Mount Welcome –Water Quality Assessment

Prepared for

Pukerua Property Group LP

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Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Pukerua Property Group LP and others (not directly contracted by PDP for the work), including Envelop Engineering Limited, BlueGreen Ecology, Blac Projects and Greater Wellington Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Executive Summary

Pukerua Property Group LP is submitting a fast-track resource consent application for the development of a residential subdivision near Pukerua Bay. Pattle Delamore Partners Limited (PDP) has been assisting with the assessment of the potential effects of the proposed development on the water quality of local wetland areas and downstream receptors. This report presents the assessment, which includes characterising baseline water quality, a review of the proposed works, the potential changes in water quality due to the works, and the mitigation and control measures proposed to minimise the impacts of the development. The impacts on wetland hydrology are assessed in a separate report.

Onsite water quality monitoring data and available data from Greater Wellington Regional Council (GWRC) has been used to establish the baseline water quality conditions prior to the development.

The results indicate that, under current conditions, nitrate concentrations at all three on-site monitoring stations are significantly higher than the mean value recorded in the Taupō Stream. However, they remain below the default freshwater guideline values for 95% species protection, as outlined in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality. The measured concentrations may be attributed to the site's current land use as a deer, beef and sheep farm. Additionally, measured concentrations of copper and zinc on-site slightly exceeded the default guideline values for 99% species protection, according to the ANZ Guidelines (2018).

Turbidity at SW02 and SW03 showed a slightly elevated baseline (5–10 NTU) compared to Taupō Stream (<5 NTU), with peaks reaching ~450 NTU during rainfall events within the month of available monitoring data, much higher than the 140 NTU peak observed at Taupō Stream. However, due to more frequent monitoring on-site (every 15 minutes) versus monthly at Taupō Stream, direct comparisons are limited and peak values in Taupō Stream are likely underestimated. The higher turbidity at the site is expected, given the steep, erodible pasture slopes, whereas Taupō Stream benefits from sediment filtration by Taupō Swamp upstream.

The proposed development could lead to the following potential changes to the water quality leaving the site if mitigation measures (where necessary) are not included:

- During construction;
  - Increased sediment run-off,
  - Hydrocarbon and chemical spills,
- Post construction;

- Reduced erosion and sediment run-off due to grading of slopes, planting of appropriate native vegetation and wetland restoration,
- Reduced nutrient run-off due to the removal of stock from the site and the planting of buffer zones around streams and wetlands,
- Increase in heavy metals and hydrocarbon concentrations in stormwater runoff due to change in land-use.

The following key mitigation and control measures will be implemented during and post development:

- During construction.
  - Minimising the open area of the earthworks as per best practice,
  - A comprehensive erosion and sediment control plan which will be implemented in a staged manner,
  - Maintenance of buffer zones around streams and wetlands as described in the Erosion and Sediment Control Plan,
  - Continuous turbidity monitoring of flows leaving site during construction,
- Post construction.
  - Part of the slopes will be planted with native vegetation to increase stability as outlined in the Erosion and Sediment Control Plan, ecology and landscaping plans,
  - Stormwater treatment and management measures will be installed upstream of any discharge into the on-site streams or natural and retention wetlands,
  - Retention wetlands will reduce the peak flow rates leaving the site, reducing scour and sediment mobilisation,
  - Buffer zones with native planting will be established around retained streams and natural wetland areas,
  - Treated stormwater will discharge through natural wetlands and the proposed retention wetlands before leaving site, providing an additional level of protection.

Provided that the above-mentioned mitigation measures are implemented, it is considered that the development will have less than minor effects on the water quality of downstream receptors—Taupō Stream, Kakaho Stream, and Porirua Harbour. However, to more accurately characterise existing conditions prior to construction, continued baseline water quality monitoring is recommended. This monitoring is already underway and will continue throughout the 2025/2026 season with the last sampling currently scheduled for June 2026. This will provide basis for comparison of the water quality during and post construction.

