IN THE MATTER	of the Resource Management Act 1991 ("RMA" or "the Act")
AND	
IN THE MATTER	of an application under section 88 of the Act to **WAIKATO REGIONAL COUNCIL** and **WAIKATO DISTRICT COUNCIL** (ref LUC0488/22) BY **GLEESON MANAGED FILL LIMITED** to establish and operate a managed fill disposal activity at 310 Riverview Road, Huntly.

STATEMENT OF EVIDENCE OF ANDREW JOHN RUMSBY

CONTAMINANTS DISCHARGE

Dated 23 November 2022

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1. INTRODUCTION

1.1 My full name is Andrew John Rumsby. I am a Principal Environmental Chemist at EHS Support New Zealand Limited ("EHS Support"), a company specialising in complex environmental, health and safety changes across a wide array of industries.

1.2 This evidence is given in respect of resource consent application LUC0488/22 by Gleeson Managed Fill Limited ("GMF") to Waikato Regional Council ("WRC") and ("Waikato District Council") ("WDC") to establish and operate a managed fill disposal activity at 310 Riverview Road, Huntly ("Site").

Qualifications and experience

1.3 I hold the qualifications of Master of Science in Chemistry and Earth Sciences from the University of Waikato (200), Bachelor of Science in Chemistry and

Geology from the University of Auckland (1994) and a Certificate in Radiochemistry from the University of Auckland.

1.4 I have undergone specialist training in ecological and human health risk assessment as well as environmental toxicology and environmental sampling.

1.5 I have worked as an Environmental Chemist since 1987. More specifically I have worked on issues involving environmental chemistry, landfill leachate and water quality since 1997, when I became employed as a Scientific Officer (Environmental Monitoring) for Taranaki Regional Council. I relocated to Auckland to fill an environmental science position at Environmental Science and Research (ESR) Limited Air Quality Group in 2000, where I worked as an Air Quality Scientist/Data Analyst. Since 2001, I have worked for environmental consultancy firms and since February 2020 have been employed by EHS Support as a Principal Environmental Chemist where I provide technical advice on:

(a) Environmental chemistry and eco-toxicity;

(b) Landfill/solid waste disposal and/or management;

(c) Contaminated land issues;

(d) Environmental geochemistry;

(e) Environmental Fate and Transport Modelling;

(f) Environmental risk assessments; and

(g) Assessment of emerging contaminants.

1.6 I have conducted a number of detailed investigations related to evaluating the fate and impacts on human health and the environment of metals and organic compounds in water. This work has included assessing the impacts of chemical exposures from contaminated sites, undertaking environmental fate and transport modelling of various chemicals, and using of environmental forensic techniques to identify the source of contaminants. I have also developed guidelines for various media (sediment, soil and water) undertaking defensible sampling as part of contaminated site investigations for various agencies including the New Zealand Defence Force, Ministry for the Environment, Office of the Parliamentary Commissioner for the Environment and various Regional Councils.

1.7 This work has comprised various projects assessing the ecological and human health effects of sediment and soil quality investigations at several locations in New Zealand. It has included the use of advanced geochemical, ecotoxicological, and acid sulphate soils assessments; environmental fate and speciation modelling, and bioavailability assessments using a weight-of-evidence approach to determine the probable effects on the environment.

1.8 I am a suitably qualified and experienced environmental practitioner as defined by the User's Guide National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health (MfE, 2012).

Involvement in the project

1.9 I have been engaged by GMF to provide technical advice on the potential environmental impact on the surface water quality of discharges and to develop Waste Acceptance Criteria for the site.

1.10 I was responsible for the preparation of:

(a) Waste Acceptance Criteria and Assessment of Environmental Effects

(b) Development of the Landfill Management Plan

(c) Soil Sampling Assessment -sub-soils Fill Area 3 (FA3).

(d) Sampling and Analysis Plan

(e) Acid Sulphate Soils Management Plan

1.11 I am familiar with the subject site and the wider receiving environment.

Site visits and background material

1.12 I undertook an initial site walkover and the surrounding areas of the site on several occasions including 1-3 July 2020.

Purpose of scope and evidence

1.13 The purpose of my evidence is to characterise the existing receiving environment and to assess the potential environmental effects of the proposed managed fill.

1.14 My evidence is structured as follows:

(a) Briefly describes the site (Section 3).

(b) Briefly describes the proposal (Section 4).

(c) Sets out the key policy matters (Section 5).

(d) Addresses the relevant contaminants discharge issues arising (Section 6).

(e) Comment on issues raised by the Officer's Report relevant to my area of expertise (Section 7).

(f) Comment on the issues raised by Submitters relevant to my area of expertise (Section 8).

(g) Comment on the conditions (Section 9).

(h) Provide a brief conclusion (Section 10).

1.15 A summary of my evidence is contained in Section 2.

1.16 My evidence should be read together with the evidence of:

(a) Scott Lowry;

(b) Michael Parsonson; and

(c) Kate Madsen.

Expert Witness Code of Conduct

1.17 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's 2014 Practice Note. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

1.18 I understand and accept that it is my overriding duty to assist the Independent Commissioner in matters which are within my expertise as a contamination expert.

2. SUMMARY OF EVIDENCE

2.1 Site specific waste acceptance criteria have been prepared for the site based upon hydrogeological data obtained by PDP previous investigation of the Gleeson Huntly Quarry and long-term monitoring data on the flow and water chemistry of the Waikato River.

2.2 The site-specific waste acceptance criteria are similar to the newly published October 2022 Wasteminz waste acceptance criteria for class 3 fill sites (i.e., managed fills).

2.3 Site-specific criteria developed for GMF considered the fact that there are no drinking wells within 1,000 m down gradient of the site and that the dilution capacity within Waikato River is much greater than 100 times (even considering the rainfall for the area). Also relevant is the fact that the soil properties will attenuate the movement of chemicals such as adsorption onto organic matter and clay particles and pH of groundwater.

2.4 GMF waste acceptance criteria set lower limits for lead and zinc before SPLP testing is required to be undertaken before accepting soils into the Managed Fill.

2.5 The GMF waste acceptance criteria also prohibit a wider range of waste streams than is specified by Wasteminz (2022) Technical Guidelines for Disposal of Waste to Land and other similar Managed Fills.

2.6 The Acid Sulphate Soil Management Plan requires that Acid Sulphate Soils are neutralised with lime and this process is validated to confirm it has been effective before they are placed within the Managed Fill.

2.7 The proposed monitoring plan meets the requirements outlined in Wasteminz (2022) Technical Guidelines for Disposal of Waste to Land and other similar Managed Fills. The proposed monitoring is sufficient for a managed fill of its size.

2.8 The combination of appropriate waste acceptance criteria, stormwater treatment and monitoring will ensure that the discharges from the site will not result in an exceedance of drinking water or water guidelines values for the protection of ecosystem within the Waikato River or Lake Puketirini.

3. SITE DESCRIPTION AND LOCALITY

3.1 The site is located approximately 4.5 km to the south of the Huntly township on the western side of the Waikato River at 300 Riverview Road adjacent to the Gleeson Huntly quarry.

3.2 The site for the proposed managed fill is located within two north-facing (Fill Area 3 and Fill Area 4) gullies and one west-facing gully (Fill Area 2) located adjacent to the Gleeson Huntly Quarry.

3.3 Fill Areas 2, 3 and 4 are located north of the existing quarry within existing steeply sloped gullies approximately 40 to 110 m above sea level. The fill area is not expected to exceed the height of the existing ridge line.

3.4 Fill Area 2 is located within an east-facing gully and will comprise approximately 3.8 hectares of land.

3.5 The geological basement rock at the site consists of Triassic-aged greywacke (Hararimata formation) which is overlain by Te Kuiti Group (calcareous mudstone to sandstone which contains the Waikato Coal Measures). The geotechnical report indicates late Pleistocene to Holocene aged alluvial ash deposits (Puketoka formation) are located on the ridgelines. Near the quarry entrance (eastern edge of the quarry outside of the managed fill area) alluvium deposits consisting of gravel, sand, silt, mud and peat. The depth of these fluvial and lacustrine sediments depth increases towards the Waikato River.

3.6 Based upon discussions with PDP Hydrogeologist Dr Parviz Namjou, data within Huntly Quarry Expansion 2020 Groundwater and Surface Water Effects and PDP memo dated 25 June 2022, the general conceptual model for the managed fill sites are as follows:

(a) There are perched/shallow in small discontinuous zones of saturation in some parts of the managed fill[1]. The ephemeral nature of the tributaries in the vicinity of the proposed Fill areas demonstrates that these lenses are not laterally continuous, are limited in their extent and not likely to form an aquifer in the area.

(b) Test pitting and drilling in Fill Area 3 did encounter perched groundwater within the mine overburden material at various depths (i.e., shallow groundwater was discontinuous and maybe only highly localised lenses).

(c) The regional groundwater (continuous zone of saturation)is at approximately RL8m to RL20 m (Quarry) and is likely to occur within the fractured greywacke and discharges to the Waikato River. The natural regional groundwater level is at RL19m and close to the pit floor. This regional groundwater is intercepted by the quarry drain at the pit floor discharging to the Waikato River. This is well below the elevation of any perched groundwater in the Fill area.

[1] Discontinuous perched groundwater water has been identified in Fill Area 3 but not in Fill Area 2 or 4.

3.7 There is a stream below Fill Area 2 which flows into a wetland before discharging northwards to Lake Puketirini approximately 2.2 km away. Based upon information from Shawn McLean and the Boffa Miskell Ecological Impact Assessment (2019) the unnamed stream is ephemeral upstream and immediately below Fill Area 2, which indicates that it is not being recharged by groundwater.

3.8 An unnamed tributary is also located to the north of Fill Areas 3 and 4. This tributary discharges into the Waikato River.

4. DESCRIPTION OF PROPOSAL

4.1 GMF proposes to infill three gullies (Fill Areas 2-4) with 2,000,000 m^3 of managed fill. Managed Fill consists of clean fill and contaminated clay, soil, rock, and other inert materials that may have contaminants that exceed background concentrations. Table 1 outlines the various fill areas and projected fill volumes.

Table 1 – Fill Areas _ Land Area and Capacity

Fill Area	Fill Area (Ha)	Projected Fill Volume (m^3)
Fill Area 2	4.5	717,000
Fill Area 3	4.34	478,500
Fill Area 4	5.21	800,000
Total	14.05	1,995,500

4.2 A maximum of 300,000 m^3 per annum of imported managed fill will be accepted into each fill area. The staging of the fill areas is sequential.

4.3 The fill material must meet the proposed fill criteria outlined in Table 2.

Table 2 – Proposed Waste Acceptance Criteria for the Managed Fill

Contaminant Type	Parameter	Proposed Waste Acceptance Criteria (> 2 m) (mg/kg)	Proposed SPLP Leachability Limits (mg/L)	Maximum Truckload Fill Concentrations Shallow (<2 m) Clean Fill (mg/kg)
Elements	Arsenic	100	-	12
	Boron	45 (260)	2	45
	Cadmium	7.5	-	0.65
	Chromium	400	-	55
	Copper	325	-	45
	Mercury	1.5	-	0.45
	Nickel	65 (320)	1	35

Contaminant Type	Parameter	Proposed Waste Acceptance Criteria (> 2 m) (mg/kg)	Proposed SPLP Leachability Limits (mg/L)	Maximum Truckload Fill Concentrations Shallow (<2 m) Clean Fill (mg/kg)
	Lead	250 (1,000)	1	65
	Thallium	23	-	1
	Zinc	400 (2,000)	1	180
BTEX Compounds	Benzene	0.2	-	0.0054
	Toluene	1.0	-	1.0
	Ethylbenzene	1.1	-	1.1
	Total xylenes	0.61	-	0.61
Polycyclic Aromatic Hydrocarbons (PAH)	Benzo-a-pyrene (eq)	20	-	2
	Naphthalene	7.2	-	0.013
Total Petroleum Hydrocarbons (TPH)	C_7-C_9	120	-	120
	C_{10}-C_{14}	300 (1,400)	-	58
	C_{15}-C_{36}	20,000	-	-
Others	DDT and isomers	8.4	-	0.7
	Aldrin	0.7	-	-
	Dieldrin	0.7	-	-
	Tributyltin	6	0.3	
Asbestos	Refer to Table 2 of the Huntly Quarry – Asbestos Fill Management Plan (PDP, 2019).			

4.4 The following material outlined in Table 3 will not be accepted into the managed fill.

Table 3 Waste Prohibited from the Managed Fill

- Acid-generating tailings from the processing of sulphide ore
- Bulk liquids.
- Bulk fertiliser waste
- Tyres.
- Medical and Veterinary Waste
- Coal Ash Waste.
- Lead-acid batteries (lead-acid batteries can be recycled in New Zealand).
- Used oil.
- Explosive, flammable, oxidising or corrosive substances - as defined under the HSNO Act.
- PCB wastes.
- Persistent Organic Pollutants wastes (as defined by the Stockholm Agreement).

- Drums or containers containing hazardous chemicals (including agrichemicals, solvents,
- petroleum compounds or toxic chemicals (as defined under the HSNO Act)).
- Viscous materials-liquids/tars/paints and painted material.
- Household Hazardous Waste.
- Vegetation, bark, wood chips and green waste.
- Lithium-ion batteries
- Municipal solid waste and domestic refuse.
- Organic Peroxide Compounds as defined under the HSNO Act
- Other sulphuric mine tailings materials
- Paper, cardboard, and fabrics.
- Electrical components, cabling, and insulation.
- Biosolids from municipal or industrial wastewater treatment plants.
- Radioactive materials
- Waste from metalliferous minerals' physical and chemical processing (including mine mullock, iron slag and conveyor sludge)

5. **KEY POLICY MATTERS**

5.1 WRP Water Module Objective 3.5.2 – Discharges: The proposed discharges will not have adverse effects that are inconsistent with the water management objectives in 3.1.2 or the discharges to land objectives in 5.2.2.

5.2 WRP Water Module Objective 3.1.2(o) – *Concentrations of contaminants leaching from land use activities and non-point source discharges to shallow ground water and surface waters do not reach levels that present significant risks to human health or aquatic ecosystems*

5.3 EHS Support has undertaken RCBA modelling which demonstrates that leaching from the managed fill does not *levels that present significant risks to human health or aquatic ecosystems.*

5.4 WRP Water Module 3.2.3 Policy 6 – The purpose of the contact recreation class is to provide a safe water quality environment for contact recreation in all rivers, streams, and lakes with significant contact recreational use by:

(a) Avoiding reductions in clarity that make the water unsuitable for contact recreation.

(b) Avoiding contamination to levels that represent a significant risk to human health or to levels that would render the water body unsuitable for contact recreation.

(c) Avoiding the development of bacterial and/or fungal growths that are visible to the naked eye.

(d) Avoiding the development of periphyton growths or mats to the extent that they cover more than 25% of the bed of the water body.

5.5 EHS Support has undertaken RCBA modelling which demonstrates that leaching from the managed fill does not *levels that present significant risks to human health or aquatic ecosystems.* Also, the purposed discharge criteria from the various sediment retention ponds are lower than either human health or recreational water quality criteria. The discharge from the managed fills is unlikely to prompt bacterial/fungal or algae growth as waste acceptance criteria prohibit waste streams (such as biosolids, bulk fertilisers, medical wastes, or municipal solid waste) that are likely to contain high nutrient concentrations that might prompt excessive growth of bacterial, fungal growths or periphyton growth.

