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146 TE MAWHAI ROAD, FORMER TOKANUI PSYCHIATRIC HOSPITAL, TE AWAMUTU

TOKANUI CLOSED LANDFILL, WHAREKORINO STREAM & BORE WATER SAMPLING, WATER QUALITY ANNUAL REPORT - 2023

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TOKANUI CLOSED LANDFILL, WHAREKORINO STREAM & BORE WATER SAMPLING QUALITY ANNUAL REPORT - 2023

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1 INTRODUCTION AND PURPOSE

The Tokanui Closed Landfill resource consent (102269) includes several monitoring conditions that must be met each year. LINZ have commissioned Fraser Thomas Ltd (FTL) to assist with fulfilment of the Site Management and Aftercare section requirements. The purpose of this report is to provide the annual results from the combined surface water and ground water sampling rounds undertaken in April and September 2023, as well as the annual site visual walkover.

2 CONSENT CONDITIONS

The stream and bore water sampling report has been produced in order to satisfy condition 7 of the Site Management and Aftercare requirements of the Tokanui Closed Landfill resource consent, dated 17th April 2000 and referenced by Waikato Regional Council as RC102269.01.01. This consent specifically relates to the Wharekōrino stream surface water and ground water sampling. Condition 7 requires the following:

The consent holder shall undertake a formal inspection of the surface and capping of the landfill site on at least an annual basis to check for the following;
I. Poor pasture establishment;
II. Vegetation die off;
III. Refuse protruding through the cap;
IV. Damage to capping materials;
V. Differential settlement and ponding;
VI. Subsidence or erosion;
VII. Leachate springs;
VIII. Visual surface water quality and
IX. Erosion at or near the Wharekōrino Stream bank.

Any defects noticed during the inspection shall be remedied immediately. A report on the inspection, including any remedial actions taken, shall be forwarded to the Waikato Regional Council within two months of inspection.

In addition, condition number 7 specifies the monitoring requirements detailed below.

The consent holder shall characterise the quality of the groundwater and the quality of the Wharekōrino Stream (upstream and downstream of the landfill) to the satisfaction of the Waikato Regional Council. To this end, the consent holder shall develop a monitoring plan in consultation with the Waikato Regional Council. This plan shall be lodged with the Waikato Regional Council for written approval within three months of the granting of this consent. The plan shall include the following sampling programme as a minimum:

Source	Frequency	Location	Parameters
Wharekōrino Stream Water	*At least twice a year to coincide with high and low groundwater levels (generally September and April). The samples shall be taken when no surface water runoff is occurring.*	*All parameters shall be taken at locations S1, S2 and S3 as shown in Figure 1 attached to this consent except for the PAHs which shall be taken from location S4.*	• *Estimate of stream flow* • *pH* • *conductivity* • *suspended solids* • *total boron·* • *total iron* • *total mercury* • *potassium* • *chloride* • *ammoniacal nitrogen* • *nitrate nitrogen* • *sulphate* • *Polycyclic Aromatic Hydrocarbons*
Groundwater	*At least twice a year to coincide with high and low groundwater levels (generally September and April)*	*Monitoring wells P2 and P7 as shown in Figure 1 attached to this consent.*	• *Water level* • *pH* • *Total Alkalinity* • *Conductivity* • *dissolved boron·* • *dissolved iron* • *dissolved mercury* • *chloride* • *ammoniacal nitrogen* • *nitrate nitrogen* • *sulphate* • *total organic carbon*

The consent holder shall undertake the monitoring programme specified in the monitoring plan or any amendment to the plan that has been made in consultation with, and with the written agreement of, the Waikato Regional Council. The consent holder shall forward the results of the monitoring to the Waikato Regional Council within two months of sampling.

3 BACKGROUND

The resource consent RC102269.01.01 allows for the discharge of leachate from the Tokanui Hospital landfill into land in circumstances that may result in contaminants entering groundwater. The "landfill" in this case refers to a number of areas close to the Wharekōrino Stream that were used for the landfilling of hospital waste over at least 40 years until the late 1990s. A large range of typical domestic, construction and specific medical waste materials were deposited in these landfilling areas, with some refuse burnt and covered with hospital boiler ash. Some of the landfilling areas were also 'capped' with low permeability clay cover and topsoil and then grassed. The landfilled area is now part of a dairy farm and is understood to be used only for grazing.

The groundwater and stream water quality monitoring events are undertaken twice yearly to check for potential leaching of contaminants from the landfilled materials into the underlying groundwater and adjacent Wharekōrino stream.

Visual checks are also undertaken of the landfill surface annually to check for a range of issues, including any refuse that may have come to the surface and any differential settlement issues, that may promote ponding on the landfill surface. Settlement of the ground may arise from consolidation of the deposited fill materials and from degradation of the waste itself. The latter depends on the nature of the waste materials. Organic

waste materials degrade relatively quickly and decrease in volume faster, compared with materials that are more resistant to degradation such as metals, building rubble, treated timber and plastics.

4 METHODOLOGY

4.1 Stream and Bore Sampling

Stream flows were not measured during either 2023 sampling round, which is consistent with previous WSP reports and the FTL 2022 monitoring report. However, it was noted that flows appeared low during both events, with areas of stagnant water commonly observed.

The first round of water quality sampling for 2023 was undertaken on 17th April 2023, and the second round was undertaken on 11th September 2023 to collect water quality samples from Wharekōrino Stream and Borehole P2. Weather conditions were mainly fine during each visit.

On both occasions, Bore P7 was found to be dry, which has been the case on all previous sampling occasions and as such no sample could be taken from this bore.

The sampling locations are shown in Figure 1.

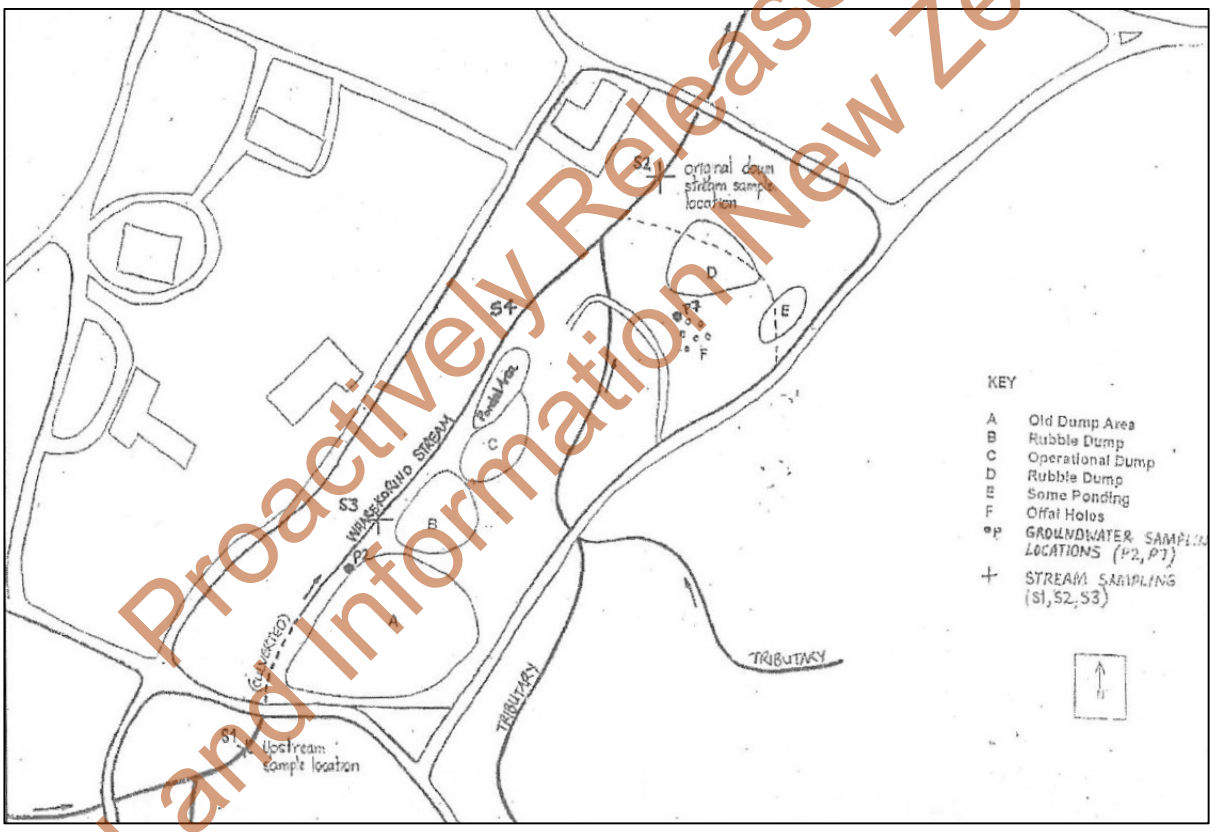


Figure 1: Location of stream and bore (groundwater) sampling sites and landfill areas.