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1.0 Introduction

1.1 Project Background

Classic Developments NZ Limited on behalf of Pukerua Property Group LP (the Applicant) are seeking to obtain fast-track resource consent for the development of a residential subdivision near Pukerua Bay in an area known as Mount Welcome.

The Mount Welcome site is located at 422 State Highway 59, near Pukerua Bay (Figure 1) and is currently mostly operated as a deer farm. The application site comprises the following parcels of land:

- Lot 1 DP 608433, Lot 1000 DP 608433 (34 Muri Road);
- Lot 1 DP 534864 (422 SH59);
- Lot 2 DP 534864 (422A SH59);
- Lot 2 DP 89102 (422B SH59);
- Part Lot 1 DP 89102 (422A SH59); and
- Road Reserve (SH59 Corridor).

The 'project' involves:

- 950 residential allotments sized between 316 m^2 to 2386 m^2 (to enable 950 future dwellings) with an average lot size of close to 523 m^2;
- A commercial centre;
- Associated infrastructure including wastewater (including wastewater storage facilities), stormwater, water reticulation, roading, and pedestrian and cycling trails;
- Earthworks to establish the required finished surface levels for building platforms, roading, parks and drainage;
- Landscaping; and
- New intersection with State Highway 59 (which is covered in a separate report).

A water reservoir is being separately consented and does not form part of the project.

Envelope Engineering Limited (Envelope) have provided draft stormwater designs, demonstrating how surface water from the site will be managed. This involves a series of raingarden treatment devices discharging into wetland retention ponds, which use some of the existing wetlands on site to retain flow during peak events, before discharging downstream.

Due to the change in land use, increase in area of impervious surfaces, along with change to the direction and intensities of surface water flows, the water quality of wetlands and streams on site may be affected. The Applicant has commissioned Pattle Delamore Partners Limited (PDP) to undertake an assessment of the impacts of the proposed development on the water quality at the onsite existing wetlands and offsite sensitive receptors.