5.6 WRP Water Module 3.2.3 Policy 8 – The zone of reasonable mixing is the area within which a discharge into water (including any discharge that occurs subsequent to a discharge onto or into land) does not need to achieve the standards specified in the water management class for the receiving water body. The size of the mixing zone must be minimised as far as is practicable and will be determined on a case-by-case basis.

5.7 This has been considered when setting discharge criteria. Note that the location of monitoring site DS2, downstream of FA3 and FA4 has been determined by access to a monitoring site. Mr O'Reilly has not given permission to access his property to collect samples, and DS2 is the most suitable monitoring location on GMF owned land.

5.8 WRP Land and Soil Module Objective 5.2.2 – Discharges onto or into land: The discharge of managed fill to land will not contaminate soil that may pose a risk to human health, and the discharge does not consist of waste or hazardous substances. Waste acceptance criteria have been set as not to pose a risk to human health. Also, a 2-metre capping layer of cleanfill is proposed to act as a barrier to protect human health (and minimise long term leaching potential) once the managed fill areas have been completed.

5.9 WRP Policy 1: Low risk discharges onto or into land – The discharge of contaminants of the proposed accepted managed fill is unlikely to result in discharges containing hazardous substances that are environmentally persistent or have high levels of toxic effects. Any impact on water quality/ecosystems and air quality are considered acceptable and where possible have been avoided, remedied and/or mitigated. The proposed waste acceptance criteria are below human health guideline values. The calculated potential discharge concentrations are below ecological guideline values.

5.10 Policy 2: Other Discharges Onto or Into Land Manage discharges of contaminants onto or into land not enabled by Policy 1, in a manner that avoids, where practicable, the following adverse effects and remedies or mitigates those effects that cannot be avoided:

(a) contamination of soils with hazardous substances or pathogens to levels that present a significant risk to human health or the wider environment.

5.11 Please refer to the answer in paragraph 5.8 of my evidence.

5.12 WRP Plan Change 1 – It is considered that the fill material proposed for acceptance (in WAC) generates a low level of contaminant discharge that is treated before being discharged to water, and in addition, the volume of water runoff from the catchment will not alter because of the overburden disposal (Policy 1).

5.13 WRP Plan Change 1 – Policy 11 recognises that some point source discharges of sediment to water (or land) provide for the continued operation of regionally significant industry – it is considered that the proposed fill sites will provide a highly engineered disposal facility that will allow responsible waste disposal for regionally significant projects, and therefore reflects the intent of this policy.

6. CONTAMINANTS DISCHARGE ISSUES

6.1 The type of managed fill material to be imported to the site includes construction and demolition fill (as defined and listed as acceptable materials in Section 4.2 of the Cleanfill Guidelines) with accepted low levels of contaminants including asbestos, soils containing acid sulphate, and marine sediment. Typically, the fill will contain soil, rock, concrete, bricks, and glass, with less than 5% timber. Peat, a naturally occurring material is also to be accepted.

6.2 Site-specific Waste Acceptance Criteria have been developed for the site using Groundwater Services Inc. Risk Based Corrective Action (RCBA) version 2.6 fate and transport modelling software to protect environmental receptors and New Zealand or International Risk Based guidance to protect human health.

6.3 RCBA modelling was undertaken in accordance with ASTM E2081-00 (which was reapproved in 2015).

6.4 The RCBA model inputs have been modified from US default input parameters for assessing risk to human receptors by using the default input parameters used within MfE (2011) Methodology for deriving standards for contaminants in soil to protect human health, New Zealand Drinking Water Standards and Australian New Zealand for Fresh and Marine Water Quality and total organic carbon and pH of Waikato Soils (provided by Matthew Taylor of Waikato Regional Council).

6.5 Modelling was undertaken using conservative hydrogeochemical parameters based on information supplied by PDP, based upon hydrological testing at the Quarry. The RCBA model used a hydraulic permeability of 1.4×10^{-5} m/s. More recent hydraulic testing based on the pumping tests undertaken by PDP indicates that the hydraulic permeability is in the order of 6×10^{-6} m/s. Therefore, the parameters used in the RCBA model are conservative

6.6 The RCBA model assumes that the average concentration of the soils is the same as the proposed Waste Acceptance Criteria. Based upon monitoring data at other managed fills such as Ridge Road, Drury Managed Fill, and Puketutu Managed Fill, the average concentration of soils within the managed fill is likely to be significantly lower than this.

6.7 The RCBA model also used the 7-day low flow average flow with a likely recurrence of 2 years. This figure is recommended to be used by the US EPA as a reasonable worst-case estimate for low flow for use in water quality modelling.

6.8 As RCBA is a 1-dimensional fate and transport model[2] and EHS Support has conservatively estimated that the average concentration of the soil of the various contaminants is the same as the proposed Waste Acceptance Criteria and used a very high estimate of the hydraulic permeability the RCBA model is likely to overpredict the impact on surface water bodies.

7. COMPARISION OF PROPOSED WASTE ACCEPTANCE CRITERIA

7.1 Since preparing the AEE and developing site-specific Waste Acceptance Criteria, WasteMINZ has updated its Technical Guidelines for Disposal to Land (October 2022) guidance for Waste Acceptance Class 3 (Managed Fills).

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[2] Fate and transport models estimate the movement and chemical alteration of contaminants as they move through air, soil, or water.

7.2 The WasteMINZ Waste Acceptance Criteria for Class 3 (Managed Fills) are a conservative genetic site of criteria which are the lowest (most conservative) values to be protective of both nearby drinking-water sources or protective of any nearby surface water environment. This Criteria, the WasteMINZ Waste Acceptance Criteria, has been derived by examining the relationship between SPLP results and total metal concentration for many soil samples analysed within New Zealand.

7.3 The WasteMINZ guidelines have also derived new target SPLP criteria (see Table 4):

<u>Table 4 - New SPLP target values</u>

Analyte	**Old SPLP criteria (MfE, 2004)**	**Groundwater Protection (Drinking water aquifer)**		**Aquatic Protection**	
		DWSNZ (MAV)	SPLP criteria (20 x MAV)	ANZG (2018) 95% ecosystem (FW)	SPLP Criteria (100 x ANZG (2018) 95% ecosystem
Arsenic	**0.5**	0.01	**0.2**	0.013	1.3
Cadmium	**0.1**	0.004	0.08	0.0002	**0.02**
Chromium (III)	**0.5**	0.05	1	0.001	**0.1**
Copper	**0.5**	2	40	0.0014	**0.14**
Lead	**0.5**	0.01	**0.2**	0.0034	0.34
Mercury	**0.02**	0.007	0.14	0.0006	**0.06**
Nickel	**1**	0.08	1.6	0.011	**1.1**
Zinc	**1**	1.5	30	0.008	**0.8**

7.4 These guidelines assume a 20 dilution and attenuation factor (DAF) for the protection of groundwater sources and 100 x times dilution and attenuation factor for the protection of aquatic ecosystems (Note no justification is provided for these default DAF factors.)

7.5 For many of the contaminants of concern, these values are different from the previously published SPLP (See Table 4).

7.6 It is necessary to note that the derivation of these new class 3 waste acceptance factors does not consider any site-specific factors, including total organic carbon, soil permeability (hydraulic conductivity), soil and groundwater pH, the flow of the river, distance to the river, or nearest drinking water bore.

7.7 The Waste Acceptance Criteria derived for Huntly Managed Fill are based upon various NZ risk-based guidelines and other factors. RCBA has been used to confirm that these will not have a significant impact on the Waikato River water quality.

7.8 The RCBA does consider the following site-specific factors which are not allowed for within the WasteMINZ criteria:

(a) Background concentrations in surface water aquifer.

(b) Depth to groundwater aquifer.

(c) Distance to surface aquifer (or groundwater take (if relevant)).

(d) Size and volume of managed fill.

(e) soil permeability (hydraulic conductivity) and permeability of groundwater aquifer.

(f) environmental mobility of the chemicals (including Koc, solubility and adsorption/desorption characteristics of the various chemicals and the effect of pH within the fill and receiving environment).

7.9 It is also important to note that there is not a drinking water groundwater aquifer downgradient of the Huntly managed fill. Therefore, for arsenic and lead, the 2022 WasteMINZ Class 3 criteria are not applicable as they are designed to protect a drinking water aquifer that does not exist in the vicinity of the proposed Huntly managed fill.

7.10 A comparison between the proposed GMF Waste Acceptance Criteria for Huntly, and the October 2022 WasteMINZ Guidance for Class 3 landfills criteria is set out in Table 5, below:

Contaminant Type	Parameter[1]	Proposed Waste Acceptance Criteria (> 2 m) (mg/kg)	WasteMINZ (2022) Class 3 Criteria
Elements	Arsenic	100	140
	Boron	45 (260)	NR
	Cadmium	7.5	10
	Chromium	400	150
	Copper	325	280
	Mercury	1.5	3
	Nickel	65 (320)	320
	Lead	250 (1,000)	460
	Thallium	23	NR
	Zinc	400 (2,000)	1,200
BTEX Compounds	Benzene	0.2	0.11
	Toluene	1.0	19
	Ethylbenzene	1.1	10
	Total xylenes	0.61	25
Polycyclic Aromatic Hydrocarbons (PAH)	Benzo-a-pyrene (eq)	20	125
	Naphthalene	7.2	NR
Total Petroleum Hydrocarbons (TPH)	C_7-C_9	120	200
	C_{10}-C_{14}	300 (1,400)	600
	C_{15}-C_{36}	20,000	NR
Others	DDT and isomers	8.4	2
	Aldrin	0.7	NR
	Dieldrin	0.7	0.1
	Tributyltin	6	NR

Waste Acceptance CriteriaWasteMINZNotes:(NR = No Recommendation).
The guidelines highlighted in Green are less than the October 2022 WasteMINZ Guidance.
The guidelines highlighted in Yellow are higher than the October 2022 WasteMINZ Guidance.

7.11 The proposed Waste Acceptance Criteria have been derived to allow soils containing elevated levels of metals and low-level asbestos fibres from residential re-development sites. It was also developed Waste Acceptance Criteria to accept soils with naturally elevated arsenic which occurs in several locations around the Waikato region (pers. comms. Jonathan Caldwell

October 2022). Currently these soils cannot go to clean fills within the Waikato Region.

7.12 Overall, the proposed GMF Waste Acceptance Criteria are very similar to those proposed by WasteMINZ (2022). The GMF Waste Acceptance Criteria are also similar to other managed fill Waste Acceptance Criteria used in Auckland and the Waikato which have similarly shown no adverse effects on local surface water quality bodies (see Table 5).

7.13 In the case of lead, nickel, and zinc, EHS Support has recommended that at concentrations above 65 mg/kg (nickel), 250 mg/kg (lead) and 400 mg/kg (zinc), SPLP tests are undertaken to verify it would be safe to accept material containing higher concentrations of these contaminants. The zinc WAC criteria have also been developed to accept some volcanic soils which are naturally elevated in zinc (up to 1160 mg/kg)[3].

7.14 GMF Waste Acceptance Criteria are slightly higher for DDT and Dieldrin than the proposed WasteMINZ (2022) Waste Acceptance Criteria (see Table 5). Both compounds are very low environmental mobility due to their high Koc and very low water solubility. RCBA modelling demonstrates that the concentrations proposed by WasteMINZ would be overly conservative for this site as it does not consider the site-specific factors at the Huntly managed fill site that would limit mobility (i.e., assumes the upper 98th percentile of all soil properties), instead of the silty/clay-rich soils with moderate to high organic carbon more likely to be encountered in the Auckland/Waikato Region. The Waste Acceptance Criteria that GMF has proposed are identical to those used at other Managed Fills/Contaminated sites in Auckland[4] and these criteria have been demonstrated not to have a measurable impact on nearby streams.

7.15 EHS Support have used the older 2004 MFE SPLP (leachability) limits for a Class B landfill in its Waste Acceptance Criteria. Given the newer SPLP limits proposed by WasteMINZ, it would be appropriate to adopt these new SPLP criteria for the GMF, as they are based upon updated New Zealand guideline values. WasteMINZ (2022) did not derive a new SPLP for boron, therefore, I recommend that the older 2.0 mg/L limit is still used as this would be protective of the ecological receptors as the 95% ecosystem (see Table 6).

[3] AC (2001) Background concentrations of inorganic elements in soils from the Auckland Region.
[4] PDP (2017) Stevenson Consent monitoring 2017 – surface water and sediment quality -425 and 475 Quarry Road

7.16 The derivation document[5] for the Class 3 and 4 landfill Waste Acceptance Criteria notes:

> *"should a soil exceed a total concentration WAC, it is still possible to carry out leachability testing using SPLP test to determine whether the soil complies with the limiting SPLP concentrations on which the various total recoverable WAC are based. If a soil complies with the relevant SPLP limits, the soil would be acceptable for disposal. The intention is that the more complicated (and expensive) leachability testing provides a fallback option for soil acceptance assessment."*

7.17 The proposed SPLP criteria and new SPLP criteria are set out in Table 6, below:

<u>Table 6 – Proposed SPLP criteria and new SPLP criteria</u>

Analyte	Gleeson Old Proposed SPLP criteria	New SPLP criteria (in accordance with Wasteminz Class 3 guidance)
Boron	2.0	2.0
Lead	1.0	0.2
Nickel	1.0	1.1
Zinc	1	0.8

8. IMPACTS OF WATER QUALITY – GROUNDWATER IMPACTS

8.1 The RCBA modelling indicates that the groundwater discharge will have a negligible impact on water quality within the Waikato River[6].

8.2 Pattle Delamore Partners' assessment by Dr Parviz Namjou states that there is no shallow aquifer (continuous zone of saturation) below the proposed Fill area and the laterally discontinuous lenses of perched groundwater minimise lateral groundwater flow away from the site. Therefore, groundwater

[5] PDP (2021) Derivation of Class 3 and 4 Landfill Waste Acceptance Criteria

[6] Based upon the results from the RCBA model that there would be no measurable change in the water quality within the Waikato River.

discharges are highly unlikely to have a significant adverse impact on the two unnamed tributaries adjacent to the proposed managed fill.

8.3 EHS Support has also undertaken leachability assessments of the sub-soil beneath Fill Area 3 as there were concerns that coal mine tailings and overburden material from the neighbouring former mine operation had been deposited in the northern half of the proposed fill area 3. The testing undertaken by EHS Support indicates that the concentration of some inorganic elements was above published Waikato Regional background concentrations for soil (but within the proposed Waste Acceptance Criteria).

9. IMPACTS OF WATER QUALITY – STORMWATER DISCHARGES

9.1 GMF has undertaken macro-invertebrate and water quality monitoring of the unnamed tributary below Fill Area 2 which flows into Lake Puketrini (herein referred to as the Puketrini stream) and the unnamed tributary below Fill Area 3 and 4 which flows into the Waikato River (herein referred to as the O'Reilly stream).

