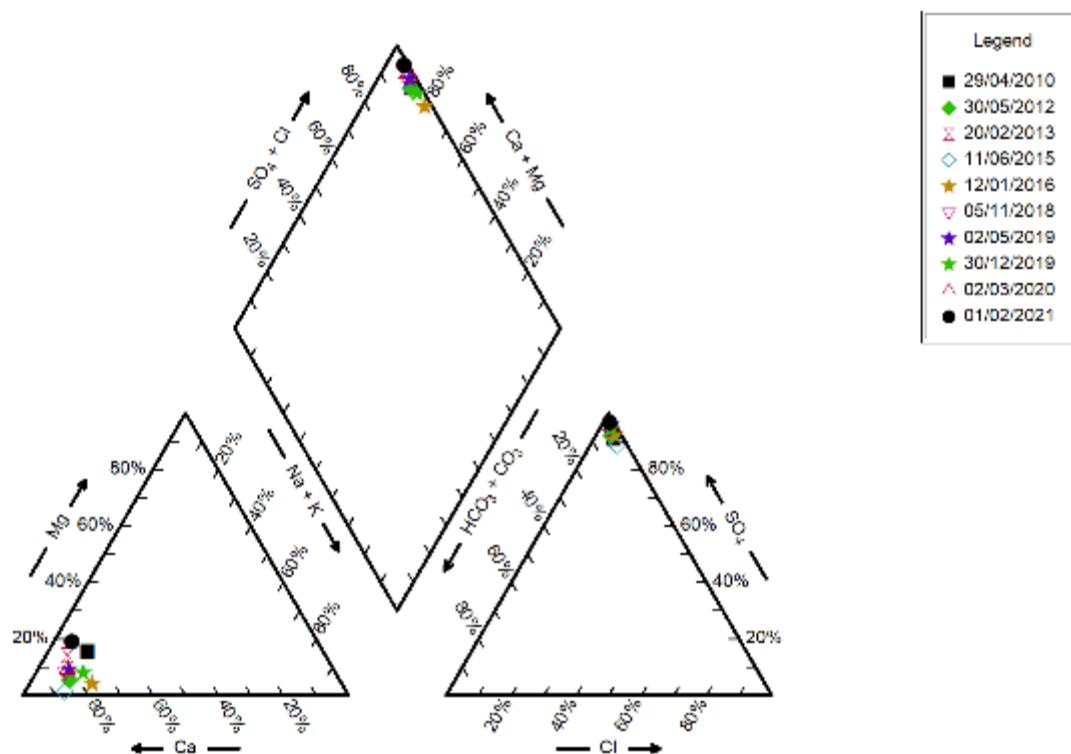


Figure 46: Treated Water Piper Trilinear Diagram

## 11 IMPROVEMENT ACTIVITIES

Works that have been undertaken to improve environmental performance during 2021 include:

- Installation of the final three piezometers to monitor Project Martha dewatering

Proposed improvement activities to be undertaken in 2022:

- Review of the Martha piezometer network to assess effectiveness
- Installation of a VW piezometer in the underground Martha mine to ~500mRL

## 12 PEER REVIEW RECOMMENDATIONS 2021

This is a new section to display peer review recommendations and how they have been or are going to be addressed in this report (Table 10).

Table 10: Peer recommendations and actions 2021

Recommendation	Action
8.2 The Peer Reviewer recommends that any (underground) substantial or anomalous water inflows, or wet ground conditions be recorded along with the structural geology during the driving of the three declines that are planned to access the deeper ore bodies for Project Martha	Action created for Principal Geotech Andre Alipate
8.6 There needs to be better resolution provided on a subset second hydrograph. The current vertical axis scale (resolution) does not allow distinguishing subtle changes/trends that may occur from mine induced impacts or climatic conditions for individual piezometers and shows cluttering of data with overlapping of piezo data.	Requested to GWS. To be included in 2022 report
8.7 "Alluvium water level contours" Need to label groundwater level contours on Figure 9 and need to include data points in contouring shallow VWP tips for piezometers P91, P93, P94, P101 and P102	Included in Figure 10
8.8 Younger Volcanics Figure 12. Suggest that you provide flow direction arrows on Figure 12	Included in Figure 12
8.9 Groundwater Results Figure 14 "Andesite Water Level Contours" Should this be renamed as the Upper Andesite Water Level Contours. Suggest providing groundwater flow direction arrows onto Figure 14. Add label for the N-S Edward lode structure and vein systems as discussed in Section 5.3.4 onto Figure 14.	Included in Figure 14
8.11 The Peer Reviewer recommends that private wells are located on a map and the Figure number should be referenced in the text	Included in Figure 9, 5.3.8 text
8.13 The Peer Reviewer recommends that the CEPA Hydrographs could be improved with labelling of geological units. The Peer Reviewer also recommends including a rainfall bar chart on all hydrographs or at least with graphs showing recharge changes including subdued effects. The Peer Reviewer recommends that performance of P94-144	Included in Figures 17 – 28. One hydrograph includes rainfall on Figure 27.

should be reviewed annually to confirm whether the water levels rebound or continue to decline.	P94 performance reviewed monthly as part of data download QAQC.
8.15 The Peer Reviewer recommends that the performance of all the Waihi South piezometers be reviewed, and their functionality confirmed in the 2021-22 DW&S report. The Peer Reviewer recommends an additional piezometer is installed near either P111/P112 which is located deeper into the andesite to confirm current measurements of these piezometers and monitor depressurisation.	Review has been commissioned with GWS. Report to be supplied to peer reviewers and included in 2022 report.
8.16 The Peer Reviewer recommended that a program for additional piezometers in the North Wall. Recommends deepest piezometers tips are 100m deeper than proposed in the GWS Memo. The Peer Reviewer also recommends OGNZL check the proximity of the proposed locations relative to a suspected substantial EW trending fault (Waihi Fault) postulated behind the North Wall and consider whether additional piezometers further back from the proposed three new multilevel piezometers are needed with respect to deep wall cutback stability.	Included in GWS piezometer network review.
8.17 Recommend a replacement piezometer in Younger Volcanics located further to southwest to monitor potential impacts from Edward/Rex mine workings	Included in GWS piezometer network review.
8.18 The Peer Reviewer recommends select piezometers from these investigations should be incorporated into the regional network to reduce spatial piezometric data gaps in this area	Included in GWS piezometer network review
8.19 The Peer Reviewer recommends that a more thorough review of the piezometer network be conducted and reported on in the 2021-22 DW&S report	Included in GWS piezometer network review
8.20 The Peer Reviewers recommend the inclusion of conceptual hydrogeological cross-sections showing relationships between piezometric levels and geological units/structures and mine surface and underground infrastructure	Review has been commissioned with GWS. To be included in 2022 report.
8.21 It should be noted that while the UG dewatering and Correnso and at times Favona are calcium sulphate waters that PC01 and at times Favona, are calcium magnesium sulphate waters. The DW&S report does not include any analyses for the treated surface water which is used for underground services. OGNZL advise that it will provide analytical data for the service water in future DW&S reports	Text amended Section 10  Treated water data included in Section 10
8.22 The Peer Reviewer recommends that the Open Pit surface runoff water quality monitoring program should be re-evaluated and reinstated once the Phase 4 North Wall Cutback is completed. In the meantime, OGNZL should consider seeking temporary suspension of this aspect of Condition 8 from Waikato Regional Authority	Have contacted WRC re: suspension. Response is that consent variation not required, and they understand the requirement currently cannot be fulfilled.
8.24 The Peer Reviewer recommends that the requirement for water chemistry data in shallow and deep aquifers	A separate report "Shallow and deep Aquifer Report" was submitted and accepted by WRC in 2020. This

needs to be clarified so that an appropriate baseline monitoring program can be instigated as soon as possible. The Peer Reviewer recommends that a section on "Predicted Post Closure Effects" should be included in future DW&S Reports	has been queried with WRC if sufficient.  To be included in 2022 report.
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### 13 RESOURCE CONSENT EVALUATION

Comments on compliance with all conditions of the Martha, Favona, Trio, Correnso and Project Martha consents including any reasons for non-compliance or difficulties in achieving conformance with the consent conditions are summarised in Table 10. The Correnso/Golden Link take 124860 has been superseded by Project Martha Water Permit 139551.

Table 11 – Favona, Trio, Correnso, SUPA, Project Martha Consent Condition Compliance Assessment

Description	Consent (Condition)	Compliance	Comment
<b>Favona Dewatering and Settlement Plan</b>	<b>109742 - 109746</b>		
Favona groundwater take	109742 (3)	Full	Favona discharge plumbed into main dewatering line, new meter installed on Favona line.
Divert and discharge ground and surface water (farm run-off and intercepted groundwater) from around the (Favona) project area.	109743	Full	Non-mine run-off has been diverted to natural drainage.
Discharge waste rock and ore onto land in temporary surface stockpiles and to discharge seepage from the temporary stockpiles into ground.	109744	Full	Stockpile area design & construction. Water quality monitoring in manholes and shallow bores (the subject of a separate report – <i>Favona Water Quality Monitoring Annual Report</i> ).
Discharge waste rock into land underground in the project area as backfill and to allow degraded quality groundwater to discharge from the flooded workings in the project area into the surrounding ground post closure.	109745	Full	Favona back-filling completed.  Dewatering being maintained
Discharge treated mine water from the Martha Mine Water Treatment Plant to ground in association with flooding the underground mine on completion of the project.	109746	Full	Favona Water Quality Monitoring Annual Report
	109742 – 109746		
	Schedule 2		
Water Management Plan	(1)		Under separate negotiation
Prior to exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Settlement, Dewatering and Water Quality Monitoring Plan	(2)	Full	Dewatering and Settlement Monitoring Plan, April 2019
The monitoring regime shall be designed to assess the effects of:		Full	Defined in this document
a) mine dewatering on the regional groundwater system,			



b) mine dewatering on settlement;			c) Reported annually in Favona Water Quality Monitoring Report.
c) leachate from stockpiles containing potentially acid forming material on shallow groundwater quality, and			d) Combined dewatering sample taken monthly
d) the discharge of degraded-quality water from the backfilled and flooded workings on groundwater quality.			
Final details of the monitoring locations are to be agreed with the Council. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.	Full		Section 5  Stockpile water quality bores agreed in Nov 2006
The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed, and updated as necessary, by the consent holder at least once every two years. Any updated Plan shall be promptly forwarded to the Council for approval and following approval the updated Plan shall be implemented in place of the previous version.	Full		Consent activated following approval of Plan. Combined plan, approved by WRC, April 2019
In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Settlement, Dewatering and Water Quality Monitoring Plan, then the conditions of this consent shall prevail.	Full		No inconsistency identified
In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Council in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:	(3)	Full	Section 7  Correspondence in Tilt Reports
a) explain the cause of the non-conformance,			Section 7
b) agree with the Council on the appropriate settlement contingency measures to be implemented as described,			Propose ongoing monitoring
c) implement settlement contingency measures as appropriate,			Not considered necessary as on company owned farmland
d) advise the Council on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.			Propose ongoing monitoring
The report shall include at least the following information:	(4)		
a) volume of groundwater abstracted		Full	Section 4
b) data from monitoring undertaken during the previous year including groundwater contour plans		Full	Section 5
c) an interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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.		Full	Section 5 & 9

This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information.	Full	GWS Ltd & OGNZL staff
d) any contingency actions that may have been taken during the year.	Full	Section 9
e) comment on compliance with all conditions of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of this consent.	Full	This section
<b>Trio Dewatering and Settlement Plan - General conditions</b>	<b>121416 - 121418, 121446 &amp; 121447</b>	
Prior to exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Settlement, Dewatering and Water Quality Monitoring Plan	Schedule 1 (5)	Full Combined plan Approved by WRC April 2019
The monitoring regime shall be designed to assess the effects of:	Full	Defined in plan
i) dewatering on the regional groundwater system,		
ii) dewatering on settlement;		
iii) the discharge of degraded-quality water from the backfilled and flooded workings on groundwater quality.		iii) No significant flooded workings as yet.
Final details of the monitoring locations are to be agreed with the Council. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.	Full	Defined in approved Plan
The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed, and updated as necessary, by the consent holder. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.	Full	Consent activated following approval of Plan Jul 2014
In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Settlement, Dewatering and Water Quality Monitoring Plan, then the conditions of this consent shall prevail.	Full	No inconsistency identified
Dewatering and Settlement Monitoring Report.	Schedule 1 (6)	
The Report shall, as a minimum, provide the following information:		
i) volume of groundwater abstracted	Full	Section 4
ii) data from monitoring undertaken during the previous year including groundwater contour plans	Full	Section 5
iii) an interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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	Full	Section 5 & 9

contingency actions, if any, the consent holder proposes to take in response to those predictions.

This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information.

Full

GWS Ltd &amp; OGNZL staff

iv) any contingency actions that may have been taken during the year.

Full

Section 9

v) comment on compliance with all conditions of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of this consent.

Full

This section

Monitoring - Tilt:

Schedule 1  
(7)

In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations, installed in accordance with the Settlement, Dewatering and Water Quality Monitoring Plan required pursuant to condition 2 above, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Council in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:

Full

Section 7

Correspondence in Jun  
2019 & Jan 2020

i) explain the cause of the non-conformance,

Section 9

ii) agree with the Councils on the appropriate settlement contingency measures to be implemented,

Propose ongoing  
monitoring

iii) implement settlement contingency measures as appropriate,

Not considered necessary

iv) advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

Propose ongoing  
monitoring

The consent holder shall provide to the Council an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:

a) The volume of groundwater abstracted;

Full

Section 4

b) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;

Full

Section 5

c) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately

Full

Annual Report reviewed  
by GWS Ltd and  
Engineering Geology

experienced and qualified to assess the information;		
d) Any contingency actions that may have been taken during the year; and	Full	Section 9
e) Comment on compliance with Conditions 27 to 34 of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.	Full	This section.
The report shall be forwarded in a form acceptable to the Council.		
Advice note:		
The Dewatering and Settlement Monitoring Report shall be consistent with the Dewatering and Settlement Monitoring Report prepared as a condition of the ground dewatering consent (RC 124860) granted by the Waikato Regional Council.		
<b>Golden Link Project Area Groundwater Take – 124860</b>		
<b>General conditions</b>		
<b>Monitoring - Abstraction Volume</b>	Full	Section 4
4.The consent holder shall monitor the volume of water abstracted on a weekly basis and shall report this to the Waikato Regional Council on a quarterly basis.		
<b>Dewatering and Settlement Monitoring Plan</b>		
5. Prior to the exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.	Full	Latest plan April 2019
The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system, as proposed in the consent application. The monitoring regime shall be designed to assess the effects of:		
(i) dewatering on the regional groundwater system; and	Full	Defined in plan
(ii) dewatering on settlement; and		
(iii) the discharge of degraded quality water from the backfilled and flooded workings on groundwater quality.		iii) No significant flooded workings as yet.
Monitoring locations are to provide appropriate resolution of surface tilt relative to the scale of surface infrastructure and final details are to be agreed with the Councils. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.	Full	Defined in plan



The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed and updated as necessary by the consent holder. Such updated Plans shall relate to the Correnso Mine or to any new mine within Area L. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.

Full

Plan April 19

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

### Dewatering and Settlement Monitoring Report

6. The consent holder shall provide to the Councils an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:

Full

Section 4

Full

Section 5

(i) The volume of groundwater abstracted;

(ii) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;

Full

Section 5 &amp; 9

(iii) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;

Full

Section 9

Full

Section 12

(iv) Any contingency actions that may have been taken during the year; and

(v) Comment on compliance with condition 5 of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

The report shall be forwarded in a form acceptable to the Councils.

### Monitoring - Tilt

7. In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations installed in accordance with the Dewatering and Settlement Monitoring Plan required pursuant to condition 5 of this consent, and such tilt is caused by the de-watering and/or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Councils in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then engage in a process with the Councils:

Full

Section 7

Correspondence in Jun  
2019 & Jan 2020

(i) explain the cause of the non-conformance,

Section 9

(ii) Propose appropriate settlement contingency measures for discussion with Councils and agree with the Councils on the appropriate settlement contingency measures and the timing for their implementation as described,

Propose ongoing monitoring

(iii) implement agreed settlement contingency measures as appropriate within the agreed time limit,

Not considered necessary

(iv) advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

Propose ongoing monitoring

### Monitoring – Water Quality

8. The consent holder shall monitor throughout the period of operation, the chemistry of the groundwater, pit run-off and pit discharge water abstracted from the open pit. The monitoring data is to be used to correlate these inflows with pit lake water quality predictions, and to provide a database for input into the closure plans. The sampling parameters and frequencies shall be described in the Martha Extended Project dewatering consent (unless agreed otherwise with the Waikato Regional Council) with the results forwarded to the Waikato Regional Council on an annual basis.

Partial

Pit sampling limited, dewatering sampled monthly. Favona and Correnso Underground WQ measured separately. Underground dewatering from Project Martha bores commenced.

### Other Water Users

9. If, in the opinion of the Waikato Regional Council, the exercise of this consent adversely affects stock, domestic or other water supplies, then the consent holder shall, at its own cost, be responsible for providing to the owner of those water supplies an alternative equivalent water supply, to the satisfaction of Waikato Regional Council. The consent holder shall be responsible for making an alternative water supply available within 12 hours of being directed to do so by the Waikato Regional Council.

Full

### Project Martha – Common Conditions

202.2018.00000857.001

### Dewatering and Settlement Monitoring Plan

14. The objectives of the groundwater and settlement management system shall be to ensure that dewatering operations do not give rise to surface instability and differential settlement beyond that authorised by this consent.

Full

Dewatering and Settlement Monitoring Plan approved April 2019 (Conditions 14-18)

15. Two months prior to dewatering below 700 m RL (mine datum), the consent holder shall prepare, and submit to the Councils for their certification, a Dewatering and Settlement Monitoring Plan. The purpose of the Dewatering and Settlement Monitoring Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

16 The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system set out in Condition 14 of this schedule. The monitoring regime shall be designed to assess the effects of: a. Dewatering on the regional groundwater system; and b. Dewatering on settlement.

17. Monitoring locations are to provide appropriate resolution of mine inflows and pumping, groundwater levels (both for shallow and deep aquifers) and ground surface tilt relative to the scale of surface infrastructure, throughout the area within the maximum extent of the groundwater cone of depression and particularly in the areas above and adjacent to the mining activities provided for in this consent. Final details are to be agreed with the Councils, but are to include additional piezometers and extensometers located along the line of upper level workings in the Rex Orebody. The Dewatering and Settlement Monitoring Plan shall also provide groundwater and settlement trigger limits that will initiate the implementation of contingency mitigation and / or monitoring measures and shall detail any linkages with the operation of the Martha Pit and Martha Underground Mine.

18. The exercise of this consent shall be in accordance with the Dewatering and Settlement Monitoring Plan as certified by the Councils. The Dewatering and Settlement Monitoring Plan shall be reviewed and updated as necessary by the consent holder. Any updated Dewatering and Settlement Monitoring Plan shall be promptly forwarded to the Councils for certification, and following this process, the updated plan shall be implemented in place of the previous version.

19. In the event that a tilt greater than 1 in 1,000 occurs between any two network monitoring locations installed in accordance with the Dewatering and Settlement Monitoring Plan required pursuant to Condition 15 of this schedule, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Councils in writing within 20 working days of receiving the results of the monitoring. The consent holder shall then:

- a. Explain the cause of the non-conformance;
- b. Propose appropriate settlement contingency measures to the Councils and the timing of implementation thereof by the consent holder;
- c. Implement settlement contingency measures as appropriate within the agreed time limit; and
- d. Advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

Full

Notification of tilts greater than 1:1000 provided in Tilt Report

No non-conformances

20. The consent holder shall as a matter of urgency, advise the Councils of any significant anomalies identified by the regular reading of groundwater levels in the piezometer network. Such advice is to include an explanation of the anomalous results and actions proposed to address any issues identified. This report is to be provided to the Councils within 10 working days of the anomalous results being identified. A "significant anomaly" is defined as a drop in groundwater level greater than the seasonal variation in piezometers within the alluvium and younger volcanic rocks and a drop of 15 m or more in the recordings from piezometers tapping the upper 50 m of Andesite over a one month period.

#### **Dewatering and Settlement Monitoring Report**

22. The consent holder shall provide to the Councils (within one month of an agreed anniversary date) an annual Dewatering and Settlement Monitoring Report. The report shall, as a minimum, provide the following information:

Full

a. The volume of groundwater abstracted;

Full

Section 4

b. The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;

c. An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, predictions of the 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, this analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;

Full

Sections 5, 6 and 9

d. Any contingency actions that may have been taken during the year; and

Full

Section 9

e. Comment on compliance with Conditions 14 to 21 of this schedule including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

Full

This section

f. The report shall be forwarded in a form acceptable to the Councils.

#### **Project Martha Groundwater take permit**

139551

#### **Dewatering Level**

1. The exercise of this consent shall not result in groundwater lowering to a level below 500mRL.

Full

Groundwater level not lowered below 500 mRL.

#### **MONITORING**

2. Upon commencement of this consent, the consent holder shall monitor the volume of water abstracted on a weekly basis and shall report this to the Waikato Regional Council.

Full

Abstraction volumes reported to Council via Hyquest,



3.	<p>Upon the first exercise of this consent the consent holder must telemeter – via a telemetry system developed after liaison with the Waikato Regional Council to ensure that the telemetry system is compatible with the Waikato Regional Council telemetry system standards and data protocols – continuous 15 minute values of: gross take volume (in units of cubic metres). The data must be reported once daily to the Waikato Regional Council via the telemetry system. There must be 96 values, respectively, per daily report. When no water is being taken the data must specify the gross take volume and calculated net take volume as zero.</p>	Full	As above.
4.	<p>The consent holder shall monitor the chemistry of the water abstracted under this consent. Prior to the commencement of this consent the sampling parameters and frequencies shall be agreed with the Waikato Regional Council, with the results forwarded to the Waikato Regional Council on an annual basis. The consent holder may change the sampling parameters and frequencies with the agreement of the Waikato Regional Council.</p>	Full	Appendix E
<b>OTHER WATER USERS</b>			
5.	<p>If, in the opinion of the Waikato Regional Council, the exercise of this consent adversely affects any existing stock, domestic or other water supplies, then the consent holder shall, at its own cost, be responsible for providing to the owner of those water supplies an alternative equivalent water supply, to the satisfaction of Waikato Regional Council. The consent holder shall be responsible for making an alternative water supply available within 12 hours of being directed to do so by the Council.</p>	N/A	
<b>MONITORING OF THE SHALLOW AND DEEP AQUIFERS</b>		Full	<p>Provided to Waikato Regional Council in June 2019</p>
6.	<p>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:</p> <ul style="list-style-type: none"> <li>(a) The nature of the geology under the Martha Pit and immediate surrounds;</li> <li>(b) Comment on the existing groundwater chemistry for the deep and shallow aquifers;</li> <li>(c) Comment on the groundwater levels in the deep and shallow aquifers; and</li> <li>(d) 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.</li> </ul>		

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.

## 14 CONCLUSION

Monitoring of dewatering, groundwater, settlement, tilt, and water quality in and around the Martha, Favona, Trio, Correnso, SUPA and Project Martha operations was undertaken during 2020 in accordance with the consent conditions and the approved monitoring plan.

In 2021, water levels underground were held at approximately 705 mRL throughout the year. No significant changes to groundwater contours in the alluvium, younger volcanics and the upper andesite rock occurred relating to the Martha Mine site during 2021.

At Favona, water levels were maintained around 800mRL and dewatering has maintained the steep but localised depression of the groundwater (contour pattern) along the NE-SW trending vein structure. Water levels in the younger volcanic suite and overlying alluvium have not responded to the significant dewatering of the vein-hosted andesite. Minor or no response has been seen in wells monitoring the upper layers of the andesite rock body. Response is only evident in deeper wells constructed in the andesite rockmass that intercept structures connected to the vein systems.

The drop in pressure in the 975 mRL piezometer in well P94 noted in 2018 and 2019 has discontinued and now appears stable. Shallower piezometers at this location have not shown any corresponding drop in pressure. The depressurisation effect at the 975mRL level is expected to reverse once mining has passed the area. Monitoring of all other piezometers in the Waihi East network show levels consistent with baseline data recorded in 2011.

Settlement monitoring, to assess any effects from groundwater changes, was conducted in May/June and November/December 2021. Settlement survey results indicated that 97% (392/403) of marks graphed were within the predicted settlement ranges, based on the newly implemented Project Martha predicted settlement. Of the greater-than-predicted settlements, four were above or near the Favona Underground mining. The other seven exceedances are generally associated with sites that are considered to be affected by unstable ground or soil creep due to proximity to stream banks or drains. At all these locations no visible effects were noted nearby, and shallow piezometers have not shown any abnormal changes.

A general settlement rate across town of 10 to 65 mm over the period from 1999 to present has been identified and is considered to be a response to ongoing dewatering of structures within the deeper andesite within the Martha groundwater system. There are no widespread ongoing dewatering effects observed in the younger volcanic or upper andesite rock that would give rise to such widespread settlement.

Settlement continues to be observed in marks near and overlying the Favona mine, although the total amount is similar to previous years. The deep monitoring wells connected to the Favona vein system are the only wells showing dewatering changes consistent with this settlement, indicating the settlement is likely to be a response to dewatering of the deeper structures of the Favona vein system and/or to changes in the rockmass volume associated with mining at Favona. Tilt is also apparent between marks near and overlying the Favona mine which is occurring on farmland owned by OGNZL and is not expected to be an issue.

Some elevated trace metal results were noted from underground water sampling during the period; however, this is expected, and all underground water is currently collected and treated.

## 15 REFERENCES

- Davies B., 2002: A review of the structural framework and evolution of the Waihi District, Hauraki Goldfield, New Zealand. Unpublished Internal Report, Newmont.
- Davies B., 2004: Updated structural environment for the Waihi District. Unpublished Internal Memorandum, Newmont.
- Engineering Geology Ltd, 2008: East Layback Project – Ground Settlement. Technical Report for Newmont Waihi Gold, November 2008.
- Engineering Geology Ltd, 2010: Proposed Trio Development Project – Assessment of Ground Settlement. Technical Report for Newmont Waihi Gold, June 2010.
- Engineering Geology Ltd, 2012. Evidence of Trevor Matuschka at Correnso Hearing. Prepared for Newmont Waihi Gold, November 2012.
- IGNS, 2002: Waihi Underground mine workings Stage II investigations Volume 2 – Figures. Prepared for Waihi Underground Mine Workings Technical Working Party. Client Report 2002/46, August.
- GWS Ltd, 2010: Proposed Trio Development Project – Assessment of Groundwater Inflows and Throughflows. Technical Report for Newmont Waihi Gold, June 2010.
- Newmont Waihi Gold, 2013: Favona Water Quality Monitoring, Annual Report 2013. Unpublished Internal Report, Newmont, October 2013.
- URS, 2003: Favona Underground Mine Assessment of Groundwater Issues. Favona Underground Project (Document) 9, 19 March.
- URS 2008; Martha Pit Lake – An Assessment of Water Balance and Water Quality. Technical Report for Newmont Waihi Gold, September 2008.
- URS 2009; Martha Pit Lake – An Assessment of Water Balance and Water Quality. Technical Report for Newmont Waihi Gold, August 2009.
- URS, 2009: Favona Temporary Stockpile – Water Quality Report.



