HAWKE'S BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

MEMO

To:	Richard Wakelin – Group Manager, Integrated Catchment Management Dr Haley Ataera – Manager, Science
From:	Ariana Mackay – Scientist, Freshwater Quality and Ecology
Date:	30th January 2026
Subject:	**WAIATAI STREAM WATER SAMPLE RESULTS**
CC:	Dr Fi McDuie – Team Leader, Fresh Water and Marine Science Pete Gimblett – Team Leader, Pollution Response and Enforcement Nathan Heath – Māori Relationship Manager Northern HB

Contents

1 Executive Summary

On the afternoon of Monday, 12 January, the Hawke's Bay Regional Council Pollution Response and Enforcement team were notified of an incident involving the mortality of numerous eels in a reach of the Waiatai Stream, north of Wairoa. Subsequent water quality testing found no evidence of petroleum contamination, with hydrocarbons (C7–C36) not detected, and oil and grease concentrations below detection limits.

A water sample collected from the Ikanui Stream, a tributary draining a wetland area into the Waiatai Stream, showed low pH (slightly acidic), elevated suspended solids, elevated concentrations of aluminium and iron, and elevated organic carbon indicators (cBOD, COD, DOC, and TOC). These characteristics were not observed in samples collected from the Waiatai Stream upstream or downstream of the tributary. A spot dissolved oxygen measurement taken from the Waiatai Stream immediately downstream of the tributary on Wednesday, 14 January, recorded extremely low oxygen concentrations (0.17 mg/L).

Environmental conditions preceding the event are also relevant. A significant rainfall event occurred on 3 January, with 117.4 mm recorded at the nearest rainfall site (MetService Wairoa Aero AWS). In addition, air temperatures exceeded 30°C in the three days before the incident, with a maximum of 35°C recorded at the Wairoa Aero weather station on 11 January. Taken together, the water quality results and environmental conditions suggest the eel mortalities were likely caused by a hypoxic event, commonly referred to as a hypoxic blackwater event.

The purpose of this memo is to summarise the Freshwater Science team's involvement in the investigation of the Waiatai Stream eel deaths, present the results of the water quality sampling, and outline the potential causes of the event.

2 Introduction

2.1 Background

On Tuesday, 13th January 2026, the Hawke's Bay Regional Council (HBRC) Environmental Science section was made aware of an incident involving eel deaths in the Waiatai Stream by the HBRC Pollution Response and Enforcement team.

The initial reports provided photos and on-the-ground staff reports from the impacted stream, which highlighted that this was a mass mortality event of shortfin eels (*Anguilla australis*), with dead eels observed along the length of the Waiatai Stream downstream of the Ikanui, and continuing to be moved downstream to other waterways. There was a noticeable rainbow sheen to the surface of the water that was easily broken up when touched and clung to the organic material, such as plants or eel carcases, in the water. The water at the time of inspection was a dark brown. While HBRC staff did not report an odour during their site visit, local reports of a "bad smell" are notable. Such odours are often associated with the mobilisation and anaerobic breakdown of stagnant organic material, which releases various organic gases as it enters the water column.

The Freshwater Science team provided advice on the water sampling suite, which consisted of a broad range of analytes, including pH, metals (Al, Ca, Cu, Fe, Mg, Mn, S, Zn), total petrol hydrocarbons (C7-C9, C10-C14, C15-C36), oil and grease, suspended solids, nitrogen indicators (ammonia, nitrate, nitrite, total Kjeldahl nitrogen), and organic carbon indicators such as carbonaceous biological oxygen demand (cBOD), chemical oxygen demand (COD), dissolved organic carbon (DOC) and total organic carbon (TOC).

2.2 The Waiatai Stream

The Waiatai Stream is characterised as a warm, wet, low-elevation, soft-sedimentary stream that drains a catchment predominantly comprised of high producing exotic grassland and exotic forest (LCDB v6.0 - Land Cover Database version 6.0). The Waiatai Stream drains to the Waihoratuna Lagoon, the Ohuia & Waihoratuna Lagoons share an outlet to the sea and are locally known as Ohuia Lake. Waihoratuna Lagoon is approximately 10 ha in size, increasing up to 30 ha or more after heavy rain (HBRC, 2018).

2.3 Shortfin Eel Autopsy

A deceased eel was collected from the Waiatai Stream upon the initial visit by the Pollution Response and Enforcement team on Tuesday, 13th. The eel was refrigerated and sent to Wildbase Pathology in Palmerston North for autopsy on the 15th of January. Unfortunately, this eel was too decomposed to glean any useful information, such as microscopic examination of the internal organs for a determination of the cause of death. This is not an uncommon result from an eel autopsy, as they are known to decompose quickly, with decomposition being accelerated by the warm weather.

2.4 Sample Locations

The initial response was led by the Pollution Response and Enforcement team, who took water samples from three sites (Figure 1):

- **Sample 94844** – Ikanui - Tributary to the Waiatai Stream (-39.014949, 177.487779)
- **Sample 94845** – Waiatai Stream upstream of the Ikanui tributary (-39.012281, 177.48898)
- **Sample 94846** – Waiatai Stream downstream of the Ikanui tributary (-39.015283, 177.477779)