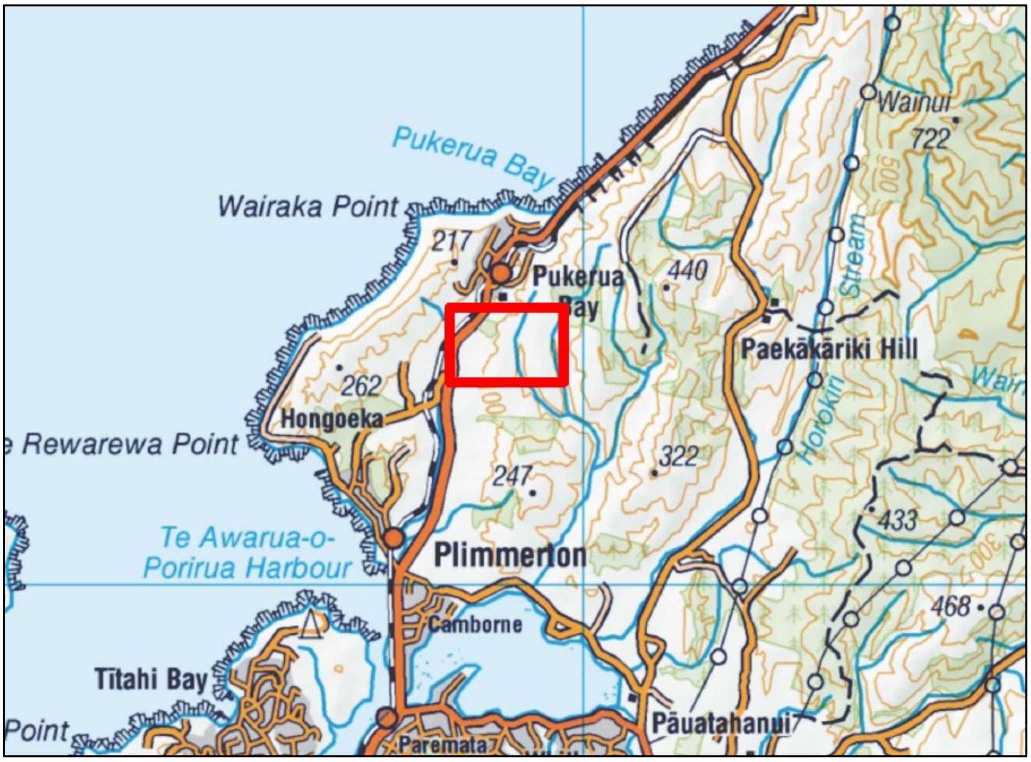

Figure 1: Site Location

1.2 Aims and exclusions

The purpose of this report is to assess the impact of the development on the water quality of the onsite wetlands, Taupō Swamp and Te Awarua-o-Porirua Harbour. The impact of the proposed development on the hydrology and the ecology of the existing wetland environments are covered in separate reports.

The assessment is also based on information which is presented in the following documents:

- Earthworks Construction Management Plan by Envelope Engineering
- Operational Stormwater Management Plan by Envelope Engineering
- Mt Welcome Station Ecology by BlueGreen Consulting

- Envelope Engineering Drawings 1753-02-4000 to 1753-02-4156 – Stormwater Infrastructure and Treatment
- Calculation Spreadsheet – 1753-02 Raingardens by Envelope Engineering
- Landscape Urban Design Strategy by Blacprojects Landscaping
- Landscape and Ecology Plans by Blacprojects Landscaping

1.3 Report overview

This report details the assessment of effects on water quality for the onsite wetland areas and downstream sensitive receiving environments, and includes the following:

- Site description and context.
- Summary of baseline water quality monitoring data for the wetlands and streams within the project area (onsite receptors).
- Summary of available baseline water quality data from Greater Wellington Regional Council for the Taupō Swamp complex and the Porirua Harbour (downstream receptors).
- Comparison of on-site and off-site baseline water quality data.
- Assessment of the existing water quality effects of the site (deer farm) on off-site receptors.
- Description of the proposed mitigation and control measures.
- Description of control measures during construction.
- Assessment of future effects on water quality of the developed site on the on and off-site receptors.

2.0 Site context

2.1 Site description

The Mt Welcome site is legally described as:

- Lot 1 DP 608433, Lot 1000 DP 608433 (34 Muri Road);
- Lot 1 DP 534864 (422 SH59);
- Lot 2 DP 534864 (422A SH59);
- Lot 2 DP 89102 (422B SH59);
- Part Lot 1 DP 89102 (422A SH59); and
- SH59 corridor adjacent to the site which is legally described as Road Reserve.

The proposed site layout is presented in Figure 2.

The site is currently covered in pasture and managed as an active deer/cattle farm. There are small pockets of native and exotic woodland, and wetland areas within the site, which will be described in more detail in Section 2.7. The site primarily comprises steep sided hills, cut by incised valleys. The ground elevation ranges from 35 m above sea level (asl) in the southwestern corner to 301 m asl on the far eastern boundary, although the highest point in the development area is 175 m asl. The lower parts of the valleys are primarily occupied by wetlands and streams.