Sampling was undertaken at the bank of the stream at locations S1-S4 on both occasions, taking two large water sampling bottles to receive the direct flow from the centre of the stream. A YSI pro plus multimeter was also used to measure temperature, pH, conductivity, DO (dissolved oxygen), and ORP (oxidation reduction potential) at stream locations S1-S3. Sampling conducted from the borehole at P2 also involved using a YSI pro plus multimeter to measure pH, conductivity, DO (dissolved oxygen), and ORP (oxidation reduction potential).

The groundwater level was approximately 0.14m higher during the September 2023 sampling round, compared with the April 2023 round, which can be attributed to the winter rainfall. Field measurements were

fairly consistent between the April and September sampling rounds. Generally, Bore P2 had significantly higher dissolved oxygen, slightly higher pH, lower conductivity, and temperature, and very low ORP during the September sampling compared with the April sampling.

Table 1: Field Measurements at P2 Borehole in April and September 2023

Field Measurements	April 2023	September 2023
Groundwater depth (m bgl)	4.02	3.885
Temperature (C°)	17.3	16.1
pH	6.49	6.94
DO (mg/L)	0.53	2.25
DO %	5.6	22.9
Specific Conductivity (µs/cm)	1090	975
ORP (mV)	422.3	4.2

Water quality samples (S1-S4 & P2) were sent to Hills Laboratories in a ruggedized chilly bin under standard chain of custody procedures for analysis.

Table 2: Field Measurements at Wharekōrino Stream (S1-S4) in April and September 2023

Field Measurements	S1 April 2023	S1 Sep 2023	S3 April 2023	S3 Sep 2023	S4 April 2023	S4 Sep 2023	S2 April 2023	S2 Sep 2023
Temperature (C°)	15.7	12.5	15.6	12.5	-	11.5	15.3	11.8
pH	6.72	8.25	6.41	8.42	-	8.8	6.41	8.4
DO (mg/L)	5.4	10.22	5.23	10.33	-	80.7	5.97	77.6
DO %	55.3	95.9	59.6	96.8	-	129.8	59.5	134.4
Specific Conductivity (µs/cm)	130.8	124.3	133.1	125.5	-	7.53	10.8	7.57
ORP (mV)	251.2	-68.5	361	-77.8	-	30.2	195.6	30.6

4.2 Landfill Visual Assessment

A grid site walkover was undertaken of the landfill on 11th September 2023. Observations were made for each grid in accordance with the consent requirements. The grid plan used is included in Appendix A along with representative photos.

5 RESULTS

5.1 Stream and Bore Sampling

The stream sampling and borehole sampling results are appended to this report. Results from locations S1, S2, S3, S4 are given in Table 3 and the results from bore P2 are given in Table 4.

The results were compared to Australian and New Zealand Environmental and Conservation Council (ANZECC) 95% trigger level for freshwater, ANZECC livestock drinking water guidelines, ANZECC Irrigation long term (100 years) guidelines, ANZECC Irrigation long term (20 years), and Ministry of Health Drinking water Standards (Aesthetics, and Health). For ammonia, the trigger value varies with pH, and was adjusted from the default pH of 8.0 to the lab pH of 6.8 and 6.7 respectively, using the formula in the ANZECC guidelines.

Table 3: Results of the Wharekorino Stream water sampling – April and September 2023

Tokanui Landfill Monitoring: GW & SW Results															
Sample Date		**ANZECC (2000)**				**Drinking Water Standards (2005-2008) (Revised 2018)**		17-Apr-23				11-Sep-23			
Sample Name								S1	S3	S4	S2	S1	S3	S4	S2
Sample Depth (m)								Surface Water							
Lab Number								3247082.1	3247082.3	3247082.4	3247082.2	3361956.1	3361956.3	3361956.4	3361956.2
Individual Tests	**Unit of measurement**	**95% Freshwater**	**Livestock**	**Irrigation Long term 100 years**	**Irrigation short term 20 years**	**Health**	**Aesthetics**								
pH	**pH Units**	-	-	-	-	-	7-8.5	6.8	6.7	-	6.7	7.1	7.0	-	7.0
Electrical Conductivity	**mS/m**	-	-	-	-	-	-	12.7	12.9	-	13.4	12.4	12.7	-	13.3
Total Suspended Solids		-	-	-	-	-	1,000	< 3	6.0000	-	< 3	< 3	4.0000	-	8.0000
Total Boron		0.37	5.0	0.50	-	1.4	-	0.0154	0.0600	-	0.0780	0.0173	0.0670	-	0.0960
Total Iron		ID	-	0.20	10.00	-	0.2	*0.57*	*0.77*	-	*0.73*	*0.61*	*0.91*	-	*1.58*
Total Mercury		0.0006	0.002	0.002	0.002	0.007	-	< 0.00008	< 0.00008	-	< 0.00008	< 0.00008	< 0.00008	-	< 0.00008
Total Potassium		-	-	-	-	-	-	3.6	3.7	-	3.7	2.5	2.5	-	2.8
Chloride	**g/m³**	-	-	-	-	-	250.0	16.2	15.9	-	16.5	16.0	15.8	-	16.6
Total Ammoniacal-N		5.944 @ 6.8pH 6.084 @ 6.7 pH	-	-	-	-	-	0.025	0.018	-	< 0.010	0.048	0.067	-	0.050
Nitrite-N		-	-	-	-	3.0	-	0.007	0.006	-	0.003	0.006	0.007	-	0.010
Nitrate-N		0.7	-	-	-	50.0	-	0.89	0.91	-	0.81	1.76	1.73	-	1.69
Nitrate-N + Nitrite N		-	-	-	-	-	-	0.89	0.91	-	0.82	1.77	1.74	-	1.70
Sulphate		-	-	-	-	-	250.0	4.3	3.5	-	3.8	4.1	4.3	-	4.4
PAHs															
BaP (BAP)	**g/m³**	ID	-	-	-	-	-	-	-	< 0.000008	-	-	-	< 0.000008	-
Naphthalene		0.016	-	-	-	-	-	-	-	< 0.00004	-	-	-	< 0.00006	-

Note:

Underlined:	above ANZECC 95% Freshwater guideline values
Italicized	above ANZECC Irrigation Long Term 100 years
BLUE	above ANZECC Irrigation Short Term 20 years
BOLD	above ANZECC Livestock drinking water guidelines
RED :	exceeded Drinking water standards for health or Aesthetics (2005-2008)
ND	not detected
- :	not tested for