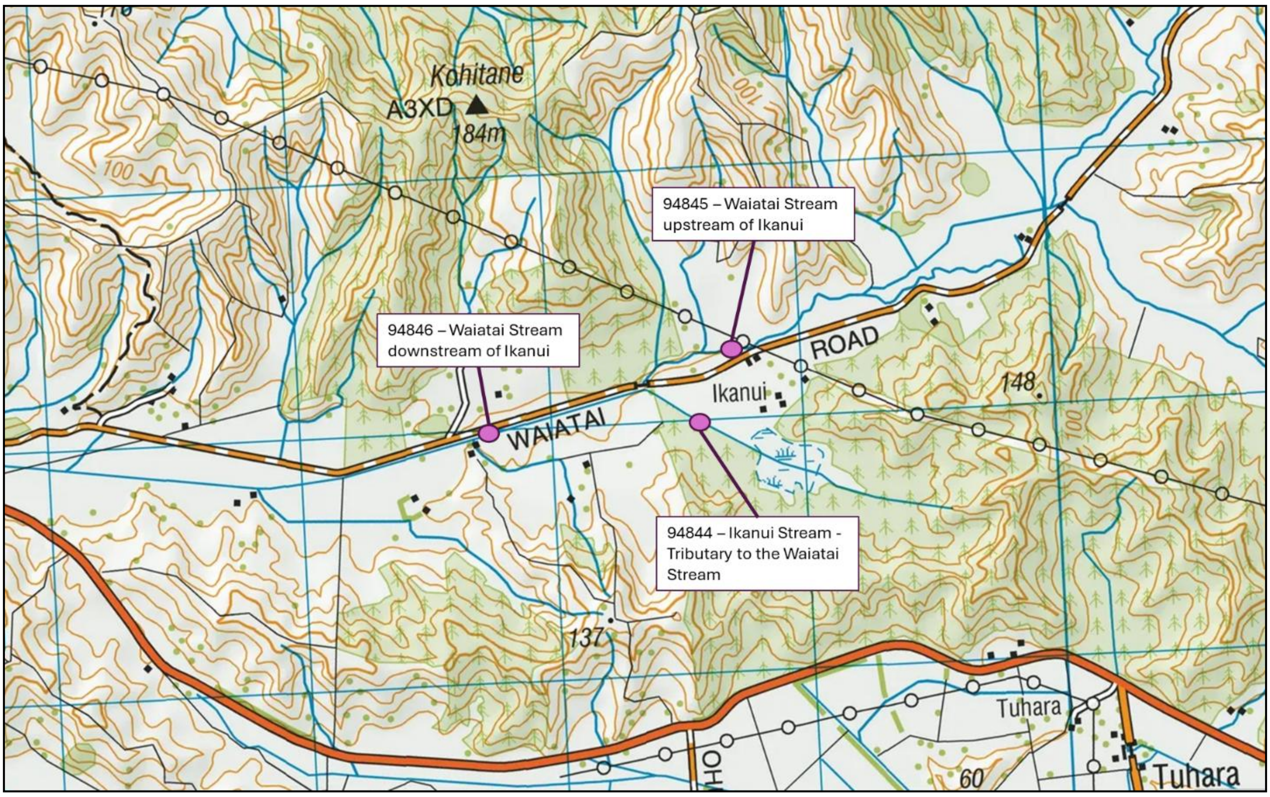

Figure 1: Water quality sampling locations along the Waiatai Stream and the Ikanui tributary, showing upstream (94845), tributary (94844), and downstream (94846) monitoring points.

3 Results

Petroleum hydrocarbon

The water sample results at the three sites showed no indication of hydrocarbons (C7-C36), and oil & grease were below detection limits, **indicating this was not a petroleum contamination event** (Table 1).

Table 1 Concentrations of petroleum hydrocarbons (TPH) and oil & grease in Waiatai Stream and its tributary, the Ikanui Stream.

Measurement	Unit	94845 – Waiatai Stream upstream of Ikanui	94844 – Ikanui - Tributary to the Waiatai Stream	94846 – Waiatai Stream downstream of Ikanui
C7-C9	g/m^3	<0.2	<0.2	<0.2
C10-C14	g/m^3	<0.2	<0.2	<0.2
C15-C36	g/m^3	<0.3	<0.3	<0.3
Oil and Grease	g/m^3	<5	<5	<5

pH

The results showed pH was slightly acidic (pH 6.2) at the site on the Ikanui Stream, tributary to the Waiatai Stream, which is below the 20th percentile (pH 7.26) of the default guideline value (DGVs) for physical and chemical (PC) stressors for warm, wet, low-elevation sites. pH values at the other two sites were within the normal range.

Water Temperature and Dissolved Oxygen
A single spot measurement was taken from the Waiatai Stream downstream of the Ikanui at midday on 14 January using a YSI ProSolo handheld field meter. Dissolved oxygen (DO) was extremely low, measuring 0.17 mg/L (1.9 % saturation), indicating hypoxic conditions approaching anoxia. For context, the minimum dissolved oxygen required for healthy freshwater ecosystem functioning is generally above 80% saturation. Warmer water holds less oxygen, while aquatic animals require more as temperatures rise, making them particularly vulnerable during the warmer summer months. DO levels below 5.0 mg/L threaten sensitive species, and long-term exposure to 6 mg/L can still impair growth. Water temperature at the time of measurement was 21.7 °C, consistent with summer conditions; however, daily fluctuations occur, and the typical range for this stream is not well characterised.

Organic Carbon
Chemical oxygen demand (COD) is the measure of oxygen being consumed during the oxidation of oxidizable organic matter in the presence of a strong oxidising agent. It is generally used to indirectly determine the amount of organic compounds in aquatic systems. High COD indicates the presence of all forms of organic matter, both biodegradable and nonbiodegradable and hence the degree of pollution in waters. This makes COD useful as an indicator of organic pollution in surface waters. Biochemical oxygen demand (BOD) is the amount of dissolved oxygen consumed in a waterbody by biological processes breaking down organic matter. BOD is used as a measure of the amount of organic pollution in water.

Sample 94844 from the Ikanui Stream, the tributary to the Waiatai, showed very high carbonaceous biochemical oxygen demand (cBOD 132 mg/L), chemical oxygen demand (COD 526 mg/L), dissolved organic carbon (DOC 83.6 mg/L), and total organic carbon (TOC 106 mg/L) (Table 2). The cBOD is elevated compared with typical New Zealand rivers (<5 mg/L in clean systems; MfE 2007; Larned et al. 2019), indicating a strong, localised input of readily biodegradable organic matter. COD is similarly high; ambient rivers generally range ~10–50 mg/L (Davies-Colley 2006), showing that the tributary contains a very high total oxidisable organic load. DOC is elevated relative to typical NZ river values (1–20 mg/L; Moore & Clarkson 2007; Larned et al. 2019), while TOC mirrors DOC but also reflects particulate organic matter.

Table 2 Water quality measurements of organic matter in Waiatai Stream and its tributary, the Ikanui Stream. Bolded values indicate elevated results.

Measurement	Unit	94845 – Waiatai Stream upstream of Ikanui	94844 – Ikanui - Tributary to the Waiatai Stream	94846 – Waiatai Stream downstream of Ikanui
Carbonaceous BOD (cBOD)	g/m^3	<1	**132**	<1
Chemical Oxygen Demand (COD)	g/m^3	33	**526**	31
Dissolved Organic Carbon (DOC)	g/m^3	8.3	**83.6**	8.5
Total Organic Carbon (TOC)	g/m^3	9.5	**106**	8.9

The Ikanui tributary drains a wetland, which is likely the primary source of this organic matter through leaching of vegetation, peat, and soil-derived carbon. However, contributions from accumulated leaf litter, recent flooding, or other catchment inputs cannot be ruled out. Results in the Ikanui are significantly higher than what you would expect from a healthy, natural wetland system. Downstream of the Waiatai Stream, DOC, TOC, cBOD, and COD are within normal ranges, indicating rapid dilution of this organic pulse (Figure 2). Overall, the data are consistent with a natural, wetland-driven hypoxic blackwater event, with very high oxygen demand and both dissolved and particulate organic matter present.