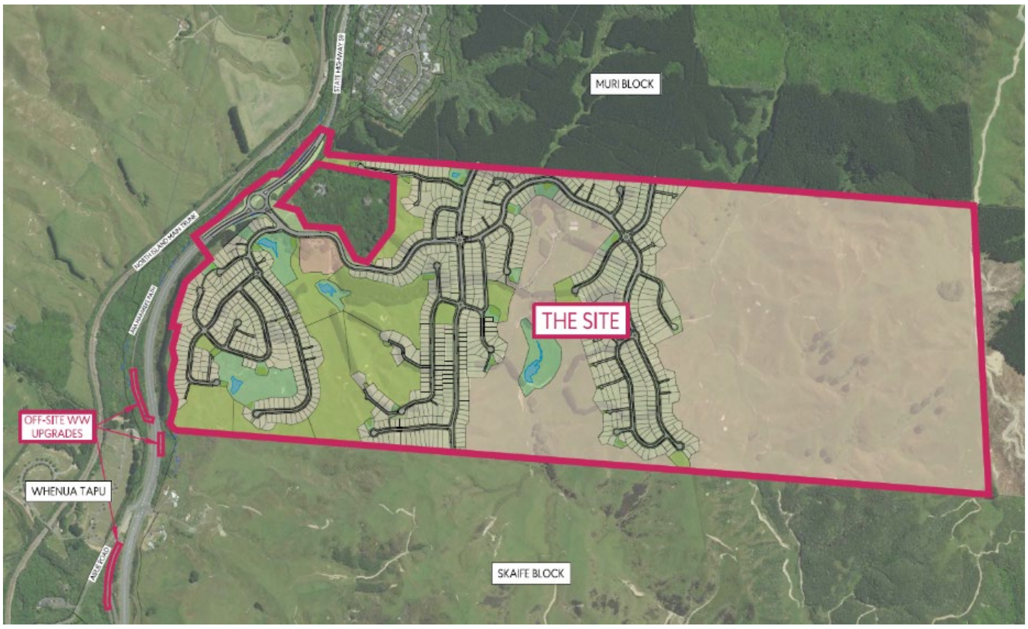

Figure 2: Proposed Site Layout (provided by Envelope Engineering)

The site is bounded to the west by State Highway 59 (SH59, formerly SH1), and to the north by the Muri Road block, which is currently undergoing development. The land to the south and east is occupied by pasture and used for farming.

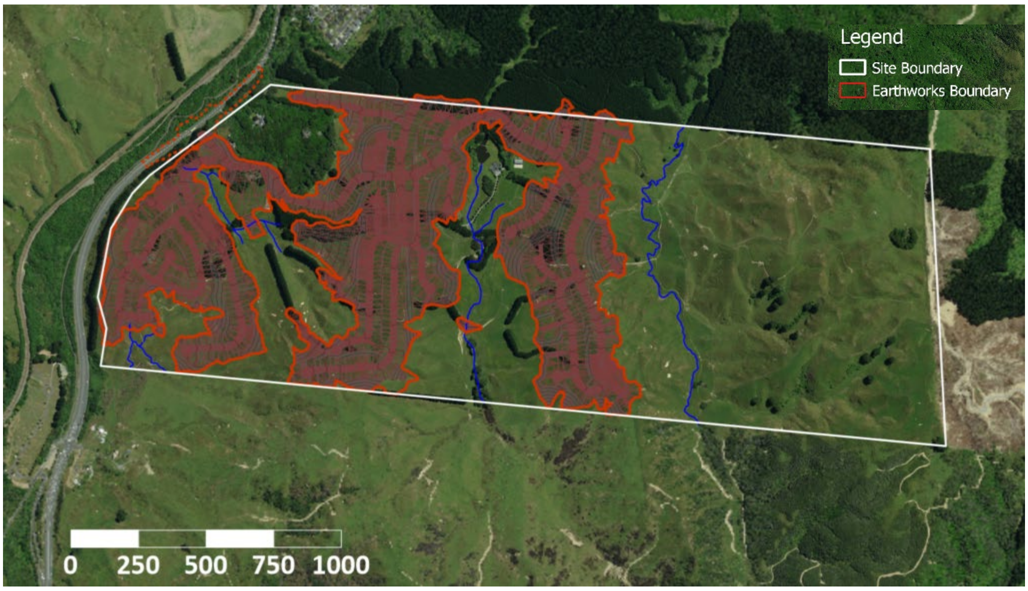

Figure 3: Earthworks Extent

2.2 Hydrology

There are four main catchments at the site (see Figure 4):

- Taupō Stream catchment
- Kakaho Stream East catchment
- Kakaho Stream West catchment
- Waimapihi Stream catchment

The Taupō Stream catchment discharges west and south forming the headwaters of Taupō Stream and Taupō Swamp. The Taupō Swamp is a regionally significant wetland and the stream flows through this feature before discharging into the Te Awarua-o-Porirua Harbour at Plimmerton.