## **Appendix A      Relevant Consent Conditions**

**Extract from conditions of Waikato Regional Council Resource Consents 109742 to 109746, pertaining to Dewatering and Settlement:**

**SCHEDULE TWO – GENERAL CONDITIONS**

The granting of consents (109742 to 109746 inclusive) is subject to the following conditions, which shall apply to each individual consent.

**Water Management Plan**

1. Prior to exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Water Management Plan describing the water management system to be applied across the project area, with emphasis on management of stormwater including water storage options, decline and mine dewatering, and stockpile runoff.

The consent holder shall exercise this consent in accordance with the approved Water Management Plan.

**Settlement, Dewatering and Water Quality Monitoring Plan**

2. Prior to exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Settlement, Dewatering & Water Quality Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement, the groundwater hydraulic regime and on water quality, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system, as proposed in the consent application. The monitoring regime shall be designed to assess the effects of:

- a) mine dewatering on the regional groundwater system,
- b) mine dewatering on settlement;
- c) leachate from stockpiles containing potentially acid forming material on shallow groundwater quality, and
- d) the discharge of degraded-quality water from the backfilled and flooded workings on groundwater quality.

Final details of the monitoring locations are to be agreed with the Council. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.

The Plan shall be consistent with the recommendations included in the reports to the Council entitled;

- *“Proposed Favona Underground Mine – Review of Groundwater Assessment” dated October 2003 and prepared by Pattle Delamore Partners; and*
- *“Technical Review of Water Quality and Geochemistry Issues - Favona Underground Project”, dated October 2003 and prepared by GEOKEM.*

The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed, and updated as necessary, by the consent holder at least once every two years. Any updated Plan shall be promptly forwarded to the Council for approval and following approval the updated Plan shall be implemented in place of the previous version.

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Settlement, Dewatering & Water Quality Monitoring Plan, then the conditions of this consent shall prevail.

3. In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations, installed in accordance with the Settlement, Dewatering & Water Quality Monitoring Plan required pursuant to condition 2 above, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Council in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:
  - a) explain the cause of the non-conformance,
  - b) agree with the Council on the appropriate settlement contingency measures to be implemented as described,
  - c) implement settlement contingency measures as appropriate,
  - d) advise the Council on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

### **Settlement, Dewatering & Water Quality Monitoring Report**

4. The consent holder shall provide to the Council (with a copy provided to the Hauraki District Council) an annual Settlement, Dewatering & Water Quality Monitoring Report. The report shall include at least the following information:
  - a) the volume of groundwater abstracted,
  - b) the data from monitoring undertaken during the previous year including groundwater contour plans (derived from the data) in respect of the piezometer network,
  - c) an interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information,
  - d) any contingency actions that may have been taken during the year,
  - e) comment on compliance with all conditions of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of this consent.

The report shall be forwarded in a format acceptable to the Council.

**Extract from conditions of Hauraki District Council Resource Consent 97/98-105, pertaining to Dewatering and Settlement:**

**3.30 Settlement**

- a) The consent holder shall prepare a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of dewatering on land settlement and the effects of the mining activities on the subsurface hydraulic regime. The Dewatering and Settlement Monitoring Plan shall address at least the following:

- i) An overall description of the groundwater and settlement monitoring system and the measures to be adopted to meet the objectives of the groundwater and settlement monitoring system.
- ii) Details of the piezometer network proposed to monitor the effects of pit dewatering on the aquifers under Waihi township.

Any monitoring bores additional to the existing piezometer network shall be installed and operational prior to the exercising of this consent.

- iii) Details of the settlement monitoring network proposed to monitor the extended zone which has been, or is likely to be, affected by settlement caused by mine dewatering.

Any settlement monitoring network locations additional to the existing monitoring locations shall be installed and operational prior to exercising this consent.

- iv) Details of the survey of facilities in the Waihi township considered by the consent holder to be potentially "at risk" of damage from ground settlement caused by mine dewatering. The survey to be completed shall include collection of information about the facility's location, the nature of construction materials, the nature of sensitive equipment that might be potentially "at risk", and the sensitivity of this equipment to ground settlement caused by mine dewatering and/or tilt.

This survey shall be completed prior to exercise of the Waikato Regional Council consent number 971286.

- v) A settlement contingency plan to include mitigation measures to be implemented in the event that ground settlement caused by mine dewatering induces a tilt that exceeds 1 in 1000 between any two network monitoring locations spaced no less than 25 metres apart. The settlement contingency plan shall particularly address those facilities identified by the consent holder as being potentially "at risk" of damage from ground settlement caused by mine dewatering.
- vi) A dewatering contingency plan that describes the steps the consent holder shall implement in the event that dewatering results in adverse impacts on affected aquifer systems and associated groundwater supplies used for domestic, stock or other purposes.

In detailing the monitoring programmes the consent holder shall provide information on the monitoring methods proposed, the parameters to be monitored, and the calibration and maintenance of monitoring equipment.

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of Waikato Regional Council consent number 971286 shall prevail.

- b) The Dewatering and Settlement Monitoring Plan shall be submitted to Hauraki District Council for approval at least one month prior to the exercise of this consent. The Hauraki District Council shall consult with the Waikato Regional Council prior to approving the Dewatering and Settlement Monitoring Plan. The consent holder shall review and update (as necessary) the Plan and shall provide promptly such updated Plan to the Hauraki District Council annually for approval.



- c) If in the opinion of Hauraki District Council the dewatering adversely affects land or facilities, then the consent holder shall at its own cost be responsible for reinstating the facilities to an equivalent standard to the reasonable satisfaction of Council.
- d) The consent holder shall measure and record the daily volume of water abstracted from the pit.
- e) The consent holder shall undertake monthly water level monitoring of the piezometer network in accordance with the Dewatering and Settlement Monitoring Plan.
- f) The consent holder shall monitor ground settlement at a minimum of six monthly intervals in accordance with the Dewatering and Settlement Monitoring Plan.
- g) In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations spaced no less than 25 metres apart, and such tilt is caused by mine dewatering, or there is a significant variance from the predicted settlement rates described in the evidence of Dr Semple (Table 5, Figure 8 dated 13 November 1997 as presented to the Joint Hearing Committee – attached hereto as Appendix C), the consent holder shall notify the Hauraki District Council and the Waikato Regional Council, in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:
  - explain the cause of the non-conformance,
  - agree with the Hauraki District Council and Waikato Regional Council on the appropriate settlement contingency measures to be implemented as described,
  - implement settlement contingency measures as appropriate,
  - advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.
- h) The consent holder shall provide to the Hauraki District Council and the Waikato Regional Council an annual dewatering and settlement monitoring report. The report shall include at least the following information:
  - The data from monitoring undertaken during the previous year including ground water contour plans (derived from the data) in respect of the piezometer network.
  - Identification of any environmentally important trends in settlement and dewatering behaviour.
  - Interpretation and analysis of any change in ground water profile over the previous year, any contingency actions that may have been taken during the year, predictions of future impacts on other bore users that may arise as a result of any trends that have been identified, and what contingency actions, if any, the consent holder proposes to take in response to those predictions.
  - A comparison of the settlement survey data with that predicted in Table 5 and Figure 8 (dated 13 November 1997) by Dr Semple of Woodward Clyde (NZ) Ltd as provided in evidence to the Joint Hearing Committee.
  - Comment on compliance with this condition.
  - A summary and analysis of complaints relevant to this condition.
  - Any reasons for non-compliance or difficulties in achieving conformance with this condition.
  - Any works that have been undertaken to improve environmental performance or that are proposed to be undertaken in the forthcoming year to improve environmental performance in relation to activities permitted by this condition.

The report shall be forwarded in a format acceptable to the Hauraki District Council.

*(Note: This condition is complementary to Waikato Regional Council consent number 971286).*

**Extract from conditions of Hauraki District Council Resource Consent RC-15735, as pertaining to Dewatering and Settlement:**

**Dewatering and Settlement Monitoring Plan**

14. Within 2 months of the exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system, as proposed in the consent application. The monitoring regime shall be designed to assess the effects of:

- (i) dewatering on the regional groundwater system; and
- (ii) dewatering on settlement.

Final details of the monitoring locations are to be agreed with the Council. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.

The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed and updated as necessary by the consent holder. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

**Dewatering and Settlement Monitoring Report**

15. The consent holder shall provide to the Council an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:
- (i) The volume of groundwater abstracted;
  - (ii) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;
  - (iii) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;
  - (iv) Any contingency actions that may have been taken during the year; and
  - (v) Comment on compliance with condition 14 of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

The report shall be forwarded in a form acceptable to the Council.

**Monitoring – Tilt**

16. In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations installed in accordance with the De-watering and Settlement Monitoring Plan required pursuant to condition 14 of this consent, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Hauraki District and Waikato Regional Councils in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:

- (i) Explain the cause of the non-conformance,
- (ii) Agree with the Councils on the appropriate settlement contingency measures to be implemented as described,
- (iii) Implement settlement contingency measures as appropriate,
- (iv) Advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

**Extract from conditions of Waikato Regional Council Resource Consents 121416, 121417, 121418, 121446, and 121447, pertaining to Dewatering and Settlement:**

**SCHEDULE ONE – GENERAL CONDITIONS**

Resource Consents **121416, 121417, 121418, 121446, and 121447** are subject to the following general conditions, which are applicable to all consents.

**Dewatering and Settlement Monitoring Plan**

- 5 Prior to exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system, as proposed in the consent application. The monitoring regime shall be designed to assess the effects of:

- (i) dewatering on the regional groundwater system; and
- (ii) dewatering on settlement, and
- (iii) the discharge of degraded quality water from the backfilled and flooded workings on groundwater quality.

Final details of the monitoring locations are to be agreed with the Council. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.

The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed and updated as necessary by the consent holder. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

**Dewatering and Settlement Monitoring Report**

6. The consent holder shall provide to the Councils an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:
- (i) The volume of groundwater abstracted;
  - (ii) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;
  - (iii) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis

shall be undertaken by a party appropriately experienced and qualified to assess the information;

- (iv) Any contingency actions that may have been taken during the year; and
- (v) Comment on compliance with condition 5 of this schedule including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

The report shall be forwarded in a form acceptable to the Council.

### **Monitoring – Tilt**

7. In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations installed in accordance with the De-watering and Settlement Monitoring Plan required pursuant to condition 5 of this schedule, and such tilt is caused by the de-watering and/or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Councils in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then engage in a process with the Councils:
  - (i) explain the cause of the non-conformance,
  - (ii) agree with the Councils on the appropriate settlement contingency measures to be implemented as described,
  - (iii) implement settlement contingency measures as appropriate,
  - (iv) advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

### **Extract from conditions of Mining Licence 32 2388, pertaining to Dewatering and Settlement:**

#### **Dewatering**

11. (a) The licensee shall prepare a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of dewatering associated with the extended project on land settlement and the effects of the mining activities on the subsurface hydraulic regime. The Dewatering and Settlement Monitoring Plan shall address at least the following:
  - (i) An overall description of the groundwater and settlement monitoring system and the measures to be adopted to meet the objectives of the groundwater and settlement monitoring system.
  - (ii) Details of the piezometer network proposed to monitor the effects of pit dewatering on the aquifers under Waihi township.  
Any monitoring bores additional to the existing piezometer network shall be installed and operational prior to the commencement of the extended project.
  - (iii) Details of the settlement monitoring network proposed to monitor the extended zone which has been, or is likely to be, affected by settlement caused by mine dewatering.  
Any settlement monitoring network locations additional to the existing monitoring locations shall be installed and operational prior to the commencement of the extended project.
  - (iv) Details of the survey of facilities in the Waihi township considered by the licensee to be potentially "at risk" of damage from ground settlement caused by mine dewatering. The survey to be completed shall include collection of information about the facility's location, the nature of construction materials, the nature of sensitive equipment that might be potentially "at risk", and the sensitivity of this equipment to ground settlement caused by mine dewatering and/or tilt.  
This survey shall be completed prior to the commencement of the extended project.
  - (v) A settlement contingency plan to include mitigation measures to be implemented in the event that ground settlement caused by mine dewatering induces a tilt that exceeds 1 in 1000 between any two network monitoring locations spaced no less than 25 metres apart. The settlement contingency plan shall particularly address those facilities identified by the licensee as being potentially "at risk" of damage from ground settlement caused by mine dewatering.



- (vi) A dewatering contingency plan that describes the steps the licensee shall implement in the event that dewatering results in adverse impacts on affected aquifer systems and associated groundwater supplies used for domestic, stock or other purposes.

In detailing the monitoring programmes the licensee shall provide information on the monitoring methods proposed, the parameters to be monitored, and the calibration and maintenance of monitoring equipment.

In the event of any conflict or inconsistency between these conditions and the provisions of the Dewatering and Settlement Monitoring Plan, these conditions shall prevail.

- (b) The Dewatering and Settlement Monitoring Plan shall be submitted to the Minister for approval at least one month prior to the commencement of the extended project. The licensee shall review and update (as necessary) the Plan and shall provide promptly such updated Plan to the Minister annually for approval.
- (c) If in the opinion of the Minister the dewatering adversely affects land or facilities, then the licensee shall at its own cost be responsible for reinstating the facilities to an equivalent standard to the reasonable satisfaction of the Minister.
- (d) The licensee shall measure and record the daily volume of water abstracted from the pit.
- (e) The licensee shall undertake monthly water level monitoring of the piezometer network in accordance with the Dewatering and Settlement Monitoring Plan.
- (f) The licensee shall monitor ground settlement at a minimum of six monthly intervals in accordance with the Dewatering and Settlement Monitoring Plan.
- (g) In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations spaced no less than 25 metres apart, and such tilt is caused by mine dewatering, or there is a significant variance from the predicted settlement rates described in the evidence of Dr Semple (Table 5, Figure 8 dated 13 November) the licensee shall notify the Minister, in writing, within 20 working days of receiving the results of the monitoring. The licensee shall then:
- Explain the cause of the non-conformance;
  - Agree with the Minister on the appropriate settlement contingency measures to be implemented as described;
  - Implement settlement contingency measures as appropriate;
  - Advise the Minister on the steps the licensee proposes to take in order to prevent any further occurrence of the situation.
- (h) The licensee shall provide to the Minister an annual dewatering and settlement monitoring report. The report shall include at least the following information:
- The data from monitoring undertaken during the previous year including ground water contour plans (derived from the data) in respect of the piezometer network;
  - Identification of any environmentally important trends in settlement and dewatering behaviour;
  - Interpretation and analysis of any change in groundwater profile over the previous year, any contingency actions that may have been taken during the year, predictions of future impacts on other bore users that may arise as a result of any trends that have been identified, and what contingency actions, if any, the licensee proposes to take in response to those predictions;
  - A comparison of the settlement survey data with that predicted in Table 5 and Figure 8 (dated 13 November 1997 by Dr Semple of Woodward Clyde (NZ) Ltd);
  - Comment on compliance with this condition;
  - A summary and analysis of complaints relevant to this condition;

- Any reasons for non-compliance or difficulties in achieving conformance with this condition;
- Any works that have been undertaken to improve environmental performance or that are proposed to be undertaken in the forthcoming year to improve environmental performance in relation to activities permitted by this condition;
- The report shall be forwarded in a format acceptable to the Minister.

**Extract from conditions of Hauraki District Council Resource Consent 202.2012 (Correnso), as pertaining to Dewatering and Settlement:**

**Dewatering and Settlement Monitoring Plan**

- 27 The objectives of the groundwater and settlement management system shall be to ensure that dewatering operations do not give rise to surface instability and differential settlement beyond that authorised by this consent.
- 28 Within 2 months of the exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.
- 29 The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system set out in Condition 27. The monitoring regime shall be designed to assess the effects of:
  - a) Dewatering on the regional groundwater system; and
  - b) Dewatering on settlement.
- 30 Monitoring locations are to provide appropriate resolution of groundwater levels and surface tilt relative to the scale of surface infrastructure, particularly in the areas above and adjacent to the mining activities provided for in this consent. Final details are to be agreed with the Council. The Plan shall also provide settlement trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.
- 31 The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed and updated as necessary by the consent holder. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.
- 32 In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations installed in accordance with the Dewatering and Settlement Monitoring Plan required pursuant to Condition 28 of this consent, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Hauraki District and Waikato Regional Councils in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then:
  - a) Explain the cause of the non-conformance;
  - b) Propose appropriate settlement contingency measures to the Councils and the timing of implementation thereof by the consent holder;
  - c) Implement settlement contingency measures as appropriate within the agreed time limit;
  - d) Advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.
- 33 The consent holder shall as a matter of urgency, advise the Council of any significant anomalies identified by the regular (monthly) reading of groundwater levels in the piezometer network. Such advice is to include an explanation of the anomalous results and actions proposed to address any issues identified. This report is to be provided to the Council within 10 working days of the anomalous results being identified.
 

A "significant anomaly" is defined as 15m or more offset occurring in piezometer recordings over a 1 month period.
- 34 In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

Advice notes:

1. The Dewatering and Settlement Monitoring Plan shall be consistent with the Dewatering and Settlement Monitoring Plan prepared as a condition of the ground dewatering consent (RC 124860) granted by the Waikato Regional Council.
2. The monitoring undertaken in terms of the Dewatering and Settlement Monitoring Plan may need to be continued for a period beyond the term of this consent depending on recharge of the groundwater following cessation of underground mining activities and the filling of the Martha Pit.

### **Dewatering and Settlement Monitoring Report**

35 The consent holder shall provide to the Council an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:

- a) The volume of groundwater abstracted;
- b) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;
- c) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;
- d) Any contingency actions that may have been taken during the year; and
- e) Comment on compliance with Conditions 27 to 34 of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

The report shall be forwarded in a form acceptable to the Council.

Advice note:

The Dewatering and Settlement Monitoring Report shall be consistent with the Dewatering and Settlement Monitoring Report prepared as a condition of the ground dewatering consent (RC 124860) granted by the Waikato Regional Council.



**Extract from conditions of Waikato Regional Council Resource Consent 124860, pertaining to Dewatering and Settlement:**

**Monitoring - Abstraction Volume**

4. The consent holder shall monitor the volume of water abstracted on a weekly basis and shall report this to the Waikato Regional Council on a quarterly basis.

**Dewatering and Settlement Monitoring Plan**

5. Prior to the exercise of this consent, the consent holder shall prepare, and submit to the Council for its written approval, a Dewatering and Settlement Monitoring Plan. The purpose of this Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system, as proposed in the consent application. The monitoring regime shall be designed to assess the effects of:

- (i) dewatering on the regional groundwater system; and
- (ii) dewatering on settlement; and
- (iii) the discharge of degraded quality water from the backfilled and flooded workings on groundwater quality.

Monitoring locations are to provide appropriate resolution of surface tilt relative to the scale of surface infrastructure and final details are to be agreed with the Councils. The Plan shall also provide trigger limits that will initiate the implementation of contingency mitigation and/or monitoring measures and shall detail any linkages with the Martha pit operation.

The exercise of this consent shall be in accordance with the Plan as approved by the Council. The Plan shall be reviewed and updated as necessary by the consent holder. Such updated Plans shall relate to the Correnso Mine or to any new mine within Area L. Any updated Plan shall be promptly forwarded to the Council for written approval and following approval, the updated Plan shall be implemented in place of the previous version.

In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

**Dewatering and Settlement Monitoring Report**

6. The consent holder shall provide to the Councils an annual Dewatering and Settlement Monitoring Report. The Report shall, as a minimum, provide the following information:
  - (i) The volume of groundwater abstracted;
  - (ii) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;
  - (iii) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, 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. This analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;
  - (iv) Any contingency actions that may have been taken during the year; and
  - (v) Comment on compliance with condition 5 of this consent including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

The report shall be forwarded in a form acceptable to the Councils.

### **Monitoring - Tilt**

7. In the event that a tilt greater than 1 in 1000 occurs between any two network monitoring locations installed in accordance with the Dewatering and Settlement Monitoring Plan required pursuant to condition 5 of this consent, and such tilt is caused by the de-watering and/or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Councils in writing, within 20 working days of receiving the results of the monitoring. The consent holder shall then engage in a process with the Councils:
  - (i) explain the cause of the non-conformance,
  - (ii) Propose appropriate settlement contingency measures for discussion with Councils and agree with the Councils on the appropriate settlement contingency measures and the timing for their implementation as described,
  - (iii) implement agreed settlement contingency measures as appropriate within the agreed time limit,
  - (iv) advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

### **Monitoring – Water Quality**

8. The consent holder shall monitor throughout the period of operation, the chemistry of the groundwater, pit run-off and pit discharge water abstracted from the open pit. The monitoring data is to be used to correlate these inflows with pit lake water quality predictions, and to provide a database for input into the closure plans. The sampling parameters and frequencies shall be described in the Martha Extended Project dewatering consent (unless agreed otherwise with the Waikato Regional Council) with the results forwarded to the Waikato Regional Council on an annual basis.

### **Other Water Users**

9. If, in the opinion of the Waikato Regional Council, the exercise of this consent adversely affects stock, domestic or other water supplies, then the consent holder shall, at its own cost, be responsible for providing to the owner of those water supplies an alternative equivalent water supply, to the satisfaction of Waikato Regional Council. The consent holder shall be responsible for making an alternative water supply available within 12 hours of being directed to do so by the Waikato Regional Council.

### **Extract from conditions of Waikato Regional Council Resource Consent 124861, pertaining to Dewatering and Settlement:**

#### **Groundwater Monitoring**

5. Piezometers shall be installed at sites to be approved by the Waikato Regional Council for the purpose of monitoring changes in groundwater arising from the exercise of this consent. The groundwater monitoring system shall be detailed in the dewatering and Settlement Monitoring Plan, prepared pursuant to condition 5 of consent number 124860.

### **Extract from common conditions of Hauraki District Council and Waikato Regional Council Resource Consent for Project Martha (202.2018), as pertaining to Dewatering and Settlement:**

#### **Dewatering and Settlement Monitoring Plan**

- 11 The objectives of the groundwater and settlement management system shall be to ensure that dewatering operations do not give rise to surface instability and differential settlement beyond that authorised by this consent.
- 12 Two months prior to dewatering below 700 m RL (mine datum), the consent holder shall prepare, and submit to the Councils for their certification, a Dewatering and Settlement Monitoring Plan. The purpose of the Dewatering and Settlement Monitoring Plan is to monitor and assess the effects of the activities on land settlement and the groundwater hydraulic regime, and also to detail the contingency measures that will be actioned should groundwater or surface settlement triggers be exceeded.

- 13 The Plan shall, as a minimum, provide an overall description of the groundwater and settlement monitoring system and the measures to be adopted, including contingency measures, to meet the objectives of the groundwater and settlement management system set out in Condition 14 of this schedule. The monitoring regime shall be designed to assess the effects of:
  - a. *Dewatering on the regional groundwater system; and*
  - b. *Dewatering on settlement.*
  
- 14 Monitoring locations are to provide appropriate resolution of mine inflows and pumping, groundwater levels (both for shallow and deep aquifers) and ground surface tilt relative to the scale of surface infrastructure, throughout the area within the maximum extent of the groundwater cone of depression and particularly in the areas above and adjacent to the mining activities provided for in this consent. Final details are to be agreed with the Councils, but are to include additional piezometers and extensometers located along the line of upper level workings in the Rex Orebody. The Dewatering and Settlement Monitoring Plan shall also provide groundwater and settlement trigger limits that will initiate the implementation of contingency mitigation and / or monitoring measures and shall detail any linkages with the operation of the Martha Pit and Martha Underground Mine.
  
- 15 The exercise of this consent shall be in accordance with the Dewatering and Settlement Monitoring Plan as certified by the Councils. The Dewatering and Settlement Monitoring Plan shall be reviewed and updated as necessary by the consent holder. Any updated Dewatering and Settlement Monitoring Plan shall be promptly forwarded to the Councils for certification, and following this process, the updated plan shall be implemented in place of the previous version.
  
- 16 In the event that a tilt greater than 1 in 1,000 occurs between any two network monitoring locations installed in accordance with the Dewatering and Settlement Monitoring Plan required pursuant to Condition 15 of this schedule, or there is a significant variance from the predicted settlement rates, the consent holder shall notify the Councils in writing within 20 working days of receiving the results of the monitoring. The consent holder shall then:
  - a. Explain the cause of the non-conformance;

**15.1.1**

- b. Propose appropriate settlement contingency measures to the Councils and the timing of implementation thereof by the consent holder;

**15.1.2**

- c. Implement settlement contingency measures as appropriate within the agreed time limit; and

**15.1.3**

- d. Advise the Councils on the steps the consent holder proposes to take in order to prevent any further occurrence of the situation.

- 17 The consent holder shall as a matter of urgency, advise the Councils of any significant anomalies identified by the regular reading of groundwater levels in the piezometer network. Such advice is to include an explanation of the anomalous results and actions proposed to address any issues identified. This report is to be provided to the Councils within 10 working days of the anomalous results being identified.

A "significant anomaly" is defined as a drop in groundwater level greater than the seasonal variation in piezometers within the alluvium and younger volcanic rocks and a drop of 15 m or more in the recordings from piezometers tapping the upper 50 m of Andesite over a one month period.

- 18 In the event of any conflict or inconsistency between the conditions of this consent and the provisions of the Dewatering and Settlement Monitoring Plan, then the conditions of this consent shall prevail.

*Advice Note:*

*The monitoring undertaken in terms of the Dewatering and Settlement Monitoring Plan may need to be continued for a period beyond the term of this consent depending on recharge of the groundwater following cessation of underground mining activities and filling of the Martha Pit.*

**Dewatering and Settlement Monitoring Report**

- 19 The consent holder shall provide to the Councils (within one month of an agreed anniversary date) an annual Dewatering and Settlement Monitoring Report. The report shall, as a minimum, provide the following information:

- g) The volume of groundwater abstracted;

**15.1.4**

- h) The data from monitoring undertaken during the previous year, including groundwater contour plans (derived from the data) in respect of the piezometer network;

**15.1.5**

- i) An interpretation and analysis of the monitoring data, in particular any change in the groundwater profile over the previous year, predictions of the 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, this analysis shall be undertaken by a party appropriately experienced and qualified to assess the information;

**15.1.6**

- j) Any contingency actions that may have been taken during the year; and

**15.1.7**

- k) Comment on compliance with Conditions 14 to 21 of this schedule including any reasons for non-compliance or difficulties in achieving conformance with the conditions of consent.

**15.1.8**

- l) The report shall be forwarded in a form acceptable to the Councils.