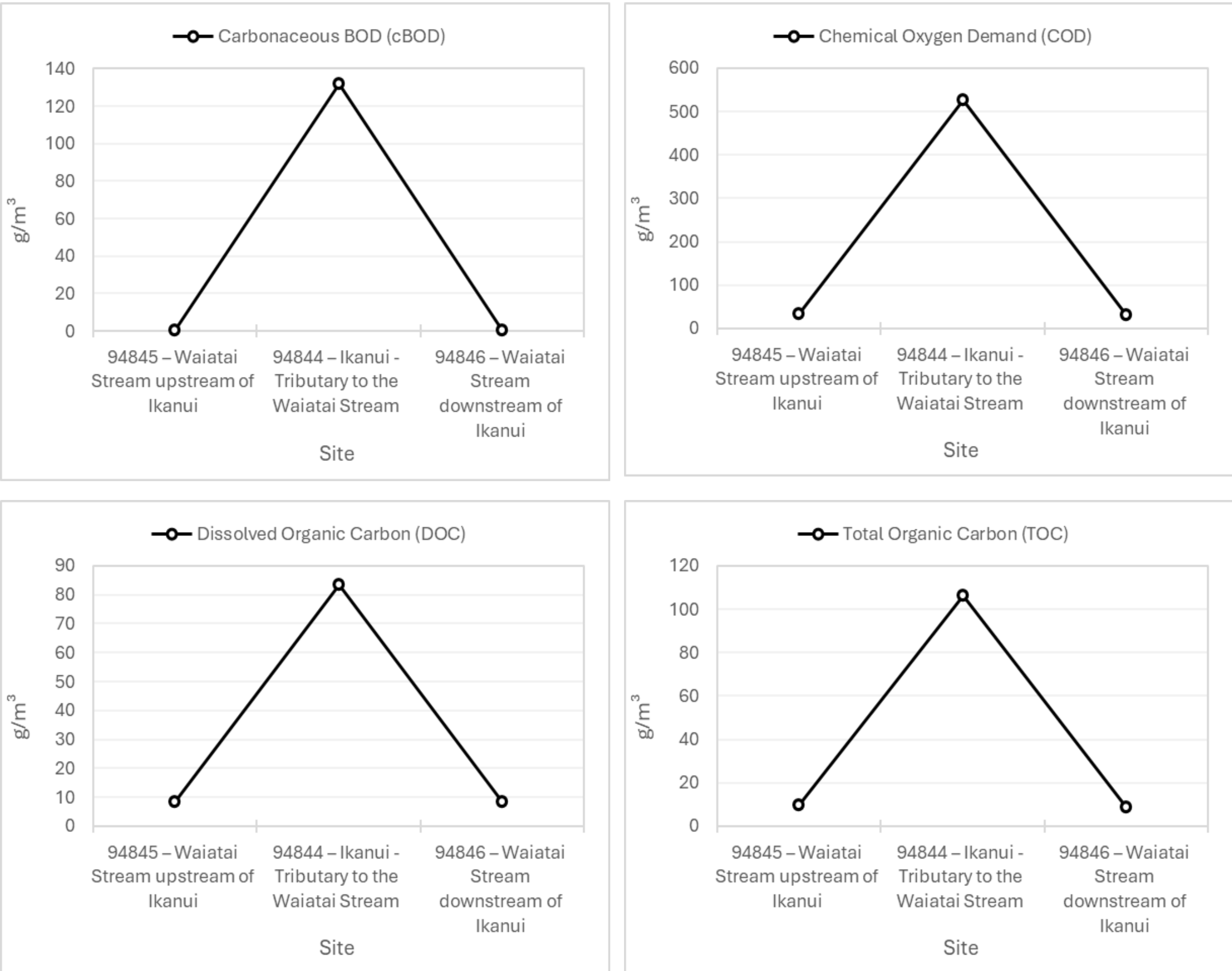

Figure 2 Comparison of organic loading indicators. Chemical Oxygen Demand (COD), Dissolved Organic Carbon (DOC), Carbonaceous Biochemical Oxygen Demand (cBOD), and Total Organic Carbon (TOC), across three monitoring sites in the Ikanui and Waiatai stream systems. Measurements are recorded in g/m^3.

Nitrogen

Ammoniacal nitrogen (NH_4-N) concentrations were low at the Ikanui tributary (0.005 g/m³) and at the Waiatai Stream upstream of the Ikanui confluence (0.0025 g/m³). When considered alongside measured pH (6.2 and 7.6, respectively), these concentrations are consistent with conditions typically observed in streams with minimal ammoniacal nitrogen inputs.

In contrast, NH_4-N concentrations were elevated at the Waiatai Stream downstream of the Ikanui confluence (0.297 g/m³). At a pH of 7.5, this concentration represents a level that may pose a risk to sensitive aquatic organisms. The sharp increase in NH_4-N between the upstream and downstream sites suggests a localised ammoniacal nitrogen input occurring between these locations. Nitrate-N and total oxidised nitrogen (NO_2-N + NO_3-N) concentrations were low across all sites (≤0.013 g/m³) and did not increase downstream. Overall, water quality at the tributary and upstream sites was consistent with usual background conditions, while the downstream site showed evidence of localised ammoniacal nitrogen enrichment.

A Total Kjeldahl Nitrogen (TKN) concentration of 8.6 mg/L substantially exceeds the expected range for a reference-condition wetland and indicates nitrogen enrichment. Elevated TKN can result from inputs such as wastewater, agricultural runoff, or decaying vegetation. High TKN concentrations can contribute to nutrient-driven issues in wetlands, including eutrophication, algal blooms, and reduced dissolved oxygen.

Table 3 Summary of nutrient concentrations and physico-chemical properties in Waiatai Stream and its tributary, the Ikanui Stream. Bolded values indicate elevated results.

Measurement	Unit	94845 – Waiatai Stream upstream of Ikanui	94844 – Ikanui - Tributary to the Waiatai Stream	94846 – Waiatai Stream downstream of Ikanui
Ammoniacal Nitrogen	g/m³	0.0025	0.005	**0.297**
Nitrate	g/m³	0.005	0.001	0.009
Total Oxidised Nitrogen (NO2N+NO3N)	g/m³	0.006	0.013	0.011
Total Kjeldahl Nitrogen	g/m³	**8.6**	0.6	0.9
pH		7.6	6.2	7.5

Metals

Total aluminium concentrations were highest in the Ikanui tributary (0.917 g/m³), where pH was below 6.5 (Table 4). Under mildly acidic conditions, aluminium is more soluble and more readily mobilised and potentially bioavailable. At pH <6.5, aluminium becomes much more toxic, especially to fish gills and invertebrates. At this pH range, the measured concentration exceeds the ANZG default guideline value (DGV) for aluminium for the protection of freshwater aquatic ecosystems, indicating a potential ecological risk within the tributary under these conditions.