Puketrini Stream background water quality

9.2 Macro-invertebrate monitoring within the Puketrini stream below Fill area 2 had an MCI score of 85 and a QMCI score of 4.33 indicative of severe organic pollution or nutrient enrichment and contained no sensitive EPT[7] taxa which are sensitive to metal pollution.

9.3 Water quality monitoring undertaken by GMF within the Puketrini stream (Site FA2) downstream of Fill Area 2 (see **Attachment 1a and 1b**) found that dissolved aluminium concentrations at this site regularly exceed 80% ANZG (2018) guidelines and that other dissolved metals (cadmium, copper, thallium, and zinc) occasionally exceeded ANZG (2018) at this monitoring site.

9.4 The average concentration of zinc at monitoring point FA2 is approximately 5 ppb (mg/m^3) (c.f. ANZG (2018) freshwater default trigger value of 8 ppb (mg/m^3)) and the 95th percentile is approximately 7 ppb (mg/m^3). These levels of zinc are similar to the average concentration of zinc in the regional stream[8]. Monitoring of other rural streams within the lower Waikato indicates that they periodically exceed ANZG (2018) freshwater default

[7] EPT taxa are Ephemeroptera (mayflies), Plecopetera (stoneflies) and Trichoptera (caddisflies).
[8] As reported in EWDOCS-#153661-v1-Complied results for zinc in surface water 2009-2010 (See Attachment 2)

trigger value for 95% ecosystem protection of 8 ppb (mg/m^3) (see **Attachment 3b**).

9.5 Downstream of the proposed fill area the Puketrini stream may also receive diffuse and point discharges from a former Solid energy coal waste dump site located on O'Reilly property, diffuse agricultural inputs, discharges from a dairy shed effluent pond located on O'Reilly property and stormwater discharges from Rotowhero Road before it discharges into Lake Puketirini.

O'Reilly Stream background water quality

9.6 Macro-invertebrate monitoring within the O'Reilly Stream below Fill area 2 had an MCI score of 82 and a QMCI score of 3.4 indicative of severe organic pollution or nutrient enrichment, but some sensitive EPT[9] taxa which are sensitive to metal pollution were present.

9.7 Water quality monitoring undertaken by GMF within the Puketrini stream (Site DS2) downstream of Fill Areas 3 and 4 (see **Attachment 2a and 2b**) found that dissolved zinc periodically exceeded ANZG (2018) freshwater default trigger value for 95% ecosystem protection of 8 ppb (mg/m^3). Dissolved manganese exceeded ANZG (2018) freshwater default trigger value for 80% ecosystem protection of 3.6 ppm (g/m^3) on one occasion.

9.8 Due to the high potential background of zinc observed at monitoring site DS2 and other small rural streams in the lower Waikato area (See **Attachment 3a and 3b**) whole effluent toxicity testing was undertaken to confirm that dissolved zinc concentrations up to 30 ppb (mg/m^3) are not toxic.

9.9 Whole effluent toxicity testing undertaken by NIWA indicates that concentrations of dissolved zinc up to 30 ppb (mg/m^3) are not toxic to algae, macro-invertebrates, and NZ native fish species (common bully).

9.10 Discharge criteria and receiving water quality criteria have been developed for stormwater ponds[10] to protect water quality for ecological receptors, drinking water (livestock and human health) and recreational users. The discharge criteria developed for the stormwater treatment system have also considered the range of concentrations of various inorganic elements within both the Puketrini stream and O'Reilly Stream as well as the results of the whole effluent toxicity (WET) testing undertaken by NIWA.

[9] EPT taxa are Ephemeroptera (mayflies), Plecopetera (stoneflies) and Trichoptera (caddisflies).
[10] Outlined within EHS (2022) Surface Water Sampling and Analysis Plan -Huntly Managed Fill

9.11 The proposed discharge criteria from the stormwater ponds at Fill Area 2, Fill Area 3 and Fill Area 4 are outlined in Table 7. The proposed discharge criteria are based upon international guidelines and assumed that there will be no adverse effect after reasonable mixing (See Sampling and Analysis Plan for more information on the selection of the analytes of concern and source of the various discharge criteria). US EPA's Criterion Maximum Concentration (CMC) water quality guidelines (US EPA, 2019) have been used for aluminium and chromium (III), which are acute exposure guidelines more relevant to intermittent stormwater discharges into ephemeral surface waters than the ANZG (2018).

9.12 Ministry of Health (MoH) drinking water standard for arsenic has been used instead of the ANZG (2018) guidelines because the MoH guideline value is lower.

9.13 The proposed surface water quality discharge criteria are set out in Table 7, below:

<u>Table 7 – Proposed surface water quality discharge criteria</u>

Parameter	Proposed Trigger values (mg/L)	Source and Rationale
Dissolved Aluminium (0.22 µm filter)	0.980[1]	US EPA CMC. Intermittent discharge and Colloidal alumino-silicates may give high values
Dissolved Arsenic	0.01[2]	MoH (2018) Drinking Water Standards
Dissolved Boron	0.940[3]	ANZG (2018) 95% Guidelines. High Background values
Dissolved Cadmium	0.0008[1]	ANZG (2018) 80% Guidelines. Allows for dilution
Dissolved Chromium (based on Cr(III))	0.57[1]	US EPA CMC. Intermittent discharge
Dissolved Copper	0.0251[5]	ANZG (2018) 80% Guidelines. Allows for dilution
Dissolved Lead	0.0056[4]	ANZG (2018) 90% Guidelines. Allows for dilution and protection of drinking water.
Dissolved Nickel	0.013[4]	ANZG (2018) 90% Guidelines and Protection of Drinking water
Dissolved Thallium	0.00003[4]	ANZG (2018) 95% Guidelines. High Background values
Dissolved Zinc	0.031	Confirmed by Whole Effluent Toxicity.

Total petroleum hydrocarbons (TPH)	15[6]	MfE (1989) Petroleum Guidelines. To avoid visible sheens
pH	>5.5 (6.0 for storage tank Fill 3 underdrain) pH units	

9.14 The proposed receiving water quality (at monitoring sites DS2 and FA2) are outlined in Table 8 below. These criteria are based on ANZG (2018) guidelines in consultation with Waikato Regional council considering local background conditions. Table 8. Proposed receiving surface water quality criteria after reasonable mixing.

Parameter	Proposed Trigger values (mg/L)	Source and Rationale
Dissolved Aluminium	0.080[1]	ANZG (2018) 90% Guidelines. Background may be elevated during storm conditions.
Dissolved Arsenic	0.024[2]	ANZG (2018) 95% Guidelines.
Dissolved Boron	0.940[2]	ANZG (2018) 95% Guidelines.
Dissolved Cadmium	0.0002[2]	ANZG (2018) 95% Guidelines.
Dissolved Chromium (as Chromium VI)	0.006[1]	ANZG (2018) 90% Guidelines. Background may be elevated.
Dissolved Copper	0.0014[2]	ANZG (2018) 95% Guidelines.
Dissolved Lead	0.0034[2]	ANZG (2018) 95% Guidelines.
Dissolved Nickel	0.011[2]	ANZG (2018) 95% Guidelines.
Dissolved Thallium	0.00003[2]	ANZG (2018) 95% Guidelines.
Total petroleum hydrocarbons (TPH)	5[4]	33% of the MfE (1989) Petroleum Guidelines. To avoid visible sheens on the surface of the water.

9.15 For Fill Area 3, GMF has also proposed testing the water of the underdrain storage tank before it is discharged into the stormwater ponds. If the water within the storage tank exceeds the criteria in Table 9 then the water in the tank will require additional treatment or off-site disposal (Appendix A of the Sampling and Analysis Plan for Flow Chart explains the process. The Sampling and Analysis Plan provides information on how these trigger values were derived).

Table 9 - Proposed trigger values for discharging Underdrain Storage Tank

Parameter	Proposed Trigger values (mg/L)	
	Level 1 Criteria	Level 2

Parameter	Proposed Trigger values (mg/L)	
Total Boron	1.0	5.0
Total Copper	0.5	1.5
Total Lead	0.1	0.3
Total Zinc	0.6	1.8

Note:
mg/L = milligram per litre

9.16 The above proposed criteria shall ensure that there is no adverse effect on the aquatic receiving environment.

10. IMPACT ON LAKE PUKETRINI

10.1 Lake Puketirini is an artificial lake created by the infill of Weaver Pit coal mine via groundwater and the diversion of the unnamed tributary (Puketirini Stream) into the former coal mine pit.

10.2 Currently, Lake Puketrini is managed by Waikato District Council, for swimming and recreational purposes.

10.3 Lake Puketrini has a surface area of approximately 0.5 km^2 and a maximum depth of 62 m.

10.4 Data from monitoring undertaken by Balvert (1996)[11] indicates that water below 20 m is oxygen-poor which will result in metal species[12] within the sediment forming relatively insoluble metal precipitates which will remove metal species from the water column.

10.5 Water quality monitoring that has been undertaken by Waikato Regional Council indicates that Lake Puketrini is currently phosphorous limited. This will limit the amount of algae growth.

10.6 Limited sampling undertaken on behalf of GMF indicates contains low dissolved metals, with Total phosphorous meeting National Policy Statement -Freshwater Attribute A criteria of ≤10 gm^3 for Total Phosphorous and ammonia (≤0.03 g/m^3).

10.7 Table 10 Water Quality Lake Puketirini (mg/m^3).

[11] Balvert, S. (2006). Limnological Characteristics and Zooplankton Dynamics of a Newly Filled Mine Lake. MSc thesis, University of Waikato.
[12] Metal species refer to the various types of metal compounds that may form. This can include iron hydroxides, oxy-hydroxides, iron phosphate metal, and metal sulphide compounds.

Parameter	Lake Puketirini (Sampled 3/11/22)	95% ecological protection default guideline values ANZG (2018)	Recreational Water Quality Guidelines (NHMRC, 2008)[13]
pH	7.4	NGV	6.5-8.5 (5-9)[14]
Ammonia as N	0.006	0.9	0.5
Dissolved Reactive Phosphorus	<0.002	NGV	NGV
Iron (dissolved)	0.022	NGV	0.3
Nitrate	0.0171	NGV	50
Sulphate	67	NGV	250
Total Phosphorous	<0.04	NGV	NGV
Dissolved Aluminium	0.0036	0.055	NGV
Dissolved Antimony	<0.000010	0.009	0.003
Dissolved Arsenic	0.00077	0.024	0.007
Dissolved Boron	0.27	0.940	4
Dissolved Cadmium	<0.000020	0.0002	0.002
Dissolved Chromium	<0.00020	0.00033	0.05
Dissolved Copper	0.0003	0.0014	1
Dissolved Lead	<0.000005	0.0034	0.01
Dissolved Nickel	0.00057	0.011	0.02
Dissolved Thallium	<0.000010	0.00003	NGV
Dissolved Zinc	<0.0003	0.008	3

Note: 1. ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

2 . NGV = No Guideline Value

10.8 A concrete weir erected at the lower reaches of the unnamed tributary (Puketrini Stream) which flows into Lake Puketrini, will remove some suspended solids (from run-off within the catchment) from entering the lake.

[13] NHMRC (2008) Recreational Water Quality Advisory Committee
[14] NHMRC notes that a wider range is acceptable for water with a very low buffering capacity

10.9 The concrete weir, the depth of the lake, thermal stratification and the young age of Lake Puketrini are reasons why the lake enjoys its relatively high-water quality compared to other lakes within the lower Waikato catchment.

10.10 The Waikato District Council Lake Puketrini Management Plan states that nutrients from non-point source run-off are a significant threat to the lake's water quality.[15]

10.11 It is highly unlikely that the discharges from the Managed Fill will impact the recreational use of Lake Puketrini, because:

(a) The predicted concentrations of inorganic elements in the discharge from managed fill area are several orders of magnitude below recreational water quality guidelines, even assuming the unrealistic assumption of the entire managed fill containing soil at the maximum concentration allowable.

(b) The operation of the sediment retention ponds will remove 95% dissolved and total metals from the discharge.

(c) The operation of the managed fill- area 2 is for a short duration (2 to 5 years). The discharges from the stormwater ponds will be infrequent – i.e., during storm events. Therefore, the total mass load discharged during the operational life of Fill area 2 is very small in comparison to the total mass load from all other sources within the catchment.

(d) The Waste Acceptance Criteria prohibit the managed fill from accepting waste streams that may be high in nutrients and highly biodegradable waste such as agrichemicals, green waste, industrial or domestic refuse (including food wastes), biosolids, medical and veterinary waste and bulk fertiliser wastes.

(e) The concrete weir and the ponded area of water behind the weir will help to remove suspended solids from unnamed tributary before it discharges into Lake Puketirini.

11. MANAGEMENT OF ACID SULPHATE SOILS

11.1 Acid sulphate soils occur naturally within the lower Waikato and many locations in the North Island. They can be associated with geothermal

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[15] WDC (2009) Puketirini Management Plan. Accessed from https://www.waikatodistrict.govt.nz/your-council/plans-policies-and-bylaws/plans/reserve-management-plans/puketirini-management-plan

features, some volcanic soils, swampy areas, intertidal zones, some coastal soils and in waterlogged soils.

11.2 GMF has developed an acid sulphate soils management plan to neutralise the soils with lime within 24 hours of receiving them.

11.3 After the soils have been neutralised and tested, then they are deposited within one of the Fill Areas.

11.4 The acid sulphate soils management plan has been formulated to meet the requirements outlined Government of Western Australia 2015 guideline on the Treatment and Management of soil and water in acid sulphate soil landscapes.

12. **ISSUES RAISED BY COUNCIL OFFICERS REPORT**

12.1 I have read the report prepared by Emma Cowan, the Council's reporting planner.

12.2 I disagree with Ms Cowan on several technical matters, including

(a) That the proposed activity is to accept Construction and Demolition fill material.

(b) Adopting the most conservative limit of each analyte from our assessment of environmental effects to develop Waste Acceptance Criteria for the Managed Fill.

(c) That further background testing is required for aluminium, chromium, and zinc.

(d) The conclusion that it is unacceptable to set a higher discharge threshold if background concentrations exceed ANZG (2018) 95% ecosystem default guideline values.

(e) Ms Cowan's statement that it is inappropriate to rely on dilution within SRP to set discharge criteria for a holding tank that discharges into the SRP.

(f) Ms Cowan's conclusion that the cumulative load entering the Waikato River Catchment would increase because of this activity.

(g) Ms Cowan's statement that site-specific guidelines which consider the condition of the existing environmental quality are inappropriate.

(h) That the management plan lacks enforceability and is subject to hap-hazard approvals.

(i) Ms Cowan's recommendation that verification sampling of the fill deposited is required if surface water quality contravenes the surface water criteria at the sampling points.

(j) Ms Cowan's comments that the application is complex and lacks certainty and that it relies on future monitoring to confirm trigger levels.

(k) That a framework is required to investigate groundwater as groundwater is not a sensitive receiving environment. If an issue detected in the surface water, then a surface water investigation is more appropriate than a groundwater investigation. Then based upon the findings of the surface water investigation the most appropriate course of action can be determined.