## Appendix B      Surveyor Reports

# MEMORANDUM

TO: **MARK BURROUGHS, KATHY MASON**

FROM: **BRUCE MORRISON**

DATE: **30<sup>TH</sup> JUNE 2021**

SUBJECT: **GROUND SETTLEMENT MONITORING –MAY 2021**

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## Introduction

This report outlines the results from the May 2021 Ground Settlement Monitoring Survey.

## Field Method

The settlement monitoring marks were levelled during May and June 2021 for OceanaGold by myself utilising an experienced *Kauri Gold* assistant under my supervision. An experienced contract surveyor assisted with the baseline levelling on the State Highways when a shadow vehicle was used to satisfy the roading authorities.

Equipment used was a LEICA DNA03 electronic digital level paired with a **new** LEICA 3 section 4.05 metre fibreglass bar coded GKNL4F staff. To minimise 'windage', the staff was used in 2 section 'mode'. The level was serviced and check calibrated by the supplier in March 2021. A field calibration check was carried out by myself before commencing this event and the check result was satisfactory.

Benchmarks AP19 to BUH5 were treated as fixed and the -38.7 mm level misclose distributed. A level run was then taken off this base line from 34BE south to C1 and this -9.2 mm misclose distributed. Control mark C1 was established and levelled during the November 2019 levelling event. The remaining monitoring marks were levelled from these baselines and adjusted using LEICA LEVELPAK-PRO software.

A summary of the above framework 'misclosures' for the last twenty-nine events is tabulated below.

Event	West –East misclose (mm)	North –South misclose (mm)
	AP2 > 34BE > AP1	34BE > AP6
May 2007	+2.4	+6.4
Nov 2007	+2.7	+3.1
May 2008	+13.2	+4.0
Nov 2008	-8.1	+7.3
May2009	+8.8	+3.7
Nov 2009	-5.8	+2.0
May 2010	-8.1	+4.3
Nov 2010	-0.6	+6.4
May 2011	+2.0	+2.7
Nov 2011	+6.9	+6.5

May 2012	+4.1	+6.7
Nov 2012	+23.3	+5.3
May 2013	+2.7	+9.5
Nov 2013	-0.9	+4.5
May 2014	-1.1	+11.5
Nov 2014	-2.6	+7.0
May 2015	+1.6	+6.3
Nov 2015	-8.0	+10.3
May 2016	+9.2	+12.2
	AP20 No 2 > AP2 > 34BE > AP1	34BE > AP6
Nov 2016	+14.2	+3.6
	AP19 > AP2 > 34BE > AP1	34BE > AP6
May 2017	+1.0	+0.4
Nov 2017	-10.2	-0.5
May 2018	+6.4	+4.0
Nov 2018	-11.1	+3.6
	AP19 > AP2 > 34BE > AP1 > BUH5	34BE > AP6
May 2019	See page 2	See page 2
	AP19 > AP2 > 34BE > AP1 > BUH5	34BE > AP6
May 2019	-7.9	-6.9
	AP19 > AP2 > 34BE > AP1 > BUH5	34BE > AP24A > 34BE
Nov 2019	+0.3	-1.3
	AP19 > AP2 > 34BE > AP1 > BUH5	34BE > AP24A > C1
May 2020	-5.5	-1.7
Nov 2020	-3.2	-2.5
May 2021	-38.7	-9.2

### Extending Levelling

This levelling event included LINZ benchmarks AP2, AP20 No 2, AP19, (to the west of Waihi), AP1 and BUH5 (to the east of Waihi). AP24 a.k.a control mark AP6 (south of Waihi) has been lost to road works. AP24A and C1 have been established as a replacement for the lost AP6 control mark in this vicinity. AP2 and AP20 No 2 have now been 'unfixed' and AP19 is the fixed benchmark west of Waihi. The 'fixed' elevation value for AP19 was deduced from LINZ data comparing the relative levels of AP19, AP2, AP20 No2, and AP24 dating back to the year 1990. East of Waihi, AP1 is now 'unfixed. The R.L. for the 'new' fixed eastern control mark (BUH5) was the mean value from two close values (relative to AP1) levelled in May 2018 and Nov 2018.

### Levelling for November 2021?

The relatively large misclose of -38.7 mm on the baseline AP19 to BUH5 is a feature of this levelling event. This misclose caused me to check the 'old' staff against the new staff – to find the following:

between two marks using the new staff the difference was 1.84774 metres then 1.84866 metres using the 'old' staff. This 0.92 millimetres is just measurable with a 5 metre builders steel tape across the 2 pieces of the 'old' and new staffs and confirmed the new staff was consistent with the steel builders tape. This -0.00092 metre difference (over say 2 metres vertical) probably accounts for some of -0.0387 metre misclose. Note the elevation difference used between 'control' marks AP19 and BUH5 is 59.2636 metres.

$$(59.2636/2)*(-0.00092) = -.02726$$

The -ve change in reduced levels on higher elevations (particularly on the north side of the pit) using the new staff is consistent with the above discussion.

The baseline misclose for the next levelling event will be of much interest and may provide some basis for minor adjustments to the elevations of the 'control' marks.

### Photographs

The order of levelling of the monitoring points has now been fixed. This has been achieved by photographing all of the settlement points and placing them in 22 albums –generally in the order the points are to be levelled. This will achieve repeatable error distribution and should therefore give better results. I believe **all** the marks now have accurate GPS fixes. In the future, this should make the task of locating these marks easier if the marks are covered over by re-seal etc, or quickly confirm if the marks have definitely been 'lost' to street maintenance etc.

I recommend continuing these 'maintenance' details before or during the next levelling event.

### Adjustments

Disturbed marks BM20 and 2.44 are excluded from the settlement contouring- as are marks F18, F20, F23, F24, and F25. Mark 2.28 has been disturbed by residential construction activity. Mark 1QC was 'missed' owing to a large stockpiles of road gravel over it. Mark 1.02C has been lost to street works and new mark 1.02D established. Mark 2.11B has been lost to land redevelopment. All the above marks are excluded from the settlement contouring.

### Results

One A1 plan is attached -colour coded by seven zones as identified in the 'Settlement and Groundwater Monitoring Plan.' Relative to previous plans, the Zone boundaries and 'trigger' settlement values have been modified to match *Engineering Geology Ltd* Drawing No. 8332-Fig 16.

This plan "Total Settlement Contours" (T20210701A) identifies all marks (in black and brown) that have been used to produce the contours for the plan. The plan shows total movement (in millimetres) at the monitoring mark itself. Missed, 'lost', or disturbed marks are shown in red and these marks are not used for contouring. New marks are also shown in red and generally not used for settlement contouring until the next levelling event.

This plan also displays settlement contours in 20mm intervals. The Settlement and Groundwater Monitoring Plan identifies gradients steeper than 1:1000 to be cause for concern. BM20 has been a large mover in the past and has been identified in past surveys as being placed on shrinking material. There are no buildings in



this area anymore. I understand (from Mark Halloran) BM20A was placed near BM20 with a 'foot' bedded in firm ground. Significant differential settlement (1:124) is now occurring between BM20A and BM20 –sufficient to decide to omit BM20 from the settlement 'contour' calculation.

These contours represent the total negative (–ve) movement (or settlement) around Waihi since monitoring began. Positive contours are not shown. In the past, small consistent ground 'rises' have been associated with the sector north of the pit. However with the new staff -only the mark with the highest elevation (BM28/2) shows a +11.3 millimetre) rise.

The closest contours (omitting disturbed marks) are between marks 20AC and BM20A. The distance between these marks using GPS measurements, calculates at 126.706 metres, and show 0.1796 metres of relative vertical movement to give a gradient of 1:705. The distance between marks BM20A and 20D using GPS measurements, calculates at 137.047 metres, and shows 0.1572 metres of relative vertical movement to give a gradient of 1:871. The distance between marks 20C and BM20A, when checked by GPS measurements, calculates at 126.865 metres, and show 0.1244 metres of relative vertical movement to give a gradient of 1:1020.

Some cracks are visible in the sealed pavements in this area of closest contours.

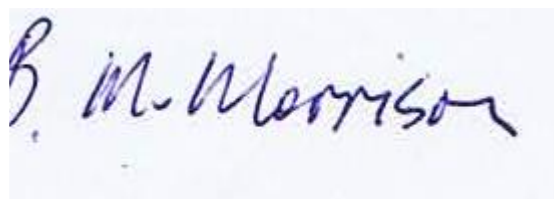
Table 1 (pages 3-12) lists all the marks used for this settlement levelling event with the marks sorted first by Zone and then by settlement value. Marks that record 'exceedences' in terms of zone predictions (for Martha (2019) are highlighted with colour and have comments attached. All marks that 'exceeded' in Table 1 were analysed further and field inspections were conducted where required.

The comments included below attempt to explain the probable reason for 'excess' movement. The comments are *Dist'd* for BM20 in Zone 6. In Zone 4, the comment is '*Nr watercourse*' for 23C. The swampy(?) ground may have de-watered during the autumn drought. For Zone 3, 2CE is near Zone 5. For Zone 1, 2.44 is *Dist'd*, 2.05 is near Zone 5, 2.35, 31DD and 31FC are near Zone 3, and 31KC, 31LC, 31MD, and 31NE are near the Ohinemuri River bridge. 31HC is near 31KC. 31GC is near 31DD.

The 'Favona' marks were installed for monitoring the effects of dewatering in the original underground mine area. The underlying original 'Martha' zone was Zone 3 and but the Favona marks were never given zone exceedence parameters in terms of the original Martha zones. The Favona marks all report significant settlement. Note marks F18, F20, F23, F24, F25 are tentatively labelled as '*Dist'd*' and not used for contouring the settlement.

The five extra 'Favona' settlement marks are again shown on the plan. These are FP1, BLOCK-S, BLOCK-N, TRIG 22, and TRIG 24. The settlements for these marks have generally been deduced relative to original reduced levels measured around the year 1987 –although FP1 (at the Favona portal) was established about the year 2000. Favona mark F07 is disturbed but has been relabelled as F07A. A 'previous history' has been calculated for F07A so this mark can be used for settlement contouring. The underlying zone for the Favona marks is now Zone 5 Martha (2019).

I understand that Time-History plots for all survey marks grouped by zone will be produced by other persons in accordance with the "Settlement and Groundwater Monitoring Plan 31 July 2005"

A handwritten signature in blue ink that reads "B. M. Morrison". The signature is written in a cursive, flowing style.

Bruce Morrison

Registered Professional Surveyor

Table 1. Total Movement

Zone	station i.d.	SURVEY			TOTAL	SETTLEMENT	Comments
		DATE	X	Y	Z	May-21	
Zone7	BM19B	1/05/2021	2117.17	1244.36	35.5558	-0.3102	
Zone7	19BB	1/05/2021	2191.56	1292.022	35.5513	-0.3065	
Zone7	17CB	1/05/2021	2014.23	1201.01	35.4869	-0.2867	
Zone6	BM20	1/05/2021	2342.50	1476.25	35.6043	-0.3765	Dist'd
Zone6	BM20A	1/05/2021	2345.50	1484.901	35.7747	-0.3025	
Zone6	19CB	1/05/2021	2296.71	1381.4	34.9425	-0.2874	
Zone6	17BB	1/05/2021	1919.52	1160.787	37.3808	-0.2502	
Zone6	17AB	1/05/2021	1841.32	1104.802	36.8988	-0.2165	
Zone6	34GC	1/05/2021	2211.33	1119.517	32.1496	-0.2022	
Zone6	2.04B	1/05/2021	1893.21	968.34	29.1084	-0.1824	
Zone6	34H	1/05/2021	2233.59	970.56	32.1707	-0.1764	
Zone6	18EE	1/05/2021	1750.73	809.328	23.4501	-0.1713	
Zone6	2.10	1/05/2021	2143.92	950.387	30.2978	-0.1711	
Zone6	18C	1/05/2021	1494.95	767.193	27.4848	-0.1701	
Zone6	18IB	1/05/2021	1611.19	784.79	25.8477	-0.1677	
Zone6	34AD	1/05/2021	1470.88	886.92	29.7795	-0.1673	
Zone6	34BE	1/05/2021	1732.56	931.603	28.3509	-0.1558	
Zone6	34C	1/05/2021	1968.90	982.673	30.1225	-0.1474	
Zone6	BM34	1/05/2021	1528.38	903.297	30.3359	-0.1472	
Zone6	10BC	1/05/2021	1560.13	1062.92	38.1213	-0.1463	
Zone6	11AC	1/05/2021	1308.26	859.512	29.3547	-0.1422	
Zone6	10AB	1/05/2021	1430.61	1036.998	35.014	-0.139	
Zone6	18AB	1/05/2021	1632.39	667.73	22.1568	-0.1346	
Zone6	BM17A	1/05/2021	1724.44	1088.919	40.0546	-0.1336	
Zone6	2.08B	1/05/2021	2289.75	782.64	24.5543	-0.1321	
Zone6	1.28B	1/05/2021	1987.03	447.71	12.1199	-0.1250	
Zone6	2.09C	1/05/2021	2228.35	868.63	28.6615	-0.1224	

Zone6	34FC	1/05/2021	2120.79	587.93	19.0839	-0.1221
Zone6	34I	1/05/2021	2229.55	765.534	28.4843	-0.1139
Zone6	2.06	1/05/2021	2351.95	334.473	11.3002	-0.1015
Zone6	2.11B	1/05/2021	2278.86	862.45	LOST	1 lost
Zone5	20C	1/05/2021	2450.61	1413.86	36.3293	-0.1781
Zone5	A10B	1/05/2021	1298.62	1049.61	30.7017	-0.1651
Zone5	21DC	1/05/2021	2573.96	1304.152	37.7751	-0.1646
Zone5	20E	1/05/2021	2535.65	1542.672	37.1	-0.1608
Zone5	25D	1/05/2021	2547.05	1248.02	36.881	-0.1598
Zone5	16BC	1/05/2021	1252.81	1336.473	39.4679	-0.1596
Zone5	21O	1/05/2021	2527.37	1356.342	36.0174	-0.1584
Zone5	A11D	1/05/2021	1277.04	1017.33	30.866	-0.1574
Zone5	25A	1/05/2021	2505.13	1203.768	35.9545	-0.1553
Zone5	25E	1/05/2021	2472.35	1162.013	34.7895	-0.154
Zone5	BM25	1/05/2021	2424.91	1100.253	33.4956	-0.1525
Zone5	10DC	1/05/2021	1279.04	1198.326	35.3159	-0.1492
Zone5	21N	1/05/2021	2623.25	1342.435	38.3028	-0.1462
Zone5	20D	1/05/2021	2482.07	1473.478	36.5721	-0.1453
Zone5	24L	1/05/2021	2761.67	1181.326	39.3353	-0.1429
Zone5	10CB	1/05/2021	1222.46	1025.855	29.7922	-0.1399
Zone5	25G	1/05/2021	2594.60	1149.415	37.6049	-0.1396
Zone5	25H	1/05/2021	2648.48	1232.956	38.9366	-0.1391
Zone5	25CB	1/05/2021	2615.91	1190.496	38.3124	-0.1389
Zone5	25F	1/05/2021	2542.53	1116.24	36.0146	-0.1383
Zone5	24I	1/05/2021	2692.57	1269.713	39.3005	-0.137
Zone5	2.41	1/05/2021	3296.32	685.398	46.28	-0.1364
Zone5	25B	1/05/2021	2497.67	1105.828	34.841	-0.136
Zone5	BM16	1/05/2021	1418.09	1218.03	46.4594	-0.1350
Zone5	12CE	1/05/2021	1499.92	543.077	21.0012	-0.1342
Zone5	18F	1/05/2021	1752.28	551.03	17.3491	-0.1320
Zone5	2.03	1/05/2021	1930.08	745.943	22.6116	-0.1318
Zone5	34EB	1/05/2021	2073.93	705.952	24.656	-0.1316
Zone5	BM12	1/05/2021	1370.27	607.735	23.9755	-0.1312

Zone5	2.02	1/05/2021	1992.61	536.097	15.2905	-0.1311
Zone5	24CD	1/05/2021	2603.21	987.721	34.838	-0.131
Zone5	18B	1/05/2021	1510.36	650.578	23.5774	-0.1296
Zone5	25I	1/05/2021	2537.20	1045.036	34.7036	-0.1291
Zone5	18G	1/05/2021	1669.05	554.602	18.4948	-0.128
Zone5	24AC	1/05/2021	2743.58	1218.9	40.1077	-0.1277
Zone5	21C	1/05/2021	2651.57	1389.82	38.4853	-0.1269
Zone5	24DC	1/05/2021	2718.29	1323.127	39.654	-0.1268
Zone5	2A	1/05/2021	1069.03	1111.858	23.8167	-0.1261
Zone5	34D	1/05/2021	2038.90	783.43	25.3607	-0.1254
Zone5	1.28A	1/05/2021	1888.26	505.887	13.2309	-0.1246
Zone5	24E	1/05/2021	2758.43	1303.234	40.3838	-0.1243
Zone5	13AC	1/05/2021	1751.98	327.376	18.6207	-0.1242
Zone5	24F	1/05/2021	2772.80	1257.274	40.1495	-0.1242
Zone5	24K	1/05/2021	2783.89	1387.719	40.6342	-0.1237
Zone5	22F	1/05/2021	2815.91	1325.407	40.2539	-0.1236
Zone5	BM24	1/05/2021	2794.55	1279.36	40.4202	-0.1229
Zone5	20AC	1/05/2021	2461.04	1536.905	37.0362	-0.1229
Zone5	BM18	1/05/2021	1771.96	674.53	19.4484	-0.1220
Zone5	24G	1/05/2021	2705.96	1170.464	39.8213	-0.1215
Zone5	21EB	1/05/2021	2799.95	1429.087	41.6529	-0.1207
Zone5	12DC	1/05/2021	1596.95	435.491	19.9854	-0.1201
Zone5	24B	1/05/2021	2667.67	1126.40	39.4012	-0.1201
Zone5	24H	1/05/2021	2630.70	1072.279	36.1749	-0.1189
Zone5	24J	1/05/2021	2749.39	1365.756	40.2523	-0.1188
Zone5	13BC	1/05/2021	1850.36	246.59	13.743	-0.1180
Zone5	12AC	1/05/2021	1388.32	488.888	19.0674	-0.1177
Zone5	15A	1/05/2021	1204.79	818.863	28.7913	-0.1174
Zone5	18HC	1/05/2021	1821.52	466.47	14.9112	-0.1167
Zone5	21M	1/05/2021	2694.90	1439.648	39.2007	-0.1148
Zone5	20BB	1/05/2021	2533.26	1622.291	37.8968	-0.1143
Zone5	15BC	1/05/2021	1169.90	708.855	26.3535	-0.1114
Zone5	4DB	1/05/2021	1033.26	1550.66	32.2669	-0.1109

Zone5	11BB	1/05/2021	1348.57	710.573	26.9501	-0.1088	
Zone5	AP22A	1/05/2021	1868.44	188.565	12.4305	-0.1085	
Zone5	20F	1/05/2021	2605.79	1575.98	37.5932	-0.1084	
Zone5	12BC	1/05/2021	1405.27	368.295	14.9408	-0.1069	
Zone5	BM13	1/05/2021	1426.61	269.34	13.5984	-0.1067	
Zone5	1.10A	1/05/2021	1599.70	278.94	16.6579	-0.1056	
Zone5	BM21	1/05/2021	2654.80	1515.397	39.4484	-0.1050	
Zone5	4B	1/05/2021	1021.54	1448.63	31.2703	-0.1041	
Zone5	21BC	1/05/2021	2719.27	1477.799	41.2914	-0.1035	
Zone5	2BC	1/05/2021	970.20	1241.898	30.4035	-0.1025	
Zone5	21K	1/05/2021	2681.11	1572.207	40.0239	-0.1014	
Zone5	2.17A	1/05/2021	3085.76	555.866	36.9315	-0.098	
Zone5	30C	1/05/2021	2573.54	1675.395	38.4651	-0.0888	
Zone5	BM9B	1/05/2021	1220.25	1523.285	34.7696	-0.0878	
Zone5	7CB	1/05/2021	1161.74	1597.63	30.63	-0.0858	
Zone5	AP3	1/05/2021	918.94	1140.585	26.0845	-0.0858	
Zone5	26EE	1/05/2021	1343.86	1621.819	44.3113	-0.0706	
Zone5	26F	1/05/2021	1392.77	1680.261	43.8783	-0.0616	
Zone5	26R	1/05/2021	1905.59	1927.165	71.3759	-0.0593	
Zone5	26PB	1/05/2021	1834.84	1893.106	67.9633	-0.0593	
Zone5	26Q	1/05/2021	1963.00	1982.711	73.6923	-0.0588	
Zone4	23C	1/05/2021	2856.14	1068.014	37.5669	-0.1992	Nr watercourse
Zone4	23AB	1/05/2021	3145.42	1078.73	37.2149	-0.1569	
Zone4	2.28	1/05/2021	3076.72	1555.994	42.9228	-0.1477	dist'd
Zone4	2.24	1/05/2021	2885.91	1215.469	41.3012	-0.1458	
Zone4	BANK1	1/05/2021	2866.21	1023.248	37.8097	-0.1446	
Zone4	23D	1/05/2021	2861.42	1154.885	38.8732	-0.1437	
Zone4	22C	1/05/2021	2846.39	1352.544	40.336	-0.1433	
Zone4	23E	1/05/2021	2774.82	972.514	37.7225	-0.139	
Zone4	23F	1/05/2021	2700.77	968.793	36.6593	-0.1383	
Zone4	2.25	1/05/2021	2874.51	1097.261	37.9979	-0.1373	
Zone4	23B	1/05/2021	2856.49	949.794	38.7645	-0.1356	
Zone4	MATAURA1	1/05/2021	2831.84	1250.806	41.0891	-0.1307	



Zone4	2.13	1/05/2021	2725.42	874.95	47.2269	-0.1290
Zone4	BARRY1	1/05/2021	3047.74	926.576	38.1369	-0.1279
Zone4	2.14A	1/05/2021	2853.28	838.669	41.3398	-0.1278
Zone4	22GB	1/05/2021	2862.88	1387.968	40.8671	-0.1271
Zone4	2.19B	1/05/2021	3270.21	916.063	38.5819	-0.127
Zone4	BARRY3	1/05/2021	3176.85	895.991	37.707	-0.1236
Zone4	MORTON	1/05/2021	2975.42	1231.913	40.7371	-0.1226
Zone4	STAFORD	1/05/2021	3139.86	998.179	37.3358	-0.1184
Zone4	BARRY4B	1/05/2021	3320.16	912.693	38.9126	-0.118
Zone4	2.18	1/05/2021	3218.04	712.756	44.5687	-0.118
Zone4	BARRY2	1/05/2021	2936.96	944.224	38.3783	-0.1173
Zone4	21P	1/05/2021	2849.17	1456.9	41.8668	-0.1165
Zone4	2HB	1/05/2021	1078.24	886.849	24.4093	-0.116
Zone4	BM23	1/05/2021	3107.42	921.049	38.1115	-0.1156
Zone4	BARRY5	1/05/2021	3397.59	904.647	41.0174	-0.115
Zone4	22E	1/05/2021	3055.20	1231.504	40.8089	-0.1146
Zone4	1.11B	1/05/2021	1675.83	133.62	9.0488	-0.1142
Zone4	BARRY6	1/05/2021	3432.52	904.356	42.5034	-0.1139
Zone4	2.23	1/05/2021	3560.02	1212.795	36.6594	-0.1131
Zone4	22BC	1/05/2021	2916.75	1435.773	42.13	-0.1118
Zone4	22I	1/05/2021	2918.98	1461.367	41.9381	-0.1111
Zone4	2.16	1/05/2021	3007.62	739.64	33.6173	-0.1105
Zone4	2.20	1/05/2021	3467.69	904.56	43.8114	-0.1097
Zone4	22H	1/05/2021	2869.25	1441.796	41.6483	-0.1085
Zone4	22M	1/05/2021	2973.44	1434.656	41.6991	-0.1069
Zone4	2.15	1/05/2021	2918.94	723.52	38.3911	-0.1058
Zone4	BARRY8	1/05/2021	3592.28	871.451	37.9571	-0.1046
Zone4	2.21	1/05/2021	3563.09	1045.181	34.0559	-0.1037
Zone4	22L	1/05/2021	3047.70	1499.876	41.0181	-0.1036
Zone4	BARRY7	1/05/2021	3518.87	901.897	43.6377	-0.1036
Zone4	GW	1/05/2021	3128.83	1140.936	38.5661	-0.1033
Zone4	BM2	1/05/2021	915.74	1091.799	24.8472	-0.1033
Zone4	AP100	1/05/2021	1893.80	81.27	11.8051	-0.1027

Zone4	2.22	1/05/2021	3339.13	1206.603	40.3757	-0.1021
Zone4	CUBA	1/05/2021	3224.32	1079.177	35.8517	-0.1015
Zone4	22D	1/05/2021	3100.02	1335.441	41.476	-0.1001
Zone4	1.05	1/05/2021	1176.96	473.454	21.8411	-0.0983
Zone4	22A	1/05/2021	3003.28	1429.771	41.6749	-0.0978
Zone4	22J	1/05/2021	2944.47	1489.763	42.4525	-0.0972
Zone4	21FB	1/05/2021	2861.65	1512.211	42.6743	-0.096
Zone4	26BE	1/05/2021	1408.78	1800.553	38.8326	-0.0935
Zone4	21AC	1/05/2021	2716.64	1617.767	39.7165	-0.0925
Zone4	21L	1/05/2021	2806.79	1575.074	43.1115	-0.0923
Zone4	2.29B	1/05/2021	2953.39	1548.172	42.6159	-0.0909
Zone4	1.26	1/05/2021	1926.81	30.05	15.1161	-0.0907
Zone4	2GB	1/05/2021	922.38	967.66	22.6949	-0.0906
Zone4	15C	1/05/2021	1156.82	571.077	24.2319	-0.0897
Zone4	BM22	1/05/2021	3115.79	1442.952	40.6449	-0.0893
Zone4	2.26	1/05/2021	3241.22	1380.889	39.2439	-0.0893
Zone4	27KB	1/05/2021	2320.23	2120.21	63.357	-0.0886
Zone4	2.27	1/05/2021	3379.40	1371.48	37.7827	-0.0879
Zone4	26CE	1/05/2021	1377.77	1711.89	40.6175	-0.0861
Zone4	1.06	1/05/2021	1159.34	302.26	17.2458	-0.0853
Zone4	21Q	1/05/2021	2899.60	1571.317	43.1529	-0.0843
Zone4	30BB	1/05/2021	2604.86	1726.496	41.5726	-0.0823
Zone4	22KB	1/05/2021	2981.80	1603.49	42.8761	-0.0806
Zone4	21I	1/05/2021	2854.70	1668.793	41.6697	-0.0801
Zone4	21J	1/05/2021	2773.44	1688.923	39.9876	-0.0791
Zone4	BM15	1/05/2021	976.94	783.004	20.5377	-0.0788
Zone4	SM822	1/05/2021	2512.91	1841.132	41.4803	-0.0778
Zone4	21GC	1/05/2021	2901.12	1614.054	43.4697	-0.0771
Zone4	27N	1/05/2021	2179.57	2075.985	71.9339	-0.0767
Zone4	1.09B	1/05/2021	1344.14	117.48	9.9497	-0.0754
Zone4	4.08	1/05/2021	2350.64	2022.32	73.2334	-0.0737
Zone4	2.31B	1/05/2021	3201.23	1637.289	42.1201	-0.0732
Zone4	27E	1/05/2021	2494.09	2171.62	50.367	-0.0712
Zone4	7BB	1/05/2021	1105.69	1689.902	35.9574	-0.0699