Tokanui Landfill Monitoring: GW & SW Results									
Sample Date		**ANZECC (2000)**				**Drinking Water Standards (2005-2008) (Revised 2018)**		17-Apr-23	11-Sep-23
Sample Name								P2	P2
Lab Number								3247082.50	3361956.5
Individual Tests	**Unit of measurement**	**95% Freshwater**	**Livestock**	**Irrigation Long term 100 years**	**Irrigation short term 20 years**	**Health**	**Aesthetics**		
pH	**pH Units**	-	-	-	-	-	7-8.5	6.9	7.2
Total Alkalinity	**g/m³ as $CaCO_3$**	-	-	-	-	-	-	410	420
Electrical Conductivity	**mS/m**	-	-	-	-	-	-	102.1	100.3
Dissolved Boron	**g/m3**	0.37	5.0	0.50	-	1.4	-	***29***	***28***
Dissolved Iron		-	-	0.20	10.00	-	0.2	<0.02	< 0.02
Dissolved Mercury		0.0006	0.002	0.002	0.002	0.007	-	<0.00008	< 0.00008
Chloride		-	-	-	-	-	250.0	13.4	12.7
Total Ammoniacal-N		5.944 @ 6.8pH	-	-	-	-	-	<0.010	< 0.010
Nitrite-N		-	-	-	-	3.0	-	< 0.002	0.0020
Nitrate-N		0.7				50.0	-	1.99	1.88
Nitrate-N + Nitrite N		-	-	-	-	-	-	1.99	1.89
Sulphate		-	-	-	-	-	250.0	149.0	134.0
Total Organic Carbon		-	-	-	-	-	-	4.3	10.4

Note:

Underlined:	above ANZECC 95% Freshwater guideline values
Italicized	above ANZECC Irrigation Long Term 100 years
BLUE	above ANZECC Irrigation Short Term 20 years
BOLD	above ANZECC Livestock drinking water guidelines
RED :	exceeded Drinking water standards for health or Aesthetics (2005-2008)
ND	not detected
- :	not tested for

Note: P7 was dry on both occasions so not included in above table.

The latest boron levels in the landfill (P2) as well as upstream (S1), midstream (S3) and downstream (S2) were added to the long-term monitoring data and the results are given in Figures 2-4 below. Similarly, the latest and long-term nitrate monitoring results are given in Figure 5.

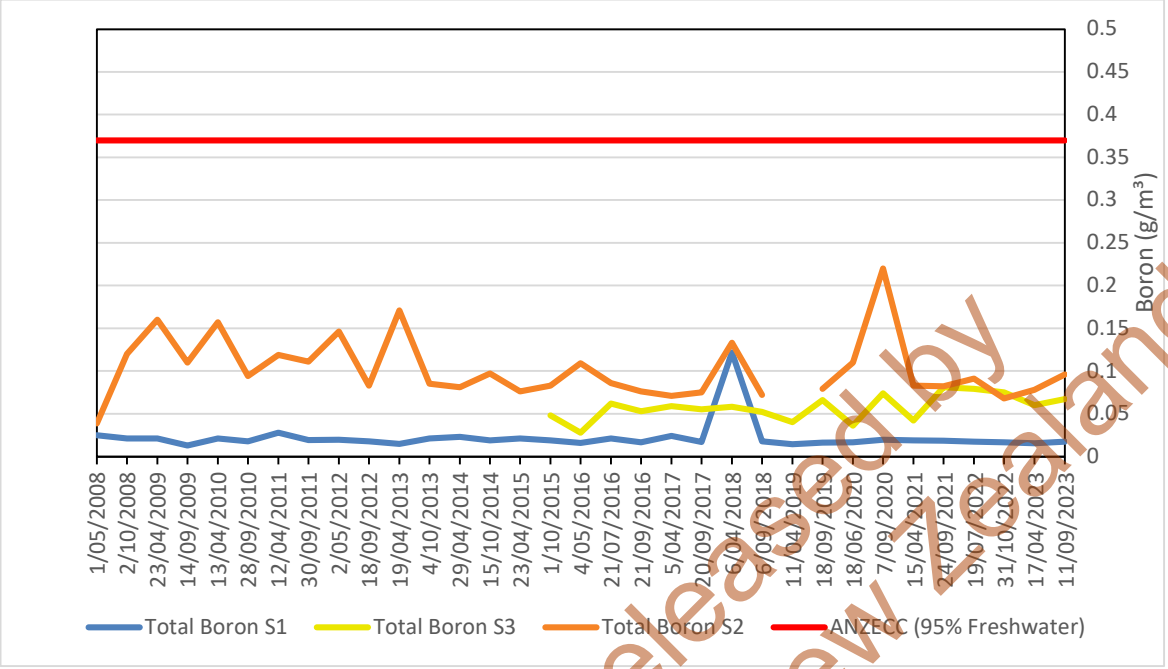


Figure 2: Long term boron levels (g/m³) upstream (S1), midstream (S3), and downstream (S2) of the landfill in comparison to ANZECC 95% protection trigger value for aquatic species.

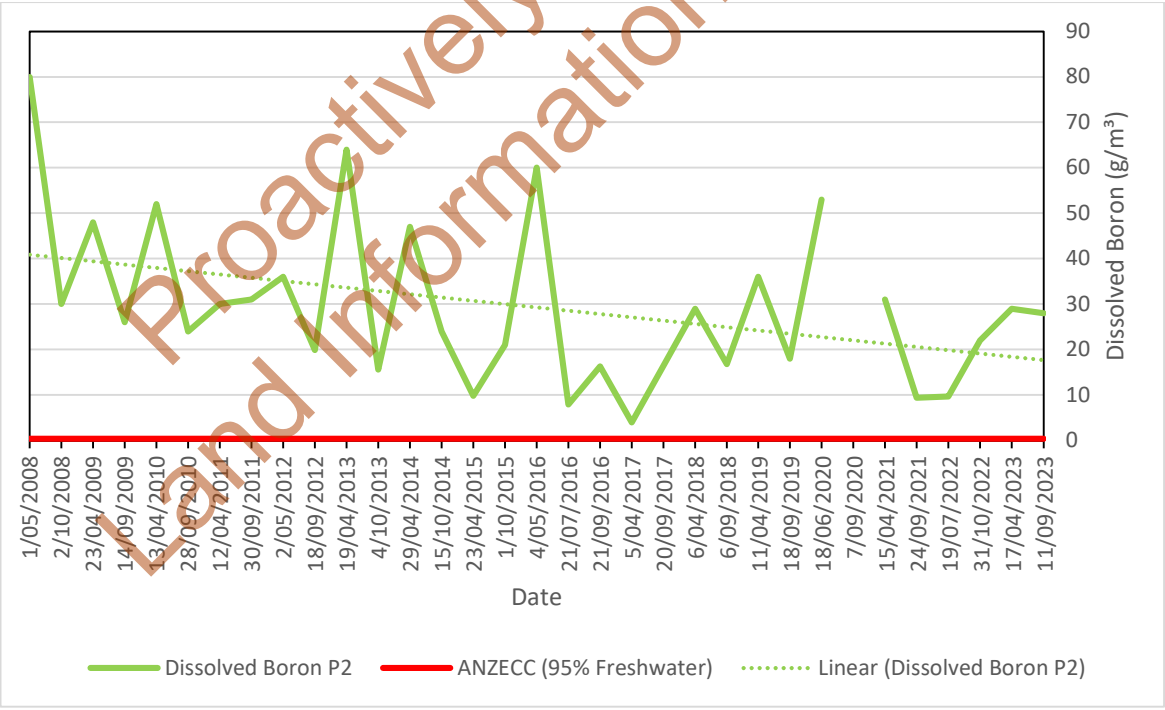


Figure 3: Long term dissolved boron levels (g/m³) within the landfill (P2).