12.3 Ms Cowan's statement that GMF will accept construction and demolition waste is incorrect. GMF has applied for a managed fill that meets class 3 managed fill criteria which includes soils with elevated concentrations of some contaminants and clean fill material (including inert materials like rocks, brick, and concrete). GMF has not applied to receive construction and demolition waste beyond want is considered acceptable in a cleanfill.

12.4 Ms Cowan has also provided an alternative set of waste acceptance criteria for the Huntly Managed Fill despite the Waikato Regional Council expert Jonathan Caldwell accepting and agreeing with the approach adopted by GMF in deriving the proposed Waste Acceptance Criteria and stating that it complies with best practice for assessing environmental effects.

12.5 Section C8 of the Wasteminz (2022) Technical Guidelines for the Disposal to Land does allow for site-specific guidelines to be derived. It states that there are site-specific factors that will effectively mitigate the potential for significant adverse effects. In the case of Huntly managed fill there are several site-specific factors that will mitigate the potential for significant adverse effects. These are:

(a) No use of groundwater within 500 m of the site being used as a drinking water aquifer.

(b) Higher organic content (i.e., greater than 1%) for Waikato soils. Waikato Regional Council estimates that the average organic content of Waikato soils is 7%. Soils in Aotearoa indicate that the average New Zealand Soils[16] have an organic matter concentration of between 4 to 10%. TP 153 indicates that Auckland soils range between 0.6 to 14% with the interquartile range for non-volcanic soils being 2.2-4.6% and the interquartile range for volcanic soils being 4 to 6.5%.

(c) Relatively low permeable geology which offers significant attenuation of contaminants.

(d) Regional groundwater at the site is very deep (approximately 30 m below base of the managed fills).

(e) RCBA modelling in accordance with ASTM E2081-2015 using site-specific factors has demonstrate there is significant attenuation of contaminants.

12.6 It also should be noted that in the case of lead and zinc, GMF has proposed Waste Acceptance Limits (before SPLP testing is required), which are less than the Wasteminz class 3 WAC. GMF has updated the SPLP criteria to align with the SPLP criteria. Therefore, the proposed waste acceptance for Huntly Managed Fill is in alignment with the Wasteminz class 3 WAC SPLP criteria (i.e., not more than 20 x Ministry of Health Maximum Acceptable Value or 100 times the ANZG (2018) default water quality guidelines for 95% ecosystem protection).

12.7 Within the original PDP report,[17] it is the leachable concentration that is critical for landfill (not total concentrations in the soil). PDP stated that deriving Total concentrations (by empirical analysis) were a cost-saving measure to reduce the cost of disposal. The PDP report also states that should soil exceed a total concentration WAC, it is still possible to conduct leachability testing using the SPLP test to determine whether the soil complies with the limiting SPLP concentrations. This is the approach that we have formalised within our Waste Acceptance Criteria for the Huntly Managed Fill.

12.8 I believe that the higher WAC criteria set for Huntly Managed Fill for benzene, DDT and Dieldrin are appropriate as it is highly likely that the fill within the site and the geology beneath the site (which comprises the Te Kuiti Group containing the Waikato Coal Measures) will have significantly higher total organic carbon content than the 1% total organic carbon used in deriving

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[16] Hewitt, A., Balks, M., Lowe, D. (2020) The Soils of Aotearoa New Zealand. World Soils Book Series.

[17] PDP (2021) Derivation of Class 3 and Class 4 Landfill Waste Acceptance Criteria

the Wasteminz Class 3 WAC. The WAC Class 3 guidelines do not consider the biodegradation/volatilisation process, which will be an important attenuation mechanism for benzene.

12.9 The Oil Industry Environmental Working Group commissioned a study to determine hydrocarbon acceptance criteria for the protection of surface water quality[18]. This study found that in silty clay, clay, and peat soils that contamination could be present in the soil at concentrations up to and including separate phase hydrocarbons being present without presenting a significant risk (via migration of dissolved phase hydrocarbons) to the quality of surface water bodies located 25 m or greater from the source. All of GMF sites are located more than 25 m from the water bodies. EHS Support RCBA modelling is consistent with the results found by the Oil Industry Environmental Working Group.

12.10 One of Ms Cowan concerns was that there was insufficient sampling to characterise background. However, GMF has collected 11 water samples from monitoring location DS2 (downstream of FA3 & FA4) and 25 water samples downstream of Fill area 2 (See Attachments 1a, 1b, 2a and 2b). While a few more samples may be advantageous to future characterise these two streams, there is currently sufficient data does exist to understand the water quality of these two sites.

12.11 I also disagree with Ms Cowan statement that water quality limits should be set at a more conservative limit to reflect the need to restore degraded receiving water. The downstream water quality limits have been set to reflect the water quality of the receiving environment. This is important for this site as there is no upstream monitoring site, and especially for the unnamed tributary discharging to the Waikato River (on Mr O'Reilly's property), there appear to be multiple other discharges that impact the water quality of this stream. The ANZG water quality guidelines allow for setting various levels of protection based on ecosystem conditions. Both background water quality monitoring and ecological monitoring of the streams have identified that these are highly disturbed ecosystems.

12.12 Ms Cowan also assumes that the discharges from the GMF will result in a deterioration in water quality. This will not be the case, and the sediment retention ponds will only discharge into the streams immediately downstream and usually during periods of high flow (i.e., during and immediately after storm events). The SRP has been designed to WRC

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[18] URS (2010) Determination of Hydrocarbon Soil Acceptance Criteria for the Protection of Surface Water Quality

requirements and will use chemical flocculation, which has the potential to remove 50 to 90% dissolved metals as well as significantly reduce suspended solids concentrations.

12.13 The purpose of setting the discharge limits at the levels proposed is to consider the variability in the concentration of various parameters already occurring at the site before GMF as undertaken any filling activity at the site. Setting consent limits lower than current background concentration levels will result in non-compliance events which will be caused by the natural condition of the site or other anthropogenic activities.

12.14 Currently, I am unaware of any WRC investigations that have been undertaken to identify the source of the elevated concentrations measured within the two streams, nor any plan to undertake any restoration of these two streams. Therefore, the implied requirement for GMF to effectively undertake the restoration of these waterways so that it could meet some lower receiving water quality is not appropriate as GMF is not the polluter.

12.15 I also disagree with Ms Cowan's statement that it is inappropriate to allow for dilution within the sediment retention pond when setting internal monitoring trigger values for FA3 holding tank water, which is receiving water from FA3 sub-surface drains. The proposal is to discharge this water into the SRP if the water within the tank meets a certain quality. The dilution factor which has been calculated takes into account the potential storage volume of the SRP, which is controlled by the height of the discharge structure, which can be changed by GMF as required. This is standard engineering practice to account for dilution within on-site treatment systems, and there is nothing inappropriate with the process. WRC technical advisor Jonathan Caldwell has reviewed the calculations and agrees that they are appropriate.

12.16 I also disagree with Ms Cowan's statement that the cumulative load entering the Waikato River Catchment will increase because of this activity. Ms Cowan has presented no evidence showing that there would be an increase nor any data showing what the current baseline loads are.

12.17 GMF has proposed several different measures which may reduce the contaminant flux from the site. These include:

(a) Installing SRP design in accordance with industry best practice which will treat stormwater from the earthworks/managed fill areas and stormwater that would have naturally occurred on the site (including the area within Fill Area 3 of historical coal mining wastes).

(b) The potential removal of contaminated material from Fill area 3 that does not meet the Waste Acceptance Criteria for the site.

(c) The collection and treatment of groundwater beneath Fill area 3.

(d) The installation of 2 m caps on top of the managed fills once filling is complete which will reduce the overall leaching and run-off of contaminants from the managed fill areas.

(e) Modelling of the contaminant fluxes from the managed fills shows a negligible change in concentration of contaminants within the Waikato River.

(f) Riparian planting and other areas of ecological compensation that will reduce contaminant fluxes into the Waikato Region. The effectiveness of riparian planting in reducing contaminant fluxes by reducing erosions and transport of sediment/nutrients into nearby waterways[19, 20, 21]

12.18 I also disagree with Ms Cowan's comment that management plans lack enforceability and are subject to haphazard approvals. Resource consent conditions can be appropriately worded, which will give Waikato Regional Council the ability to enforce compliance with the management plans. Any update of the management plan will need to be reviewed and certified by Waikato Regional Council. The Waikato Regional Council review and certification process involves review of the plan by appropriate experts and is not a haphazard process.

12.19 I disagree with Ms Cowan's recommendation that verification sampling of the fill deposited is required if surface water quality contravenes the surface water criteria at the sampling points. There are several potential reasons why surface water quality could contravene the surface water criteria where it would not be appropriate to automatically undertake verification sampling of the fill deposited, which include (but not limited to):

(a) Laboratory analytical error

[19] NZ EPA Riparian planting and the effects of chemicals in Waterways.
[20] K. Collins (2011) Evaluating the effectiveness of riparian plantings on water quality: A case study of lowland streams in the Lake Ellesmere catchment. Unpublished thesis from Lincoln University
[21] McKergow 2016 Riparian management: A restoration tool for New Zealand streams. Ecological Management & Restoration, pp 218-227.

(b) Sampling error (i.e., sample bottle collects stream sediment or cross-contamination).

(c) Naturally occurring colloidal aluminium elevates the dissolved aluminium concentrations (note: there is no WAC for aluminium, but there is a discharge criterion for aluminium).

(d) Off-site discharge or spill.

(e) On-site spill.

(f) Issue with the operation of sediment retention ponds.

12.20 Requiring verification sampling of the fill deposited is not the most appropriate action (and is costly) for any of the above scenarios. GMF has proposed an investigation strategy within the Sampling and Analysis Plan a water quality event occurs.

12.21 Ms Cowen's statement that the discharge criteria rely on future monitoring is incorrect. Discharge criteria have been proposed by GMF as part of the application and have undertaken extensive background monitoring already.

12.22 I have read the report prepared by Dr Jonathan Caldwell, the Council's Senior Scientist, technical assessment of contaminant discharges to land and water-GMF.

12.23 I agree with most of the findings of Jonathan Caldwell's Technical Report. However, I disagree that it will be necessary to undertake additional modelling using RCBA to derive site-specific values for Fill area 2, for the following reasons:

(a) The WasteMINZ (2022) Waste Acceptance Criteria are very similar to GMF's proposed Waste Acceptance Criteria, which is designed to be highly conservative and used to be used as the minimum standard for all managed fill across the country (irrespective of depth of groundwater, location, and size of surface water bodies).

(b) An engineering option similar to Fill Area 3 (which has inserted sub-surface drains and groundwater collection system) would ultimately be a more effective solution than adjusting the fill acceptance criteria.

(c) In my opinion, it would be more appropriate to undertake a hydrogeological investigation of Fill Area 2 to verify the hydrogeological model and, then, if necessary, develop appropriate engineering solutions. This would be a more pro-active approach and give greater protection to the receiving environment.

13. ISSUES RAISED BY SUBMITTERS

13.1 A total of 42 submissions have been received. The topics raised in submissions that I can comment are as follows:

(a) Water quality impacts – Lake Puketirini;[22]

(b) Water quality impacts – Waikato River;[23]

(c) Water quality impacts – local tributaries;[24]

(d) Soil quality impacts;[25] and

(e) Contaminant discharge and water quality monitoring. [26]

Water quality impacts – Lake Puketirini

13.2 An unnamed tributary of Lake Puketirini starts in the vicinity of Fill Area 2 and drains northwards towards Rotowaro Road and discharges into Lake Puketirini and Lake Waihi. Due to the reasons that I have outlined in Section 9, I consider that the water quality impacts on Lake Puketirini will be negligible.

13.3 Submitters have raised concerns that acidic discharge from acid sulphate soils will affect the water quality in Lake Puketirini, potentially lowering the pH and killing aquatic flora and fauna. Any acid sulphate soils deposited at GMF will need to be lime neutralised before being deposited into the

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22 Submissions of: Dorothy Claire Molloy (#1), Wayne Robert Rutherford (#3), Maree Frances Rutherford (#4), Denise Lamb (#5), Kate Thomas (#6), Jennifer Lee Malloy (#8), Cyril & Marion Shanley (#9), Allan & Bronwyn Kosoof (#11), Daisy Thomas (#14), Garry & Audrey Cox (#15), Paul Vitasovich (#16), Andrew Parkin & Leanne Ralph (#17), Katie Shepard (#21), Nicola Vitasovich (#22), Colleen Earby (#24), Emily Joy Thomas (#25), Nicola Maplesden (#33), Lorrel Cherie Mowles & Alex John Mowles (#36), Clive & Pauline Kosoof (#38), Robert Hunt (#40), and Waikato District Council (#41).

23 Submissions of: Denise Lamb (#5), Kate Thomas (#6), Norm Hill (#7), Cyril & Marion Shanley (#9), Appollonia Johnston (#10), Allan & Bronwyn Kosoof (#11), Daisy Thomas (#14), Garry & Audrey Cox (#15), Paul Vitasovich (#16), Katie Shepard (#21), Colleen Earby (#24), Warren Gavin Dickinson (#30), Nicola Maplesden (#33), Te Kauri Maarae Trust (#37), Clive & Pauline Kosoof (#38), and Waikato District Council (#41).

24 Submissions of: Dorothy Claire Molloy (#1), Kate Thomas (#6), Norm Hill (#7), Jennifer Lee Malloy (#8), Director-General of Conservation (#12), Daisy Thomas (#14), Paul Vitasovich (#16), Katie Shepard (#21), Colleen Earby (#24), Seli Saararaba Scutts (#27), Warren Gavin Dickinson (#30), Arthur & Esmae Baylis (#31), Nicola Maplesden (#33), Lorrel Cherie Mowles & Alex John Mowles (#36), and Robert Hunt (#40).

25 Submissions of: Maree Frances Rutherford (#4), Jennifer Lee Malloy (#8), Colleen Earby (#24), Arthur & Esmae Baylis (#31), and Waikato District Council (#41).

26 Submissions of: Wayne Robert Rutherford (#3), Denise Lamb (#5), Andrew Parkin & Leanne Ralph (#17), and Colleen Earby (#24).

managed fill. This strategy has proven successful overseas and at the Tui Mine at Mt Te Ahora. GMF is also required to regularly monitor the pH of the water within the Sediment Retention Ponds. If acidic water was detected, then the SRP could be closed off and the ponds dosed with lime to bring the pH up to an acceptable range. The lime neutralisation of the soils, monitoring of the water and the distance between the managed fill and Lake Puketirini. The addition of lime to any acid sulphate soils may also increase the alkalinity of the SRP, which could increase the buffering capacity (and acid neutralising capacity) of the ponds.

13.4 Mr Rutherford has stated that he is concerned that discharges from the managed fill will damage wildlife, adversely affect human health, and cause the lake to be unswimmable. The Waste Acceptance Criteria (as well as the items that are prohibited for the Managed Fill to accept) have been designed to protect the environment and human health. The discharge criteria from the SRP have been set lower than the threshold known to have an adverse effect on the environment or human health (both issues have been considered when setting these criteria (see Section 8). Mrs Rutherford's submission also echoes Mr Rutherford's concerns regarding damage to Lake Puketirini. Furthermore, Ms Lamb is concerned about the potential for discharges that could affect the water quality of Lake Puketrini.