Zone4	2.30B	1/05/2021	3000.35	1672.941	43.1984	-0.0692	
Zone4	4.09	1/05/2021	2249.27	2029.944	78.9399	-0.0688	
Zone4	21HC	1/05/2021	2916.84	1728.842	42.9086	-0.0674	
Zone4	3.01	1/05/2021	1291.95	1690.33	37.3158	-0.0637	
Zone4	26AE	1/05/2021	1432.47	1883.479	37.57	-0.0628	
Zone4	3.04B	1/05/2021	1123.76	1821.50	39.3024	-0.0625	
Zone4	26NC	1/05/2021	1641.16	1772.4	60.409	-0.0609	
Zone4	27H	1/05/2021	2413.27	2149.76	57.0497	-0.0608	
Zone4	27G	1/05/2021	2440.97	2157.30	54.5851	-0.0600	
Zone4	4.07	1/05/2021	2554.47	2079.24	45.0733	-0.0598	
Zone4	27J	1/05/2021	2344.14	2136.138	62.1567	-0.0592	
Zone4	26H	1/05/2021	1452.90	1729.593	49.9797	-0.0591	
Zone4	26JB	1/05/2021	1495.71	1756.55	53.7437	-0.0587	
Zone4	4.05	1/05/2021	2809.68	1897.68	40.6437	-0.0577	
Zone4	26I	1/05/2021	1481.67	1750.49	52.744	-0.0567	
Zone4	26G	1/05/2021	1425.06	1706.748	47.0187	-0.0561	
Zone4	26MB	1/05/2021	1593.46	1750.663	58.9871	-0.056	
Zone4	3.02	1/05/2021	1344.87	1837.735	34.9623	-0.0549	
Zone4	27I	1/05/2021	2385.10	2141.94	59.5529	-0.0545	
Zone4	3.09	1/05/2021	1618.51	1870.174	51.9377	-0.0543	
Zone4	3.11A	1/05/2021	1786.17	1929.216	62.1682	-0.0539	
Zone4	BM30	1/05/2021	2715.36	1996.207	44.1111	-0.0525	
Zone4	27F	1/05/2021	2466.48	2164.026	52.3439	-0.051	
Zone4	27M	1/05/2021	2224.38	2095.26	69.1771	-0.0500	
Zone4	27AB	1/05/2021	2009.08	2064.33	73.5019	-0.0487	
Zone4	30AB	1/05/2021	2685.64	1898.443	46.2599	-0.0487	
Zone4	3.10A	1/05/2021	1689.03	1978.29	53.4564	-0.0480	
Zone4	27L	1/05/2021	2280.24	2115.41	65.8605	-0.0474	
Zone4	27O	1/05/2021	2101.57	2042.82	75.044	-0.0465	
Zone4	27DC	1/05/2021	2541.24	2190.709	48.2132	-0.0463	
Zone4	BM26	1/05/2021	1542.45	1837.805	45.4419	-0.0442	
Zone4	3.13	1/05/2021	1744.89	2097.492	53.7804	-0.0442	
Zone4	26OB	1/05/2021	1706.93	1812.27	67.1993	-0.0355	
Zone4	3.6A	1/05/2021	1526.28	2015.739	38.94	-0.0256	
Zone3	2CE	1/05/2021	774.75	1313.19	34.6275	-0.0984	Near Zone 5

Zone3	14DB	1/05/2021	876.99	411.215	15.1689	-0.0849
Zone3	2.34	1/05/2021	3452.45	1683.502	37.7344	-0.0789
Zone3	A33C	1/05/2021	456.03	1219.23	35.8654	-0.0745
Zone3	2DA	1/05/2021	682.15	1189.58	35.8196	-0.0690
Zone3	2.36	1/05/2021	3433.14	1534.88	35.9468	-0.0684
Zone3	1.25	1/05/2021	2175.94	-129.11	20.0776	-0.0684
Zone3	1.07	1/05/2021	924.43	267.487	12.5158	-0.0678
Zone3	4EC	1/05/2021	782.01	1687.78	41.1431	-0.0666
Zone3	2.40B	1/05/2021	3572.85	1526.452	33.1742	-0.0659
Zone3	2FC	1/05/2021	720.33	843.06	23.9406	-0.0659
Zone3	4.02	1/05/2021	2797.90	2143.571	45.7833	-0.0658
Zone3	2.33	1/05/2021	3294.51	1691.95	40.3272	-0.0657
Zone3	4A	1/05/2021	815.01	1494.15	40.7072	-0.0652
Zone3	15DB	1/05/2021	917.56	466.148	15.6165	-0.0635
Zone3	14CB	1/05/2021	759.10	389.766	18.8327	-0.0631
Zone3	14BC	1/05/2021	535.45	340.67	20.9231	-0.0624
Zone3	14EA	1/05/2021	808.56	504.72	17.1078	-0.0610
Zone3	4.03B	1/05/2021	2794.90	2044.78	43.8203	-0.0606
Zone3	31BC	1/05/2021	3159.33	1954.857	45.5222	-0.0603
Zone3	BM31	1/05/2021	2967.04	1873.48	43.306	-0.0595
Zone3	2EB	1/05/2021	689.02	1054.62	29.2745	-0.0575
Zone3	1.08	1/05/2021	1052.91	107.17	16.5423	-0.0565
Zone3	4.01C	1/05/2021	2891.78	2113.146	47.323	-0.0551
Zone3	4.04	1/05/2021	2662.60	2131.765	45.9403	-0.0549
Zone3	31AC	1/05/2021	3059.04	1910.629	44.09	-0.0525
Zone3	1.21A	1/05/2021	1939.94	-325.504	19.6778	-0.0519
Zone3	29DB	1/05/2021	2996.63	2106.66	47.8276	-0.0513
Zone3	14FB	1/05/2021	705.60	649.144	20.1686	-0.0508
Zone3	1.22	1/05/2021	1510.00	-249.925	15.8855	-0.0473
Zone3	3.25	1/05/2021	3116.90	2107.056	49.8325	-0.0446
Zone3	31CC	1/05/2021	3248.97	1989.89	47.0557	-0.0442
Zone3	29AC	1/05/2021	2641.62	2218.071	48.5388	-0.0371
Zone3	29CE	1/05/2021	2891.84	2285.59	51.5932	-0.0364
Zone3	3.24	1/05/2021	3017.29	2258.71	51.9543	-0.0319
Zone3	29B	1/05/2021	2772.84	2242.217	50.024	-0.0227

Zone2	1K	1/05/2021	511.74	957.174	29.6109	-0.0581
Zone2	7AC	1/05/2021	994.54	1781.82	43.5375	-0.0544
Zone2	3.14	1/05/2021	1752.75	2214.323	48.7723	-0.0543
Zone2	3.03	1/05/2021	1134.46	1917.24	39.3623	-0.0526
Zone2	33F	1/05/2021	347.95	1511.678	42.0581	-0.0504
Zone2	BM4	1/05/2021	689.21	1555.547	42.2918	-0.0489
Zone2	3.12	1/05/2021	1599.68	2152.41	40.2803	-0.0475
Zone2	BM7	1/05/2021	1057.32	1843.069	44.1289	-0.0475
Zone2	1JB	1/05/2021	604.79	822.761	26.423	-0.0472
Zone2	1C	1/05/2021	421.48	1098.886	34.8018	-0.0468
Zone2	4FB	1/05/2021	562.51	1370.97	39.3864	-0.0467
Zone2	33A	1/05/2021	338.15	1303.89	36.7328	-0.0458
Zone2	1B	1/05/2021	337.50	1062.94	34.0119	-0.0453
Zone2	6A	1/05/2021	946.43	1928.115	47.5245	-0.0435
Zone2	33E	1/05/2021	437.71	1437.524	41.0037	-0.0426
Zone2	33DB	1/05/2021	265.40	1714.72	46.3765	-0.0419
Zone2	1I	1/05/2021	468.34	761.228	27.2879	-0.0411
Zone2	1.12	1/05/2021	800.71	-50.228	10.8057	-0.041
Zone2	1.04	1/05/2021	795.98	129.36	12.8182	-0.0407
Zone2	3.07	1/05/2021	1362.08	2096.818	48.0586	-0.0406
Zone2	BM6	1/05/2021	881.86	1837.08	46.2465	-0.0371
Zone2	1NB	1/05/2021	-206.98	842.119	24.8164	-0.0369
Zone2	1SC	1/05/2021	-674.31	739.267	14.4561	-0.0367
Zone2	BM14	1/05/2021	718.16	485.96	19.8509	-0.0367
Zone2	1FB	1/05/2021	210.46	850.779	29.8435	-0.034
Zone2	1O	1/05/2021	-271.35	814.183	22.7238	-0.0339
Zone2	5C	1/05/2021	705.43	1754.71	45.1832	-0.0338
Zone2	33GA	1/05/2021	415.95	1621.64	45.3667	-0.0338
Zone2	1HC	1/05/2021	299.70	702.8	27.0572	-0.0337
Zone2	1EB	1/05/2021	388.60	912.09	30.4457	-0.0332
Zone2	14AC	1/05/2021	515.17	457.622	24.0402	-0.0329
Zone2	1LD	1/05/2021	-102.13	906.045	28.3679	-0.0321
Zone2	1A	1/05/2021	249.92	1026.38	33.3443	-0.0314
Zone2	1GB	1/05/2021	-2.87	769.742	29.3043	-0.0304
Zone2	BM5	1/05/2021	325.93	1806.47	47.8159	-0.0295



Zone2	1ME	1/05/2021	-155.40	879.887	26.1137	-0.0295	
Zone2	3.15	1/05/2021	1696.24	2315.821	39.1191	-0.0289	
Zone2	1.14	1/05/2021	496.74	-535.095	8.4409	-0.0287	
Zone2	BM1	1/05/2021	152.75	994.869	32.7869	-0.0277	
Zone2	5BC	1/05/2021	547.16	1824.599	49.1514	-0.0274	
Zone2	33B	1/05/2021	156.88	1430.80	34.427	-0.0260	
Zone2	5AC	1/05/2021	470.30	1688.45	47.0519	-0.0259	
Zone2	1.03B	1/05/2021	365.55	323.37	19.3997	-0.0255	
Zone2	3.22A	1/05/2021	2891.15	2398.649	56.6793	-0.0254	
Zone2	1.01	1/05/2021	56.47	604.08	25.4617	-0.0252	
Zone2	3.05	1/05/2021	966.29	1990.771	47.2077	-0.0247	
Zone2	33C	1/05/2021	222.53	1621.24	44.4236	-0.0245	
Zone2	BM29	1/05/2021	2608.80	2400.756	55.9841	-0.0243	
Zone2	1PA	1/05/2021	-351.51	787.24	20.0759	-0.0239	
Zone2	1RA	1/05/2021	-579.06	750.356	16.747	-0.0208	
Zone2	AP2	1/05/2021	-1276.40	954.13	5.7787	-0.0173	
Zone2	1D	1/05/2021	-32.05	911.592	30.0556	-0.0172	
Zone2	1.16	1/05/2021	1552.97	-1086.27	18.3813	0.0033	
Zone2	1.02D	1/05/2021	85.42	283.30	18.6724	new mark	new mark
Zone2	1QC	1/05/2021	-466.05	769.147	MISSED	missed	Gravel heap
Zone1	2.44	1/05/2021	2734.64	421.025	27.2493	-0.5794	dist'd
Zone1	2.05	1/05/2021	2535.68	272.68	20.7811	-0.0990	Near Zone 5
Zone1	31MD	1/05/2021	4275.09	1884.55	30.7355	-0.0745	Nr river bridge
Zone1	31NE	1/05/2021	4349.43	1927.42	33.3594	-0.0692	Nr river bridge
Zone1	2.35	1/05/2021	3609.80	1652.681	34.1168	-0.0689	Near Zone 3
Zone1	31FC	1/05/2021	3614.22	1954.151	43.4352	-0.0669	Near Zone 3
Zone1	31LC	1/05/2021	4168.53	1862.106	32.1036	-0.064	Nr river bridge
Zone1	31KC	1/05/2021	4076.39	1883.199	34.4952	-0.0591	Nr river bridge
Zone1	31DD	1/05/2021	3400.43	1989.833	46.7025	-0.0574	Near Zone 3
Zone1	31HC	1/05/2021	3810.83	1924.65	40.34	-0.0555	Near 31KC
Zone1	31GC	1/05/2021	3711.83	1939.28	42.1881	-0.0552	Near 31DD
Zone1	31IC	1/05/2021	3909.03	1909.895	37.857	-0.0534	
Zone1	31JD	1/05/2021	4005.65	1911.42	35.5676	-0.0529	
Zone1	28AE	1/05/2021	2128.26	2448.76	85.9251	-0.0512	
Zone1	31ED	1/05/2021	3496.21	1975.774	45.9301	-0.0481	

Zone1	27CD	1/05/2021	2122.89	2374.362	85.0616	-0.0442	
Zone1	31PC	1/05/2021	4393.52	1991.662	37.7402	-0.0425	
Zone1	31QC	1/05/2021	4417.71	2035.37	39.6359	-0.0398	
Zone1	3.21	1/05/2021	2585.77	2493.38	64.9422	-0.0340	
Zone1	1VA	1/05/2021	-994.62	800.62	6.4358	-0.0312	
Zone1	3.30	1/05/2021	3296.29	2235.94	50.3925	-0.0302	
Zone1	3.16	1/05/2021	2195.60	2563.077	95.6192	-0.0273	
Zone1	AP2A	1/05/2021	-766.18	738.506	12.3252	-0.0245	
Zone1	3.26B	1/05/2021	3200.09	2347.92	55.4301	-0.0244	
Zone1	31OD	1/05/2021	4374.76	1958.375	36.075	-0.0237	
Zone1	1.20B	1/05/2021	1995.49	-664.093	22.0512	-0.0213	
Zone1	3.28A	1/05/2021	3212.99	2635.997	53.849	-0.0207	
Zone1	3.23	1/05/2021	3035.80	2453.65	59.6373	-0.0203	
Zone1	1.24	1/05/2021	2225.16	-613.228	16.7136	-0.02	
Zone1	1.23	1/05/2021	1013.01	-440.769	13.2893	-0.0193	
Zone1	3.29	1/05/2021	3662.64	2323.53	44.9323	-0.0182	
Zone1	1.13	1/05/2021	591.36	-310.80	7.0744	-0.0181	
Zone1	3.27B	1/05/2021	3148.37	2510.53	60.2937	-0.0179	
Zone1	1UA	1/05/2021	-914.75	759.05	8.7386	-0.0160	
Zone1	AP20No2	1/05/2021	-2303.63	731.69	20.1894	-0.0158	
Zone1	1TB	1/05/2021	-832.77	738.92	11.2432	-0.0113	
Zone1	AP1A	1/05/2021	4557.10	2288.33	42.4904	-0.0096	
Zone1	AP1	1/05/2021	4486.29	2137.01	41.384	-0.0085	
Zone1	1.27B	1/05/2021	1401.56	-701.57	15.3553	-0.0058	
Zone1	1.15	1/05/2021	923.35	-995.413	14.3705	-0.0015	
Zone1	1.17B	1/05/2021	2082.20	-1093.92	25.603	-0.0006	
Zone1	AP19	1/05/2021	-3242.58	480.68	-6.5213	0.0000	control
Zone1	BUH5	1/05/2021	5480.15	2780.65	52.7423	0.0000	control
Zone1	C1	1/05/2021	2183.23	-1759.33	32.8425	0.0000	control
Zone1	BM28/2	1/05/2021	2282.46	2770.68	101.897	0.0113	
Zone 1	AP24A	1/05/2021	2114.57	-1292.93	28.076	0.0008	
Favona	F18	1/05/2021	3423.83	648.30	39.9981	-0.3333	Dist'd?
Favona	F20	1/05/2021	3411.70	665.722	40.9183	-0.2858	Dist'd?
Favona	F23	1/05/2021	3393.93	684.822	40.6171	-0.2835	Dist'd?
Favona	F21	1/05/2021	3405.99	671.998	40.7569	-0.2564	

Favona	F24	1/05/2021	3388.13	690.85	40.6332	-0.2547	Dist'd?
Favona	F17B	1/05/2021	3405.48	613.91	43.9903	-0.2492	
Favona	F22	1/05/2021	3399.79	678.393	40.6987	-0.2377	
Favona	F25	1/05/2021	3381.55	697.882	40.6062	-0.2153	Dist'd?
Favona	F15C	1/05/2021	3297.17	585.319	57.34	-0.1765	
Favona	BLOCK-S	1/05/2021	3295.82	124.324	24.8389	-0.1731	
Favona	F26	1/05/2021	3374.47	705.54	40.593	-0.1729	
Favona	F16B	1/05/2021	3367.38	578.70	46.3938	-0.1722	
Favona	F11C	1/05/2021	3192.52	479.444	51.4416	-0.1687	
Favona	F27B	1/05/2021	3372.41	717.52	40.5064	-0.1668	
Favona	BLOCK-N	1/05/2021	3336.45	215.69	24.3093	-0.1537	
Favona	F34C	1/05/2021	3339.49	849.569	40.1871	-0.1534	
Favona	F10B	1/05/2021	3176.88	446.75	49.275	-0.1531	
Favona	F12C	1/05/2021	3207.32	503.824	53.5003	-0.1525	
Favona	F28B	1/05/2021	3365.21	727.17	40.5103	-0.1494	
Favona	F09A	1/05/2021	3157.20	388.283	45.1623	-0.1427	
Favona	F14C	1/05/2021	3275.29	551.31	60.6656	-0.1422	
Favona	F13C	1/05/2021	3236.43	533.631	57.914	-0.1415	
Favona	F30B	1/05/2021	3359.36	748.26	40.6995	-0.1380	
Favona	F31B	1/05/2021	3354.47	756.84	41.2443	-0.1361	
Favona	F29B	1/05/2021	3363.20	738.71	40.4961	-0.1359	
Favona	F33	1/05/2021	3348.56	812.51	40.6357	-0.128	
Favona	F08A	1/05/2021	3126.97	430.49	42.7504	-0.1271	
Favona	F32B	1/05/2021	3348.78	769.103	40.8662	-0.1258	
Favona	F35B	1/05/2021	3336.68	896.063	39.7775	-0.1197	
Favona	F07A	1/05/2021	3110.57	437.24	41.3654	-0.1171	
Favona	ITXCIVB	1/05/2021	2943.85	542.17	32.6113	-0.1114	
Favona	F06	1/05/2021	3107.08	445.21	40.5065	-0.1113	
Favona	F04	1/05/2021	3100.96	470.88	38.7269	-0.108	
Favona	F03	1/05/2021	3099.03	480.33	38.402	-0.1057	
Favona	F02	1/05/2021	3097.60	490.00	38.2054	-0.1053	
Favona	F05	1/05/2021	3104.66	455.54	39.4645	-0.1046	
Favona	FP1	1/05/2021	3004.15	131.25	45.4194	-0.0896	
Favona	TRIG 24	1/05/2021	3260.76	-615.678	25.6939	-0.0361	
Favona	TRIG 22	1/05/2021	3681.97	89.358	26.1576	-0.0324	



MEMORANDUM

TO: **MARK BURROUGHS**

FROM: **BRUCE MORRISON**

DATE: **23<sup>RD</sup> JANUARY 2022**

SUBJECT: **GROUND SETTLEMENT MONITORING –NOVEMBER 2021**

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### **Introduction**

This report outlines the results from the November 2021 Ground Settlement Monitoring Survey.

### **Field Method**

The settlement monitoring marks were levelled during November and December 2021 for OceanaGold by myself utilising an experienced *Kauri Gold* assistant under my supervision. An experienced contract surveyor assisted with the baseline levelling on the State Highways when a shadow vehicle was used to satisfy the roading authorities.

The following notes (in red) are from my May 2021 report.

#### **Levelling for November 2021?**

The relatively large misclose of -38.7 mm on the baseline AP19 to BUH5 is a feature of this levelling event. This misclose caused me to check the 'old' staff against the new staff – to find the following:

between two marks using the new staff the difference was 1.84774 metres then 1.84866 metres using the 'old' staff. This 0.92 millimetres is just measurable with a 5 metre builders steel tape across the 2 pieces of the 'old' and new staffs and confirmed the new staff was consistent with the steel builders tape. This - 0.00092 metre difference (over say 2 metres vertical) probably accounts for some of -0.0387 metre misclose. Note the elevation difference used between 'control' marks AP19 and BUH5 is 59.2636 metres.

$$(59.2636/2)*(-0.00092) = -.02726$$

The -ve change in reduced levels on higher elevations (particularly on the north side of the pit) using the new staff is consistent with the above discussion.

The baseline misclose for the next levelling event will be of much interest and may provide some basis for minor adjustments to the elevations of the 'control' marks.

Equipment used for this November 2021 event was the LEICA DNA03 electronic digital level (SN330350) paired with the **new** LEICA 3 section 4.05 metre fibreglass bar coded GKNL4F staff. To minimise 'windage', the staff was used in 2 section 'mode'. The level was serviced and check calibrated by the supplier in March 2021. A field calibration check was carried out by myself before commencing this event and the check result was satisfactory.

The unadjusted level traverses for this event between bench marks AP19 through 34BE to BUH5 were compared with those unadjusted elevations for the May event. An unadjusted level run was then taken off this base line from 34BE south to C1 and compared with unadjusted elevations for the May event. The levelling was extended south from C1 to AP26 at Waimata. A further check levelling traverse was extended via Baxter road to ABE4 on Waihi Beach Road. These traverses are shown on an A3 plan (T20211213A) with the numbers and logic used to modify the control elevations for BUH5 and C1. These control elevation adjustments are tabulated below.

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	Control Elevation (Borough)	Control Elevation (Borough)	Difference
Mark I.D.	May 2021	November 2021	
AP19	-6.5213	-6.5213	0
BUH5	52.7423	52.7029	-0.0394
C1	32.8245	32.8139	-0.0106

With reference to plan T20211213A, by applying + 76.8164 metres to the 'Borough' values, then the elevations can be compared to the Auckland Vertical Datum 1946 (AKVD) elevations shown in the LINZ geodetic database. The compared elevations for AP26 and ABE4 are in reasonable agreement with AKVD values rather than New Zealand Vertical Datum 2016 values. Note AP24 and AP25 have been lost to road improvements.

Using the framework provided by the November 2021 control mark traverses, the many remaining monitoring marks were levelled from the control baselines and adjusted using LEICA LEVELPAK-PRO software.

A summary of the above framework 'misclosures' for the last thirty events is tabulated below.

Event	West –East misclose (mm)	North –South misclose (mm)
	AP2 > 34BE > AP1	34BE > AP6
May 2007	+2.4	+6.4
Nov 2007	+2.7	+3.1
May 2008	+13.2	+4.0
Nov 2008	-8.1	+7.3
May2009	+8.8	+3.7
Nov 2009	-5.8	+2.0
May 2010	-8.1	+4.3
Nov 2010	-0.6	+6.4
May 2011	+2.0	+2.7
Nov 2011	+6.9	+6.5
May 2012	+4.1	+6.7
Nov 2012	+23.3	+5.3
May 2013	+2.7	+9.5
Nov 2013	-0.9	+4.5

May 2014	-1.1	+11.5
Nov 2014	-2.6	+7.0
May 2015	+1.6	+6.3
Nov 2015	-8.0	+10.3
May 2016	+9.2	+12.2
	AP20 No 2 > AP2 > 34BE > AP1	34BE > AP6
Nov 2016	+14.2	+3.6
	AP19 > AP2 > 34BE > AP1	34BE > AP6
May 2017	+1.0	+0.4
Nov 2017	-10.2	-0.5
May 2018	+6.4	+4.0
Nov 2018	-11.1	+3.6
	AP19 > AP2 > 34BE > AP1 > BUIH5	34BE > AP6
May 2019	See page 2	See page 2
	AP19 > AP2 > 34BE > AP1 > BUIH5	34BE > AP6
May 2019	-7.9	-6.9
	AP19 > AP2 > 34BE > AP1 > BUIH5	34BE > AP24A > 34BE
Nov 2019	+0.3	-1.3
	AP19 > AP2 > 34BE > AP1 > BUIH5	34BE > AP24A > C1
May 2020	-5.5	-1.7
Nov 2020	-3.2	-2.5
May 2021	-38.7	-9.2
Nov 2021	-0.8	+1.7

### Extending Levelling

This levelling event included LINZ benchmarks AP2, AP20 No 2, AP19, (to the west of Waihi), AP1 and BUIH5 (to the east of Waihi). AP24 a.k.a control mark AP6 (south of Waihi) and AP25 have been lost to road works. AP24A and C1 have been established as a replacement for the lost AP6 control mark in this vicinity. AP2 and AP20 No 2 have now been 'unfixed' and AP19 is the fixed benchmark west of Waihi. The 'fixed' elevation value for AP19 was deduced from LINZ data comparing the relative levels of AP19, AP2, AP20 No2, and AP24 dating back to the year 1990. East of Waihi, AP1 is now 'unfixed, and there has never been any LINZ data for this mark although AP1 appears to be constructed to the same specifications as AP19 and AP26. The R.L. for the 'new' fixed eastern control mark (BUIH5) was the mean value from two close values (relative to AP19) levelled in May 2021 and Nov 2021.

## Photographs

The order of levelling of the monitoring points has now been fixed. This has been achieved by photographing all of the settlement points and placing them in 22 albums –generally in the order the points are to be levelled. This will achieve repeatable error distribution and should therefore give better results. I believe **all** the marks now have accurate GPS fixes. In the future, this should make the task of locating these marks easier if the marks are covered over by re-seal etc, or quickly confirm if the marks have definitely been 'lost' to street maintenance etc.

I recommend continuing these 'maintenance' details before or during the next levelling event.

## Adjustments

Disturbed marks BM20 and 2.44 are excluded from the settlement contouring- as are marks F18, F20, F23, F24, and F25. Mark 2.28 has been disturbed by residential construction activity. Mark 2.11C is a new mark. All the above marks are excluded from the settlement contouring.

## Results

One A1 plan is attached -colour coded by seven zones as identified in the 'Settlement and Groundwater Monitoring Plan. The original Zone boundaries and 'trigger' settlement values have been modified to match *Engineering Geology Ltd* Drawing No. 8332-Fig 16.

This plan "Total Settlement Contours" (T20220123A) identifies all marks (in black) that have been used to produce the contours for the plan. The plan shows total movement (in millimetres) at the monitoring mark itself. Missed, 'lost', or disturbed marks are shown in red and these marks are not used for contouring. New marks are also shown in red and generally not used for settlement contouring until the next levelling event.