In the Waiatai Stream upstream and downstream of the Ikanui confluence, total aluminium concentrations were substantially lower (0.154 g/m³ and 0.098 g/m³, respectively) and were measured under near-neutral pH conditions. These concentrations are consistent with levels commonly observed in streams without elevated aluminium inputs and are unlikely to have ecological impacts. Total iron and manganese showed a similar spatial pattern, with markedly higher concentrations in the Ikanui tributary (45.5 g/m³ iron; 1.74 g/m³ manganese) compared with the upstream and downstream Waiatai Stream sites. Manganese does not have an ANZG default guideline value for freshwater ecosystem protection. Elevated manganese concentrations are therefore interpreted as indicative of reducing conditions and metal mobilisation rather than as a direct measure of ecological toxicity. The co-occurrence of elevated iron, aluminium, and manganese is consistent with metal mobilisation from anoxic wetland environments.

Total iron concentrations at all sites exceed the ANZG ecosystem default guideline value for freshwater, with the Ikanui tributary (45.5 mg/L) being very elevated, and upstream and downstream Waiatai sites (1–1.68 mg/L) also several times above the guideline. Elevated iron concentrations in freshwater can degrade habitat quality through flocculation and deposition of iron precipitates, which can inhibit aquatic respiration and exacerbate ecological stress during low-oxygen conditions, such as those observed in the Waiatai Stream (0.17 mg/L dissolved oxygen). These effects are consistent with wetland-fed stream behaviour during periods of organic matter mobilisation and oxygen depletion.

Other metals, including copper and zinc, were present at concentrations below relevant ANZG DGVs and showed little variation between sites. Major ions (calcium, magnesium, and sulfur) were consistent across all sites. Overall, results indicate that elevated aluminium, iron and manganese were confined to the Ikanui tributary under low pH conditions, with no evidence of elevated metals persisting in the Waiatai Stream upstream or downstream of the confluence.

Table 4 Concentrations of metals and major ions in Waiatai Stream and its tributary, the Ikanui Stream. Bolded values indicate elevated results.

Measurement	Unit	94845 – Waiatai Stream upstream of Ikanui	94844 – Ikanui - Tributary to the Waiatai Stream	94846 – Waiatai Stream downstream of Ikanui
Total Aluminium (Al)	g/m³	0.154	**0.917**	0.098
Total Calcium (Ca)	g/m³	45.5	43	44.7
Total Copper (Cu)	g/m³	0.001	0.002	0.0007
Total Iron (Fe)	g/m³	1	**45.5**	1.68
Total Magnesium (Mg)	g/m³	10.4	10.6	10.2
Total Manganese (Mn)	g/m³	0.085	1.74	0.396
Total Sulfur (S)	g/m³	<10	<10	<10
Total Zinc (Zn)	g/m³	<0.003	0.005	<0.003

Suspended Solids

Total suspended solids (TSS) concentrations were markedly elevated in the Ikanui tributary (155 g/m³) compared with the Waiatai Stream upstream (6 g/m³) and downstream (7 g/m³) of the confluence (Table 5). TSS concentrations at the upstream and downstream Waiatai Stream sites were low and consistent with usual background conditions.

Table 5 Total suspended solids concentrations in Waiatai Stream and its tributary, the Ikanui Stream.

Measurement	Unit	94845 – Waiatai Stream upstream of Ikanui	94844 – Ikanui - Tributary to the Waiatai Stream	94846 – Waiatai Stream downstream of Ikanui
Total Suspended Solids (TSS)	g/m^3	6	155	7

4 What is Hypoxic Water?

Hypoxia means low oxygen. When water sources like rivers or lakes have very low oxygen, we say they have hypoxic water. **Hypoxia** is when dissolved oxygen drops below 2 mg/L; under these conditions, most fish and bugs go into respiratory distress. **Anoxia** is when dissolved oxygen hits 0 mg/L. Oxygen is usually present in water because it dissolves from the air, and because aquatic plants and algae produce oxygen during daylight through photosynthesis. At night, oxygen concentrations often decline as photosynthesis stops while respiration continues. Fish and other aquatic animals rely on dissolved oxygen to survive. Some native fish and freshwater macroinvertebrates are particularly vulnerable to oxygen depletion. When oxygen levels fall too low, aquatic organisms can become stressed and, in severe cases, may die (Abell & Goucet, 2024).

4.1 Hypoxic Blackwater Events

Blackwater events occur when high-flow or flood conditions mobilise large quantities of organic matter from floodplains, wetlands, and catchment sediment into receiving waters. This material increases concentrations of dissolved organic carbon (DOC), which is rapidly metabolised by aquatic microbial communities (Hladyz et al., 2011).

The initial breakdown of this organic matter is dominated by aerobic microbial respiration, resulting in a sharp increase in biochemical oxygen demand and rapid depletion of dissolved oxygen (DO). Where oxygen demand exceeds reaeration and supply, hypoxic to anoxic conditions can develop, posing a high risk to oxygen-dependent aquatic organisms.

As DO becomes depleted, microbial metabolism shifts from aerobic pathways to processes with alternative electron acceptors (e.g. nitrate, iron, sulphate) used for respiration. These processes can result in the accumulation of reduced and potentially toxic by-products, including hydrogen sulphide, ammonium, and dissolved metals.

During blackwater events, surface sheens that appear orange or rainbow-coloured iridescent are often mistaken for petrol or diesel contamination (Figure 3). These sheens can instead form from organic films at the water surface, enriched in dissolved organic carbon (DOC) and colonised by microbial communities (Yang et al., 2024; Romani et al., 2003). Proteins, lipids, and humic substances from DOC inputs accumulate at the air-water interface, producing a visible film. Decomposition of plant or animal material can also contribute to surface sheens, often giving a brownish or oily appearance. Certain bacteria, including iron-oxidising species, may interact with naturally occurring metals such as iron, manganese, or sulfur, sometimes altering the colour of the film. Biological or “organic” sheens typically break irregularly when disturbed and do not reform, in contrast to petroleum sheens, which tend to swirl and reform after disturbance (Washington State Department of Ecology, 2024). Naturally occurring sheens are generally not harmful to humans.