13.5 A number of other submitters are concerned about the potential impact on the receiving environment due to placing low-level contaminated soils at the proposed managed fill site. The concentration of contaminants requested by GMF is similar to those at other sites (such as Drury Managed Fill, operated by Stevenson Aggregate Limited) and long-term monitoring has shown that those fill sites have not adversely impacted nearby streams. Site-specific environmental fate modelling indicates that the proposed managed fill will not have an adverse impact on Lake Puketirini or the unnamed tributaries.

13.6 Some submitters have also raised concerns over discharges during extreme weather events. These concerns are best addressed by Michael Parsonson of Southern Skies Limited. However, the RCBA model has assumed worst-case conditions (low flow conditions within the river). In an extreme weather events, there will be significantly more flow within the catchment (both the Waikato River and unnamed tributaries) and under those conditions the impact of the discharges from the managed fill will be less than those predicted under low-flow conditions. This is because stormwater from the wider catchment entering the tributaries and Waikato River will increase the flow within these waterbodies proportionately more than the discharge from the SRPs. This will increase the amount of dilution within the catchment (and allowable mixing zone) and thereby decreasing the relative impact that the discharges from the managed fill has on Lake Puketirini.

13.7 The main threats to the future suitability for Lake Puketirini as a recreational lake are:

(a) Turbidity (reduced visibility).

(b) Nutrient (particularly phosphorous) promoting algae blooms.

(c) Microbiological issues.

GMF has adopted industry best practices to design sediment retention ponds to remove suspended solids before stormwater is discharged from the site. Section 9 of my evidence outlines the reason why I do not consider that suspended solids discharge from the site will adversely affect the visibility within Lake Puketirini. GMF Waste Acceptance Criteria prohibit material that is likely to contain high nutrient concentrations (i.e., biosolids) or microbiological risks. The discharges of microbes and nutrients from GMF will be many orders of magnitude lower than current diffuse contaminants sources which are known to discharge into the unnamed tributary (i.e., dairy ponds, farming, stormwater runoff, waterfowl and potentially the WDC long-drop toilet located next to Lake Puketirini).

13.8 The submissions received from Mr and Mrs Thomas states they are concerned that leachate from Fill Area 2 will enter the unnamed tributary (Puketirini Stream) and impact the water quality. Currently, there is no evidence that this stream will receive any leachate because it is not groundwater fed. If small discontinuous preached groundwater is encountered during the developmental phase, then engineering controls similar to those proposed for Fill area 3 can be adopted to collect and treat the preached groundwater before discharging it to the sediment retention ponds or disposing of the water off-site.

13.9 The submission received from Ms Molloy indicates that the unnamed tributary (Puketirini Stream) has copied photographs (see Photograph 1) of iron floc discharging from groundwater. Most groundwater contains high iron (II) concentrations when exposed to air is oxidised into iron (III) which results in the precipitation of iron hydroxide minerals. Acid sulphate waters are defined by low pH (less than pH 4.5)[27] and high sulphate waters (greater

[27] Typically, acidic mine drainage or the oxidation of pyrite gives rise to the formation of sulphuric acid, and within any acid neutralisation reaction can give rise to surface water pH's of less than pH of 2. AMD is caused by oxidation of sulphide minerals and therefore, AMD indicators can be used as an indicator of ASS. Water Quality Australia (2018) National Acid Sulphate

than 500 ppm). Water samples collected from the stream can have circum-neutral pH and low sulphate concentrations (less than 10 ppm) (See Table 10). However, at other times sulphate concentrations can be elevated (~ 200 ppm). Therefore, the waters of the unnamed tributary (Puketirini Stream) may be receiving some acid sulphate waters periodically. Also, the stream can have elevated concentrations of zinc. The source of this zinc is unknown but other streams near coal mines (Rotowaro Mine and Kopuku (also referred to as Maramarua Coalfield) mine can have elevated sulphate and zinc.

13.10 The acid sulphate soils received at the site will be neutralised before they are placed in the fill. Therefore, it is unlikely to result in acidification of the unnamed tributary or Lake Puketirini.

Table 10 Water Quality of Unnamed Tributary near Lake Puketirini

Parameter	Unnamed Trib (by bridge) Concentration (mg/L)	Unnamed Trib (by bridge) Concentration (mg/L)	Unnamed Trib (by bridge) Concentration (mg/L)	Guideline value (ecological) (mg/L)
Date	31/7/20	26/10/22	26/10/22	
pH	6.5	7.3	7.1	>4[1]
Alkalinity (as $CaCO_3$)	12.1	29.8		NGV
Ammonia nitrogen	0.03	0.2	0.24	0.9[2] (at pH =8) (2.46 at pH=6.5). 0.4[3]
Calcium	3.6	41.1	46.2	NGV
Nitrate-N	0.0852	0.612	0.594	2.4[3]
Phosphorus (dissolved reactive)	0.005	0.004	0.003	50[3]
Sulphate	9.47	180	188	<500 mg/L[1]
Dissolved arsenic	<0.0005	<0.0005	<0.0005	0.024[2,4]
Dissolved boron	0.022	NR	NR	0.940[2]
Dissolved copper	0.00036	0.00035	0.00062	0.0014[2]
Dissolved iron	0.38	0.967	0.932	NGV

Soils Guidance: National acid sulfate soils sampling and identification methods manual indicates that a pH of less than 5.5 may be an indicator of ASS, however organic soil/peat and swamp areas may have low pH (~4.5 pH units).

Dissolved lead	<0.00005	<0.00005	<0.00005	0.0034[2]
Dissolved manganese	0.0514	1.45	1.44	1.9[2]
Dissolved mercury	<0.00008	NR	NR	0.00006[5]
Dissolved zinc	0.0017	0.018	0.027	0.008[2]

Notes: 1. Indicative AMD indictors as defined by USGS.

2. ANZG (2018) default guideline values (DGV) for 95% ecosystem protection

3. NPS (2020) National Bottom Line

4. DGV for arsenic (III)

5. ANZG (2018) default guideline values (DGV) for 99% ecosystem protection for protection against bioaccumulate substance

NGV= no guideline value

NR= No Result. Parameter was not measured.

P*hotograph 1. Iron floc discharging from a groundwater drain (discharging into unnamed tributary within 100 m of Lake Puketirini).*

Water quality impacts – Waikato River

13.11 A number of submitters have raised concerns about the impact of discharges (both surface water and groundwater discharges) on the Water Quality within the Waikato River.

13.12 Risk-based fate and transport modelling using the RBCA model (see Section 6) have predicted that there will be a negligible impact on the water quality within the Waikato River.

13.13 This is because the mass flux of contaminants from the landfill is very much less than the mass flux of contaminants within the Waikato River. The predicted changes in concentration of contaminants after reasonable mixing is several orders of magnitude less than the current analytical detection limits.

13.14 The discharges from the managed fill will have no effect on the quality of Waikato River as a drinking water source whether at Huntly or further downstream.

Water quality impacts – local tributaries

13.15 A few other submitters are concerned about the potential impact on the receiving environment due to placing low-level contaminated soils at the proposed managed fill site. The concentration of contaminants requested by GMF is similar to those at other sites (such as Drury Managed Fill operated by Stevenson Aggregate Limited) and long-term monitoring has shown that those fill sites have not adversely impacted nearby streams[28]. Site-specific environmental fate modelling indicates that the proposed managed fill will not have an adverse impact on Lake Puketirini or the unnamed tributaries.

13.16 Several submitters are concerned about unknown chemicals being disposed of at the fill site. GMF's proposal is to take cleanfill material and soil which contains slightly elevated concentrations (which are within the concentration range found in urban soils in New Zealand). No hazardous chemicals will be disposed of at the site.

13.17 Based upon our current understanding of groundwater hydrogeology and the local tributaries' hydrology, there is no groundwater recharge into the local tributaries.

13.18 For Fill Area 3, the groundwater will be collected into a storage tank before it can be discharged into the SRP or whether it would require further treatment or off-site disposal.

13.19 The discharges from the stormwater treatment ponds are likely to be intermittent and occur for a short period of time during and after a storm

[28] PDP (2017) Stevenson Consent monitoring 2017 – surface water and sediment quality -425 and 475 Quarry Road

event where there is more likely to be significant dilution with other stormwater flows entering the tributaries.

13.20 The proposed sediment retention ponds and management systems are in accordance with industry best practices.

13.21 GMF has also proposed to undertake monitoring and developed site-specific trigger values, together will the measures described in 11.6 to 11.8 will ensure that GMF will meet the proposed receiving water criteria.

Soil quality impacts

13.22 Some submitters have raised concerns over potential erosion releasing contaminants into the environment.

13.23 The site has a series of sediment retention ponds on-site to control discharges of suspended solids.

13.24 After each site has been closed, it will be capped within a capping layer in accordance with the requirements of the WasteMINZ guidelines. The capping layer will prevent will be 2 m thick and comprised with clean fill only and design to minimise erosional loses. This will prevent contaminated sediment from entering the waterways.

Contaminant discharge and water quality monitoring

13.25 Several submitters including Waikato District Council have raised concerns regarding the adequacy of the environmental monitoring and have suggested that more frequent monitoring is required.

13.26 For details of the monitoring of the SRP please refer to the evidence of Michael Parsonson of Southern Skies Limited.

13.27 The WasteMINZ (2022) Technical Guidelines for Disposal to Land [29](Table 8.3 p.121) indicates that a surface water sampling frequency Class 3 landfill that 6 monthly would be sufficient.

13.28 As there is no upstream monitoring and agricultural activities/other diffuse contamination/natural process may result in elevated concentrations of some elements (i.e., aluminium, boron, and zinc) it is necessary to consider background variation when setting the site trigger values.

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[29] Wasteminz (2022) Technical Guidelines for Disposal to Land. Revision 3- October 2022 Accessed from https://www.wasteminz.org.nz/technical-guidelines-for-disposal-to-land#our_board

13.29 GMF has proposed that surface water samples shall be collected from the discharge points of all operative sediment retention ponds on a six-monthly basis, and at the outlet of the pond and from the downstream sampling points identified in the Sampling and Analysis Plan on a quarterly basis excepting times when there are no discharges until the time as the fill activities on site have ceased, and the site has been rehabilitated.

13.30 GMF proposed monitoring regime will result in more surface water sampling monitoring than is required under WasteMINZ (2022) Technical Guidelines for Disposal to Land.

13.31 Several submitters have also questioned if the water of the Waikato River will be regularly tested to ensure it will be safe to use as a drinking water supply. Waikato Regional Council regularly test the water quality of the Waikato River at Horotiu (upstream of the Site) and at Huntly Bridge and publishers these results on their webpage (https://www.waikatoregion.govt.nz/environment/natural-resources/water/rivers/water-quality-monitoring-map/#e4865) and within technical reports which are available online.

13.32 In my opinion, Waikato District Council's recommendation to undertake monthly monitoring of the downstream turbidity is excessive for the size and nature of the proposed activity and would be more than is typically required for a large Class 1 (hazardous Waste) landfill.

14. COMMENTS ON CONDITIONS

14.1 In my opinion, the Applicant's proposed consent conditions for the discharge to land - solid waste are appropriate for the site and the nature of the fill material.

14.2 The Applicant proposed consent conditions to discharge stormwater and treated waste in association with Fill Area 2, 3 and 4 which are within my area of expertise (conditions 1-5 and 8 – 10). I consider that these conditions are appropriate for the site and the nature of the proposed activity.

15. CONCLUSIONS

15.1 Based upon the hydrogeological model for the site and observation of the freshwater ecologists the tributary below Fill area 2 are ephemeral and not groundwater feed.

15.2 The proposed waste acceptance conditions are sufficient to protect the water quality in nearby tributaries.

15.3 The placement of managed fill in accordance with the proposed Waste Acceptance Criteria will not have an adverse impact on the water quality of Lake Puketirini.

15.4 The placement of managed fill in accordance with the proposed Waste Acceptance Criteria will not have an adverse impact on the water quality of Waikato River.

15.5 The placement of managed fill in accordance with the proposed Waste Acceptance Criteria will not have an adverse impact on the drinking water quality of Huntly.

15.6 The acid sulphate soil management plan requiring the soils to be neutralised with lime and tested before being placed within the managed fill is sufficient to protect the environment from acidification because of sulphide mineral oxidation of soil deposited within the facility.

15.7 The proposed monitoring conditions are sufficient and meet industry best practice to monitor the effects of discharges from the fill areas.

Andrew John Rumsby
EHS Support New Zealand Limited
23 November 2022

Attachment 1a: Water Quality (Cations/Anions) at Monitoring Point Downstream of Fill Area 2

Reference		Units	20-22586-1	21-50440	21-50442	21-50443	21-50444	21-52971	21-52981	21-52978	22-08754	22-08755	22-08756	22-08757	22-08758				
Sample Description			FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2				
Sample Date			22/6/2020	24/11/2021	25/11/2021	26/11/2021	29/11/2021	01/12/2021	06/12/2021	13/12/2021	02/02/2022	04/02/2022	08/02/2022	11/02/2022	15/02/2022	minimum	maximum	mean	geomean
Dissolved Inorganic elements																			
pH		pH	6	6.8	6.7	6.8	6.8	6.7	6.6	6.5	7.7	7.7	7.7	7.7	7.7	6	7.8	7.35	7.33
Electrical Conductivity	(EC)	µS/cm	165	154	152	153	154	169	161	162	1,100	1,130	1,130	1,130	1,130	152	1130	711	533
Total Alkalinity (CaCO3)		$g\ CaCO_3/m^3$	4	30.2	25.3	26.8	29.8	23.2	24.1	22.9	127	128	125	131	128	4	133	81.55	62.48
Chloride	(Cl-)	g/m^3	16.6	27.9	27.7	27.8	27.3	28.3	27.9	27.3	18.8	18.7	18.4	18.7	18.7	17	28.3	21.10	20.71
Sulfate	(SO42-)	g/m^3	159	2.05	2.03	2.05	1.98	3.1	3.06	2.98	490	470	515	494	507	2	515	283.22	87.50
Nitrate-N	(NO3-N)	g/m^3	0.573	0.158	0.159	0.162	0.156	0.289	0.286	0.287	0.388	0.396	0.388	0.387	0.399	0	0.573	0.32	0.30
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	<0.002	0.002	0.003	0.004	0.003	0.002	<0.002	<0.002	0.003	0.004	0.005	0.005	0.004	0	0.005	nc	nc
Ammonia as N	(NH3N)	g/m^3	0.005	0.04	0.02	0.03	0.02	0.01	0.02	0.02	<0.005	0.01	<0.005	<0.005	0.008	0	0.04	nc	nc
Sodium	(Na)	g/m^3	19.3	19.6	20.2	20.3	20.2	21.6	22.4	22.2	42.5	42.9	42.4	42.1	42.4	19	43.5	32.24	30.92
Potassium	(K)	g/m^3	2.5	1.6	1.7	1.7	1.6	1.6	1.7	1.7	3.2	3.3	3.2	3.2	3.2	2	6.5	3.30	3.04
Calcium	(Ca)	g/m^3	4.8	4.5	4.7	4.5	4.5	4.2	4.4	4.3	183	187	187	187	186	4	190	104.7	48.4
Sum of Anions*		meq/L	NC	1.45	1.34	1.38	1.42	1.35	1.35	1.31	13.31	12.92	13.78	13.48	13.68	1	13.78	8.34	5.91
Sum of Cations*		meq/L	NC	1.45	1.5	1.48	1.49	1.51	1.58	1.56	13.46	13.7	13.64	13.67	13.63	1	13.92	8.40	6.08
EC/10*	(EC/10)	(mS/m)/10	1.65	1.54	1.52	1.53	1.54	1.69	1.61	1.62	10.98	11.32	11.32	11.3	11.29	2	11.32	7.11	5.33
Conductivity of Water (mS/m)		mS/m	16.5	15	15	15	15	17	16	16	110	113	113	113	113	15	113	71.0	53.1