This plan also displays settlement contours in 20mm intervals. The Settlement and Groundwater Monitoring Plan identifies gradients steeper than 1:1000 to be cause for concern. BM20 has been a large mover in the past and has been identified in past surveys as being placed on shrinking material. There are no buildings in this area anymore. I understand (from Mark Halloran) BM20A was placed near BM20 with a 'foot' bedded in firm ground. Significant differential settlement (1:122) is now occurring between BM20A and BM20 –sufficient to decide to omit BM20 from the settlement 'contour' calculation.

These contours represent the total negative (–ve) movement (or settlement) around Waihi since monitoring began.

The closest contours (omitting disturbed marks) are between marks 20AC and BM20A. The distance between these marks using GPS measurements, calculates at 126.706 metres, and show 0.1817 metres of relative vertical movement to give a gradient of 1:697. The distance between marks BM20A and 20D using GPS measurements, calculates at 137.047 metres, and shows 0.1593 metres of relative vertical movement to give a gradient of 1:860. The distance between marks 20C and BM20A, when checked by GPS measurements, calculates at 126.865 metres, and show 0.1268 metres of relative vertical movement to give a gradient of 1:1001.

Some cracks are visible in the sealed pavements in this area of closest contours.

Table 1 (pages 4-12) lists all the marks used for this settlement levelling event with the marks sorted first by Zone and then by settlement value. Marks that record 'exceedences' in terms of zone predictions (for Martha (2019) are highlighted with colour and have comments attached. All marks that 'exceeded' in Table 1 were analysed further and field inspections were conducted where required.

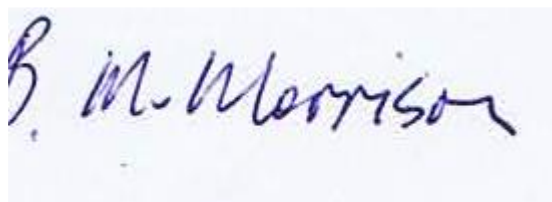
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The comments included below attempt to explain the probable reason for 'excess' movement. The comments are *Dist'd* for BM20 in Zone 6. In Zone 4, the comment is '*Nr watercourse*' for 23C. The swampy(?) ground may have de-watered during the autumn drought. For Zone 3, 2CE is near Zone 5. For Zone 2, 3.14 is near Zone 4. For Zone 1, 2.44 is *Dist'd*, 2.05 is near Zone 5, 2.35, 31DD and 31FC are near Zone 3, and 31KC, 31LC, 31MD, and 31NE are near the Ohinemuri River bridge. 31HC is near Zone 3. 31GC is near Zone 3.

The 'Favona' marks were installed for monitoring the effects of dewatering in the original underground mine area. The underlying original 'Martha' zone was Zone 3 and but the Favona marks were never given zone exceedence parameters in terms of the original Martha zones. The Favona marks all report significant settlement. Note marks F18, F20, F23, F24, F25 are tentatively labelled as 'Dist'd' and not used for contouring the settlement.

The five extra 'Favona' settlement marks are again shown on the plan. These are FP1, BLOCK-S, BLOCK-N, TRIG 22, and TRIG 24. The settlements for these marks have generally been deduced relative to original reduced levels measured around the year 1987 –although FP1 (at the Favona portal) was established about the year 2000. Favona mark F07 is disturbed but has been relabelled as F07A. A 'previous history' has been calculated for F07A so this mark can be used for settlement contouring. The underlying zone for the Favona marks is now Zone 5 Martha (2019).

I understand that Time-History plots for all survey marks grouped by zone will be produced by other persons in accordance with the "Settlement and Groundwater Monitoring Plan 31 July 2005"



Bruce Morrison

Registered Professional Surveyor

Table 1. Total Movement

	station	SURVEY			TOTAL	SETTLEMENT	
Zone	I.D.	DATE	X	Y	Z	Nov-21	Comments
Zone7	BM19B	1/11/2021	2117.17	1244.355	35.53	-0.336	
Zone7	19BB	1/11/2021	2191.56	1292.022	35.5259	-0.3319	
Zone7	17CB	1/11/2021	2014.23	1201.01	35.4606	-0.313	
Zone6	BM20	1/11/2021	2342.5	1476.25	35.5779	-0.4029	dist'd
Zone6	BM20A	1/11/2021	2345.5	1484.9	35.7491	-0.3281	

Zone6	19CB	1/11/2021	2296.71	1381.4	34.9173	-0.3126	
Zone6	17BB	1/11/2021	1919.52	1160.787	37.355	-0.276	
Zone6	17AB	1/11/2021	1841.32	1104.802	36.8745	-0.2408	
Zone6	34GC	1/11/2021	2211.33	1119.517	32.1258	-0.226	
Zone6	2.04B	1/11/2021	1893.21	968.34	29.0835	-0.2073	
Zone6	34H	1/11/2021	2233.59	970.561	32.1484	-0.1987	
Zone6	18EE	1/11/2021	1750.73	809.328	23.4266	-0.1948	
Zone6	18C	1/11/2021	1494.95	767.193	27.4607	-0.1942	
Zone6	2.10	1/11/2021	2143.92	950.387	30.2764	-0.1925	
Zone6	18IB	1/11/2021	1611.19	784.79	25.8231	-0.1923	
Zone6	34AD	1/11/2021	1470.88	886.92	29.756	-0.1908	
Zone6	34BE	1/11/2021	1732.56	931.603	28.3263	-0.1804	
Zone6	34C	1/11/2021	1968.9	982.673	30.0984	-0.1715	
Zone6	BM34	1/11/2021	1528.38	903.297	30.3118	-0.1713	
Zone6	10BC	1/11/2021	1560.13	1062.92	38.0983	-0.1693	
Zone6	34FC	1/11/2021	2120.79	587.93	19.0375	-0.1685	dist?
Zone6	11AC	1/11/2021	1308.26	859.512	29.3311	-0.1658	
Zone6	10AB	1/11/2021	1430.61	1036.998	34.9914	-0.1616	
Zone6	18AB	1/11/2021	1632.39	667.733	22.1344	-0.157	
Zone6	BM17A	1/11/2021	1724.44	1088.919	40.0316	-0.1566	
Zone6	2.08B	1/11/2021	2289.75	782.64	24.5305	-0.1559	
Zone6	1.28B	1/11/2021	1987.03	447.71	12.097	-0.1479	
Zone6	2.09C	1/11/2021	2228.35	868.63	28.6371	-0.1468	
Zone6	34I	1/11/2021	2229.55	765.53	28.4586	-0.1396	
Zone6	2.06	1/11/2021	2351.95	334.473	11.2785	-0.1232	
							new
Zone6	2.11C	1/11/2021	2292.35	896.99	26.6088		mark
Zone5	20C	1/11/2021	2450.61	1413.86	36.3061	-0.2013	
Zone5	21DC	1/11/2021	2573.96	1304.152	37.7516	-0.1881	
Zone5	A10B	1/11/2021	1298.62	1049.61	30.6793	-0.1875	
Zone5	20E	1/11/2021	2535.65	1542.672	37.0739	-0.1869	
Zone5	25D	1/11/2021	2547.05	1248.02	36.856	-0.1848	
Zone5	A11D	1/11/2021	1277.04	1017.33	30.8433	-0.1801	
Zone5	25A	1/11/2021	2505.13	1203.77	35.9301	-0.1797	
Zone5	21O	1/11/2021	2527.37	1356.342	35.9967	-0.1791	
Zone5	25E	1/11/2021	2472.35	1162.013	34.7658	-0.1777	

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Zone5	16BC	1/11/2021	1252.81	1336.473	39.4504	-0.1771
Zone5	BM25	1/11/2021	2424.91	1100.253	33.472	-0.1761
Zone5	21N	1/11/2021	2623.25	1342.435	38.2797	-0.1693
Zone5	20D	1/11/2021	2482.07	1473.478	36.5486	-0.1688
Zone5	10DC	1/11/2021	1279.04	1198.326	35.2986	-0.1665
Zone5	25G	1/11/2021	2594.6	1149.415	37.5795	-0.165
Zone5	25H	1/11/2021	2648.48	1232.956	38.911	-0.1647
Zone5	25CB	1/11/2021	2615.91	1190.496	38.2867	-0.1646
Zone5	BM16	1/11/2021	1418.09	1218.03	46.4309	-0.1635
Zone5	2.41	1/11/2021	3296.32	685.398	46.2532	-0.1632
Zone5	25F	1/11/2021	2542.53	1116.24	35.9898	-0.1631
Zone5	24I	1/11/2021	2692.57	1269.713	39.2749	-0.1626
Zone5	10CB	1/11/2021	1222.46	1025.855	29.7704	-0.1617
Zone5	25B	1/11/2021	2497.67	1105.828	34.8163	-0.1607
Zone5	12CE	1/11/2021	1499.92	543.077	20.978	-0.1574
Zone5	2.03	1/11/2021	1930.08	745.943	22.5866	-0.1568
Zone5	34EB	1/11/2021	2073.93	705.952	24.6316	-0.156
Zone5	18F	1/11/2021	1752.28	551.03	17.3256	-0.1555
Zone5	13AC	1/11/2021	1751.98	327.376	18.5898	-0.1551
Zone5	BM12	1/11/2021	1370.27	607.735	23.9524	-0.1543
Zone5	24L	1/11/2021	2761.67	1181.326	39.3241	-0.1541
Zone5	2.02	1/11/2021	1992.61	536.097	15.2684	-0.1532
Zone5	21C	1/11/2021	2651.57	1389.816	38.4599	-0.1523
Zone5	24DC	1/11/2021	2718.29	1323.13	39.6287	-0.1521
Zone5	18B	1/11/2021	1510.36	650.578	23.5552	-0.1518
Zone5	18G	1/11/2021	1669.05	554.602	18.4714	-0.1514
Zone5	25I	1/11/2021	2537.2	1045.036	34.6823	-0.1504
Zone5	34D	1/11/2021	2038.9	783.43	25.3364	-0.1497
Zone5	24K	1/11/2021	2783.89	1387.719	40.6102	-0.1477
Zone5	2A	1/11/2021	1069.03	1111.858	23.7955	-0.1473
Zone5	1.28A	1/11/2021	1888.26	505.887	13.2082	-0.1473
Zone5	24AC	1/11/2021	2743.58	1218.9	40.089	-0.1464
Zone5	20AC	1/11/2021	2461.04	1536.905	37.0127	-0.1464
Zone5	22F	1/11/2021	2815.91	1325.407	40.2314	-0.1461
Zone5	21EB	1/11/2021	2799.95	1429.087	41.6275	-0.1461

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Zone5	BM18	1/11/2021	1771.96	674.53	19.4245	-0.1459
Zone5	24E	1/11/2021	2758.43	1303.234	40.3628	-0.1453
Zone5	24F	1/11/2021	2772.8	1257.274	40.129	-0.1447
Zone5	BM24	1/11/2021	2794.55	1279.361	40.399	-0.1441
Zone5	24J	1/11/2021	2749.39	1365.756	40.2273	-0.1438
Zone5	13BC	1/11/2021	1850.36	246.587	13.7182	-0.1428
Zone5	12DC	1/11/2021	1596.95	435.491	19.9637	-0.1418
Zone5	15A	1/11/2021	1204.79	818.863	28.7677	-0.141
Zone5	12AC	1/11/2021	1388.32	488.888	19.0446	-0.1405
Zone5	18HC	1/11/2021	1821.52	466.47	14.8874	-0.1405
Zone5	24G	1/11/2021	2705.96	1170.464	39.8029	-0.1399
Zone5	20BB	1/11/2021	2533.26	1622.291	37.8716	-0.1395
Zone5	24CD	1/11/2021	2603.21	987.721	34.8297	-0.1393
Zone5	24B	1/11/2021	2667.67	1126.399	39.3834	-0.1379
Zone5	21M	1/11/2021	2694.9	1439.648	39.1778	-0.1377
Zone5	15BC	1/11/2021	1169.9	708.855	26.3298	-0.1351
Zone5	24H	1/11/2021	2630.7	1072.279	36.1596	-0.1342
Zone5	AP22A	1/11/2021	1868.44	188.57	12.4049	-0.1341
Zone5	11BB	1/11/2021	1348.57	710.573	26.9261	-0.1328
Zone5	20F	1/11/2021	2605.79	1575.98	37.569	-0.1326
Zone5	4DB	1/11/2021	1033.26	1550.66	32.2471	-0.1307
Zone5	1.10A	1/11/2021	1599.7	278.938	16.633	-0.1305
Zone5	12BC	1/11/2021	1405.27	368.295	14.9178	-0.1299
Zone5	BM21	1/11/2021	2654.8	1515.4	39.4235	-0.1299
Zone5	21BC	1/11/2021	2719.27	1477.799	41.2659	-0.129
Zone5	BM13	1/11/2021	1426.61	269.34	13.5764	-0.1287
Zone5	21K	1/11/2021	2681.11	1572.207	39.9984	-0.1269
Zone5	2.17A	1/11/2021	3085.76	555.866	36.9049	-0.1246
Zone5	4B	1/11/2021	1021.54	1448.629	31.2501	-0.1243
Zone5	2BC	1/11/2021	970.2	1241.898	30.3836	-0.1224
Zone5	30C	1/11/2021	2573.54	1675.395	38.4389	-0.115
Zone5	BM9B	1/11/2021	1220.25	1523.29	34.7477	-0.1097
Zone5	7CB	1/11/2021	1161.74	1597.63	30.6078	-0.108
Zone5	AP3	1/11/2021	918.94	1140.585	26.0637	-0.1066
Zone5	26EE	1/11/2021	1343.86	1621.82	44.2896	-0.0923

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Zone5	26Q	1/11/2021	1963	1982.71	73.6633	-0.0878	
Zone5	26R	1/11/2021	1905.59	1927.165	71.3482	-0.087	
Zone5	26PB	1/11/2021	1834.84	1893.106	67.9362	-0.0864	
Zone5	26F	1/11/2021	1392.77	1680.26	43.8552	-0.0847	
Zone4	23C	1/11/2021	2856.14	1068.014	37.5515	-0.2146	Nr watercourse
Zone4	23AB	1/11/2021	3145.42	1078.732	37.1894	-0.1824	Nr 23C?
Zone4	2.28	1/11/2021	3076.72	1555.994	42.8967	-0.1738	dist'd?
Zone4	22C	1/11/2021	2846.39	1352.544	40.3125	-0.1668	Nr Zone 5
Zone4	2.24	1/11/2021	2885.91	1215.469	41.2819	-0.1651	Nr Zone 5
Zone4	23D	1/11/2021	2861.42	1154.885	38.8562	-0.1607	Nr 23C
Zone4	BANK1	1/11/2021	2866.21	1023.248	37.794	-0.1603	Nr 23C
Zone4	2.25	1/11/2021	2874.51	1097.261	37.9796	-0.1556	
Zone4	23B	1/11/2021	2856.49	949.794	38.7446	-0.1555	
Zone4	2.14A	1/11/2021	2853.28	838.669	41.3158	-0.1518	
Zone4	2.19B	1/11/2021	3270.21	916.063	38.5572	-0.1517	
Zone4	23E	1/11/2021	2774.82	972.514	37.7098	-0.1517	
Zone4	MATAURA1	1/11/2021	2831.84	1250.806	41.0682	-0.1516	
Zone4	22GB	1/11/2021	2862.88	1387.968	40.8429	-0.1513	
Zone4	BARRY1	1/11/2021	3047.74	926.576	38.1141	-0.1507	
Zone4	MORTON	1/11/2021	2975.42	1231.913	40.7141	-0.1456	
Zone4	BARRY3	1/11/2021	3176.85	895.991	37.6854	-0.1452	
Zone4	2.18	1/11/2021	3218.04	712.756	44.5419	-0.1448	
Zone4	BARRY4B	1/11/2021	3320.16	912.693	38.8867	-0.1439	
Zone4	BARRY5	1/11/2021	3397.59	904.647	40.99	-0.1424	
Zone4	23F	1/11/2021	2700.77	968.793	36.6558	-0.1418	
Zone4	BARRY6	1/11/2021	3432.52	904.356	42.4759	-0.1414	
Zone4	22E	1/11/2021	3055.2	1231.504	40.7823	-0.1412	
Zone4	2.13	1/11/2021	2725.42	874.951	47.215	-0.1409	
Zone4	BARRY2	1/11/2021	2936.96	944.224	38.3555	-0.1401	
Zone4	2.23	1/11/2021	3560.02	1212.795	36.6333	-0.1392	
Zone4	2HB	1/11/2021	1078.24	886.85	24.3865	-0.1388	
Zone4	BM23	1/11/2021	3107.42	921.049	38.0888	-0.1383	
Zone4	1.11B	1/11/2021	1675.83	133.622	9.025	-0.138	
Zone4	STAFORD	1/11/2021	3139.86	998.179	37.3163	-0.1379	
Zone4	2.20	1/11/2021	3467.69	904.56	43.7838	-0.1373	

Zone4	22BC	1/11/2021	2916.75	1435.773	42.105	-0.1368
Zone4	22H	1/11/2021	2869.25	1441.796	41.6224	-0.1344
Zone4	21P	1/11/2021	2849.17	1456.9	41.849	-0.1343
Zone4	22I	1/11/2021	2918.98	1461.367	41.9153	-0.1339
Zone4	22M	1/11/2021	2973.44	1434.656	41.6725	-0.1335
Zone4	2.16	1/11/2021	3007.62	739.64	33.5954	-0.1324
Zone4	2.15	1/11/2021	2918.94	723.52	38.3654	-0.1315
Zone4	2.22	1/11/2021	3339.13	1206.603	40.3476	-0.1302
Zone4	BARRY7	1/11/2021	3518.87	901.897	43.6117	-0.1296
Zone4	GW	1/11/2021	3128.83	1140.936	38.5399	-0.1295
Zone4	22L	1/11/2021	3047.7	1499.876	40.9928	-0.1289
Zone4	2.21	1/11/2021	3563.09	1045.18	34.0308	-0.1288
Zone4	AP100	1/11/2021	1893.8	81.273	11.7793	-0.1285
Zone4	22D	1/11/2021	3100.02	1335.441	41.4487	-0.1274
Zone4	22A	1/11/2021	3003.28	1429.771	41.6457	-0.127
Zone4	CUBA	1/11/2021	3224.32	1079.177	35.8266	-0.1266
Zone4	BARRY8	1/11/2021	3592.28	871.451	37.9353	-0.1264
Zone4	22J	1/11/2021	2944.47	1489.763	42.4259	-0.1238
Zone4	BM2	1/11/2021	915.74	1091.799	24.827	-0.1235
Zone4	21FB	1/11/2021	2861.65	1512.211	42.6478	-0.1225
Zone4	1.05	1/11/2021	1176.96	473.454	21.8173	-0.1221
Zone4	27KB	1/11/2021	2320.23	2120.21	63.3263	-0.1193
Zone4	21AC	1/11/2021	2716.64	1617.767	39.6903	-0.1187
Zone4	21L	1/11/2021	2806.79	1575.074	43.0857	-0.1181
Zone4	2.29B	1/11/2021	2953.39	1548.172	42.5895	-0.1173
Zone4	BM22	1/11/2021	3115.79	1442.95	40.6173	-0.1169
Zone4	2.26	1/11/2021	3241.22	1380.889	39.2165	-0.1167
Zone4	1.26	1/11/2021	1926.81	30.053	15.0906	-0.1162
Zone4	26BE	1/11/2021	1408.78	1800.55	38.8101	-0.116
Zone4	2.27	1/11/2021	3379.4	1371.481	37.7558	-0.1148
Zone4	15C	1/11/2021	1156.82	571.08	24.2086	-0.113
Zone4	2GB	1/11/2021	922.38	967.661	22.6728	-0.1127
Zone4	21Q	1/11/2021	2899.6	1571.317	43.1257	-0.1115
Zone4	30BB	1/11/2021	2604.86	1726.5	41.5461	-0.1088
Zone4	26CE	1/11/2021	1377.77	1711.89	40.5949	-0.1087

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Zone4	22KB	1/11/2021	2981.8	1603.49	42.8482	-0.1085
Zone4	1.06	1/11/2021	1159.34	302.262	17.2232	-0.1079
Zone4	21I	1/11/2021	2854.7	1668.793	41.6432	-0.1066
Zone4	27N	1/11/2021	2179.57	2075.985	71.9054	-0.1052
Zone4	21GC	1/11/2021	2901.12	1614.05	43.4421	-0.1047
Zone4	21J	1/11/2021	2773.44	1688.923	39.9621	-0.1046
Zone4	SM822	1/11/2021	2512.91	1841.132	41.4552	-0.1029
Zone4	27E	1/11/2021	2494.09	2171.622	50.3365	-0.1017
Zone4	4.08	1/11/2021	2350.64	2022.324	73.2058	-0.1013
Zone4	2.31B	1/11/2021	3201.23	1637.289	42.0925	-0.1008
Zone4	1.09B	1/11/2021	1344.14	117.48	9.9256	-0.0995
Zone4	BM15	1/11/2021	976.94	783	20.5183	-0.0982
Zone4	2.30B	1/11/2021	3000.35	1672.941	43.1698	-0.0978
Zone4	4.09	1/11/2021	2249.27	2029.944	78.9112	-0.0975
Zone4	21HC	1/11/2021	2916.84	1728.842	42.8807	-0.0953
Zone4	7BB	1/11/2021	1105.69	1689.9	35.9353	-0.092
Zone4	27H	1/11/2021	2413.27	2149.757	57.0198	-0.0907
Zone4	4.07	1/11/2021	2554.47	2079.237	45.0425	-0.0906
Zone4	27J	1/11/2021	2344.14	2136.138	62.1259	-0.09
Zone4	27G	1/11/2021	2440.97	2157.3	54.5557	-0.0894
Zone4	3.01	1/11/2021	1291.95	1690.33	37.2938	-0.0857
Zone4	26AE	1/11/2021	1432.47	1883.479	37.5475	-0.0853
Zone4	4.05	1/11/2021	2809.68	1897.682	40.6163	-0.0851
Zone4	26NC	1/11/2021	1641.16	1772.4	60.3849	-0.085
Zone4	27I	1/11/2021	2385.1	2141.94	59.5224	-0.085
Zone4	3.04B	1/05/2021	1123.76	1821.498	39.2814	-0.0835
Zone4	27F	1/11/2021	2466.48	2164.026	52.3133	-0.0816
Zone4	26H	1/11/2021	1452.9	1729.593	49.9581	-0.0807
Zone4	3.11A	1/11/2021	1786.17	1929.216	62.1419	-0.0802
Zone4	BM30	1/11/2021	2715.36	1996.207	44.0834	-0.0802
Zone4	26G	1/11/2021	1425.06	1706.748	46.9949	-0.0799
Zone4	26MB	1/11/2021	1593.46	1750.663	58.9635	-0.0796
Zone4	27M	1/11/2021	2224.38	2095.26	69.1482	-0.0789
Zone4	26JB	1/11/2021	1495.71	1756.55	53.7237	-0.0787
Zone4	26I	1/11/2021	1481.67	1750.49	52.7223	-0.0784

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Zone4	3.09	1/05/2021	1618.51	1870.17	51.9142	-0.0778	
Zone4	27AB	1/11/2021	2009.08	2064.33	73.4729	-0.0777	
Zone4	3.02	1/11/2021	1344.87	1837.74	34.9399	-0.0773	
Zone4	30AB	1/11/2021	2685.64	1898.443	46.2329	-0.0757	
Zone4	27L	1/11/2021	2280.24	2115.41	65.8328	-0.0751	
Zone4	3.10A	1/11/2021	1689.03	1978.29	53.4305	-0.0739	
Zone4	27O	1/11/2021	2101.57	2042.821	75.0172	-0.0733	
Zone4	27DC	1/11/2021	2541.24	2190.709	48.1869	-0.0726	
Zone4	3.13	1/11/2021	1744.89	2097.49	53.7553	-0.0693	
Zone4	BM26	1/11/2021	1542.45	1837.805	45.4187	-0.0674	
Zone4	26OB	1/11/2021	1706.93	1812.27	67.1747	-0.0601	
Zone4	3.6A	1/11/2021	1526.28	2015.74	38.9163	-0.0493	
Zone3	2CE	1/11/2021	774.75	1313.191	34.6086	-0.1173	Nr Zone 5
Zone3	2.34	1/11/2021	3452.45	1683.502	37.7074	-0.1059	Nr Zone 4
Zone3	14DB	1/11/2021	876.99	411.215	15.1516	-0.1022	Nr Zone 4
Zone3	2.36	1/11/2021	3433.14	1534.879	35.9196	-0.0956	Nr Zone 4
Zone3	1.25	1/11/2021	2175.94	-129.105	20.051	-0.095	
Zone3	4.02	1/11/2021	2797.9	2143.571	45.7562	-0.0929	
Zone3	2.40B	1/11/2021	3572.85	1526.452	33.1473	-0.0928	
Zone3	2.33	1/11/2021	3294.51	1691.952	40.3004	-0.0925	
Zone3	A33C	1/11/2021	456.03	1219.23	35.8481	-0.0918	
Zone3	4A	1/11/2021	815.01	1494.154	40.6837	-0.0887	
Zone3	BM31	1/11/2021	2967.04	1873.48	43.2773	-0.0882	
Zone3	4.03B	1/11/2021	2794.9	2044.78	43.7928	-0.0881	
Zone3	4EC	1/11/2021	782.01	1687.78	41.1216	-0.0881	
Zone3	31BC	1/11/2021	3159.33	1954.86	45.4945	-0.088	
Zone3	1.07	1/11/2021	924.43	267.49	12.4967	-0.0869	
Zone3	2FC	1/11/2021	720.33	843.06	23.9204	-0.0861	
Zone3	2DA	1/11/2021	682.15	1189.579	35.8042	-0.0844	
Zone3	15DB	1/11/2021	917.56	466.148	15.5963	-0.0837	
Zone3	4.01C	1/11/2021	2891.78	2113.146	47.2946	-0.0835	
Zone3	4.04	1/11/2021	2662.6	2131.77	45.9129	-0.0823	
Zone3	14EA	1/11/2021	808.56	504.723	17.0871	-0.0817	
Zone3	31AC	1/11/2021	3059.04	1910.63	44.0616	-0.0809	
Zone3	14CB	1/11/2021	759.1	389.766	18.8156	-0.0802	