Figure 3: An example of a wetland biological sheen. Source: Washington State Department of Ecology, 2024

4.2 Why do Fish Die?

Fish mortality during blackwater events is not solely attributable to hypoxia. While low dissolved oxygen is typically the primary stressor, multiple interacting physiological and chemical mechanisms can contribute to mortality.

Low pH can directly impair gill structure and function, reducing respiratory efficiency. Elevated dissolved carbon dioxide (CO_2), produced during intense microbial respiration, can further exacerbate respiratory stress by reducing the diffusion gradient for CO_2 across the gills, leading to blood acidosis and disruption of acid-base balance (Hamish et al., 2010).

Low pH conditions also increase the solubility and bioavailability of certain metals, including aluminium, copper, and cadmium, increasing their toxicity to aquatic organisms (Jellyman & Harding, 2014). Under acidic conditions, aluminium can be mobilised from soils and sediments into the water column. Dissolved aluminium is particularly harmful to fish, as it can precipitate on gill surfaces, damage epithelial tissues, and interfere with ion regulation and oxygen uptake (Collier, 2017).

4.3 Typical Wetland Function

In a healthy wetland system, inputs of organic matter generally occur gradually over time, often with seasonal pulses (e.g. leaf fall or flood events), and are processed through slow decomposition pathways (Kayranli et al., 2010). Under natural conditions, biochemical oxygen demand is typically balanced by atmospheric reaeration, photosynthesis, and physical mixing, such that surface waters usually retain sufficient dissolved oxygen to support tolerant fish and macroinvertebrate communities. Although wetland waters are often darkly stained due to dissolved organic matter, this does not inherently indicate oxygen depletion (Sustainability Directory, 2025).

Wetland water chemistry is spatially heterogeneous and commonly stratified. Bottom waters and sediments are frequently hypoxic or anoxic, supporting anaerobic microbial processes, while near-surface waters within the photic zone receive oxygen inputs from photosynthesis by algae and aquatic plants.

Functioning wetlands generally act as sinks for carbon, sediment, nutrients, and contaminants. Organic carbon is gradually buried within sediments such as peat or organic-rich material, while fine sediments and associated nutrients are retained within the wetland matrix (National Research Council, 1995). Wetlands also contribute to nitrogen removal through denitrification, moderate flood flows, support groundwater recharge, and protect downstream and coastal environments by attenuating flood energy.

5 Conclusion

The water quality results and environmental conditions indicate that the Waiatai Stream fish mortalities were most likely caused by a hypoxic blackwater event. This event was likely driven by a combination of intense rainfall in early January following prolonged hot conditions, resulting in a rapid influx of oxygen-demanding organic material into the stream.

Blackwater events occur naturally when flooding mobilises accumulated organic matter (e.g. leaf litter, grasses, and wetland-derived carbon) from floodplains, riparian margins, and wetlands into waterways. Under warm conditions, microbial decomposition of this material substantially increases biochemical oxygen demand, often exceeding atmospheric reaeration and leading to rapid declines in dissolved oxygen concentrations. The severity of such events is influenced by the volume and type of organic material, dry periods, water and air temperatures, and the timing and magnitude of rainfall.

In this case, a significant rainfall event on 3 January delivered 117.4 mm at the nearest rainfall site (MetService Wairoa Aero AWS), following a period of extreme heat. Air temperatures exceeded 30°C in the days preceding the incident, with a maximum of 35°C recorded at the Wairoa Aero weather station on 11 January (Appendix A). Elevated temperatures reduce oxygen solubility in the water while simultaneously accelerating microbial metabolic rates and the breakdown of organic matter, compounding oxygen depletion. Taken together, these conditions are consistent with the development of acute hypoxia within the stream.

The rapid onset of low-oxygen conditions is consistent with blackwater dynamics, where oxygen concentrations can fall from non-limiting to lethal levels over short timeframes as carbon-rich water moves downstream. Eels, while relatively tolerant of low dissolved oxygen, remain vulnerable to severe hypoxia and associated physiological stress. Elevated carbon dioxide concentrations commonly associated with blackwater can impair gas exchange and acid–base balance, leading to hypercapnia and acidosis, which may cause mortality before complete oxygen exhaustion occurs. Behavioural responses of eels, such as remaining within benthic refugia rather than actively escaping, may further increase exposure risk during rapid hypoxic conditions.

Several site characteristics likely increased susceptibility to this event, including historical stream and wetland modification, excess nutrient availability, and limited riparian shading. Channelisation and drainage reduce landscape storage and processing of organic matter, allowing carbon-rich water to accumulate in tributary wetlands. Elevated nutrient concentrations further stimulate microbial respiration, while the absence of riparian shade increases thermal loading, particularly in dark, organic-rich waters. These factors collectively increase the likelihood, intensity, and ecological impact of hypoxic blackwater events.

Overall, the available evidence strongly suggests that the eel mortalities in the Waiatai Stream resulted from a naturally driven but climatically exacerbated hypoxic blackwater event, rather than from petroleum contamination or other toxic inputs.

Next Steps

Future interventions, both within this catchment and across similar at-risk areas, should focus on restoring the landscape's natural resilience and its ability to buffer these organic pulses:

- **Riparian Restoration:** Prioritise native riparian planting along the tributary margins. This provides essential thermal buffering via shading and stabilises the banks to prevent further sediment-bound carbon from entering the water column. Additionally, these zones act as filters, intercepting and processing nutrient runoff (nitrogen and phosphorus) to mitigate downstream eutrophication.
- **Wetland Restoration:** Explore options to re-meander the tributary and restore adjacent wetland margins. Increasing the hydraulic residence time allows for natural settling, sedimentation, and biological processing of organic carbon before it reaches the Waiatai Stream.
- **Ecological Connectivity:** Ensure downstream passage remains unobstructed, particularly during “risk windows”, such as during warmer months, especially following heavy rainfall. Maintaining clear passage to the Waiatai Stream is critical for fish seeking refuge from hypoxic conditions.

Reviewed by:
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Glossary

Aerobic: Aerobic describes a condition of water where the oxygen level is high enough to support the growth of oxygen-using organisms such as fish and plants.

Ammonia: Ammonia (chemical formula NH3) is a gas and a common nitrogen-based pollutant that at high concentrations and under certain temperature and pH conditions is toxic to many species, particularly fish and invertebrates.

Biochemical oxygen demand (BOD): The amount of dissolved oxygen consumed in a waterbody by biological processes breaking down organic matter. BOD is used by some councils as a measure of the amount of organic pollution in water.

Carbon: an element in all living beings and consumed by plant matter as carbon dioxide to produce energy, new organic matter and release oxygen.

Contaminant: Contaminants are any substances that pollute, spoil or poison something.