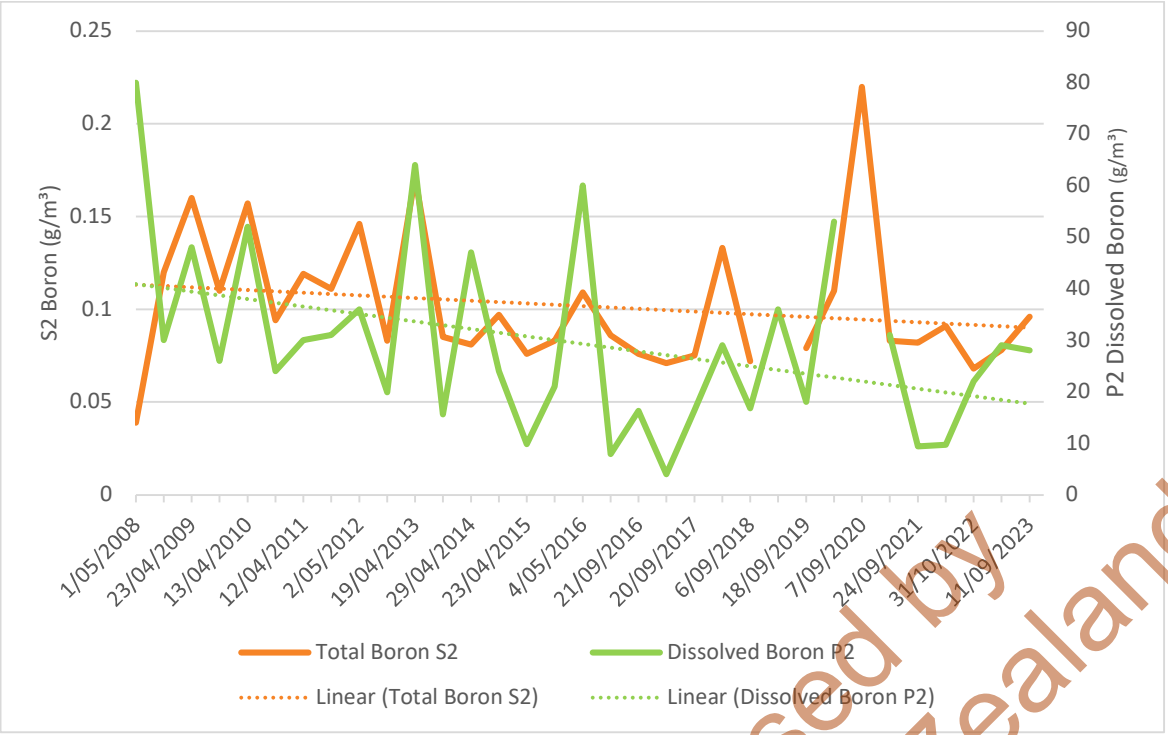


Figure 4: Relationship between boron levels (g/m³) at the downstream site (S2) and bore (P2). Stream (S2) boron values are shown on the left axis, bore (P2) values on the right axis.

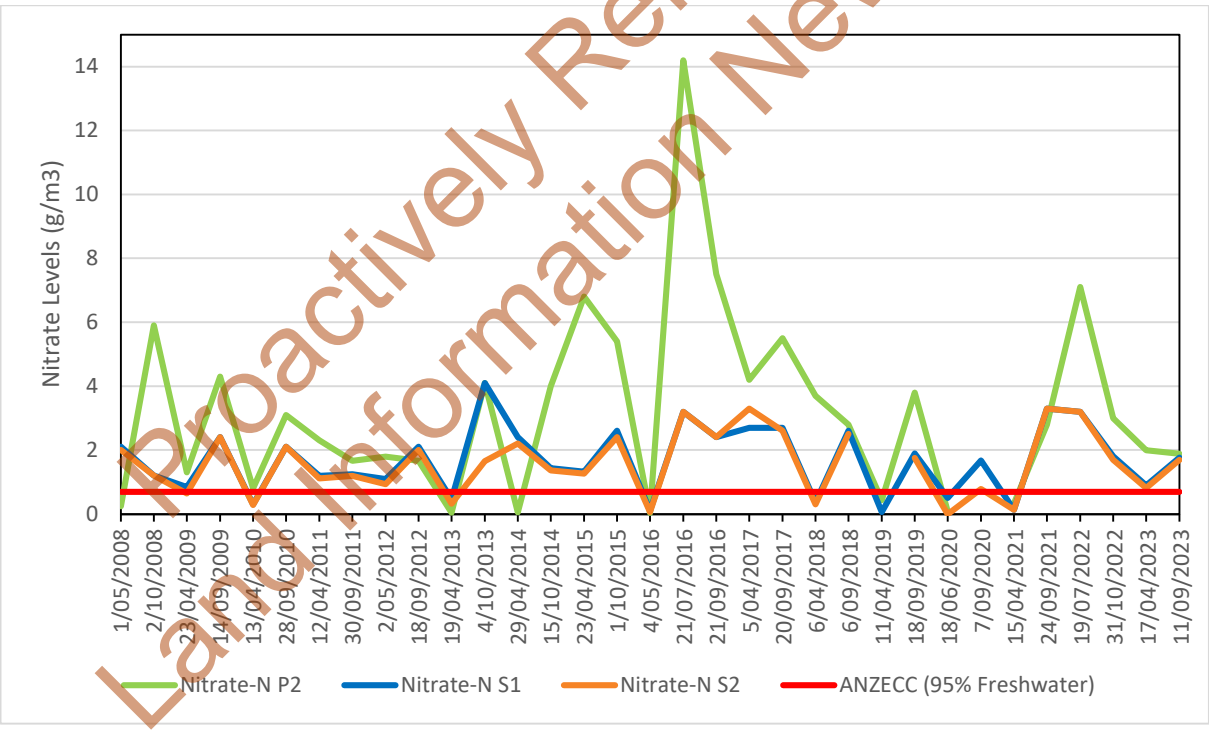


Figure 5: Long term nitrate levels (g/m³) in the landfill (P2) and upstream (S1) and downstream (S2) of the landfill. Note that the P2 bore was dry during the sampling period of September 2020.

5.2 Landfill Walkover Observations

Landfill walkover observations are summarised in Table 4 (below), with reference to grid locations for each item, where relevant.

Table 4: Landfill Walkover Site Observations Summary

Item	2022 Observation	2022 Grid Reference	2023 Walkover & Grid Reference
Pasture Establishment	Generally good, except patchy in specified locations	A1, B1, E6, E7, F6, G5, J5	E6, F5, H5, I4, L6, L7, M7, M8, M9, N8, 08
Vegetation Die-off	Vegetation die-off at stream bank near ponding location	H4	Unchanged from 2022
Refuse protruding through landfill cap	Consistently positioned near the extents of the landfill.	A3, B3, B4, D4, E4, H6, H7, L5, M6, N6	Test pit & trench locations containing fill generally exhibit subduction & refuse protrusion through landfill cap post intrusive investigation
Damage to capping materials	Minor (couple) of noticeable instances	B3, N8	Unchanged from 2022
Differential settlement & ponding	Ponding near stream and extents, significant at H4	B2, D7, E4, H4, I7, K4, K5,	Brown/oily sheen observed at H4 during the 2023 site walkover
Subsidence or erosion	Subsidence present along extents of landfill, and in centre of area D	A3, E4, I5, J8, K6, N7, N8,	Unchanged from 2022
Leachate Springs	None found	-	
Surface water quality	No visual changes observed	-	
Stream bank erosion	None noted	-	
Burn Piles	None noted	-	L8, K8, I7 – 3 large burn piles consisting of charred felled trees

5.2.1 Pasture Establishment

The pasture appeared mostly lush, with some localized areas of patchiness or die off. Pasture die-off was particularly evident where test pits and trenches had been excavated during the FTL intrusive investigation (see Appendix A).

5.2.2 Vegetation die-off

Overall, the vegetation on the banks of the Wharekōrino stream and areas surrounding the landfill appeared to be healthy. Some tree die-off (unconfirmed species) was observed bordering area A, B and C, and some die-off of grasses along the bank of the Wharekōrino Stream was present bordering the area of ponding at area C. (see Appendix A - slide 9).

5.2.3 Refuse protruding through the cap

There were various instances of individual pieces of refuse protruding through the cap, consistently near the extents of the landfill. Since the intrusive investigations have been completed, protrusion of refuse at the surface of the test-pits & trenches containing fill is evident in localised areas across the site (see Appendix A).