Zone3	29DB	1/11/2021	2996.63	2106.66	47.7993	-0.0796	
Zone3	1.21A	1/11/2021	1939.94	-325.5	19.651	-0.0787	
Zone3	14BC	1/11/2021	535.45	340.672	20.9073	-0.0782	
Zone3	2EB	1/11/2021	689.02	1054.62	29.2556	-0.0764	
Zone3	1.08	1/11/2021	1052.91	107.171	16.5231	-0.0757	
Zone3	31CC	1/11/2021	3248.97	1989.886	47.0278	-0.0721	
Zone3	1.22	1/11/2021	1510	-249.93	15.8608	-0.072	
Zone3	14FB	1/11/2021	705.6	649.144	20.1475	-0.0719	
Zone3	3.25	1/11/2021	3116.9	2107.06	49.8059	-0.0712	
Zone3	29CE	1/11/2021	2891.84	2285.59	51.5649	-0.0647	
Zone3	29AC	1/11/2021	2641.62	2218.071	48.5116	-0.0643	
Zone3	3.24	1/11/2021	3017.29	2258.712	51.9261	-0.0601	
Zone3	29B	1/11/2021	2772.84	2242.217	49.9973	-0.0494	
Zone2	3.14	1/11/2021	1752.75	2214.32	48.748	-0.0786	Nr Zone 4
Zone2	7AC	1/11/2021	994.54	1781.823	43.5159	-0.076	Nr Zone 3
Zone2	1K	1/11/2021	511.74	957.174	29.5935	-0.0755	Nr Zone 3
Zone2	3.03	1/05/2021	1134.46	1917.237	39.3411	-0.0738	Nr Zone 4
Zone2	BM4	1/11/2021	689.21	1555.547	42.2698	-0.0709	Nr Zone 3
Zone2	3.12	1/11/2021	1599.68	2152.41	40.2575	-0.0703	Nr Zone 4
Zone2	BM7	1/11/2021	1057.32	1843.07	44.1078	-0.0686	Nr Zone 4
Zone2	33F	1/05/2021	347.95	1511.68	42.0403	-0.0682	Nr BM4
Zone2	4FB	1/11/2021	562.51	1370.97	39.3661	-0.067	Nr Zone 3
Zone2	3.07	1/05/2021	1362.08	2096.818	48.0347	-0.0645	
Zone2	6A	1/11/2021	946.43	1928.12	47.5042	-0.0638	
Zone2	33A	1/11/2021	338.15	1303.89	36.715	-0.0636	
Zone2	1JB	1/11/2021	604.79	822.76	26.4069	-0.0633	
Zone2	1C	1/11/2021	421.48	1098.89	34.7854	-0.0632	
Zone2	33E	1/05/2021	437.71	1437.52	40.9837	-0.0626	
Zone2	1.04	1/11/2021	795.98	129.359	12.7985	-0.0604	
Zone2	1.12	1/11/2021	800.71	-50.23	10.7864	-0.0603	
Zone2	1I	1/11/2021	468.34	761.228	27.2705	-0.0585	
Zone2	1B	1/11/2021	337.5	1062.935	33.9989	-0.0583	
Zone2	BM6	1/11/2021	881.86	1837.08	46.2253	-0.0583	
Zone2	33DB	1/05/2021	265.4	1714.719	46.3602	-0.0582	
Zone2	BM14	1/11/2021	718.16	485.955	19.8296	-0.058	

Zone2	5C	1/11/2021	705.43	1754.71	45.1623	-0.0547	
Zone2	3.22A	1/11/2021	2891.15	2398.649	56.6511	-0.0536	
Zone2	BM29	1/11/2021	2608.8	2400.756	55.9555	-0.0529	
Zone2	3.15	1/11/2021	1696.24	2315.82	39.0954	-0.0526	
Zone2	14AC	1/11/2021	515.17	457.622	24.0205	-0.0526	
Zone2	33GA	1/05/2021	415.95	1621.638	45.3482	-0.0523	
Zone2	1NB	1/11/2021	-206.98	842.119	24.8019	-0.0514	
Zone2	1FB	1/11/2021	210.46	850.779	29.8263	-0.0512	
Zone2	1SC	1/11/2021	-674.31	739.27	14.4418	-0.051	
Zone2	1EB	1/11/2021	388.6	912.09	30.4289	-0.05	
Zone2	1HC	1/11/2021	299.7	702.8	27.0422	-0.0487	
Zone2	1O	1/11/2021	-271.35	814.183	22.7096	-0.0481	
Zone2	1A	1/11/2021	249.92	1026.38	33.3281	-0.0476	
Zone2	1LD	1/11/2021	-102.13	906.05	28.3534	-0.0466	
Zone2	5BC	1/11/2021	547.16	1824.599	49.1326	-0.0462	
Zone2	5AC	1/11/2021	470.3	1688.454	47.0328	-0.045	
Zone2	3.05	1/05/2021	966.29	1990.771	47.1876	-0.0448	
Zone2	1GB	1/11/2021	-2.87	769.742	29.2901	-0.0446	
Zone2	33B	1/11/2021	156.88	1430.804	34.4086	-0.0444	
Zone2	BM5	1/11/2021	325.93	1806.47	47.8013	-0.0441	
Zone2	BM1	1/11/2021	152.75	994.869	32.7707	-0.0439	
Zone2	1ME	1/11/2021	-155.4	879.887	26.0994	-0.0438	
Zone2	33C	1/11/2021	222.53	1621.241	44.4046	-0.0435	
Zone2	1.03B	1/11/2021	365.55	323.37	19.3818	-0.0434	
Zone2	1.02D	1/11/2021	85.42	283.3	18.6548	-0.0432	
Zone2	1.01	1/11/2021	56.47	604.08	25.447	-0.0399	
Zone2	1PA	1/11/2021	-351.51	787.24	20.0612	-0.0386	
Zone2	1RA	1/11/2021	-579.06	750.356	16.7322	-0.0356	
Zone2	1D	1/11/2021	-32.05	911.592	30.0404	-0.0324	
Zone2	1QC	1/11/2021	-466.05	769.147	18.1476	-0.0291	
Zone2	1.14	1/11/2021	496.74	-535.095	8.4408	-0.0288	
Zone2	AP2	1/11/2021	-1276.4	954.13	5.768	-0.028	
Zone2	1.16	1/11/2021	1552.97	-1086.27	18.3556	-0.0224	
Zone1	2.44	1/11/2021	2734.64	421.025	27.2412	-0.5875	dist'd
Zone1	2.05	1/11/2021	2535.68	272.682	20.7628	-0.1173	Nr Zone 5

Zone1	31MD	1/11/2021	4275.09	1884.554	30.7041	-0.1059	Nr river bridge
Zone1	31NE	1/11/2021	4349.43	1927.421	33.3284	-0.1002	Nr river bridge
Zone1	31FC	1/11/2021	3614.22	1954.151	43.4051	-0.097	Nr Zone 3
Zone1	31LC	1/11/2021	4168.53	1862.106	32.0717	-0.0959	Nr river bridge
Zone1	2.35	1/11/2021	3609.8	1652.68	34.0916	-0.0941	Nr Zone 3
Zone1	31KC	1/11/2021	4076.39	1883.2	34.4632	-0.0911	Nr river bridge
Zone1	31JD	1/11/2021	4005.65	1911.423	35.5328	-0.0877	Nr 31KC
Zone1	31HC	1/11/2021	3810.83	1924.654	40.3096	-0.0859	Nr Zone 3
Zone1	31DD	1/11/2021	3400.43	1989.833	46.6743	-0.0856	Nr Zone 3
Zone1	31GC	1/11/2021	3711.83	1939.277	42.1578	-0.0855	Nr Zone 3
Zone1	31IC	1/11/2021	3909.03	1909.9	37.825	-0.0854	Nr 31JD
Zone1	28AE	1/11/2021	2128.26	2448.76	85.8958	-0.0805	Nr Zone 2
Zone1	31ED	1/11/2021	3496.21	1975.77	45.9011	-0.0771	Nr Zone 3
Zone1	31PC	1/11/2021	4393.52	1991.662	37.7113	-0.0714	Nr river bridge
Zone1	27CD	1/11/2021	2122.89	2374.362	85.0344	-0.0714	Nr Zone 3
Zone1	31QC	1/11/2021	4417.71	2035.374	39.6077	-0.068	Nr river bridge
Zone1	3.30	1/11/2021	3296.29	2235.94	50.365	-0.0577	Nr Zone 2
Zone1	3.21	1/11/2021	2585.77	2493.375	64.92	-0.0562	Nr Zone 2
Zone1	3.16	1/11/2021	2195.6	2563.077	95.5908	-0.0557	Nr Zone 2
Zone1	31OD	1/11/2021	4374.76	1958.38	36.0465	-0.0522	
Zone1	3.26B	1/11/2021	3200.09	2347.92	55.4033	-0.0512	
Zone1	1.20B	1/11/2021	1995.49	-664.09	22.0236	-0.0489	
Zone1	3.23	1/11/2021	3035.8	2453.65	59.6097	-0.0479	
Zone1	3.28A	1/11/2021	3212.99	2635.997	53.822	-0.0477	
Zone1	1.24	1/11/2021	2225.16	-613.23	16.6861	-0.0475	
Zone1	3.29	1/11/2021	3662.64	2323.53	44.9042	-0.0463	
Zone1	3.27B	1/11/2021	3148.37	2510.53	60.2662	-0.0454	
Zone1	1VA	1/11/2021	-994.62	800.624	6.4227	-0.0443	
Zone1	1.23	1/11/2021	1013.01	-440.769	13.2654	-0.0432	
Zone1	AP2A	1/11/2021	-766.18	738.51	12.3104	-0.0393	
Zone1	1.13	1/11/2021	591.36	-310.797	7.0549	-0.0376	
Zone1	AP1A	1/11/2021	4557.1	2288.33	42.4626	-0.0374	
Zone1	AP1	1/11/2021	4486.29	2137.008	41.3578	-0.0347	
Zone1	1.27B	1/11/2021	1401.56	-701.57	15.3289	-0.0322	
Zone1	1UA	1/11/2021	-914.75	759.05	8.7248	-0.0298	

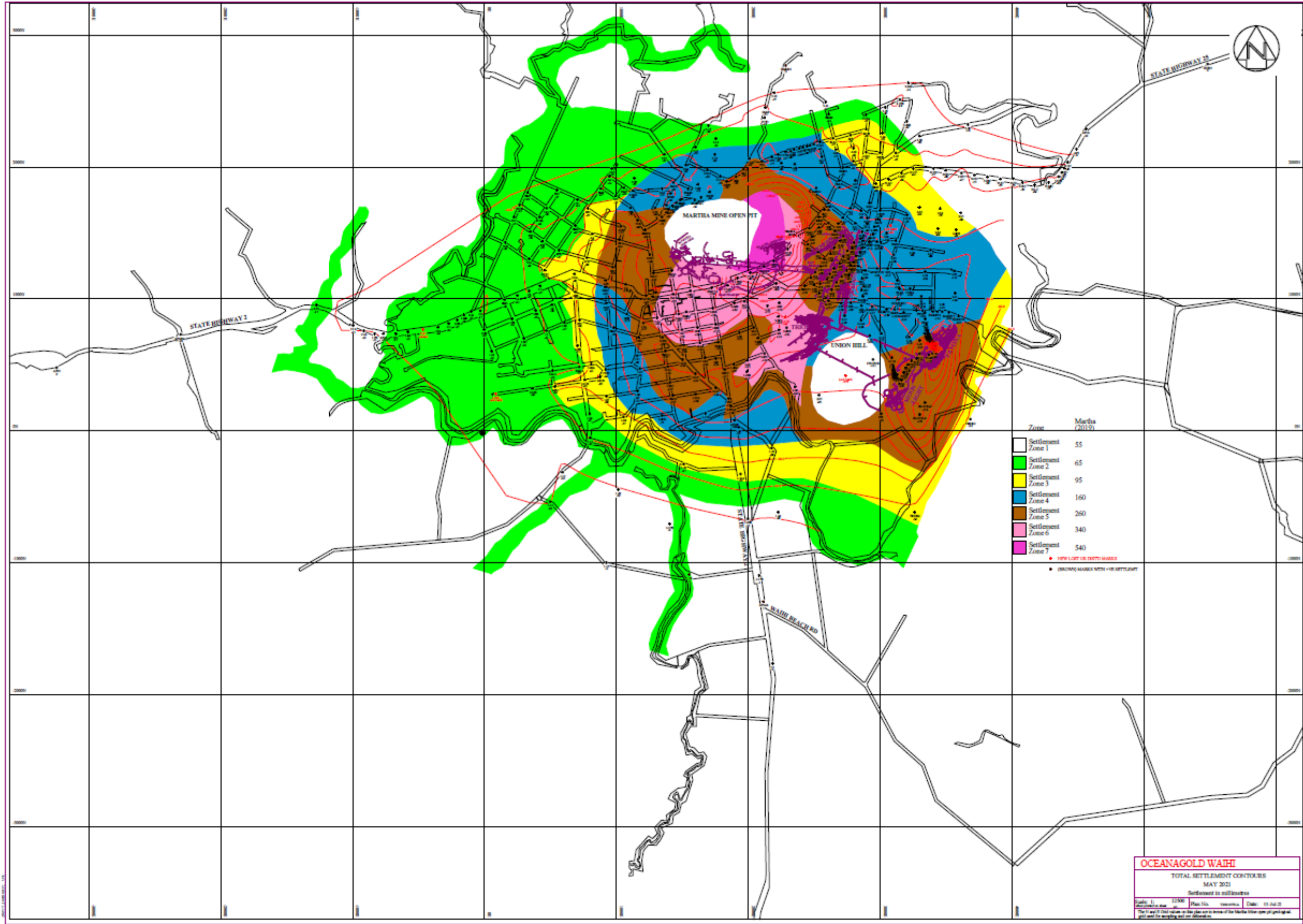
Zone1	1.17B	1/11/2021	2082.2	-1093.92	25.5759	-0.0277	
Zone 1	AP24A	1/11/2021	2114.57	-1292.93	28.0483	-0.0269	
Zone1	1TB	1/11/2021	-832.77	738.922	11.229	-0.0255	
Zone1	1.15	1/11/2021	923.35	-995.413	14.3477	-0.0243	
Zone1	AP20No2	1/11/2021	-2303.63	731.69	20.1848	-0.0204	
Zone1	BM28/2	1/11/2021	2282.46	2770.684	101.8713	-0.0144	
Zone1	AP19	1/11/2021	-3242.58	480.68	-6.5213	0	control
Zone1	BUH5	1/11/2021	5480.15	2780.649	52.7029	0	control
Zone1	C1	1/11/2021	2183.23	-1759.33	32.8139	0	control
Favona	F18	1/11/2021	3423.83	648.3	39.9761	-0.3553	dist'd
Favona	F23	1/11/2021	3393.93	684.82	40.5921	-0.3085	dist'd?
Favona	F20	1/11/2021	3411.7	665.722	40.8972	-0.3069	dist'd?
Favona	F24	1/11/2021	3388.13	690.846	40.6082	-0.2797	dist'd?
Favona	F21	1/11/2021	3405.99	672	40.7366	-0.2767	Nr F20
Favona	F17B	1/11/2021	3405.48	613.912	43.9634	-0.2761	Nr F24
Favona	F22	1/11/2021	3399.79	678.393	40.6783	-0.2581	
Favona	F25	1/11/2021	3381.55	697.882	40.5816	-0.2399	dist'd?
Favona	F15C	1/11/2021	3297.17	585.319	57.3093	-0.2072	
Favona	F16B	1/11/2021	3367.38	578.696	46.3662	-0.1998	
Favona	BLOCK-S	1/11/2021	3295.82	124.324	24.8143	-0.1977	
Favona	F11C	1/11/2021	3192.52	479.444	51.4141	-0.1962	
Favona	F26	1/11/2021	3374.47	705.541	40.5698	-0.1961	
Favona	F27B	1/11/2021	3372.41	717.518	40.4843	-0.1889	
Favona	F10B	1/11/2021	3176.88	446.75	49.2476	-0.1805	
Favona	BLOCK-N	1/11/2021	3336.45	215.694	24.2825	-0.1805	
Favona	F12C	1/11/2021	3207.32	503.82	53.4727	-0.1801	
Favona	F34C	1/11/2021	3339.49	849.57	40.1605	-0.18	
Favona	F28B	1/11/2021	3365.21	727.17	40.4883	-0.1714	
Favona	F14C	1/11/2021	3275.29	551.312	60.637	-0.1708	
Favona	F09A	1/11/2021	3157.2	388.28	45.1348	-0.1702	
Favona	F13C	1/11/2021	3236.43	533.63	57.8867	-0.1688	
Favona	F30B	1/11/2021	3359.36	748.26	40.6756	-0.1619	
Favona	F31B	1/11/2021	3354.47	756.84	41.2202	-0.1602	
Favona	F29B	1/11/2021	3363.2	738.71	40.4727	-0.1593	
Favona	F33	1/11/2021	3348.56	812.51	40.6094	-0.1543	

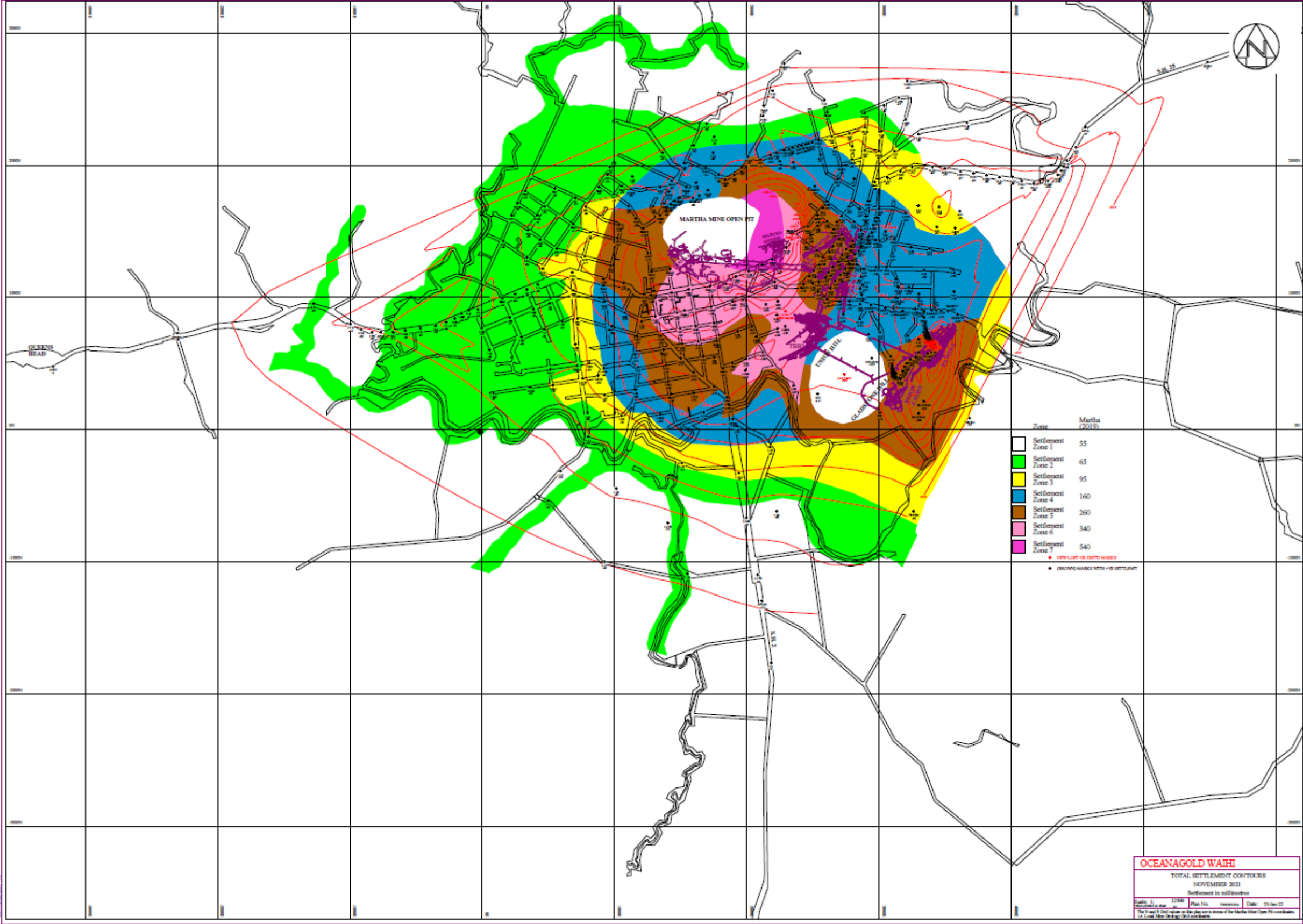


Favona	F08A	1/11/2021	3126.97	430.49	42.7235	-0.154
Favona	F32B	1/11/2021	3348.78	769.103	40.8414	-0.1506
Favona	F35B	1/11/2021	3336.68	896.06	39.7509	-0.1463
Favona	F07A	1/11/2021	3110.57	437.24	41.3387	-0.1438
Favona	F06	1/11/2021	3107.08	445.21	40.4796	-0.1382
Favona	F04	1/11/2021	3100.96	470.88	38.7004	-0.1345
Favona	ITXCIVB	1/11/2021	2943.85	542.17	32.5898	-0.1329
Favona	F03	1/11/2021	3099.03	480.33	38.3753	-0.1324
Favona	F02	1/11/2021	3097.6	490	38.1788	-0.1319
Favona	F05	1/11/2021	3104.66	455.54	39.4381	-0.131
Favona	FP1	1/11/2021	3004.15	131.25	45.3937	-0.1153
Favona	TRIG 24	1/11/2021	3260.76	-615.678	25.6679	-0.0621
Favona	TRIG 22	1/11/2021	3681.97	89.358	26.1341	-0.0559

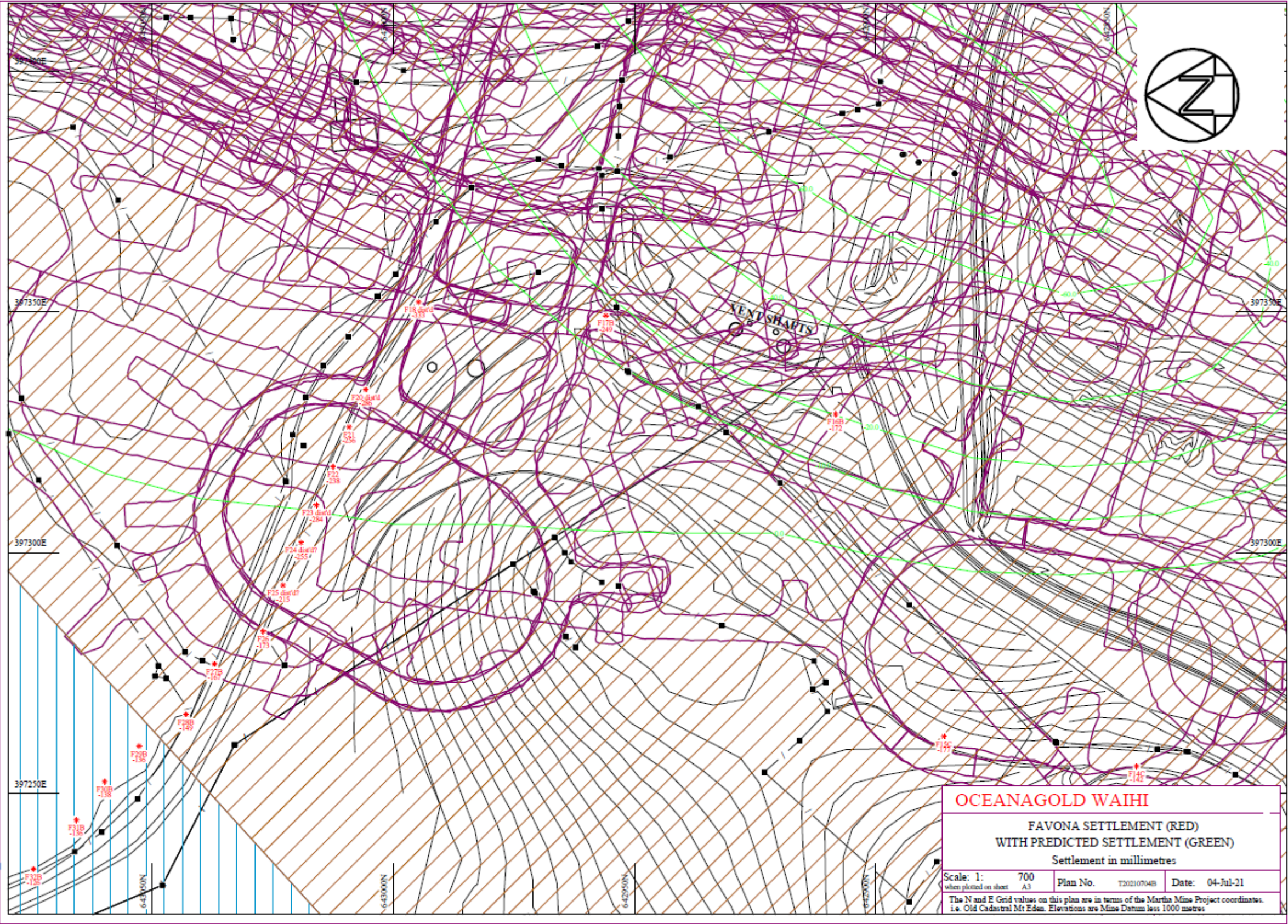
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## **Appendix C      Plans of Settlement Marks & Contours**