Copper (Cu): A heavy metal contaminant that can be toxic to animals if concentrations are too high.

Dissolved oxygen: The oxygen content of water. Dissolved oxygen is important for fish and other aquatic life to breathe. For example, water quality guidelines recommend that water should be more than 80 percent saturated with DO for aquatic plants and animals to be able to live in it.

Ecosystem: All plants, animals, and microorganisms in a particular area that interact with the non-living physical features of that environment. Ecosystems may be small and short-lived (for example, water-filled tree holes or logs rotting on a forest floor), or large and long-lived (such as forests or lakes).

Floodplain: A flat area of land that borders a river and is subject to flooding.

Guideline: Guidelines refer to particular processes according to a set routine or sound practice. For example, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) provide guidelines on water quality for rivers and coastal waters in New Zealand. Although following a guideline is never mandatory (guidelines are not binding and are not enforced), it is generally regarded as best practice to follow the guidelines.

Heavy metal(s): Any metal or alloy with high specific gravity (a density higher than 5 grams per cubic centimetre). Usually, even at low concentrations, heavy metals are toxic to most plants and animals. Mercury, plutonium, and lead are examples of toxic metals and their accumulation over time in the bodies of animals can cause serious illness.

Hydrocarbons: Hydrocarbons are compounds comprised exclusively of carbon and hydrogen. Hydrocarbons are commonly used for fuel (e.g., petrol, natural gas, fuel oil, diesel fuel, jet fuel, coal, kerosene, and propane etc).

Inorganic matter: In chemistry terms, inorganic matter refers to substances that include salts, metals, substances made from single elements and any other compounds that don't contain carbon bonded to hydrogen.

Nitrate nitrogen (nitrate): A highly soluble form of nitrogen that is both a nutrient and, in excess quantities, a toxic substance.

Nitrogen: A nutrient essential for plant and animal life. Too much can cause large amounts of weeds and algae to grow, harming river health. In some forms, it can be toxic to fish and other aquatic animals.

Nutrient: Chemicals needed by plants and animals for growth, especially nitrogen and phosphorus.

Organic contaminants: In chemistry, ‘organic’ refers to substances with a chemical structure containing carbon−hydrogen bonds. Contaminants are any substances that pollute, spoil or poison something. Organic contaminants, therefore, are substances that contain carbon and hydrogen atoms and can have adverse effects on air, water, soil, or living organisms when they enter the environment. Examples include polycyclic aromatic hydrocarbons (PAHs) which come from fossil fuels, and dichloro-diphenyl-trichloroethane (DDT) which was a commonly used insecticide.

Organic matter: In chemistry terms, this refers to matter which is composed of organic compounds that has come from the remains of living organisms such as plants and animals and their waste products.

Organic pollution: Pollution from organic waste, such as sewage from wastewater treatment plants and discharges of carbohydrate and protein material from timber treatment plants, meat works, and dairy factories.

Oxygen: A chemical element with the symbol O. Aerobic organisms such as birds, mammals and reptiles require oxygen to release energy via respiration, whereas anaerobic organisms do not require oxygen for growth. Oxygen is produced by plants as part of photosynthesis. In water, dissolved oxygen is important for fish and macroinvertebrates to respire.

pH: The degree of acidity or alkalinity as measured on a scale of 0 to 14 where 7 is neutral, less than 7 is more acidic, and greater than 7 is more alkaline. Most natural waters fall within the slightly alkaline range between pH 6.5 to 8.0 and in the absence of contaminants most waters maintain a pH value that varies only a few tenths of a pH unit.

Respiration: The process whereby animals, plants, algae and some bacteria ‘breathe’ oxygen to break down carbohydrates to generate energy and carbon dioxide.

Shortfin Eel: Shortfin eel (Anguilla australis) is one of two native eel species found in New Zealand. The length of their top fin is the same length as the bottom fin, so the ends are almost adjacent when the fish is viewed side-on.

Total Oxidised Nitrogen (TON): Total Oxidised Nitrogen or TON is a measure of two inorganic forms of nitrogen (nitrite nitrogen+ nitrate nitrogen) found in a sample. These soluble compounds are in a form that can be readily used by plants and algae to help them grow. Too much TON can contribute to excessive algal growth in waterways.

Toxic: If something is toxic, it is poisonous to an organism and has the potential to cause damage. For example, high concentrations of heavy metals in a waterway are toxic for aquatic organisms such as fish.

Wetland: A wetland is a land area saturated with water, either permanently or seasonally, such that it takes on the characteristics of its own ecosystem. What distinguishes wetlands from other land forms or water bodies is the characteristic vegetation that is adapted to its unique soil conditions which support aquatic plants.

Zinc (Zn): A heavy metal contaminant that can be toxic to animals if concentrations are too high.

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Appendix A Rainfall and Air Temperature Data

Daily rainfall and air temperature statistics for the MetService Wairoa Aero AWS

Day (January 2026)	Rainfall (mm/day)	Wind Direction	Mean Wind Speed	Wind Speed (Gust)	Air Temperature (Min)	Air Temperature (Max)
1 Thu	0	NNW	16.6	42.6	16.1	27.6
2 Fri	0	WSW	9.3	31.5	15.5	25.7
3 Sat	117.4	S	14.7	42.6	15	18
4 Sun	7.8	S	16	46.3	11.6	18.8
5 Mon	0	ENE	9.9	27.8	8.7	23.4
6 Tue	0	ESE	8.2	31.5	13	26.5
7 Wed	0	ENE	8.5	31.5	16.2	27.7
8 Thu	0	SE	9.7	29.6	15	22.6
9 Fri	0	NW	9.6	29.6	14.7	30.6
10 Sat	0	N	9.7	27.8	15.4	31.2
11 Sun	0	NW	18	57.4	17.7	35
12 Mon	0	SSW	14.4	70.4	17.5	26.3
13 Tue	0	N	13	35.2	14.9	27.9
14 Wed	0	N	8.9	37	17.2	28.2
15 Thu	10.4	NE	6.6	27.8	17.5	23.2
16 Fri	5.6	NNW	14.5	40.7	17	30.5
17 Sat	5.6	S	12.8	38.9	13.9	17.9
18 Sun	20	SSE	16.4	42.6	13.4	17.4
19 Mon	18.2	SE	19.5	46.3	15.2	19.4
20 Tue	9.6	ESE	9.4	38.9	15	18.8
21 Wed	44	ESE	6.3	37	14.9	17.6
22 Thu	22.6	WNW	13.4	48.2	16.1	29.8
23 Fri	0	NNW	17.6	48.2	15.2	28.1
24 Sat	0	NW	18	57.4	14.3	22.9
25 Sun	0	NW	18.8	53.7	12.9	24.4
26 Mon	0	NNW	12	38.9	13.2	24.5
27 Tue	0	SE	9.3	27.8	10.1	23
28 Wed	0	SW	8.5	24.1	16.1	21.9