5.2.4 Damage to capping materials

Overall, only one area of note showing damage to capping materials was found in grid A3 prior to completion of the 2022 FTL Intrusive investigation – this was also mentioned in previous WSP reports. Following completion of the FTL intrusive investigation, areas of test-pitting and trenching have resulted in some localised subduction (i.e. cavity creation at these locations) (see Appendix A).

5.2.5 Differential settlement and ponding

Ponding was observed across much of the site, exacerbated during periods of heavy rainfall and unlikely to be reflective of normal weather conditions in some areas. Grid H8 at the border of Area C has shown consistent ponding since the 2017 WSP field visit, and therefore a frequent ongoing ponding problem is likely present (see Appendix A - slide 8).

5.2.6 Erosion, Subduction and Subsidence

There was no erosion noted across the landfill areas. Minor subsidence was observed around the site, resulting in an uneven profile across the landfill areas. It is unclear whether this is naturally occurring, or a result of subsidence influenced by the landfill. Subduction has occurred across the site where most trenches and test pits excavated during the intrusive investigations have settled (see Appendix A).

5.2.7 Leachate Springs

No leachate springs were observed during the inspection, or during the 2022 inspection.

5.2.8 Visual Surface water quality

The Wharekōrino Stream had a reasonably low flow rate and was mostly clear with localised areas of clouding and surface scum observed during both the April and September visits. Flow rate was generally higher at S1, showing a gradual reduction with proximity to S2. Water appeared mostly stagnant at S2.

5.2.9 Erosion at or near the Wharekōrino Stream Bank

No significant erosion was observed along the stream bank of the Wharekōrino stream. Debris build-up at the fence line and ponding in the paddock (both remaining since 2022 FTL visit) suggest that when flows are high, the capacity of the stream banks is exceeded and the overflow spills and ponds into low lying pasture.

5.2.10 Burn Piles

There were 3 burn piles encountered during the September site walkover, all located toward the eastern boundary of the site. The burn piles consisted only of felled trees. (see Appendix A – slide 11-13).

Note: All photographs included within Appendix A are considered supplemental to photos from the 2022 FTL inspection, which give a large-scale understanding of the subject site. Photographs presented in Appendix A in this report have been aggregated with the intention of focusing on significant site walkover observations, such as those described within section 5.2.

6 DISCUSSION

6.1 Wharekōrino Stream

Generally, stream water samples had neutral to slightly acidic pH, low suspended solids and electrical conductivity, low boron and low chloride levels. Heavy metal concentrations were typically considerably lower than all ANZECC criteria assessed.

Total Iron concentrations were found to be in exceedance of the ANZECC long term Irrigation (100 years), and the Drinking water standards for Aesthetics (2005-2008), in samples S1, S2 and S3 by 2-4x guideline values during the April sampling visits, and by 3-8x guideline values during the September sampling visit. Total Iron concentrations were relatively consistent by location in the April samples (ranging between 0.57-0.77g/m^3) but showed significant variation in the September samples (ranging between 0.61-1.58 g/m^3). These exceedances are considered more likely to be due to natural phenomena rather than leachate effects, as no iron was detected in corresponding groundwater bore samples from under the landfill. Furthermore, the measured iron concentrations are only considered a cause for concern in situations where the water is used for continuous long-term irrigation (100 years +). The long term guideline value of 0.2g/m^3 is considerably less than the short term value (up to 20 years) of 10g/m^3, which all stream water results readily comply with. As noted in the 2021 WSP monitoring report, The Report to Hearings Committee (2000) states that due to the low flows in the vicinity of the site, the Wharekōrino Stream is highly unlikely to be used for irrigation purposes; therefore, these elevated iron levels are not a cause for concern.

Nitrate levels in stream samples from both sampling events (S1-S3) were elevated above ANZECC 95% Freshwater guidelines for aquatic species protection. High nitrate concentrations have been consistent for samples taken in the second half of the year since 2015. Nitrate levels were consistent across all stream sampling locations tested at each visit, ranging between 0.81-0.91 g/m^3 in the April samples, and 1.69-1.76 in the September samples. Nitrate levels from the September samples were approximately 100% higher in the September samples than in the April samples, which is the opposite when compared with the 2022 sampling results. This has been attributed to the long-term stocking of the paddock with high numbers of cattle, or potential fertiliser application. The nitrate results do not show any indication of being affected by landfill leachate.

Historical nitrate levels in the Wharekōrino stream have fluctuated from <0.10 to 3.3 g/m^3. These levels tend to be lower during low water levels (first half of the year) and higher during high water levels (second half of the year). Because the criteria for ANZECC 95% Freshwater guidelines for aquatic species protection is 0.7 g/m^3, this may mean that it is likely that samples taken in the first half of the year will have nitrate levels within guidelines, and likely that samples taken in the second half of the year will exceed guidelines into the future.

All stream site samples recorded boron levels below the ANZECC 95% Freshwater guidelines for aquatic species protection (Appendix B). Historical data and the 2023 samples show that boron levels are consistently higher downstream of the landfill (Figure 2). It is worth noting that during the April sampling event, location S3 (mid-stream) had a slightly higher boron concentration than locations S1 (upstream) and S2 (downstream), however, in September, boron concentrations were significantly higher downstream. This may indicate that boron leaching is primarily coming from landfill areas A or B, as the S3 sampling location borders these areas, and the value for S1 which is upstream of the landfill is significantly lower than the S3 and S2 samples. While this is a consistent trend and could suggest possible leaching of contaminants from the landfill where boron levels are much higher, all values have remained within the ANZECC 95% Freshwater guidelines for aquatic species protection.

PAHs were not detected above the laboratory limit of detection, which is consistent with all previous sampling rounds over the period 2016-2022. Mercury was also not detected, which is consistent with long term trends.

Overall, the water quality results indicate in our opinion that the historic landfilling activity is not affecting the surface water quality in the stream, other than for boron.

6.2 Bore Water

Bore P7 has been observed as dry and no sampling was able to take place. This is consistent with previous sampling events.

Nitrate levels in groundwater samples from Bore location P2 were elevated above the ANZECC 95% freshwater guidelines for aquatic species, with a value of 1.99 g/m^3 (April) and 1.88 g/m^3 (September) compared with the guideline value of 0.7 g/m^3. It is worth noting that these values are significantly lower than the 2022 sampling results.

Historical nitrate levels for the P2 Bore site have been highly variable, fluctuating from 0.0039-14.2 g/m^3. Values over 0.7 g/m^3 exceed the thresholds for aquatic species protection (95%). Therefore, it is possible that these values will exceed ANZECC guidelines in the future, as was found to be the case in this sampling round.

The P2 bore site has consistently higher and more variable nitrate levels than the stream sites. The results from this sampling event support this trend, although P2 nitrate levels have shown a significant decrease compared with 2022 results. As the downstream sampling site (S2) typically has lower nitrate levels than the upstream site (S1), there is no indication that the stream is being impacted by nitrate leaching from the landfill.

Water from Bore P2 produced a level of 29 g/m^3 of dissolved boron in the April samples, and a level of 28 g/m^3 in the September sampling results. These results are reasonably consistent overall, but historic results indicate that sampling during the first half of the year has had more than double the average dissolved boron levels than samples taken during the second half of the year, since 2015. Generally, historical data shows a regular seasonal fluctuation of dissolved boron levels and a possible overall decline over time.

Historic data indicates a possible relationship between boron levels at the bore (P2) and downstream (S2) sites (Figure 4). This relationship along with the higher boron levels downstream (S2) compared with upstream (S1) suggests possible contamination from groundwater seepage through the landfill into the stream. However, as stated above all contaminant levels in the stream have remained below ANZECC Freshwater guidelines for aquatic species 95% protection.