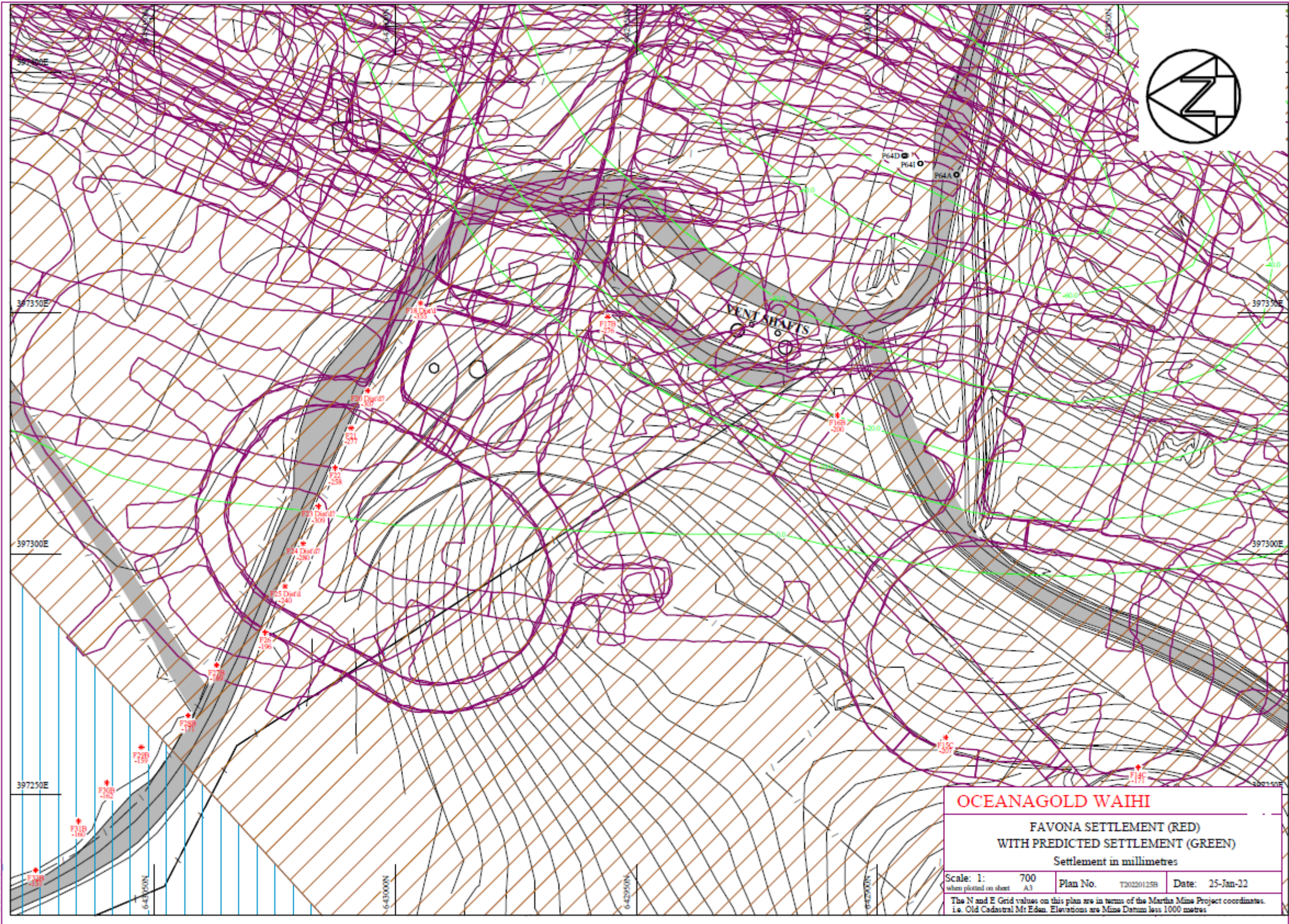






SURPAC - GEOVIA -prepared by B.M. Morrison

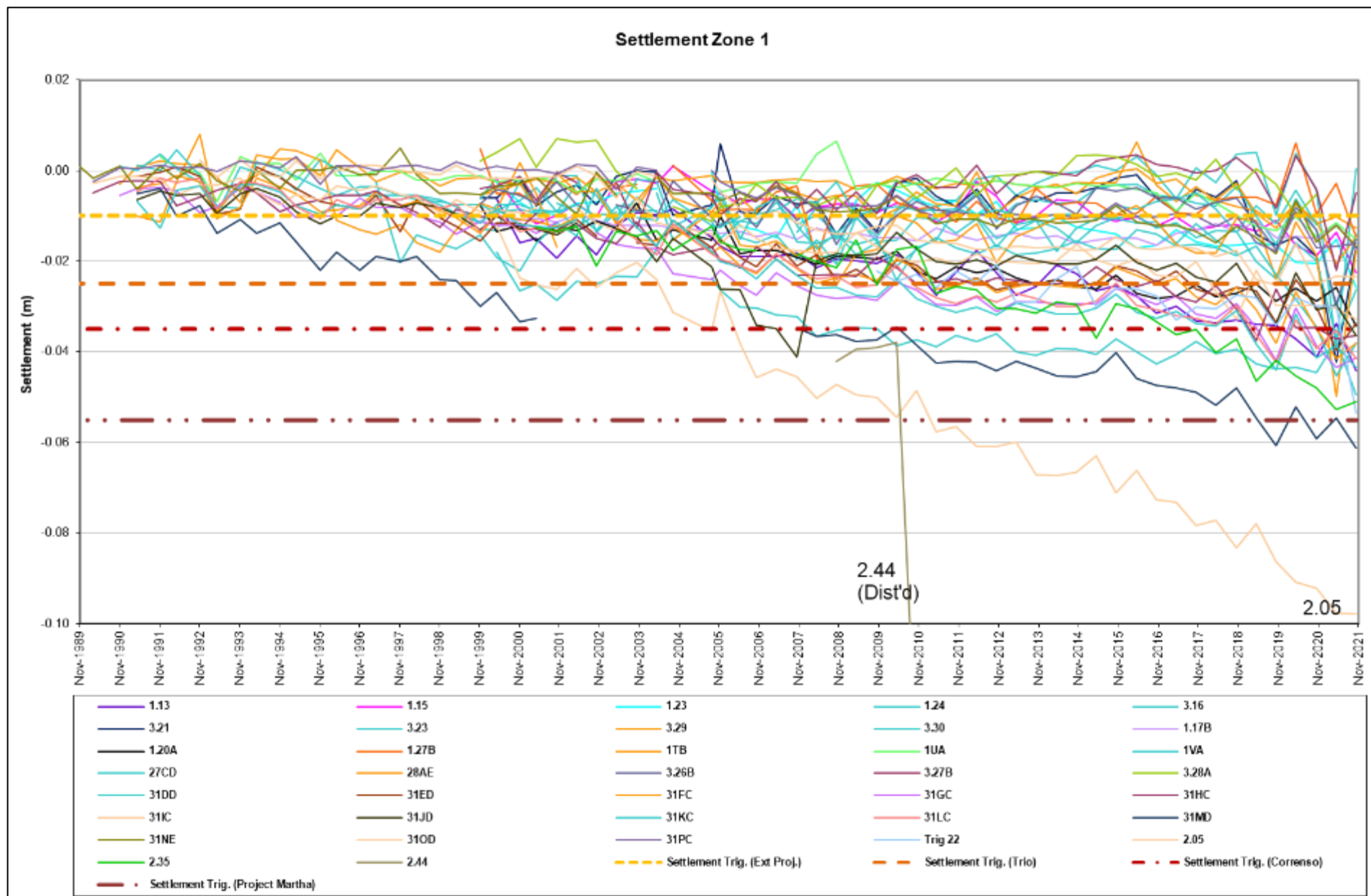


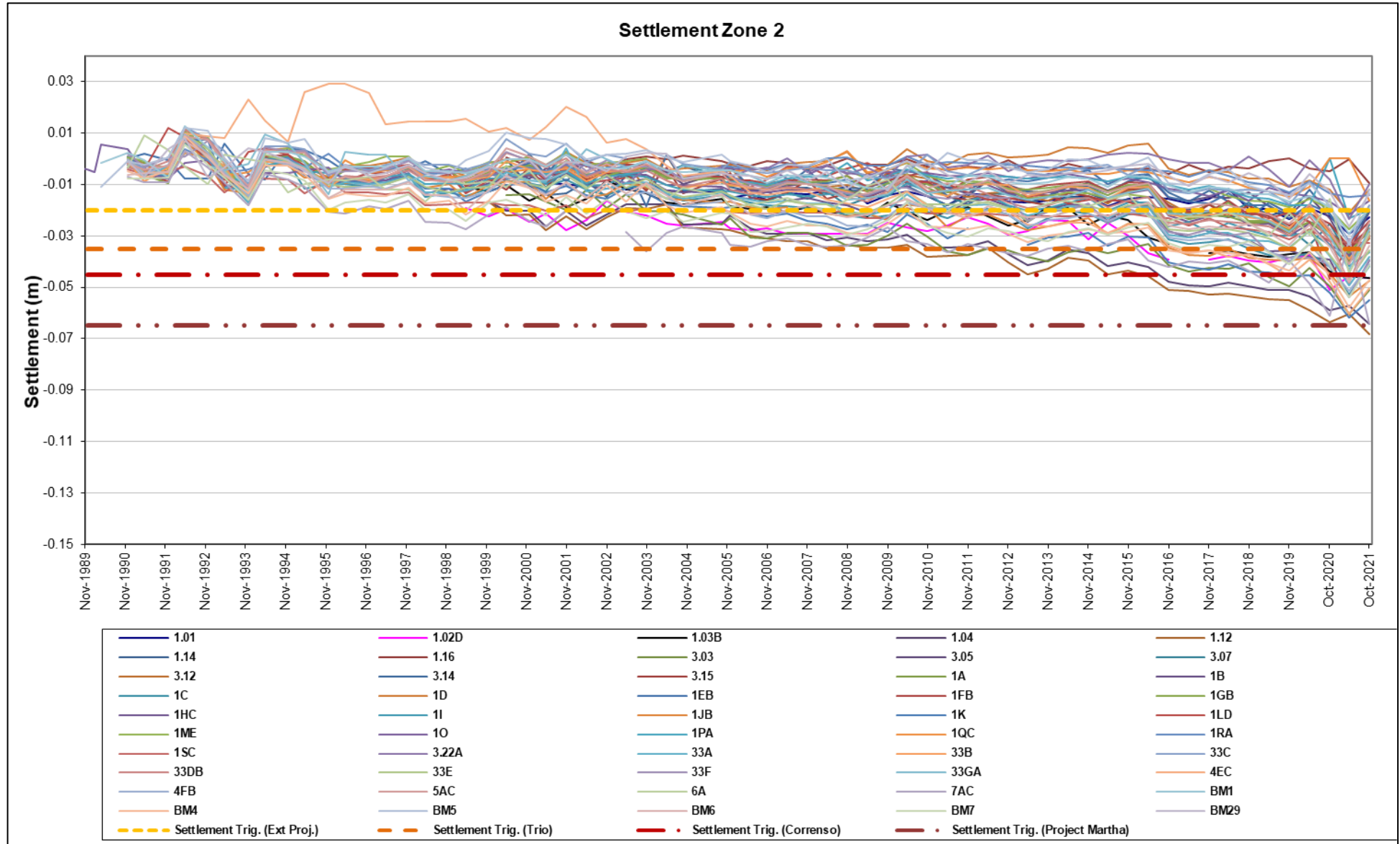


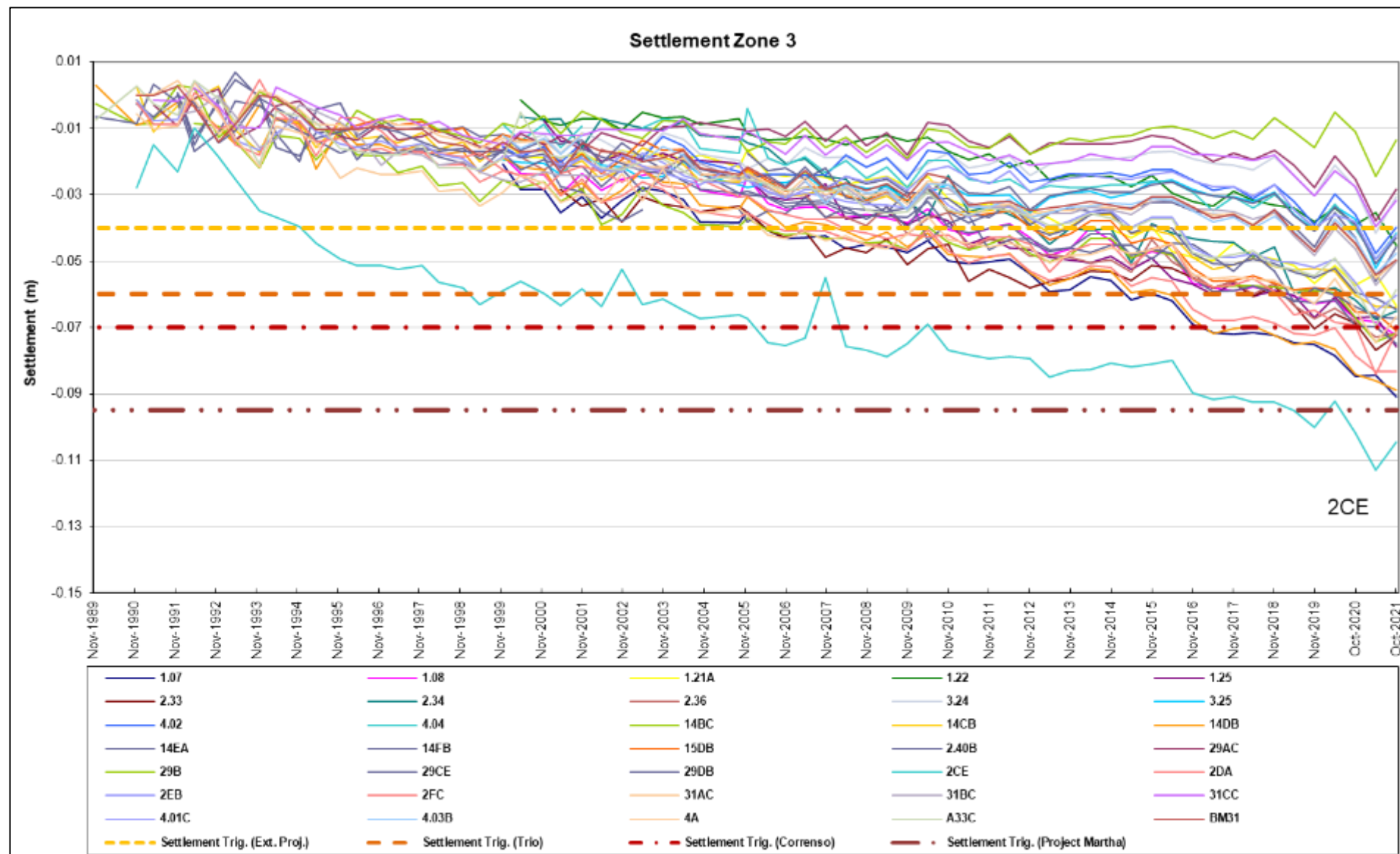
SURPAC - GEOVIA -prepared by B.M. Morrison



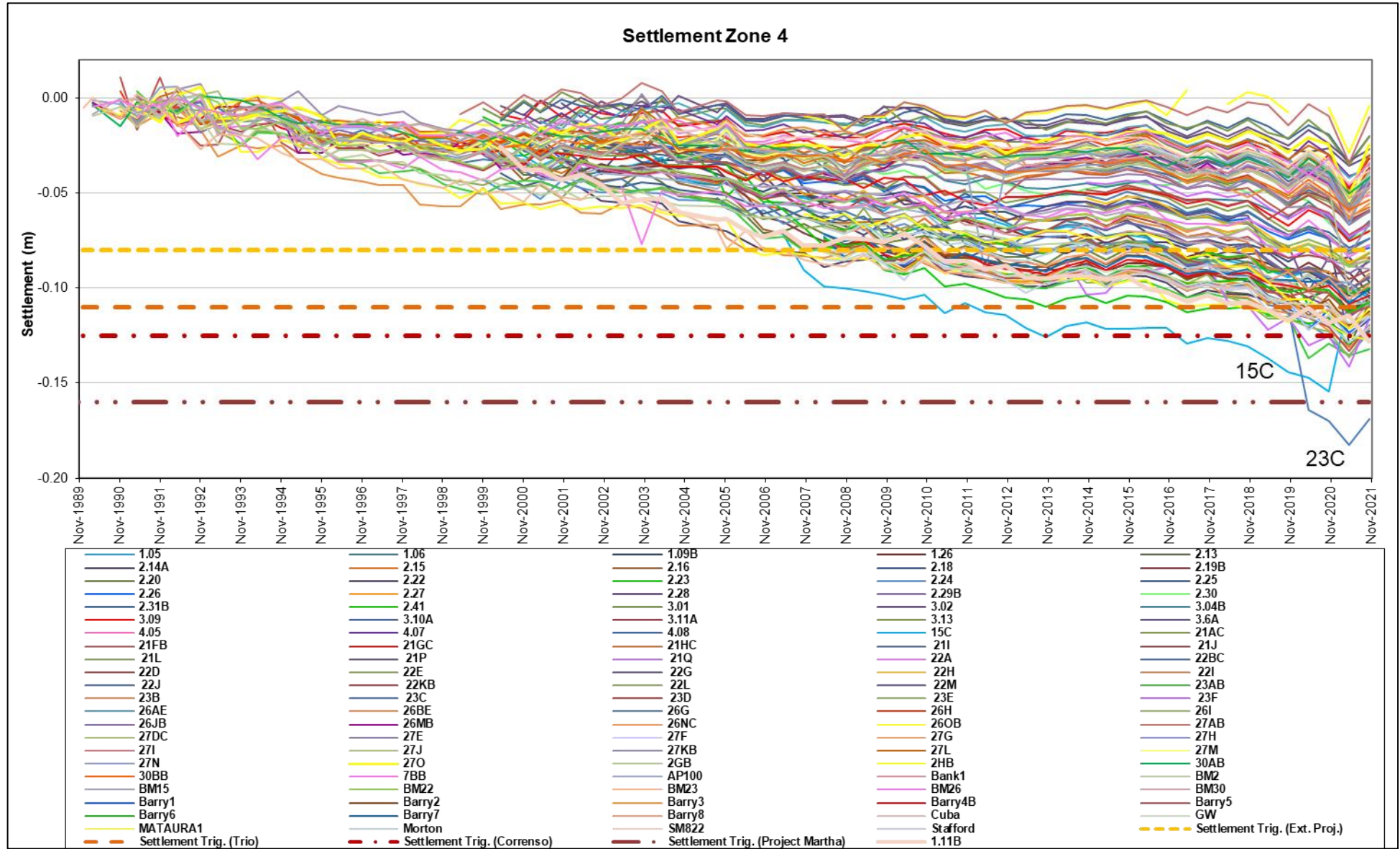
## **Appendix D      Trend Plots of Settlement Zones**