Appendix B Water Sample Results

ALS Environmental NZ

Hawkes Bay Regional Council
Private Bag 6006
Napier
Hawkes Bay 4142

Results Report

Batch Number: 26/400
Issue: 1
27 January 2026

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
26/400-01	Surface Water		15/01/2026 13:50	15/01/2026 11:30	PN00041093

Notes: No:94844

	Test Code	Result	Units	Test Date	Validated By
H-01307	pH	6.2		15/01/2026	Georgia Kapene KTP
H-1004	Temperature on arrival	3.7	Deg C	15/01/2026	Natalia Domagala KTP
ICPWT_AL	Aluminium - Total	0.917	g/m³		ALS Food & Environmental NZ
ICPWT_CA	Calcium - Total	43	g/m³		ALS Food & Environmental NZ
ICPWT_CU	Copper - Total	0.002	g/m³		ALS Food & Environmental NZ
ICPWT_FE	Iron - Total	45.5	g/m³		ALS Food & Environmental NZ
ICPWT_MG	Magnesium - Total	10.6	g/m³		ALS Food & Environmental NZ
ICPWT_MN	Manganese - Total	1.74	g/m³		ALS Food & Environmental NZ
ICPWT_S	Sulfur* - Total	< 10 *	g/m³		ALS Food & Environmental NZ
ICPWT_ZN	Zinc - Total	0.005	g/m³		ALS Food & Environmental NZ
TPH_W_1	C7-C9	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_2	C10-C14	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_3	C15-C36	< 0.3	g/m³		ALS Food & Environmental NZ
W_CBOD	Carbonaceous BOD	132	g/m3		ALS Food & Environmental NZ
W_COD	Chemical Oxygen Demand	526	g/m3		ALS Food & Environmental NZ
W_DOC	Dissolved Organic Carbon	83.60	g/m³		ALS Food & Environmental NZ
W_NH3N_F	Ammoniacal Nitrogen as N	0.005	g/m³		ALS Food & Environmental NZ
W_NO2N	Nitrite as N	0.017	g/m³		ALS Food & Environmental NZ
W_NO3N	Nitrate as N	< 0.002	g/m³		ALS Food & Environmental NZ
W_NOX_F	Total Oxidised Nitrogen (NO2N + NO3N)	0.013	g/m³		ALS Food & Environmental NZ
W_OG	Oil and Grease	< 5	g/m³		ALS Food & Environmental NZ
W_TKN	Total Kjeldahl Nitrogen as N	8.6	g/m³		ALS Food & Environmental NZ
W_TOC	Total Organic Carbon	106	g/m³		ALS Food & Environmental NZ
W_TOTHAR	Total Hardness	151	g eqv. CaCO3/m³		ALS Food & Environmental NZ
W_TSS	Total suspended solids	155	g/m3		ALS Food & Environmental NZ
W_VSS	Volatile Suspended Solids	68	g/m³		ALS Food & Environmental NZ

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
26/400-02	Surface Water		15/01/2026 14:20	15/01/2026 11:30	PN00041093

Notes: No:94845

	Test Code	Result	Units	Test Date	Validated By
H-01307	pH	7.6		15/01/2026	Georgia Kapene KTP
H-1004	Temperature on arrival	3.7	Deg C	15/01/2026	Natalia Domagala KTP
ICPWT_AL	Aluminium - Total	0.154	g/m³		ALS Food & Environmental NZ
ICPWT_CA	Calcium - Total	45.5	g/m³		ALS Food & Environmental NZ
ICPWT_CU	Copper - Total	0.001	g/m³		ALS Food & Environmental NZ
ICPWT_FE	Iron - Total	1	g/m³		ALS Food & Environmental NZ
ICPWT_MG	Magnesium - Total	10.4	g/m³		ALS Food & Environmental NZ
ICPWT_MN	Manganese - Total	0.085	g/m³		ALS Food & Environmental NZ
ICPWT_S	Sulfur* - Total	< 10 *	g/m³		ALS Food & Environmental NZ
ICPWT_ZN	Zinc - Total	< 0.003	g/m³		ALS Food & Environmental NZ
TPH_W_1	C7-C9	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_2	C10-C14	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_3	C15-C36	< 0.3	g/m³		ALS Food & Environmental NZ
W_CBOD	Carbonaceous BOD	< 1	g/m3		ALS Food & Environmental NZ
W_COD	Chemical Oxygen Demand	33	g/m3		ALS Food & Environmental NZ

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HAWKE'S BAY REGIONAL COUNCIL

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
26/400-02	Surface Water		15/01/2026 14:20	15/01/2026 11:30	PN00041093
Notes: No:94845					

	Test Code	Result	Units	Test Date	Validated By
W_DOC	Dissolved Organic Carbon	8.30	g/m³		ALS Food & Environmental NZ
W_NH3N_F	Ammoniacal Nitrogen as N	< 0.005	g/m³		ALS Food & Environmental NZ
W_NO2N	Nitrite as N	0.002	g/m³		ALS Food & Environmental NZ
W_NO3N	Nitrate as N	0.005	g/m³		ALS Food & Environmental NZ
W_NOX_F	Total Oxidised Nitrogen (NO2N + NO3N)	0.006	g/m³		ALS Food & Environmental NZ
W_OG	Oil and Grease	< 5	g/m³		ALS Food & Environmental NZ
W_TKN	Total Kjeldahl Nitrogen as N	0.6	g/m³		ALS Food & Environmental NZ
W_TOC	Total Organic Carbon	9.50	g/m³		ALS Food & Environmental NZ
W_TOTHAR	Total Hardness	156	g eqv. CaCO3/m³		ALS Food & Environmental NZ
W_TSS	Total suspended solids	6	g/m3		ALS Food & Environmental NZ
W_VSS	Volatile Suspended Solids	< 3	g/m³		ALS Food & Environmental NZ

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
26/400-03	Surface Water		15/01/2026 15:15	15/01/2026 11:30	PN00041093
Notes: No:94846					