6.3 Landfill Assessment

Following intrusive investigations by Fraser Thomas Limited during 2022-23, some areas where test pits and trenches had been dug and backfilled show signs of localised settlement, minor refuse protrusion at the surface, and patchiness/die-off of grass and vegetation. Some unidentified trees adjacent to the landfill, as well as grasses alongside the Wharekōrino Stream bank showed signs of dieback. Area C has continued to show frequent ponding conditions, which appeared with a brown/orange (ferrous oxide?) sheen on the surface during the 2023 site walkover where the ponded water has settled and been isolated from the stream. Wharekōrino Stream continued to present a clear and, in places, slightly cloudy appearance, with debris build-up at the fence line and ponding in the paddock indicative of stream bank overtopping during periods of high stream flows. Previous instances of damage to capping materials have increased due to the additional FTL intrusive investigation this year, while ponding, subsidence and erosion, surface water quality and stream bank erosion appear unchanged since the 2022 intrusive investigation.

7 CONCLUSIONS AND RECOMMENDATIONS

Long term monitoring data appears to show that boron is leaching from the landfill into the stream. The likely source is coal ash, which is understood to have been used as a cover material in some landfilling areas.

Water quality test parameters should be reviewed and discussed with WRC, as some parameters have consistently not been detected for many sampling rounds (e.g. mercury, PAHs). Similarly, some consent requirements, such as stream flow measurement, should be discussed with WRC, as these have never been reported on to our knowledge and never been raised as an issue by WRC.

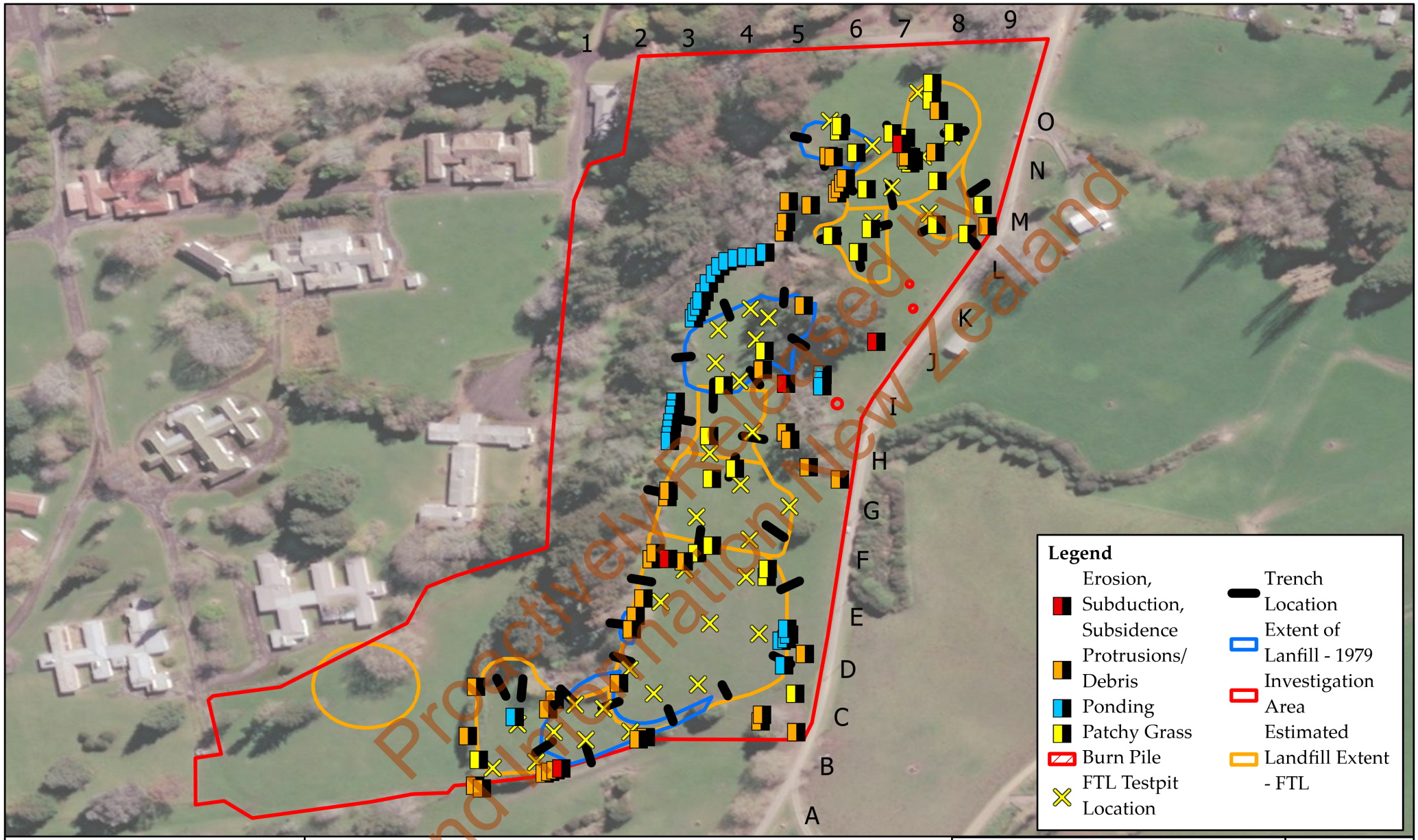
Grid walkover survey findings were similar to the 2022 Fraser Thomas Investigation, with changes detailed in Table 4. Intrusive landfill investigations have recently been undertaken by Fraser Thomas (Oct-Nov 2022) and (April 2023) into the content and extent of the landfilled area. Short term immediate landfill remedial works are considered necessary, in the form of topsoiling areas of testpit and trench settlement.

The draft Intrusive Investigation Report dated July 2023, outlines reinstatement measures required for the site, consisting of additional material compaction where test pits have been backfilled, track rolling of test pit locations, re-topsoiling of the depressions, and regrassing the deposited topsoil to reestablish a vegetative cover over the test pit areas. Once these reinstatement measures have been completed, the paddock can be used for farming/grazing again. It is noted that the farmer is now using this area for grazing and the localised settlement observed at the test pit/trench locations is likely causing a minor increase in infiltration into the landfill. Hence, it is recommended that these works are completed as a high priority.

No remedial works have been proposed for the site at this stage, but annual monitoring of the landfill and Wharekōrino Stream is set to continue.

Appendix A

Landfill Grid Walkover Survey



Fraser Thomas
ENGINEERS • RESOURCE MANAGERS • SURVEYORS

Appendix A - Site Features Plan

Toitū Te Whenua Land Information New Zealand
Landfill Grid Walkover Survey
Tokanui Closed Landfill, Te Awamutu
Wharekorino Stream & Bore Water Sampling
Water Quality Annual Report - 2023

Date:	29/09/2023
Figure Reference:	33097/A
Drawn by:	BLM
Reviewed by:	SF
Job Number:	33097