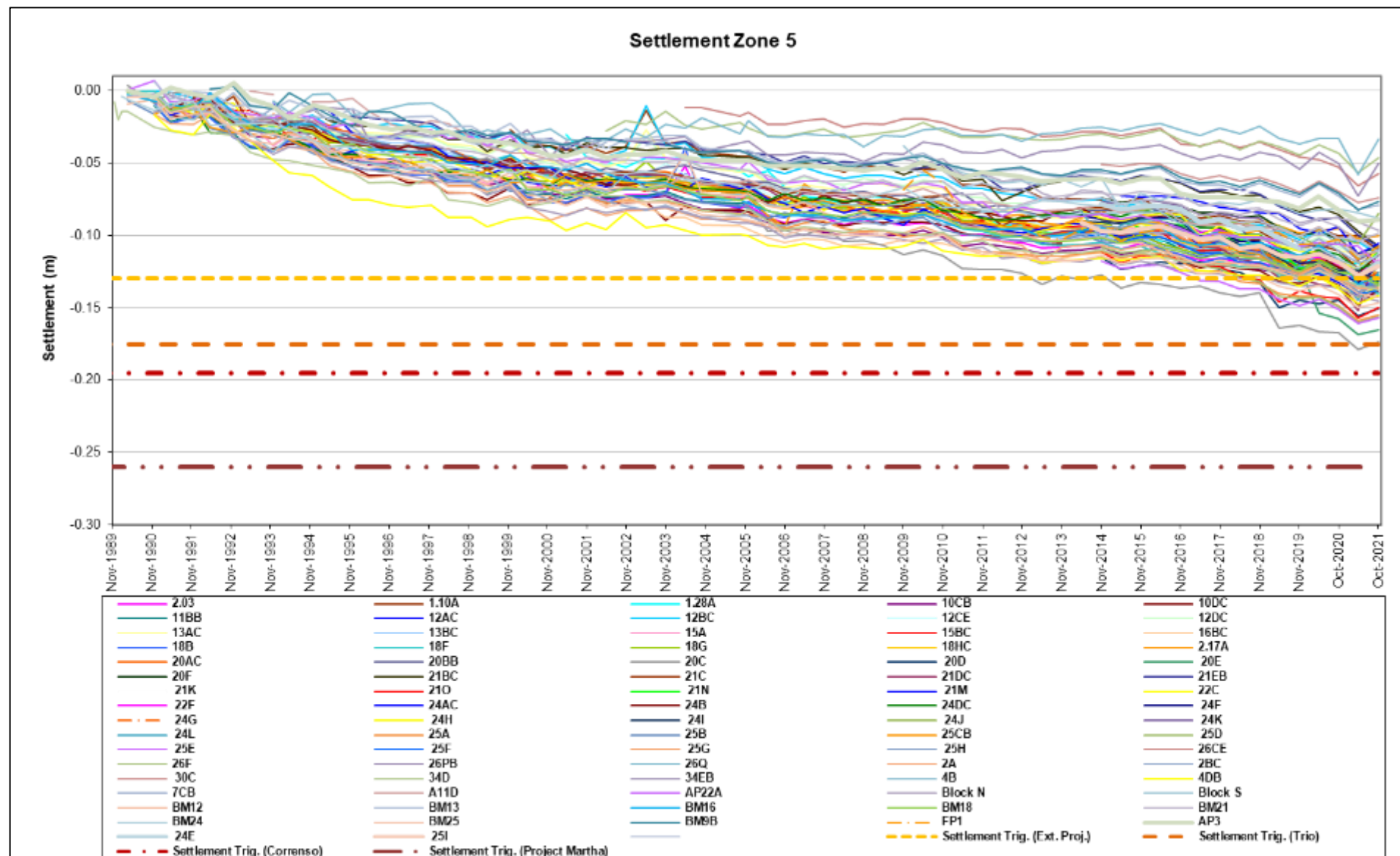


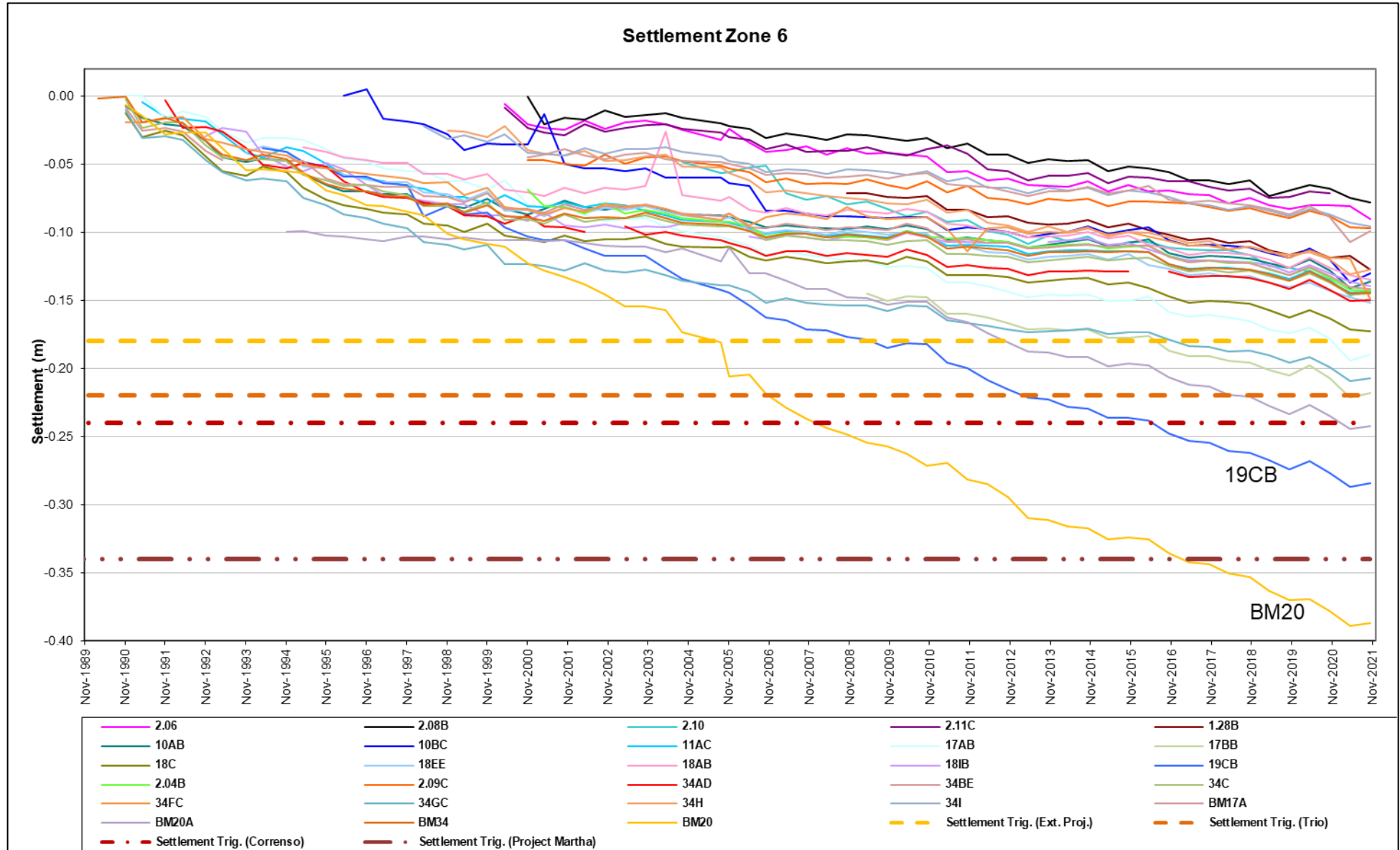


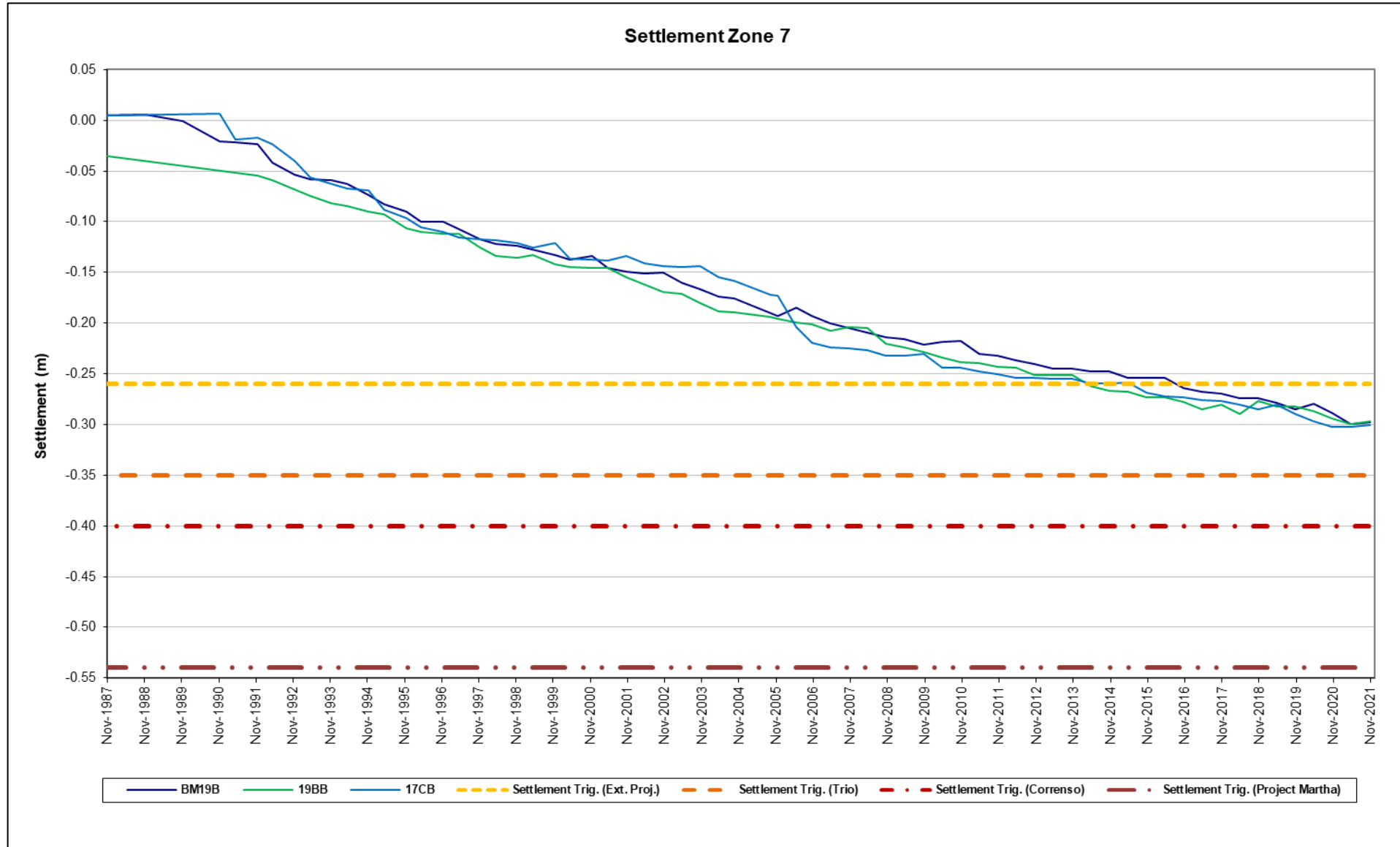


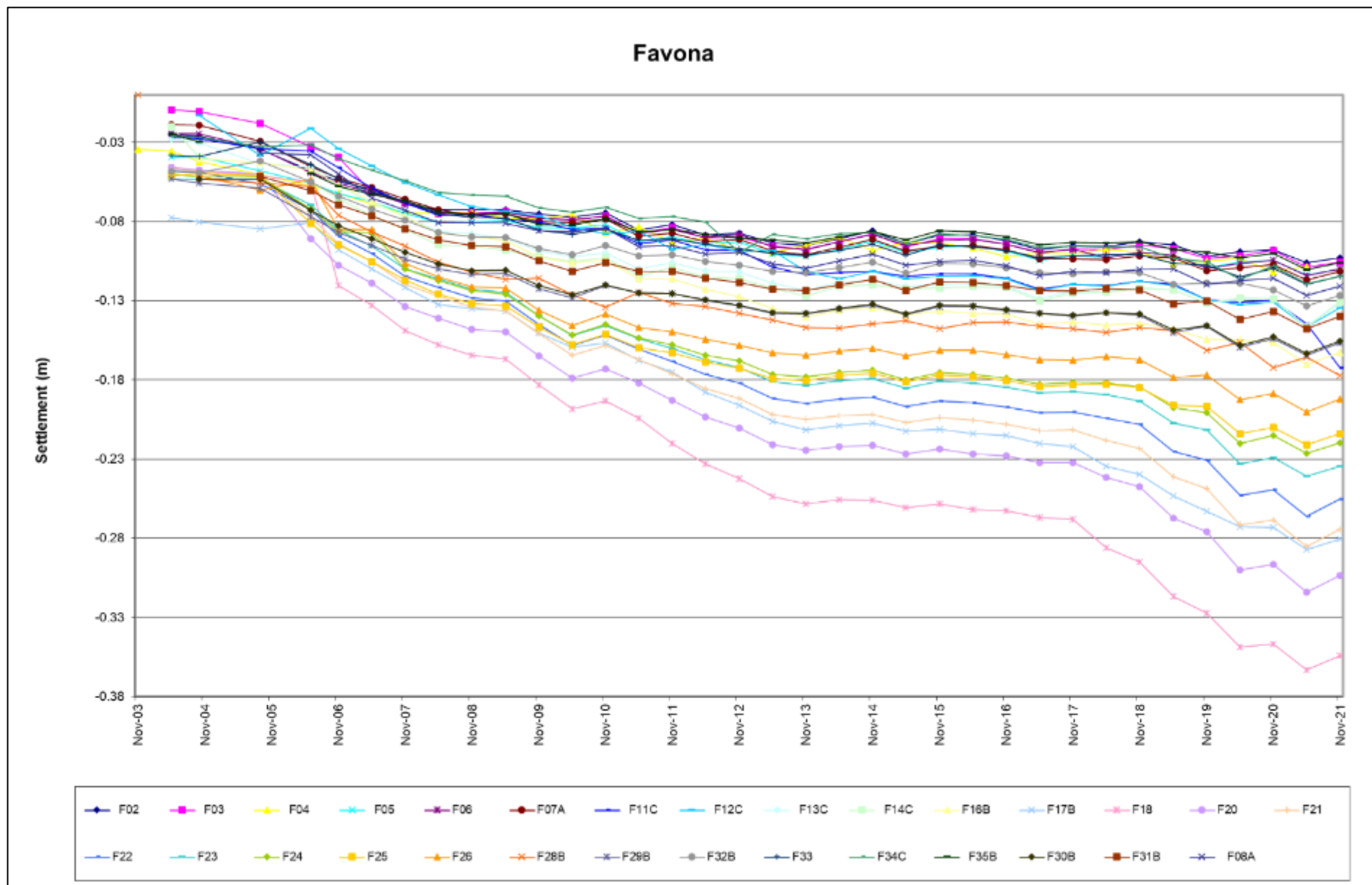














## **Appendix E      Pit/Underground & Pit Wall Runoff – Water Quality 2021**

## **Pit / Underground Dewatering Water Quality**

Date	Data Point	FLS Comments	FLS EC (mS/m)	FLS pH	FLS Temp	Acidity (p	Acidity (pH 3.7)	Alk-Bicarb	Alk-T	#N/A	AlS	SbA	SbS	AsA	AsS	Bicarb	CdA	CdS	CaSO	COD	Cl	CrS
5/01/2021	Underground Dewatering		293.4	6.11	27.7		1	85	85		0.014		0.0009		0.002	103		0.0027	540	6	11	0.001
9/02/2021	Underground Dewatering					1				119									556		13.5	
4/03/2021	Underground Dewatering					1				102									495		12.2	
22/03/2021	800 PC1						1	142	142		0.006		0.0005		0.022	173		0.00121	550	6	12	0.001
22/03/2021	705 Gladstone sump						1	870	870		0.116		0.0025		0.002	1060		0.0034	650	12	26	0.001
22/03/2021	Favona 800 sump						320	1	1		56		0.001		0.006	1		0.0088	510	32	18	0.0065
7/04/2021	Underground Dewatering					1				127									541.1		13.7	
17/05/2021	Underground Dewatering		189.8	6.17	15.5		1	192	192		0.011		0.0026		0.002	230		0.00181	490	6	12	0.001
14/06/2021	Underground Dewatering					1				177									585.6		14.7	
6/07/2021	Underground Dewatering						1	120	120		0.043		0.0007		0.003	146		0.003	530	6	10	0.001
5/08/2021	Underground Dewatering		301.3	6.44	22.5	1				129									561		13.7	
6/09/2021	Underground Dewatering		299.5	6.45	24.9	1				132									546		10	
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
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
19/09/2021	705 Gladstone sump	Sump dry, no sample taken. Sampled from Edward 800 instead.					48	1	1		49		0.0004		0.0082	1		0.023	350	6	5	0.033
19/09/2021	Favona 800 sump	Sludgy sump, no sample taken.																				
30/09/2021	Underground Dewatering											0.0022		0.024			0.006		490			
5/10/2021	800 PC2						1	113	113		0.006		0.0005		0.002	137		0.0048	530	6	11	0.001
5/10/2021	800 PC1						1	18.7	18.7		0.006		0.0004		0.002	23		0.0001	480	7	11	0.001
11/10/2021	Underground Dewatering		298	6.48	24.4		1	230	230		0.018		0.0022		0.0019	280		0.0038	510	160	12	0.0005
27/10/2021	Underground Dewatering											0.0022		0.1			0.0063		530			
8/11/2021	Underground Dewatering		307	6.21	27.1		1	105	106		0.036		0.0011		0.0011	129		0.0032	530	6	12.3	0.0005
10/11/2021	Underground Dewatering											0.0022		0.0151			0.0026		540			
23/11/2021	Underground Dewatering											0.0016		0.0109			0.0017		540		8	
6/12/2021	Underground Dewatering		302.2	6.27	27.3		1	123	124		0.03		0.0008		0.0015	150		0.00195	560	6	13	0.0005
7/12/2021	Underground Dewatering											0.0029		0.025			0.0023		560		11	
21/12/2021	Underground Dewatering											0.0022		0.036			0.0052		520		16	

Date	Data Point	FLS Comments	Cr6col	CoS	CuA	CuS	CNTOT	EC (mS/m)	NH3	AuS	Hard	FeA	FeT	PbA	PbS	MgSO	MnA	MnS	HgA	HgT	NiA	NiS	NO3-N	NOxN
5/01/2021	Underground Dewatering		0.01	0.066		0.0018	0.02	298	0.000118	0.0006	1990	2.4	10.1		0.0012	158		19.8	8.00E-05	9.00E-05		0.114	0.44	0.49
9/02/2021	Underground Dewatering							306			2000	3.1				157	21							
4/03/2021	Underground Dewatering							302			1800	2.8				137	20							
22/03/2021	800 PC1		0.01	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
22/03/2021	705 Gladstone sump		0.01	0.0057		0.0019	0.02	354	0.0004	0.0006	2300	53	350		0.0005	171		1.11	8.00E-05	0.0034		0.03	75	75
22/03/2021	Favona 800 sump		0.01	0.43		0.074	0.02	446	1.00E-05	0.005	2600	172	189		0.035	320		25	8.00E-05	8.00E-05		0.53	0.1	0.1
7/04/2021	Underground Dewatering							310			2000	2.091				159.3	18.1							
17/05/2021	Underground Dewatering		0.01	0.039		0.001	0.02	299	0.00035	0.0006	1800	0.94	2.3		0.0002	142		17.1	8.00E-05	8.00E-05		0.07	1.45	1.56
14/06/2021	Underground Dewatering							300			2100	0.073				154.69	17							
6/07/2021	Underground Dewatering		0.01	0.042		0.0082	0.02	299	6.00E-05	0.0006	1910	2.3	4.9		0.0023	145		16.5	8.00E-05	8.00E-05		0.085	0.32	0.34
5/08/2021	Underground Dewatering							293			2000	5.1				150	24							
6/09/2021	Underground Dewatering							270			2000	5.6				151	18							
19/09/2021	800 PC1	Sample taken but pump not running.	0.01	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
19/09/2021	800 PC2	Sample taken but pump not running.	0.01	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
19/09/2021	705 Gladstone sump	Sump dry, no sample taken. Sampled from Edv	0.01	0.47		0.67	0.02	270	1.00E-05	0.0006	1420	14.6	14.1		0.165	130		33	8.00E-05	8.00E-05		0.99	8.4	8.5
19/09/2021	Favona 800 sump	Sludgy sump, no sample taken.																						
30/09/2021	Underground Dewatering		0.01		0.049			289	0.00079		1780	5.1		0.096		136	16.7		8.00E-05		0.112			
5/10/2021	800 PC2		0.01	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
5/10/2021	800 PC1		0.01	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
11/10/2021	Underground Dewatering		0.01	0.049		0.0026	0.02	299	0.00088	0.0006	1810	16.6	133		0.00028	131		15.8	8.00E-05	0.00076		0.096	1.41	1.57
27/10/2021	Underground Dewatering		0.01		0.038			276	0.0003		1790	12.2		0.164		115	13		8.00E-05		0.059			
8/11/2021	Underground Dewatering		0.01	0.048		0.0098	0.02	286	0.000171	0.0006	1910	1.74	4.8		0.00108	140		16.5	8.00E-05	8.00E-05		0.093	1.02	1.15
10/11/2021	Underground Dewatering		0.01		0.022			292	0.00072		1900	3.3		0.04		131	14.6		8.00E-05		0.079			
23/11/2021	Underground Dewatering		0.01		0.0184			280	6.40E-05		1950	2.7		0.0179		145	14.7		8.00E-05		0.052			
6/12/2021	Underground Dewatering		0.01	0.029		0.0019	0.02	277	0.00028	0.0006	1920	2.2	3.5		0.0004	128		13.6	8.00E-05	8.00E-05		0.055	0.46	0.53
7/12/2021	Underground Dewatering		0.01		0.041			281	0.0037		1990	8.5		0.094		142	13.2		8.00E-05		0.099			
21/12/2021	Underground Dewatering		0.01		0.06			290	0.00088		1870	13.1		0.083		137	16.7		8.00E-05		0.128			

Date	Data Point	FLS Comments	NO2-N	NH4N	pH	PTO	KSO	DRP	SeA	SeS	SeT	SI	AgA	AgS	NaSO	NaT	SO4	Sum Anion	Sum Cation	TKN	SeTR	TSS	CNWAD	ZnA	ZnS
5/01/2021	Underground Dewatering		0.1	0.25	6.3	0.072	10.5	0.005		0.002	0.0021	35		0.0002	44		2000	44	43	0.28		330	0.02		1.64
9/02/2021	Underground Dewatering				6.7		11			0.0094					44		2100				0.0094	340			
4/03/2021	Underground Dewatering				6.5		9.6			0.0094					39		1950				0.0094	140			
22/03/2021	800 PC1		0.1	0.03	7.2	0.004	10.4	0.004		0.002	0.0021	37		0.0002	48		1790	40	43	0.14		9	0.02		1.1
22/03/2021	705 Gladstone sump		0.1	0.1	7.2	8.3	18.8	0.004		0.003	0.0121	11.2		0.0002	74		2000	65	50	0.74		28000	0.02		0.45
22/03/2021	Favona 800 sump		0.1	0.59	3.1	0.061	16	0.009		0.005	0.0025	122		0.0002	76		3500	73	64	1.09		123	0.02		10.5
7/04/2021	Underground Dewatering				6.6		11.1			0.0094					46.9		2100				0.0094	87			
17/05/2021	Underground Dewatering		0.1	0.44	6.5	0.85	12.3	0.004		0.002	0.0021	37		0.0002	47		1920	44	39	0.78		1920	0.02		1.02
14/06/2021	Underground Dewatering				6.7		12			0.0094					51		2000				0.0094	1600			
6/07/2021	Underground Dewatering		0.1	0.083	6.5	0.039	10.9	0.004		0.002	0.0011	37		0.0002	46		2100	45	41	0.16		127	0.02		1.49
5/08/2021	Underground Dewatering				6.6		11			0.0094					50		1960					510			
6/09/2021	Underground Dewatering				6.6		10			0.0094					48		1740				0.0094	1200			
19/09/2021	800 PC1	Sample taken but pump not running.	0.1	0.1	6.8	0.01	9.8	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.	0.1	0.062	6.4	0.002	10.8	0.04		0.001	0.0011	41		0.0001	45		2000	44	43	0.1		12	0.02		3.6
19/09/2021	705 Gladstone sump	Sump dry, no sample taken. Sampled from Edv	0.1	1.03	3.4	0.005	5.4	0.004		0.003	0.0032	54		0.0001	11.8		1850	39	37	1.01		13	0.02		11.1
19/09/2021	Favona 800 sump	Sludgy sump, no sample taken.																							
30/09/2021	Underground Dewatering			0.71	6.7	0.32		0.004	0.0009				0.0001				1830					940	0.02	2.5	
5/10/2021	800 PC2		0.1	0.069	6.8	0.002	11.7	0.004		0.002	0.0011	37		0.0002	51		1950	43	42	0.1		15	0.02		3.5
5/10/2021	800 PC1		0.1	0.02	6.1	0.007	11.4	0.004		0.002	0.0011	13.3		0.0002	48		1960	41	39	0.1		160	0.02		0.156
11/10/2021	Underground Dewatering		0.16	0.27	7.2	2.1	11.3	0.004		0.001	0.0044	38		0.0001	45		1850	44	39	0.38		4400	0.02		1.5
27/10/2021	Underground Dewatering			0.21	6.8	0.82		0.004	0.0005				0.0001				1740					450	0.02	1.93	
8/11/2021	Underground Dewatering		0.13	0.25	6.5	0.061	10.9	0.004		0.001	0.0011	37		0.0001	50		1860	41	41	0.43		220	0.02		1.44
10/11/2021	Underground Dewatering			0.7	6.7	0.185		0.004	0.0009				0.0001			46	1850					670	0.02	1.34	
23/11/2021	Underground Dewatering			0.085	6.5	0.21		0.004	0.0005				0.0001			45	2000					630	0.02	0.93	
6/12/2021	Underground Dewatering		0.1	0.148	6.9	0.028	10.9	0.004		0.001	0.0021	37		0.0001	42		2000	44	41	0.19		99	0.02		1.03
7/12/2021	Underground Dewatering			1.91	6.9	0.41		0.004	0.0017				0.0001			47	1880					1020	0.02	1.31	
21/12/2021	Underground Dewatering			0.45	6.9	0.44		0.004	0.0012				0.0001			48	1860					840	0.02	2.3	



## **Treated Water Quality**

[illegible]

Date	Data Point	FeA	FeS	PbA	PbS	MgSO	MnA	MnS	HgA	HgS	NiA	NiS	NO3-N	NOxN	NO2-N	NH4N	pH	PTO	KSO	DRP	SeA	SeS	SI	AgA	AgS	NaSO	SO4	Sum Anion	Sum Cation	TKN	TSS		
4/01/2021 10:30	Treated Water Discharge	0.04		0.0002		56	0.0095		8.00E-05		0.001			8.2		1.22	8.7	0.002		0.004	0.0005				0.0002		NaSO	1810				3	
11/01/2021 9:30	Treated Water Discharge																8.4				0.002	0.002										3	
18/01/2021 10:30	Treated Water Discharge																8.9				0.002	0.002										3	
24/01/2021 10:00	Treated Water Discharge																8.9				0.002	0.002										3	
1/02/2021 9:30	Treated Water Discharge	0.04	0.04	0.0002	0.0002	85	0.0122	0.0088	8.00E-05	8.00E-05	0.001	0.001	2	2.1	0.1	1.46	8.9	0.002	10.9	0.004	0.0004	0.0004	7.1	0.0002	0.0002	41	2000	43	37	1.55	3		
2/02/2021 9:30	Treated Water Discharge																8.9				0.002	0.002										3	
14/02/2021 19:15	Treated Water Discharge																8.7				0.002	0.002										3	
21/02/2021 13:00	Treated Water Discharge																8.6				0.002	0.002										3	
1/03/2021 9:30	Treated Water Discharge	0.04		0.0002		67	0.0158		8.00E-05		0.001			6.8		0.75	8.5	0.004		0.004	0.0023			0.0002		1730						3	
7/03/2021 12:30	Treated Water Discharge																8.7				0.004	0.004										3	
15/03/2021 11:30	Treated Water Discharge																8.8				0.002	0.002										3	
22/03/2021 14:30	Treated Water Discharge																8.2				0.002	0.002										3	
28/03/2021 12:00	Treated Water Discharge																8.6				0.005	0.005										3	
6/04/2021 11:00	Treated Water Discharge	0.02		0.0001		91	0.0149		8.00E-05		0.0007					0.95	8.5	0.002		0.004	0.0009			0.0001		1950						3	
11/04/2021 9:30	Treated Water Discharge																8.6				0.006	0.006										3	
18/04/2021 11:00	Treated Water Discharge																8.6				0.002	0.002										3	
27/04/2021 9:30	Treated Water Discharge																8.1				0.0075	0.0077										6	
3/05/2021 14:00	Treated Water Discharge	0.04		0.0002		94	0.0124		8.00E-05		0.001					2.1	8.7	0.01		0.004	0.0021			0.0002		1880						4	
6/05/2021 13:30	Treated Water Discharge	0.71		0.0002		94	0.024		8.00E-05		0.0015					0.86	8.7	0.004		0.004	0.0005			0.0002		1940						3	
7/05/2021 1:40	Treated Water Discharge	0.04		0.0002		98	0.0143		8.00E-05		0.001					0.64	8.8	0.004		0.004	0.0004			0.0002		1900						3	
10/05/2021 0:00	Treated Water Discharge																8.7				0.002	0.002										3	
17/05/2021 9:30	Treated Water Discharge																8.7				0.002	0.002										3	
25/05/2021 12:00	Treated Water Discharge																8.8				0.002	0.005										3	
1/06/2021 13:30	Treated Water Discharge	0.04		0.0002		82	0.0156		8.00E-05		0.001					0.65	8.7	0.004		0.004	0.0005			0.0002		1580						3	
8/06/2021 12:30	Treated Water Discharge																8.3				0.002	0.002										3	
14/06/2021 12:47	Treated Water Discharge																8.8				0.002	0.002										3	
20/06/2021 19:53	Treated Water Discharge																8.1				0.002	0.002										3	
28/06/2021 10:00	Treated Water Discharge																8.3				0.0026	0.0026										3	
5/07/2021 0:00	Treated Water Discharge	0.03		0.0001		67	0.0163		8.00E-05		0.0009					1.52	8.5	0.004		0.004	0.0045			0.0001		1620						3	
12/07/2021 13:00	Treated Water Discharge																8.9				0.0025	0.0025										5	
20/07/2021 12:30	Treated Water Discharge																8.3				0.001	0.001										3	
28/07/2021 15:00	Treated Water Discharge																8.1				0.0012	0.001										3	
4/08/2021 13:10	Treated Water Discharge	0.02		0.0001		68	0.0127		8.00E-05		0.0005					1.2	7.7	0.007		0.004	0.0042			0.00023		1500						3	
9/08/2021 12:25	Treated Water Discharge																8.6				0.0062	0.0068										3	
17/08/2021 13:30	Treated Water Discharge																8.4				0.0093	0.0094										3	
9/09/2021 0:00	Treated Water Discharge																																
13/09/2021 12:55	Treated Water Discharge	0.02		0.0001		85	0.0103		8.00E-05		0.0005					1.94	8.6	0.014		0.004	0.0055			0.0001		1650						3	
24/09/2021 9:50	Treated Water Discharge																7				0.0047	0.0052										3	
28/09/2021 16:30	Treated Water Discharge																8.6				0.0064	0.0072										3	
5/10/2021 11:02	Treated Water Discharge	0.02		0.0001		55	0.0109		8.00E-05		0.0007					1.93	8.7	0.009		0.004	0.0046			0.0001		1460						3	
11/10/2021 13:22	Treated Water Discharge																8.6				0.0054	0.0058										3	
19/10/2021 11:20	Treated Water Discharge																8.6				0.0057	0.0057										3	
26/10/2021 15:21	Treated Water Discharge	0.02		0.0001		69	0.0127		8.00E-05		0.0006					0.97	8.6	0.002		0.004	0.0012			0.0001		1470						3	
2/11/2021 13:30	Treated Water Discharge	0.02		0.0001		67	0.0097		8.00E-05		0.0013					0.49	8.7	0.002		0.004	0.0009			0.0001		1710						3	
8/11/2021 11:40	Treated Water Discharge																8.8				0.0109	0.0107										3	
15/11/2021 12:30	Treated Water Discharge																8.7				0.007	0.0071										3	
22/11/2021 16:20	Treated Water Discharge																8.3				0.007	0.007										3	
30/11/2021 11:20	Treated Water Discharge																7.9				0.0111	0.0113										3	
6/12/2021 14:25	Treated Water Discharge	0.02		0.0001		64	0.0088		8.00E-05		0.0011					3	8.5	0.006		0.005	0.0122			0.00014		1750						3	
13/12/2021 11:50	Treated Water Discharge																8.5				0.0128	0.0127										3	
22/12/2021 15:20	Treated Water Discharge																8.6				0.0115	0.012										4	
29/12/2021 11:50	Treated Water Discharge																8.8				0.0139	0.014										3	

Date	Data Point	CNWAD	ZnA	ZnS
4/01/2021 10:30	Treated Water Discharge	0.02	0.002	
11/01/2021 9:30	Treated Water Discharge			
18/01/2021 10:30	Treated Water Discharge			
24/01/2021 10:00	Treated Water Discharge			
1/02/2021 9:30	Treated Water Discharge	0.002	0.002	0.002
2/02/2021 9:30	Treated Water Discharge			
14/02/2021 19:15	Treated Water Discharge			
21/02/2021 13:00	Treated Water Discharge			
1/03/2021 9:30	Treated Water Discharge	0.02	0.002	
7/03/2021 12:30	Treated Water Discharge			
15/03/2021 11:30	Treated Water Discharge			
22/03/2021 14:30	Treated Water Discharge			
28/03/2021 12:00	Treated Water Discharge			
6/04/2021 11:00	Treated Water Discharge	0.02	0.001	
11/04/2021 9:30	Treated Water Discharge			
18/04/2021 11:00	Treated Water Discharge			
27/04/2021 9:30	Treated Water Discharge			
3/05/2021 14:00	Treated Water Discharge	0.02	0.002	
6/05/2021 13:30	Treated Water Discharge	0.02	0.002	
7/05/2021 1:40	Treated Water Discharge	0.02	0.002	
10/05/2021 0:00	Treated Water Discharge			
17/05/2021 9:30	Treated Water Discharge			
25/05/2021 12:00	Treated Water Discharge			
1/06/2021 13:30	Treated Water Discharge	0.02	0.002	
8/06/2021 12:30	Treated Water Discharge			
14/06/2021 12:47	Treated Water Discharge			
20/06/2021 19:53	Treated Water Discharge			
28/06/2021 10:00	Treated Water Discharge			
5/07/2021 0:00	Treated Water Discharge	0.02	0.0014	
12/07/2021 13:00	Treated Water Discharge			
20/07/2021 12:30	Treated Water Discharge			
28/07/2021 15:00	Treated Water Discharge			
4/08/2021 13:10	Treated Water Discharge	0.02	0.002	
9/08/2021 12:25	Treated Water Discharge			
17/08/2021 13:30	Treated Water Discharge			
9/09/2021 0:00	Treated Water Discharge			
13/09/2021 12:55	Treated Water Discharge	0.02	0.0018	
24/09/2021 9:50	Treated Water Discharge			
28/09/2021 16:30	Treated Water Discharge			
5/10/2021 11:02	Treated Water Discharge	0.02	0.0022	
11/10/2021 13:22	Treated Water Discharge			
19/10/2021 11:20	Treated Water Discharge			
26/10/2021 15:21	Treated Water Discharge	0.02	0.0018	
2/11/2021 13:30	Treated Water Discharge	0.02	0.001	
8/11/2021 11:40	Treated Water Discharge			
15/11/2021 12:30	Treated Water Discharge			
22/11/2021 16:20	Treated Water Discharge			
30/11/2021 11:20	Treated Water Discharge			
6/12/2021 14:25	Treated Water Discharge	0.02	0.001	
13/12/2021 11:50	Treated Water Discharge			
22/12/2021 15:20	Treated Water Discharge			
29/12/2021 11:50	Treated Water Discharge			

### **Pit Wall Runoff Water Quality**

No pit wall sampling was undertaken in 2021.