Reference		Units	22-08759	22-08761	22-08762	22-14279	22-14278	22-14279	22-14280	22-14281	22-14282	22-14285	22-14287	22-14279					
Sample Description			FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2					
Sample Date			18/02/2022	25/02/2022	28/02/2022	01/03/2022	04/03/2022	08/03/2022	10/03/2022	15/03/2022	18/03/2022	25/03/2022	01/04/2022	08/04/2022		minimum	maximum	mean	geomean
Dissolved Inorganic elements																			
pH		pH	7.7	7.6	7.7	N/A	7.8	7.8	7.7	7.8	7.8	7.7	7.7	7.8		6	8	7.35	7.33
Electrical Conductivity	(EC)	µS/cm	1,120	1,080	1,130	N/A	833	804	862	881	856	860	874	866		152	1,130	710.67	533.19
Total Alkalinity (CaCO3)		$g\ CaCO_3/m^3$	130	133	132	N/A	90.3	85.4	94.4	94.2	93.6	93.8	92.3	92.9		4	133	81.55	62.48
Chloride	(Cl-)	g/m^3	18.8	18.6	18.6	N/A	18.2	18.4	18.4	18.2	18.4	18.2	18.5	18		17	28	21.10	20.71
Sulfate	(SO42-)	g/m^3	491	490	500	N/A	316	303	331	333	335	331	358	357		2	515	283.22	87.50
Nitrate-N	(NO3-N)	g/m^3	0.388	0.39	0.385	N/A	0.307	0.312	0.304	0.303	0.303	0.302	0.302	0.307		0	1	0.32	0.30
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.004	0.004	0.004	N/A	0.005	0.003	0.003	0.003	0.003	0.002	0.004	0.003		0	0	nc	nc
Ammonia as N	(NH3N)	g/m^3	<0.005	0.006	<0.005	N/A	0.01	<0.005	0.01	0.01	0.009	0.009	0.009	0.01		0	0	nc	nc
Sodium	(Na)	g/m^3	42.5	43.5	43.4	33.4	32.7	32.6	33.4	33.8	33.4	33.6	32.8	32.8		19	44	32.24	30.92
Potassium	(K)	g/m^3	3.2	3.3	3.3	4.5	4.5	6.5	4.5	4.5	4.5	4.5	4.5	4.6		2	7	3.30	3.04
Calcium	(Ca)	g/m^3	188	190	190	122	121	108	122	124	122	122	122	120		4	190	104.68	48.36
Sum of Anions*		meq/L	13.39	13.43	13.6	N/A	8.92	8.57	9.32	9.35	9.38	9.31	9.85	9.84		1	14	8.34	5.91
Sum of Cations*		meq/L	13.75	13.88	13.92	N/A	9.16	8.4	9.23	9.36	9.28	9.26	9.19	9.11		1	14	8.40	6.08
EC/10*	(EC/10)	(mS/m)/10	11.21	10.84	11.25	N/A	8.33	8.04	8.62	8.81	8.56	8.6	8.74	8.66		2	11	7.11	5.33
Conductivity of Water (mS/m)		mS/m	112	108	113	N/A	83	80	86	88	86	86	87	87		15	113	71.0	53.1

Reference		Units	ANZG WQG (2018) includes 2021 updates [1].				WRC WQ Criteria 2		NPS Freshwater (2020) [3]										
Sample Description							satisfactory	excellent	99% species protection		95% species protection		National Bottom Line						
Sample Date			95% ecosystem protection	90% ecosystem protection	80% ecosystem protection				annual median	Annual maximum	annual median	Annual maximum	annual median	Annual maximum		minimum	maximum	mean	geomean
Dissolved Inorganic elements																			
pH		pH					6.5-9	7 to 8								6	8	7.35	7.33
Electrical Conductivity	(EC)	µS/cm														152	1,130	710.67	533.19
Total Alkalinity (CaCO3)		$g\ CaCO_3/m^3$														4	133	81.55	62.48
Chloride	(Cl-)	g/m^3														17	28	21.10	20.71
Sulfate	(SO42-)	g/m^3														2	515	283.22	87.50
Nitrate-N	(NO3-N)	g/m^3	2.4 [2]	3.8 [2]	6.9 [2]				≤1	≤1.5	>0.1 to ≤2.4	>1.5 to ≤3.5	2.4	3.5		0	1	0.32	0.30
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3														0	0	nc	nc
Ammonia as N	(NH3N)	g/m^3	0.9	1.43	2.3	v.high			≤0.03	≤0.05	>0.03 to ≤0.24	>0.05 to ≤0.4	0.24	0.4		0	0	nc	nc
Sodium	(Na)	g/m^3														19	44	32.24	30.92
Potassium	(K)	g/m^3														2	7	3.30	3.04
Calcium	(Ca)	g/m^3														4	190	104.68	48.36
Sum of Anions*		meq/L														1	14	8.34	5.91
Sum of Cations*		meq/L														1	14	8.40	6.08
EC/10*	(EC/10)	(mS/m)/10														2	11	7.11	5.33
Conductivity of Water (mS/m)		mS/m														15	113	70.98	53.08

Notes:

1 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines
2 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton
3 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection or applicable guidelines
	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available

Attachment 1b. Water Quality (Metals and non-metals) Downstream Fill Area 2

Reference		Units	20-22586-1	21-50440	21-50442	21-50443	21-50444	21-52971	21-52981	21-52978	22-08754	22-08755	22-08756	22-08757	22-08758					ANZG WQG (2018) includes 2021 updates [1]			
Sample Description			FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2								
Sample Date			22/6/2020	24/11/2021	25/11/2021	26/11/2021	29/11/2021	01/12/2021	06/12/2021	13/12/2021	02/02/2022	04/02/2022	08/02/2022	11/02/2022	15/02/2022	minimum	maximum	mean	geomean	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Dissolved Inorganic elements																							
Aluminium	(Al)	g/m^3	0.685	0.243	0.241	0.207	0.236	0.177	0.197	0.188	0.0032	<0.0030	<0.0030	<0.0030	<0.0030	0.0032	0.685	0.17	0.10	0.055	0.08	0.15	low
Arsenic	(As)	g/m^3	<0.00050	0.0005	<0.00050	0.00051	0.00051	<0.00050	<0.00050	<0.00050	0.00075	0.00074	0.00088	0.0017	0.00081	0.0005	0.0046	0.0021	0.0016	0.024	0.094	0.36	moderate
Boron	(B)	g/m^3	0.026	0.015	0.016	0.016	0.016	0.026	0.025	0.025	0.093	0.098	0.097	0.095	0.095	0.015	0.16	0.09	0.07	0.94	1.5	2.5	v.high
Cadmium	(Cd)	g/m^3	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	0	NC	NC	0.0002	0.0004	0.0008	v.high
Chromium	(Cr)	g/m^3	0.0032	<0.00020	<0.00020	0.001	0.0037	<0.00020	0.0003	0.00024	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.0037	NC	NC		0.0033		unknown
Copper	(Cu)	g/m^3	0.00097	0.00074	0.00073	0.00073	0.0008	0.00077	0.00071	0.00077	0.00023	<0.00020	<0.00020	0.00041	<0.00020	0.0002	0.00097	NC	NC	0.0014	0.0018	0.0025	v.high
Lead	(Pb)	g/m^3	0.00032	0.000093	0.00016	0.000077	0.000099	0.00012	0.000077	0.00056	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.00056	NC	NC	0.0034	0.0056	0.0094	moderate
Nickel	(Ni)	g/m^3	0.00048	0.0012	0.0013	0.0013	0.0014	0.00088	0.00083	0.001	0.00037	0.00038	0.00037	0.00077	0.00033	<0.00020	0.0014	NC	NC	0.011	0.013	0.017	low
Thallium	(Tl)	g/m^3	0.000018	0.000039	0.000041	0.000035	0.000038	0.000054	0.000042	0.000029	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000054	NC	NC		0.00003		unknown
Magnesium	(Mg)	g/m^3	2.87	3.6	3.71	3.6	3.68	3.63	3.82	3.81	29.2	29.5	29.2	29.3	29.4	2.87	30.2	17.46	12.84				
Iron	(Fe)	g/m^3	0.674	0.778	0.705	0.723	0.818	0.43	0.44	0.44	<0.0050	0.0055	<0.0050	<0.0050	<0.0050	<0.0050	0.818	0.46	0.20				
Manganese	(Mn)	g/m^3	0.0575	0.286	0.283	0.268	0.259	0.166	0.173	0.162	0.0972	0.0987	0.105	0.0899	0.0972	0.048	0.286	0.12	0.09	1.9	2.5	3.6	moderate
Zinc	(Zn)	g/m^3	0.00482	0.0044	0.0089	0.0042	0.0044	0.0017	0.002	0.0023	<0.0010	<0.0010	<0.0010	0.0017	<0.0010	<0.0010	0.0089	0.0038	0.0033	0.008	0.015	0.031	v. High

Reference		Units	22-08759	22-08761	22-08762	22-14279	22-14278	22-14279	22-14280	22-14281	22-14282	22-14285	22-14287	22-14279						ANZG WQG (2018) includes 2021 updates [1]			
Sample Description			FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2									
Sample Date			18/02/2022	25/02/2022	28/02/2022	01/03/2022	04/03/2022	08/03/2022	10/03/2022	15/03/2022	18/03/2022	25/03/2022	01/04/2022	08/04/2022		minimum	maximum	mean	geomean	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Dissolved Inorganic elements																							
Aluminium	(Al)	g/m^3	<0.0030	<0.0030	<0.0030	0.121	0.118	0.0091	0.121	0.119	0.122	0.121	0.121	0.0081		0.0032	0.685	0.17	0.10	0.055	0.08	0.15	low
Arsenic	(As)	g/m^3	0.00076	0.00081	0.00082	0.0037	0.0037	0.0046	0.0036	0.0037	0.0036	0.0037	0.0037	0.0037		0.0005	0.0046	0.0021	0.0016	0.024	0.094	0.36	moderate
Boron	(B)	g/m^3	0.096	0.095	0.097	0.13	0.13	0.16	0.13	0.13	0.13	0.13	0.13	0.14		0.015	0.16	0.09	0.07	0.94	1.5	2.5	v.high
Cadmium	(Cd)	g/m^3	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		<0.000020	0	NC	NC	0.0002	0.0004	0.0008	v.high
Chromium	(Cr)	g/m^3	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	0.0037	NC	NC	0.0033			unknown
Copper	(Cu)	g/m^3	<0.00020	0.00021	0.0002	<0.00020	0.0002	0.00023	0.00022	<0.00020	<0.00020	<0.00020	<0.00020	0.00025		0.0002	0.00097	NC	NC	0.0014	0.0018	0.0025	v.high
Lead	(Pb)	g/m^3	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	0.00056	NC	NC	0.0034	0.0056	0.0094	moderate
Nickel	(Ni)	g/m^3	0.00042	0.00032	0.00035	0.00022	0.00024	<0.00020	<0.00020	0.00022	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	0.0014	NC	NC	0.011	0.013	0.017	low
Thallium	(Tl)	g/m^3	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000013	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000014		<0.000010	0.000054	NC	NC	0.00003			unknown
Magnesium	(Mg)	g/m^3	29.7	29.4	30.2	19.2	19.2	17.4	19.4	19.5	19.5	19.4	19.1	19.2		2.87	30.2	17.46	12.84				
Iron	(Fe)	g/m^3	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.02	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.013		<0.0050	0.818	0.46	0.20				
Manganese	(Mn)	g/m^3	0.102	0.103	0.104	0.048	0.049	0.048	0.048	0.049	0.048	0.049	0.048	0.05		0.048	0.286	0.12	0.09	1.9	2.5	3.6	moderate
Zinc	(Zn)	g/m^3	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	0.0089	0.0038	0.0033	0.008	0.015	0.031	v. High

Note:

1 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines

2 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton.

3 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

(yellow)	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection
(orange)	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
(red)	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available

Attachment 2a Water Quality (Cation/Annion) downstream of FA3 and FA4

Reference		Units	PQL	20-24364	21-39433	21-40427	21-43796	21-45328	21-46133	21-46738	21-46473	21-47091	21-47088	21-48782						ANZG WQG (2018) includes 2021 updates [2]			
Description				A000103	CW J000103	CW J000103	J000103	J000103	CW J000103	CW J000103	CW J000103	CW J000103	CW J000103	CW J000103									
Sample Description				DS2	DS2	DS2	DS2	DS2	DS2	DS2	DS2	DS2	DS2	DS2	minimum	maximum	mean	geomean	95% percentile	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Sample Date				7/1/2020	16/09/2021	24/09/2021	18/10/2021	28/10/2021	02/11/2021	04/11/2021	05/11/2021	09/11/2021	10/11/2021	22/11/2021									
pH		pH	1	6.7	6.7	6.4	6.6	6.7	6.6	6.6	6.6	6.6	6.6	6.8	6.4	6.8	6.63	6.63	6.75				
Electrical Conductivity	(EC)	µS/cm	0.2	450	373	271	293	296	312	306	308	319	311	290	271	450	321	318	411.5				
Total Alkalinity (CaCO3)		g $CaCO_3$/m	1	8	8.2	5.1	12.5	34.7	26.7	23.4	23.2	25.4	23.7	24.3	5.1	34.7	19.56	16.83	30.7				
Chloride	(Cl-)	g/m^3	0.5	16.6	22	21	22.2	24.6	24.3	26.1	26	25.5	25.6	25.5	16.6	26.1	23.58	23.40	26.05				
Sulfate	(SO42-)	g/m^3	0.15	159	128	61.7	72.2	54.7	71.7	65.5	65	83.6	83.6	72.5	54.7	159	83.41	79.18	143.5				
Nitrate-N	(NO3-N)	g/m^3	0.002	<0.001	0.531	3.62	0.151	<0.0020	0.0551	0.172	0.184	0.0697	0.069	0.056	<0.0020	3.62	0.55	0.17	2.38	2.4 [2]	3.8 [2]	6.9 [2]	
Dissolved Reactive Phosphorus	(DRP)	g/m^3	0.002	<0.002	0.004	<0.002	0.003	<0.002	0.003	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	NC	NC	NC				
Ammonia as N	(NH3N)	g/m^3	0.005	<0.005	0.009	0.02	<0.005	0.009	0.005	0.02	0.02	0.01	0.01	0.01	0.005	0.02	0.013	0.011	0.020	0.9	1.43	2.3	v.high
Potassium	(K)	g/m^3	0.05	5.78	4.7	4.5	3.9	3.9	3	2.7	2.6	2.9	2.8	2.9	2.6	5.78	3.61	3.49	5.24				
Calcium	(Ca)	g/m^3	0.05	27.1	27.1	15.2	16.3	16.1	17.7	17.1	16.8	20.7	20.8	20.2	15.2	27.1	19.55	19.18	27.1				
Sum of Anions*		meq/L	0.01	1.54	3.49	2.24	2.39	2.53	2.72	2.58	2.57	2.97	2.94	2.72	1.54	3.49	2.61	2.56	3.23				
Sum of Cations*		meq/L	0.01	1.59	3.45	2.28	2.47	2.61	2.74	2.69	2.64	3.02	3.04	3.03	1.59	3.45	2.69	2.64	3.245				
EC/10*	(EC/10)	(mS/m)/1(	0.002	1.89	3.73	2.71	2.93	2.96	3.12	3.06	3.08	3.19	3.11	2.9	1.89	3.73	2.97	2.94	3.46				
Conductivity of Water (mS/m)		mS/m	0.02	45	37	27	29	30	31	31	31	32	31	29	27	45	32.1	31.8	41				