N

0 25 50 100 150 200 250
Meters

Area H

Area H

Area H

Area A

Area A

Area A

Area A

Area A

Area A

Area A

Area B

Boundary of Area B

Boundary of Area B

Area B

Area C

Area C

Area G

Between Area G and F

Area F

Area F

Area F

East of Area G

East of Area C

Area E

Area E & D

Area D

Area D

Area D

A2 - Patchy Pasture, Debris

A2 - Patchy Pasture

B1 - Minor Debris

B3 - Patchy Pasture

B3 - Patchy Pasture, Discolouration

B3 - Patchy Pasture

B3 - Subduction

B5 - Trench Subduction, Minor Ponding

C4 - Test Pit Subduction, Debris

C5 - Test Pit Subduction

D4 - Subduction, Minor Ponding

D5 - Patchy Pasture

D5 - Patchy Pasture

D5 - Subduction

D5 - Test Pit Subduction

D5 -Trench Subduction & Patchy Pasture

D7 - Discolouration

E5 - Patchy Pasture, Debris

E5 - Test Pit Subduction

E7 - Ponding

F5 – Patchy Pasture

F5 - Patchy Pasture, Discoloration, Debris

F5 - Patchy Pasture

G4 - Patchy Pasture, Debris

G5 - PACM debris

H4 - Ponding

H4 - Ponding

H4 - Ponding

H4 - Test Pit Subduction

H4 - Vegetation Die-off

H4 - Vegetation Die-off

H5 - Patchy Pasture

I4 - Trench Subduction

I5 - Test Pit Subduction, Minor Ponding

I5 - Trench Subduction

I5 - Patchy Pasture

I5 - Test Pit subduction, patchy pasture

I7 - Burn Pile

K4 - Ponding

K5 - Minor Ponding

K8 - Burn Pile

L6 & L7 - Patchy Pasture

L7 - Patchy Pasture

L8 - Burn Pile

L8 - Burn Pile

N7 Patchy Pasture, Surface Debris

N7 - Subduction

N8 - Patchy Pasture & discolouration

Site Grid Walkover – Additional Area I

Appendix B

Sampling Results and Lab Transcripts

Hill Laboratories
TRIED, TESTED AND TRUSTED

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

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

Certificate of Analysis

Client:	Fraser Thomas Limited	**Lab No:**	3247082	SPv2
Contact:	Elliot Bish	**Date Received:**	19-Apr-2023	
	C/- Fraser Thomas Limited	**Date Reported:**	05-May-2023	
	PO Box 204006	**Quote No:**	117021	
	Highbrook	**Order No:**	PO000879	
	Auckland 2161	**Client Reference:**	33097	
		Submitted By:	Ben Laing-McConnell	

Sample Type: Sediment

Sample Name:		S1 17-Apr-2023	S2 17-Apr-2023 1:30 pm	S3 17-Apr-2023	S4 17-Apr-2023
Lab Number:		3247082.6	3247082.7	3247082.8	3247082.9
Individual Tests					
Dry Matter	g/100g as rcvd	41	17.9	39	40
Total Recoverable Boron	mg/kg dry wt	< 20	< 20	31	< 20
Heavy metals screen level As,Cd,Cr,Cu,Ni,Pb,Zn					
Total Recoverable Arsenic	mg/kg dry wt	5	8	6	4
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	0.70	0.52	0.27
Total Recoverable Chromium	mg/kg dry wt	7	12	12	9
Total Recoverable Copper	mg/kg dry wt	14	22	24	15
Total Recoverable Lead	mg/kg dry wt	10.2	15.5	18.9	14.0
Total Recoverable Nickel	mg/kg dry wt	4	7	6	4
Total Recoverable Zinc	mg/kg dry wt	28	151	129	68
Asbestos in Soil					
As Received Weight	g	185.8	166.0	239.4	184.9
Dry Weight	g	97.7	36.0	128.3	80.3
<2mm Subsample Weight	g dry wt	54.9	22.5	54.4	31.8
Asbestos Presence / Absence		Asbestos NOT detected.	Asbestos NOT detected.	Asbestos NOT detected.	Asbestos NOT detected.
Description of Asbestos Form		-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Solids*					
Total of Reported PAHs in Soil	mg/kg dry wt	< 0.6	< 1.4	< 0.7	< 0.6
1-Methylnaphthalene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
2-Methylnaphthalene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Acenaphthylene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Acenaphthene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Anthracene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[a]anthracene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.058	< 0.14	< 0.061	< 0.058
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.057	< 0.14	< 0.061	< 0.058
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[e]pyrene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Chrysene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Fluoranthene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Fluorene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03

Sample Type: Sediment					
Sample Name:		S1 17-Apr-2023	S2 17-Apr-2023 1:30 pm	S3 17-Apr-2023	S4 17-Apr-2023
Lab Number:		3247082.6	3247082.7	3247082.8	3247082.9
Polycyclic Aromatic Hydrocarbons Screening in Solids*					
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Naphthalene	mg/kg dry wt	< 0.12	< 0.3	< 0.13	< 0.12
Perylene	mg/kg dry wt	0.07	< 0.06	< 0.03	0.05
Phenanthrene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03
Pyrene	mg/kg dry wt	< 0.03	< 0.06	< 0.03	< 0.03

Sample Type: Aqueous						
Sample Name:		S1 17-Apr-2023	S2 17-Apr-2023	S3 17-Apr-2023	S4 17-Apr-2023	P2 17-Apr-2023 12:30 pm
Lab Number:		3247082.1	3247082.2	3247082.3	3247082.4	3247082.5
Individual Tests						
Total Organic Carbon (TOC)‡	mg/L	-	-	-	-	4.3
pH	pH Units	6.8	6.7	6.7	-	6.9
Total Alkalinity	g/m³ as $CaCO_3$	-	-	-	-	410
Electrical Conductivity (EC)	mS/m	12.7	13.4	12.9	-	102.1
Total Suspended Solids	g/m³	< 3	< 3	6	-	-
Dissolved Boron	g/m³	-	-	-	-	29
Total Boron	g/m³	0.0154	0.078	0.060	-	-
Dissolved Iron	g/m³	-	-	-	-	< 0.02
Total Iron	g/m³	0.57	0.73	0.77	-	-
Dissolved Mercury	g/m³	-	-	-	-	< 0.00008
Total Mercury	g/m³	< 0.00008	< 0.00008	< 0.00008	-	-
Total Potassium	g/m³	3.6	3.7	3.7	-	-
Chloride	g/m³	16.2	16.5	15.9	-	13.4
Total Ammoniacal-N	g/m³	0.025	< 0.010	0.018	-	< 0.010
Nitrite-N	g/m³	0.007	0.003	0.006	-	< 0.002
Nitrate-N	g/m³	0.89	0.81	0.91	-	1.99
Nitrate-N + Nitrite-N	g/m³	0.89	0.82	0.91	-	1.99
Sulphate	g/m³	4.3	3.8	3.5	-	149
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	-	< 0.000008	-
Acenaphthylene	g/m³	-	-	-	< 0.000008	-
Anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]pyrene (BAP)	g/m³	-	-	-	< 0.000008	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	-	< 0.000008	-
Benzo[g,h,i]perylene	g/m³	-	-	-	< 0.000008	-
Benzo[k]fluoranthene	g/m³	-	-	-	< 0.000008	-
Chrysene	g/m³	-	-	-	< 0.000008	-
Dibenzo[a,h]anthracene	g/m³	-	-	-	< 0.000008	-
Fluoranthene	g/m³	-	-	-	< 0.000008	-
Fluorene	g/m³	-	-	-	< 0.000008	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	-	< 0.000008	-
Naphthalene	g/m³	-	-	-	< 0.00004	-
Phenanthrene	g/m³	-	-	-	< 0.000008	-
Pyrene	g/m³	-	-	-	< 0.000008	-

Analyst's Comments

‡ Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - Watercare Report

Summary of Methods

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

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	6-9
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	6-9
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	6-9
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	6-9
Total Recoverable Boron	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	20 mg/kg dry wt	6-9
Heavy metals screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	6-9
Polycyclic Aromatic Hydrocarbons Screening in Solids*	Sonication extraction, GC-MS/MS analysis. Tested on as received sample. In-house based on US EPA 8270.	0.010 - 0.05 mg/kg dry wt	6-9
Asbestos in Soil			
As Received Weight	Measurement on analytical balance. Analysed at Hill Laboratories - Asbestos; 101c Waterloo Road, Christchurch.	0.1 g	6-9
Dry Weight	Sample dried at 100 to 105°C, measurement on balance. Analysed at Hill Laboratories - Asbestos; 101c Waterloo Road, Christchurch.	0.1 g	6-9
<2mm Subsample Weight	Sample dried at 100 to 105°C, weight of <2mm sample fraction taken for asbestos identification if less than entire fraction. Analysed at Hill Laboratories - Asbestos; 101c Waterloo Road, Christchurch.	-	6-9
Asbestos Presence / Absence	Examination using Low Powered Stereomicroscopy followed by 'Polarised Light Microscopy' including 'Dispersion Staining Techniques'. Analysed at Hill Laboratories - Asbestos; 101c Waterloo Road, Christchurch. AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples.	0.01%	6-9
Description of Asbestos Form	Description of asbestos form and/or shape if present.	-	6-9

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Total Organic Carbon (TOC)	Total Organic Carbon by Non-dispersive infrared detection - Carbon, Inorganic Carbon and Total Organic Carbon. Subcontracted to Watercare Services Ltd, Auckland.	0.5 mg/L	5
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3, 5
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	1-3
pH	pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3, 5
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3, 5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	1-3
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	5
Dissolved Boron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	5
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0053 g/m^3	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m³	5
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m³	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	5
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m³	1-3
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m³	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	1-3, 5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m³	1-3, 5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m³	1-3, 5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m³	1-3, 5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m³	1-3, 5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	1-3, 5
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, GC-MS/MS analysis. In-house based on US EPA 8270.	0.000005 g/m³	4

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

Testing was completed between 20-Apr-2023 and 05-May-2023. For completion dates of individual analyses please contact the laboratory.