	Test Code	Result	Units	Test Date	Validated By
H-01307	pH	7.5		15/01/2026	Georgia Kapene KTP
H-1004	Temperature on arrival	3.7	Deg C	15/01/2026	Natalia Domagala KTP
ICPWT_AL	Aluminium - Total	0.098	g/m³		ALS Food & Environmental NZ
ICPWT_CA	Calcium - Total	44.7	g/m³		ALS Food & Environmental NZ
ICPWT_CU	Copper - Total	0.0007	g/m³		ALS Food & Environmental NZ
ICPWT_FE	Iron - Total	1.68	g/m³		ALS Food & Environmental NZ
ICPWT_MG	Magnesium - Total	10.2	g/m³		ALS Food & Environmental NZ
ICPWT_MN	Manganese - Total	0.396	g/m³		ALS Food & Environmental NZ
ICPWT_S	Sulfur* - Total	< 10 *	g/m³		ALS Food & Environmental NZ
ICPWT_ZN	Zinc - Total	< 0.003	g/m³		ALS Food & Environmental NZ
TPH_W_1	C7-C9	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_2	C10-C14	< 0.2	g/m³		ALS Food & Environmental NZ
TPH_W_3	C15-C36	< 0.3	g/m³		ALS Food & Environmental NZ
W_CBOD	Carbonaceous BOD	< 1	g/m3		ALS Food & Environmental NZ
W_COD	Chemical Oxygen Demand	31	g/m3		ALS Food & Environmental NZ
W_DOC	Dissolved Organic Carbon	8.50	g/m³		ALS Food & Environmental NZ
W_NH3N_F	Ammoniacal Nitrogen as N	0.297	g/m³		ALS Food & Environmental NZ
W_NO2N	Nitrite as N	0.003	g/m³		ALS Food & Environmental NZ
W_NO3N	Nitrate as N	0.009	g/m³		ALS Food & Environmental NZ
W_NOX_F	Total Oxidised Nitrogen (NO2N + NO3N)	0.011	g/m³		ALS Food & Environmental NZ
W_OG	Oil and Grease	< 5	g/m³		ALS Food & Environmental NZ
W_TKN	Total Kjeldahl Nitrogen as N	0.9	g/m³		ALS Food & Environmental NZ
W_TOC	Total Organic Carbon	8.90	g/m³		ALS Food & Environmental NZ
W_TOTHAR	Total Hardness	154	g eqv. CaCO3/m³		ALS Food & Environmental NZ
W_TSS	Total suspended solids	7	g/m3		ALS Food & Environmental NZ
W_VSS	Volatile Suspended Solids	< 3	g/m³		ALS Food & Environmental NZ

Comments:

* Not an accredited test.

Sampled by customer using ALS approved containers.

Results relate to the samples as received and only to the samples tested. Samples received within the correct time and temperature condition unless otherwise noted on this report.

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Test Methodology:

Test	Methodology	Detection Limit
pH	pH meter following APHA Online Edition Method 4500-H+ B :Note : It is not possible to achieve the APHA storage time recommended for the test (15mins) when samples are analysed upon receipt after 15 mins.	0.1
Temperature on arrival	Thermometer following APHA Online Edition Method 2550 B	0.1 Deg C
Aluminium - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	0.003 g/m³
Calcium - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	0.05 g/m³
Copper - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	n/a g/m³
Iron - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	n/a g/m³
Magnesium - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	0.01 g/m³
Manganese - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	0.0005 g/m³
Sulfur* - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	10 g/m³
Zinc - Total	ICP-MS following an acid digestion. In house procedure based on US EPA method 200.8	n/a g/m³
C7-C9	Solvent extraction, silica cleanup, followed by GC-FID analysis (C7-C36). MFE Petroleum Industry Guidelines.	0.2 g/m³
C10-C14	Solvent extraction, silica cleanup, followed by GC-FID analysis (C7-C36). MFE Petroleum Industry Guidelines.	0.2 g/m³
C15-C36	Solvent extraction, silica cleanup, followed by GC-FID analysis (C7-C36). MFE Petroleum Industry Guidelines.	0.3 g/m³
Carbonaceous BOD	Dissolved oxygen measured using a dissolved oxygen electrode after addition of the nitrification inhibitor ATU and a 5 day incubation period. (APHA 5210 B - Online edition).	1 g/m3
Chemical Oxygen Demand	Samples analysed colourimetrically following an acid digestion. (APHA 5220 D - Online edition).	10 g/m3
Dissolved Organic Carbon	Samples analysed as received by combustion analysis at 850°C following a filtration step.(APHA 5310 B - Online edition)	0.5 g/m³
Ammoniacal Nitrogen as N	Samples are filtered and measured colourimetrically by flow injection analysis. Results represent total ammonical nitrogen (APHA 4500-NH3 H - Modified - Online edition)	0.005 g/m³
Nitrite as N	Samples analysed colourimetrically by flow injection analysis following filtration. (APHA 4500-NO2 I. Online edition) - Result reported as Nitrite (N2) species.	0.001 g/m³
Nitrate as N	Calculated from oxidised nitrogen and Nitrite-N, measured colourimetrically by flow injection analysis. (APHA NO3-I. Online edition) - Result reported as Nitrate as nitrogen.	0.002 g/m³
Total Oxidised Nitrogen (NO2N + NO3N)	Measurement of Nitrite-N and Nitrate-N determined colourimetrically by flow injection analysis. (APHA NO3- I. Online edition)	0.002 g/m³
Oil and Grease	Samples are filtered and undergo subsequent soxtec extraction in n-hexane, followed by gravimetric determination of oil and grease content. In-house method based on APHA Method 5520D (Online Version)	5 g/m³
Total Kjeldahl Nitrogen as N	colorimetric analysis following acid digestion. (APHA 4500-N Org D - Modified - Discrete Analyser - Online edition).	0.1 g/m³
Total Organic Carbon	APHA 23rd Edition online 5310B	0.5 g/m³
Total Hardness	Result calculated from Total Magnesium and Calcium. (APHA 2340B - Online edition) DL = 0.05 g equiv CaCO3/m3	0.05 g eqv. CaCO3/m³
Total suspended solids	Measured gravimetrically following filtration through glass micro-fibre filters. (APHA 2540 D - Modified - Online edition)	3 g/m3
Volatile Suspended Solids	Samples filtered and ashed at 550°C, VSS is a measure of solids lost after ashing. (APHA 2540 E - Modified - Online edition).	3 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

Report Released By
Natalia Domagala
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY
№ 1360, 1080, 1081

This laboratory is accredited by International Accreditation New Zealand and its reports are recognised in all countries affiliated to the International Laboratory Accreditation Co-operation Mutual Recognition Arrangement (ILAC-MRA). The tests reported have been performed in accordance with our terms of accreditation, with the exception of tests marked "not an accredited test", which are outside the scope of this laboratory's accreditation.

Batch Number: 26/400

27 January 2026 16:01:22

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Page 3 of 3