Reference		Units	PQL	WRC WQ Criteria[3]		NPS Freshwater (2020)											ANZG WQG (2018) includes 2021 updates [2]			
Description				satisfactory	excellent	99% species protection		95% species protection		National Bottom Line										
Sample Description						annual median	Annual maximum	annual median	Annual maximum	annual median	Annual maximum	minimum	maximum	mean	geomean	95% percentile	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Sample Date																				
pH		pH	1	6.5-9	7 to 8							6.4	6.8	6.63	6.63	6.75				
Electrical Conductivity	(EC)	µS/cm	0.2									271	450	320.8	317.8	411.5				
Total Alkalinity (CaCO3)		g $CaCO_3$/m	1									5.1	34.7	19.56	16.83	30.7				
Chloride	(Cl-)	g/m^3	0.5									16.6	26.1	23.58	23.40	26.05				
Sulfate	(SO42-)	g/m^3	0.15									54.7	159	83.41	79.18	143.5				
Nitrate-N	(NO3-N)	g/m^3	0.002			≤1	≤1.5	>0.1 to ≤2.4	>1.5 to ≤3.5	2.4	3.5	<0.0020	3.62	0.55	0.17	2.38	2.4 [2]	3.8 [2]	6.9 [2]	
Dissolved Reactive Phosphorus	(DRP)	g/m^3	0.002									<0.002	0.004	NC	NC	NC				
Ammonia as N	(NH3N)	g/m^3	0.005			≤0.03	≤0.05	>0.03 to ≤0.24	>0.05 to ≤0.4	0.24	0.4	0.005	0.02	0.013	0.011	0.020	0.9	1.43	2.3	v.high
Potassium	(K)	g/m^3	0.05									2.6	5.78	3.61	3.49	5.24				
Calcium	(Ca)	g/m^3	0.05									15.2	27.1	19.55	19.18	27.1				
Sum of Anions*		meq/L	0.01									1.54	3.49	2.61	2.56	3.23				
Sum of Cations*		meq/L	0.01									1.59	3.45	2.69	2.64	3.245				
EC/10*	(EC/10)	(mS/m)/1(	0.002									1.89	3.73	2.97	2.94	3.46				
Conductivity of Water (mS/m)		mS/m	0.02									27	45	32.1	31.8	41				

Notes

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2 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines

3 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton.

4 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

(yellow)	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection
(orange)	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
(red)	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available

Attachment 2b Summary of DS2 WQ results - Metals

Reference		Units	PQL	20-24364	21-39433	21-40427	21-43796	21-45328	21-46133					ANZG WQG (2018) includes 2021 updates [2]			
Description				A000103	CW J000103	CW J000103	J000103	J000103	CW J000103								
Sample Description				DS2	DS2	DS2	DS2	DS2	DS2	minimum	maximum	mean	geomean	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Sample Date				7/1/2020	16/09/2021	24/09/2021	18/10/2021	28/10/2021	02/11/2021								
Aluminium*	(Al)	g/m^3	0.003	0.023	0.024	0.06	0.014	0.0097	0.0062	<0.0005	0.060	0.01593	0.01093189	0.055	0.08	0.15	low
Arsenic	(As)	g/m^3	0.0005	<0.0005	<0.00050	<0.00050	<0.00050	0.00052	<0.00050	0.00052	0.001	NC	NC	0.024	0.094	0.36	moderate
Boron	(B)	g/m^3	0.01	0.26	0.18	0.1	0.13	0.12	0.12	0.1	0.260	0.14	0.135098064	0.94	1.5	2.5	v.high
Cadmium	(Cd)	g/m^3	0.00002	<0.00002	0.000025	0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	NC	NC	0.0002	0.0004	0.0008	v.high
Chromium	(Cr)	g/m^3	0.0002	<0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	NC	NC	0.0033			unknown
Copper	(Cu)	g/m^3	0.0002	0.00037	0.00047	0.00089	0.00048	0.00027	<0.00020	0.00027	0.001	0.00042	0.00039	0.0014	0.0018	0.0025	v.high
Lead	(Pb)	g/m^3	0.00005	<0.00005	<0.000050	0.000059	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NC	NC	0.0034	0.0056	0.0094	moderate
Thallium	(Tl)	g/m^3	0.00001	<0.0001	0.006	0.00002	0.000013	<0.000010	<0.000010	<0.000010	0.006	NC	NC	0.00003			low
Nickel	(Ni)	g/m^3	0.0002	0.0035	<0.000010	0.007	0.0046	0.0072	0.0041	<0.000010	0.0072	0.0044	0.0042	0.011	0.013	0.017	unknown
Iron	(Fe)	g/m^3	0.005	0.17	0.031	0.11	0.15	0.32	0.2	0.031	0.320	0.2	0.2	NGV	NGV	NGV	
Zinc	(Zn)	g/m^3	0.001	0.017	0.026	0.038	0.011	0.0031	0.0036	0.0031	0.038	0.012	0.008	0.008	0.015	0.031	v. High

Reference		Units	PQL	21-46738	21-46473	21-47091	21-47088	21-48782						ANZG WQG (2018) includes 2021 updates [2]			
Description				CW J000103	CW J000103	CW J000103	CW J000103	CW J000103									
Sample Description				DS2	DS2	DS2	DS2	DS2		minimum	maximum	mean	geomean	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection	
Sample Date				04/11/2021	05/11/2021	09/11/2021	10/11/2021	22/11/2021									
Aluminium*	(Al)	g/m^3	0.003	<0.0030	0.0081	0.0046	0.0046	0.0051		<0.0005	0.06	0.016	0.011	0.055	0.08	0.15	low
Arsenic	(As)	g/m^3	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		0.00052	0.00052	NC	NC	0.024	0.094	0.36	moderate
Boron	(B)	g/m^3	0.01	0.11	0.12	0.13	0.13	0.14		0.1	0.26	0.14	0.14	0.94	1.5	2.5	v.high
Cadmium	(Cd)	g/m^3	0.00002	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		<0.000020	<0.000020	NC	NC	0.0002	0.0004	0.0008	v.high
Chromium	(Cr)	g/m^3	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020	NC	NC	0.0033			unknown
Copper	(Cu)	g/m^3	0.0002	0.00028	0.00034	0.00033	0.00032	0.00044		0.00027	0.00089	0.00042	0.00039	0.0014	0.0018	0.0025	v.high
Lead	(Pb)	g/m^3	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050	NC	NC	0.0034	0.0056	0.0094	moderate
Thallium	(Tl)	g/m^3	0.00001	<0.000010	0.000013	<0.000010	<0.000010	<0.000010		<0.000010	0.006	NC	NC	0.00003			low
Nickel	(Ni)	g/m^3	0.0002	0.0035	0.0035	0.0034	0.0034	0.0037		<0.000010	0.0072	0.0044	0.0042	0.011	0.013	0.017	low
Iron	(Fe)	g/m^3	0.005	0.11	0.19	0.29	0.29	0.31		0.031	0.32	0.20	0.17	NGV	NGV	NGV	
Zinc	(Zn)	g/m^3	0.001	0.005	0.0053	0.0056	0.006	0.009		0.0031	0.038	0.012	0.008	0.008	0.015	0.031	v. High

Notes

1 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines

2 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton.

3 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

4 NGV= No guideline Value

(yellow)	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection
(orange)	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
(red)	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available

Attachment 3a Lower Waikato Region of Data Set -Anion/Cations

Parameters				Rotowaro											
Reference				1302_1			39_11			612_9			665_5		
Sample Location Description				Whangape Stm			Awaroa Stm (Rotowaro)			Ohaeroa Stm			Oputia Stream		
Additional sample details				Rangiriri-Glen Murray Rd			Sansons Br @ Rotowaro-Huntly Rd			SH22 Br			Ponganui Road		
Sample Date(s)				20/1/2010 - 16/06/2020			19/01/2010 - 11/06/2020			20/01/2010 - 16/06/2020			20/01/2010 - 16/06/2020		
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
pH		pH	1	6.8	9.2	7.54	7.2	8.3	7.8	6.7	8	7.62	7.0	8.0	7.51
Electrical Conductivity	(EC)	mS/cm	0.2	12.5	34.7	21.19	27	178	74	12	22	46	11	47	18
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	30	59	40.88	61	420	180.1	25	62	117.33	25	48	40.83
Chloride	(Cl-)	g/m^3	0.5	15.3	32	22.85	11.8	20	16.38	17.1	26	17.59	17.6	24.0	20.92
Sulfate	(SO42-)	g/m^3	0.15	12.4	36	22.38	51	260	147.04	2.8	6	80.15	4.5	12.1	8.38
Nitrate-N	(NO3-N)	g/m^3	0.002	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	(NH3N)	g/m^3	0.005	0.01	2.6	0.12	0.01	0.4	0.05	0.01	0.053	0.042	0.010	0.045	0.017
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	0.004	0.031	0.01	0.004	0.054	0.01	0.004	0.028	0.009	0.004	0.038	0.007
Sodium	(Na)	g/m^3	0.01	11	26	16.90	27	210	75.96	12.1	20	49.07	12.4	17.8	15.04
Potassium	(K)	g/m^3	0.05	1.67	3.4	2.51	2.6	10	5.08	0.9	3	3.46	0.95	2.4	1.46
Calcium	(Ca)	g/m^3	0.05	13.5	24	17.72	21	78	47	7.6	13.7	29.80	9.3	16.9	13.49
Magnesium	(Mg)	g/m^3	0.01	2.5	4.7	3.39	5.6	24	13.56	2.9	6.2	9.34	2.2	3.8	3.16
Iron	(Fe)	g/m^3	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Sum of Anions*		meq/L	0.01	-	-	-	-	-	-	-	-	-	1.28	1.79	1.64
Sum of Cations*		meq/L	0.01	-	-	-	-	-	-	-	-	-	1.27	1.92	1.63
EC/10*	(EC/10)	(mS/m)/10	0.002	-	-	-	-	-	-	-	-	-	-	-	-

Parameters				Maramarua								
Reference				MAN/003			KAP004			MM3		
Sample Location Description				Maramarua Opencast K4 Project - Baseline Surface Monitoring - Solid Energy New Zealand Limited (PDP, 2010)			Maramarua Opencast K4 Project - Baseline Surface Monitoring - Solid Energy New Zealand Limited (PDP, 2010)			BT Mining Ltd Maramarua M1 Pit Hydrology and Water Qauality Assessment (Bathurst Resources Ltd, June 2022)		
Additional sample details				Maramarua River downstream of mine confluence			Kopuku Stream			Upstream of MAN/003 (PDP, 2010) and mine confluence		
Sample Date(s)				08/03/2010-19/11/2010			08/03/2010-13/01/2011			2008-2022		
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
pH		pH	1	6.6	7.5	7.15	5.9	7.5	6.94	-	-	-
Electrical Conductivity	(EC)	mS/cm	0.2	12	49	31	21	45	35	-	-	-
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	34	54	44	130	143	136.5	-	-	-
Chloride	(Cl-)	g/m^3	0.5	18	27	22.5	41	46	43.5	-	-	-
Sulfate	(SO42-)	g/m^3	0.15	2.7	164	83.35	21	32	26.5	-	-	-
Nitrate-N	(NO3-N)	g/m^3	0.002	0.0031	1.66	0.470	0.0021	0.31	0.099	-	-	-
Ammonia as N	(NH3N)	g/m^3	0.005	0.012	0.057	0.026	0.021	0.041	0.0324	-	-	-
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	0.0112	0.029	0.023	0.018	0.115	0.064	-	-	-
Sodium	(Na)	g/m^3	0.01	13	41	27	66	73	69.5	-	-	-
Potassium	(K)	g/m^3	0.05	1.7	4.1	2.9	2.8	2.9	2.85	1.9	2.4	2.2
Calcium	(Ca)	g/m^3	0.05	5.6	34	19.8	10.9	11	10.95	5.2	5.5	5.28
Magnesium	(Mg)	g/m^3	0.01	2.8	14.1	8.45	5	5.3	5.15	2.5	2.6	2.58
Iron	(Fe)	g/m^3	0.005	0.26	0.51	0.36	1.25	1.89	1.55	0.13	0.31	0.24
Sum of Anions*		meq/L	0.01	1.2	5.2	3.2	4.5	4.6	4.55	-	-	-
Sum of Cations*		meq/L	0.01	1.1	4.8	2.95	4	4.3	4.15	-	-	-
EC/10*	(EC/10)	(mS/m)/10	0.002	-	-	-	-	-	-	-	-	-

Parameters						ANZG WQG (2018) includes 2021 updates [2]			Water Quality Criteria	
							90%	80%	WRC WQ Criteria[3]	
		Units	PQL	minimum	maximum	95% ecosystem protection	ecosystem protection	ecosystem protection	satisfactory	excellent
pH		pH	1	3.50	9.30				6.5-9	7 to 8
Electrical Conductivity	(EC)	mS/cm	0.2	0.126	178					
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	12.1	420				NPS-FW Criteria[4]	
Chloride	(Cl-)	g/m^3	0.5	11.8	46.0				National Bottom Line	
Sulfate	(SO42-)	g/m^3	0.15	2.7	260				annual median	Annual maximum
Nitrate-N	(NO3-N)	g/m^3	0.002	0.0021	1.66	2.4 [2]	3.8 [2]	6.9 [2]	2.4	3.5
Ammonia as N	(NH3N)	g/m^3	0.005	0.01	2.60	0.9	1.43	2.3	0.24	0.4
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	0.004	0.115					
Sodium	(Na)	g/m^3	0.01	11	210					
Potassium	(K)	g/m^3	0.05	0.9	10.0					
Calcium	(Ca)	g/m^3	0.05	3.6	78.0					
Magnesium	(Mg)	g/m^3	0.01	2.2	24.0					
Iron	(Fe)	g/m^3	0.005	0.13	1.89					
Sum of Anions*		meq/L	0.01	1.14	5.20					
Sum of Cations*		meq/L	0.01	1.10	4.80					
EC/10*	(EC/10)	(mS/m)/10	0.002	1.26	1.97					