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

Kim Harrison MSc
Client Services Manager - Environmental

watercare
Laboratory Services

Watercare Services Limited
52 Aintree Ave, Māngere, Auckland, 2022
PO Box 107028, Auckland, 2150
T: 0800 522 365
clientsupport@water.co.nz
www.watercarelabs.co.nz

Certificate of Analysis
Laboratory Reference:230502-138

Attention:	Subcontracting .	*Final Report:*	**507967-0**
Client:	**R J HILLS**	*Report Issue Date:*	**04-May-2023**
Address:	**28 Duke Street, Frankton, Hamilton, 3204**	*Received Date:*	**02-May-2023**
		Sampled By:	**Hills**
Client Reference:	**EnvSubWC 314**	*Laboratory Activity Dates:*	**04-May-2023 - 04-May-2023**
Purchase Order:	**159466**	*Quote Reference :*	**15559**

All samples received outside of holding time (DOC - 48 hrs, TOC - 5 days) for analysis. Results may not accurately reflect composition of sample at the time of sampling.

Sample Details	WATERS
Lab Sample ID:	**230502-138-1**
Client Sample ID:	3247082.5
Sample Date/Time	17/04/2023 12:30
Description:	Ground Water
Organics	
Total Organic Carbon by Non-dispersive infrared detection	
Total Organic Carbon mg/L	4.3

*Results marked with * are not accredited to International Accreditation New Zealand. A dash indicates no test performed.*

Where samples have been supplied by the client, they are tested as received.
The results of analysis contained in this report relate only to the sample(s) tested. Where sample collection was performed by the laboratory, the results of analysis contained in this report relate only to the sample(s) collected.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Compliance and Projects Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

Peter Boniface

KTP Signatory

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

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

Certificate of Analysis

Client:	Fraser Thomas Limited	**Lab No:**	3361956 SPv1
Contact:	Dr S Finnigan	**Date Received:**	11-Sep-2023
	C/- Fraser Thomas Limited	**Date Reported:**	20-Sep-2023
	PO Box 204006	**Quote No:**	117021
	Highbrook	**Order No:**	PO000950
	Auckland 2161	**Client Reference:**	LINZ Six Monthly Landfill Monitoring - Water
		Submitted By:	Elliot Bish

Sample Type: Aqueous

Sample Name:		S1 11-Sep-2023 10:30 am	S2 11-Sep-2023 10:30 am	S3 11-Sep-2023 10:30 am	S4 11-Sep-2023 10:30 am	P2 11-Sep-2023 10:30 am
Lab Number:		3361956.1	3361956.2	3361956.3	3361956.4	3361956.5
Individual Tests						
pH	pH Units	7.1	7.0	7.0	-	7.2
Total Alkalinity	g/m³ as $CaCO_3$	-	-	-	-	420
Electrical Conductivity (EC)	mS/m	12.4	13.3	12.7	-	100.3
Total Suspended Solids	g/m³	< 3	8	4	-	-
Dissolved Boron	g/m³	-	-	-	-	28
Total Boron	g/m³	0.0173	0.096	0.067	-	-
Dissolved Iron	g/m³	-	-	-	-	< 0.02
Total Iron	g/m³	0.61	1.58	0.91	-	-
Dissolved Mercury	g/m³	-	-	-	-	< 0.00008
Total Mercury	g/m³	< 0.00008	< 0.00008	< 0.00008	-	-
Total Potassium	g/m³	2.5	2.8	2.5	-	-
Chloride	g/m³	16.0	16.6	15.8	-	12.7
Total Ammoniacal-N	g/m³	0.048	0.050	0.067	-	< 0.010
Nitrite-N	g/m³	0.006	0.010	0.007	-	0.002
Nitrate-N	g/m³	1.76	1.69	1.73	-	1.88
Nitrate-N + Nitrite-N	g/m³	1.77	1.70	1.74	-	1.89
Sulphate	g/m³	4.1	4.4	4.3	-	134
Total Organic Carbon (TOC)	g/m³	-	-	-	-	10.4
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq						
Acenaphthene	g/m³	-	-	-	< 0.000008	-
Acenaphthylene	g/m³	-	-	-	< 0.000008	-
Anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]anthracene	g/m³	-	-	-	< 0.000008	-
Benzo[a]pyrene (BAP)	g/m³	-	-	-	< 0.000008	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	-	-	-	< 0.000008	-
Benzo[g,h,i]perylene	g/m³	-	-	-	< 0.000008	-
Benzo[k]fluoranthene	g/m³	-	-	-	< 0.000008	-
Chrysene	g/m³	-	-	-	< 0.000008	-
Dibenzo[a,h]anthracene	g/m³	-	-	-	< 0.000008	-
Fluoranthene	g/m³	-	-	-	< 0.000008	-
Fluorene	g/m³	-	-	-	< 0.000008	-
Indeno(1,2,3-c,d)pyrene	g/m³	-	-	-	< 0.000008	-
Naphthalene	g/m³	-	-	-	< 0.00006	-
Phenanthrene	g/m³	-	-	-	< 0.000008	-
Pyrene	g/m³	-	-	-	< 0.000008	-

Analyst's Comments

Sample 5 Comment:
Please note that the level of Uncertainty of Measurement (UOM) for the TOC result is significantly greater than that usually reported for this analyte (up to 100-200% at the 95% confidence level).

Summary of Methods

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Polycyclic Aromatic Hydrocarbons Trace in Water, By Liq/Liq	Liquid / liquid extraction, GC-MS/MS analysis. In-house based on US EPA 8270.	0.000005 g/m^3	4
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3, 5
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	1-3
pH	pH meter. APHA 4500-H$^+$ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3, 5
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m^3 as $CaCO_3$	5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1-3, 5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) 23rd ed. 2017.	3 g/m^3	1-3
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	5
Filtration for dissolved metals analysis - Misc	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 23rd ed. 2017.	-	5
Dissolved Boron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.005 g/m^3	5
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0053 g/m^3	1-3
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.02 g/m^3	5
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m^3	1-3
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	5
Total Mercury	Bromine Oxidation followed by Atomic Fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1-3
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3, 5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3	1-3, 5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-3, 5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1-3, 5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-3, 5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m^3	1-3, 5
Total Organic Carbon (TOC)	Supercritical persulphate oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC -TIC.The uncertainty of the calculated result is a combination of the uncertainties of the two analytical determinands in the subtraction calculation. Where both determinands are similar in magnitude, the calculated result has a significantly higher uncertainty than would normally be achieved if one of the results was significantly less than the other. In such cases, the elevated uncertainty should be kept in mind when interpreting the data. APHA 5310 C (modified) 23rd ed. 2017.	0.5 g/m^3	5

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

Testing was completed between 13-Sep-2023 and 19-Sep-2023. For completion dates of individual analyses please contact the laboratory.

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

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