Waikato Region of Data Set															
Reference				2069_1			RA3			RA7			RT7		
Sample Location Description				Lake Puketirini (Lake Weavers)			Awaroa Stream			Awaroa Stream at Sanson's Bridge					
Additional sample details				Centre (Surface)			Waipuna West Extension (Pushback) Hydrology and Water Quality Assessment (Liquid Earth, 2021 for Bathurst Resources Limited December 2021)								
Sample Date(s)				1/10/2009 - 10/06/2019			04/01/2017 - 30/03/2022			04/01/2017 - 30/03/2022			24/10/2018 - 30/03/2022		
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
pH		pH	1	7	9.3	7.87	7.1	8.1	7.78	7.2	8.4	7.88	6.9	8.3	7.78
Electrical Conductivity	(EC)	mS/cm	0.2	28.7	33.4	31.75	-	-	-	-	-	-	-	-	-
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	(Cl-)	g/m^3	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	(SO42-)	g/m^3	0.15	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate-N	(NO3-N)	g/m^3	0.002	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia as N	(NH3N)	g/m^3	0.005	0.01	0.082	0.02	-	-	-	-	-	-	-	-	-
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	<0.004	0.008	<0.004	-	-	-	-	-	-	-	-	-
Sodium	(Na)	g/m^3	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	(K)	g/m^3	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	(Ca)	g/m^3	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	(Mg)	g/m^3	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Iron	(Fe)	g/m^3	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Sum of Anions*		meq/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Sum of Cations*		meq/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-
EC/10*	(EC/10)	(mS/m)/10	0.002	-	-	-	-	-	-	-	-	-	-	-	-

Waikato Region of Data Set										Mercer-unnamed stream				
Reference				RT7A			RW3A			20-07389	20-28096-1	20-28096-2	20-28096-3	20-28096-4
Sample Location Description				Te Wha Stream (up from Mine discharge)			Waitewhara Stream (upstream for Awaroa stm confluence)			A381	D/S	G4	G2	U/S P
Additional sample details				Waipuna West Extension (Pushback) Hydrology and Water Quality Assessment (Liquid Earth, 2021 for Bathurst Resources Limited December 2021)						Mercer-unnamed stream				
Sample Date(s)				04/01/2017 - 30/03/2022			04/01/2017 - 30/03/2022							
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	2/20/2020	7/31/2020	7/31/2020	7/31/2020	7/31/2020
pH		pH	1	3.5	8.2	7.37	6.5	8.1	7.78	-	6.5	6.3	6.4	6.5
Electrical Conductivity	(EC)	mS/cm	0.2	-	-	-	-	-	-	-	0.197	0.131	0.129	0.126
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	-	-	-	-	-	-	-	20.9	15.4	15.9	12.1
Chloride	(Cl-)	g/m^3	0.5	-	-	-	-	-	-	-	27.1	25.4	24.6	24.8
Sulfate	(SO42-)	g/m^3	0.15	-	-	-	-	-	-	-	32.3	10.4	9.24	9.47
Nitrate-N	(NO3-N)	g/m^3	0.002	-	-	-	-	-	-	-	0.011	0.089	0.075	0.085
Ammonia as N	(NH3N)	g/m^3	0.005	-	-	-	-	-	-	-	0.04	0.01	0.02	0.03
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	-	-	-	-	-	-	-	0.008	0.008	0.008	0.005
Sodium	(Na)	g/m^3	0.01	-	-	-	-	-	-	-	17.5	16.6	17.2	16.6
Potassium	(K)	g/m^3	0.05	-	-	-	-	-	-	-	4	2.3	2.3	2.1
Calcium	(Ca)	g/m^3	0.05	-	-	-	-	-	-	-	13.2	3.9	3.9	3.6
Magnesium	(Mg)	g/m^3	0.01	-	-	-	-	-	-	-	4.48	2.88	2.68	2.74
Iron	(Fe)	g/m^3	0.005	-	-	-	-	-	-	0.609	0.881	0.38	0.36	0.38
Sum of Anions*		meq/L	0.01	-	-	-	-	-	-	-	1.86	1.25	1.21	1.14
Sum of Cations*		meq/L	0.01	-	-	-	-	-	-	-	1.93	1.23	1.23	1.2
EC/10*	(EC/10)	(mS/m)/10	0.002	-	-	-	-	-	-	-	1.97	1.31	1.29	1.26

Waikato Region of Data Set						ANZG WQG (2018) includes 2021 updates [2]			Water Quality Criteria	
							90%	80%	WRC WQ Criteria[3]	
		Units	PQL	minimum	maximum	95% ecosystem protection	ecosystem protection	ecosystem protection	satisfactory	excellent
pH		pH	1	3.50	9.30				6.5-9	7 to 8
Electrical Conductivity	(EC)	mS/cm	0.2	0.126	178					
Total Alkalinity (CaCO3)		g $CaCO_3/m^3$	1	12.1	420				NPS-FW Criteria[4]	
Chloride	(Cl-)	g/m^3	0.5	11.8	46.0				National Bottom Line	
Sulfate	(SO42-)	g/m^3	0.15	2.7	260				annual median	Annual maximum
Nitrate-N	(NO3-N)	g/m^3	0.002	0.0021	1.66	2.4 [2]	3.8 [2]	6.9 [2]	2.4	3.5
Ammonia as N	(NH3N)	g/m^3	0.005	0.01	2.60	0.9	1.43	2.3	0.24	0.4
Dissolved Reactive Phosphorus (FIA)	(DRP)	g/m^3	0.002	0.004	0.115					
Sodium	(Na)	g/m^3	0.01	11	210					
Potassium	(K)	g/m^3	0.05	0.9	10.0					
Calcium	(Ca)	g/m^3	0.05	3.6	78.0					
Magnesium	(Mg)	g/m^3	0.01	2.2	24.0					
Iron	(Fe)	g/m^3	0.005	0.13	1.89					
Sum of Anions*		meq/L	0.01	1.14	5.20					
Sum of Cations*		meq/L	0.01	1.10	4.80					
EC/10*	(EC/10)	(mS/m)/10	0.002	1.26	1.97					

1 All results are g/m^3 unless specified
2 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines
3 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton.
4 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

(yellow)	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection
(orange)	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
(red)	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available

Attachment 3B Concentration of Dissolved Metals in selected streams of the Lower Waikato Catchment.

Waikato Region of Data Set				Rotowaro											
Reference				1302_1			39_11			612_9			665_5		
Sample Location Description				Whangape Stm			Awaroa Stm (Rotowaro)			Ohaeroa Stm			Oputia Stream		
Additional sample details				Rangiriri-Glen Murray Rd			Sansons Br @ Rotowaro-Huntly Rd			SH22 Br			Ponganui Road		
Sample Date(s)				20/1/2010 - 16/06/2020			19/01/2010 - 11/06/2020			20/01/2010 - 16/06/2020			20/01/2010 - 16/06/2020		
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Aluminium	(Al)	g/m^3	0.003	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	(As)	g/m^3	0.0005	0.0017	0.0028	0.002	0.0011	0.0012	0.00115	< 0.0011	< 0.0011	< 0.0011	0.0012	0.0012	0.0012
Boron	(B)	g/m^3	0.01	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	(Cd)	g/m^3	0.00002	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	(Cr)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
Copper	(Cu)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
Iron	(Fe)	g/m^3	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Lead	(Pb)	g/m^3	0.00005	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	(Mn)	g/m^3	0.0005	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	(Ni)	g/m^3	0.00001	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	(Zn)	g/m^3	0.001	0.0099	0.0099	0.0099	0.0011	0.0052	0.002	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001
Thallium	(Tl)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-

Waikato Region of Data Set	Maramarua																
Reference	MAN/003			KAP004			MM3			MM4							
Sample Location Description	Maramarua Opencast K4 Project - Baseline Surface Monitoring - Solid Energy New Zealand Limited (PDP, 2010)			Maramarua Opencast K4 Project - Baseline Surface Monitoring - Solid Energy New Zealand Limited (PDP, 2010)			BT Mining Ltd Maramarua M1 Pit Hydrology and Water Qaulity Assessment (Bathurst Resources Ltd, June 2022)			BT Mining Ltd Maramarua M1 Pit Hydrology and Water Qaulity Assessment (Bathurst Resources Ltd, June 2022)					ANZG WQG (2018) includes 2021 updates [2]		
Additional sample details	Maramarua River downstream of mine confluence			Kopuku Stream			Upstream of MAN/003 (PDP, 2010) and mine confluence			Maramarua River (same location as MAN/003 (PDP, 2010)							
Sample Date(s)	08/03/2010-19/11/2010			08/03/2010-13/01/2011			2008-2022			2008-2022							
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	minimum	maximum	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection
Aluminium	0.0141	0.23	0.08385	0.038	0.183	0.103	<0.0059	0.93	0.1	<0.0059	1.2	0.1	0.0059	7.1	0.055	0.08	0.15
Arsenic	< 0.0010	< 0.0010	< 0.0010	0.0014	0.0015	0.0014	0.0024	0.0024	0.0024	-	-	-	0.00115	0.0028	0.024	0.094	0.36
Boron	0.016	1.05	0.5075	0.171	1.3	0.66	<0.0054	11	0.14	0.03	4.3	0.69	0.016	11	0.94	1.5	2.5
Cadmium	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.0001	0.0001	0.0001	-	-	-	0.000023	0.0001	0.0002	0.0004	0.0008
Chromium	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0005	-	-	-	0.00023	0.00048	0.0033		
Copper	0.00052	0.00072	0.00062	0.00051	0.00076	0.00060	0.0008	0.049	0.0104	-	-	-	0.00036	0.049	0.0014	0.0018	0.0025
Iron	0.26	0.51	0.36	1.25	1.89	1.55	0.13	0.31	0.24	-	-	-	0.13	1.89			
Lead	0.000102	0.00017	0.000136	0.00038	0.00044	0.00041	<0.005	<0.005	<0.005	-	-	-	0.000102	0.00044	0.0034	0.0056	0.0094
Manganese	0.043	0.13	0.083	0.62	1	0.78	0.033	0.13	0.073	-	-	-	0.028	1.0	1.9	2.5	3.6
Nickel	0.00062	0.0008	0.00071	0.00076	0.00086	0.0008	0.0023	0.0023	0.0023	-	-	-	0.00049	0.0026	0.011	0.013	0.017
Zinc	0.00142	0.0053	0.0029	0.0024	0.051	0.01	0.015	0.18	0.0460	-	-	-	0.0011	0.18	0.008	0.015	0.031
Thallium	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	-	-	-	<0.00001	<0.0005	0.00003		

Waikato Region of Data Set				Rotowaro											
Reference				RA3			RA7			RT7			RT7A		
Sample Location Description				Awaroa Stream			Awaroa Stream at Sanson's Bridge						Te Wha Stream (up from Mine discharge)		
Additional sample details				Waipuna West Extension (Pushback) Hydrology and Water Quality Assessment (Liquid Earth, 2021 for Bathurst Resources Limited December 2021)											
Sample Date(s)				04/01/2017 - 30/03/2022			04/01/2017 - 30/03/2022			24/10/2018 - 30/03/2022			04/01/2017 - 30/03/2022		
		Units	PQL	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Aluminium	(Al)	g/m^3	0.003	0.0059	0.25	0.025	0.0059	0.24	0.031	0.0059	0.23	0.016	0.0059	7.1	0.079
Arsenic	(As)	g/m^3	0.0005	-	-	-	-	-	-	-	-	-	-	-	-
Boron	(B)	g/m^3	0.01	0.026	1.3	0.12	0.026	1.3	0.12	0.026	1.3	0.12	0.026	1.3	0.12
Cadmium	(Cd)	g/m^3	0.00002	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	(Cr)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
Copper	(Cu)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-
Iron	(Fe)	g/m^3	0.005	-	-	-	-	-	-	-	-	-	-	-	-
Lead	(Pb)	g/m^3	0.00005	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	(Mn)	g/m^3	0.0005	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	(Ni)	g/m^3	0.00001	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	(Zn)	g/m^3	0.001	0.008	0.084	0.016	0.008	0.079	0.0195	0.008	0.078	0.033	0.008	0.16	0.0222
Thallium	(Tl)	g/m^3	0.0002	-	-	-	-	-	-	-	-	-	-	-	-

Waikato Region of Data Set				Mercer-unnamed tributasry of the Waikato River.									
Reference	RW3A			20-07389	20-28096-1	20-28096-2	20-28096-3	20-28096-4					
Sample Location Description	Waitewhara Stream (upstream for Awaroa			A381	D/S	G4	G2	U/S P			ANZG WQG (2018) includes 2021 updates [2]		
Additional sample details				Mercer-unnamed stream									
Sample Date(s)	04/01/2017 - 30/03/2022												
	Minimum	Maximum	Average	2/20/2020	7/31/2020	7/31/2020	7/31/2020	7/31/2020	minimum	maximum	95% ecosystem protection	90% ecosystem protection	80% ecosystem protection
Aluminium	0.0059	1.2	0.039	<0.0005	-	-	-	-	0.0059	7.1	0.055	0.08	0.15
Arsenic	-	-	-	<0.0005	0.0018	<0.0005	<0.0005	<0.0005	0.00115	0.0028	0.024	0.094	0.36
Boron	0.026	1.3	0.12	0.019	0.024	0.022	0.022	0.022	0.016	11	0.94	1.5	2.5
Cadmium	-	-	-	<0.00002	0.000028	0.000023	<0.00002	<0.00002	0.000023	0.0001	0.0002	0.0004	0.0008
Chromium	-	-	-	<0.0002	0.00048	0.00027	0.00023	0.00028	0.00023	0.00048	0.0033		
Copper	-	-	-	<0.0002	0.0022	0.00078	0.00063	0.00036	0.00036	0.049	0.0014	0.0018	0.0025
Iron	-	-	-	0.609	0.881	0.38	0.36	0.38	0.13	1.89			
Lead	-	-	-	<0.00005	0.00017	<0.00005	<0.00005	<0.00005	0.000102	0.00044	0.0034	0.0056	0.0094
Manganese	-	-	-	-	0.0593	0.028	0.035	0.0514	0.028	1.0	1.9	2.5	3.6
Nickel	-	-	-	<0.001	0.0026	0.0011	0.00075	0.00049	0.00049	0.0026	0.011	0.013	0.017
Zinc	0.008	0.079	0.025	-	0.009	0.0052	0.0022	0.0017	0.0011	0.18	0.008	0.015	0.031
Thallium	-	-	-	<0.00001	-	-	-	-	<0.00001	<0.0005	0.00003		

Notes

1

2 ANZG 2018 water quality guidelines: https://www.waterquality.gov.au/anz-guidelines

3 WRC water quality Criteria from Tulagi, A. 2017. Waikato River Water Quality Monitoring Programme: Data Report 2016. Waikato Regional Council Technical Report 2017/14. Waikato Regional Council, Hamilton.

4 National Policy Statement (NPS) for Freshwater Management 2020: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

	exceeds ANZG (2018) freshwater default trigger values for 95% ecosystem protection
	exceeds ANZG (2018) freshwater default trigger values for 90% ecosystem protection
	exceeds ANZG (2018) freshwater default trigger values for 80% ecosystem protection
-	Analyte not tested / no guideline available