The two eastern catchments (Kakaho East and West) discharge south into Kakaho Stream, which flows into the Pauatahanui Arm of the Te Awarua-o-Porirua Harbour 4.6 km downstream of the site. This is a highly sensitive estuarine environment.

The site also includes a small portion of the upper reaches of the Waimapihi Stream catchment, which discharges north into the Muri Road block and flows into the sea at Pukerua Bay.

The majority of the streams on the site are ephemeral, but there are perennial reaches in the lower parts of the catchments. Stream flows are generally low but respond rapidly to rainfall run-off from the steep catchments. The ecology assessment indicates that the streams draining west into the Taupo catchment are low value stream systems and whilst the streams in the Kakaho catchments are in better condition, they are still modified with a of lack of shading, nutrient inputs, stock inputs, bank slumping and increased sedimentation.

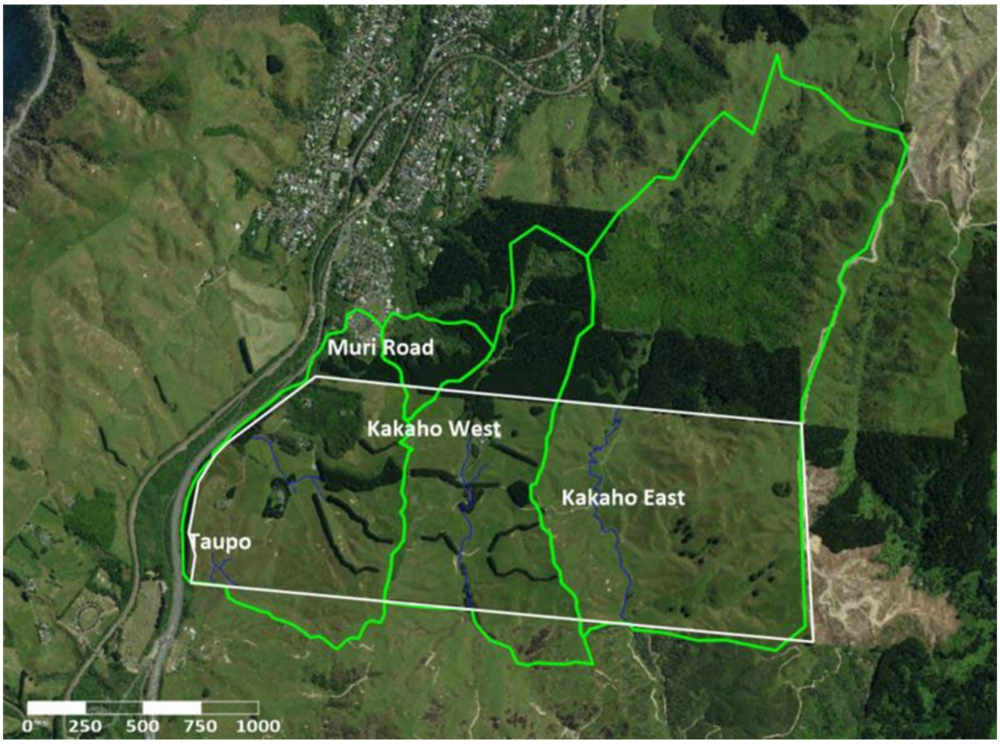

Figure 4: Key Site Catchments

2.3 Taupō Stream and Swamp - downstream receptors

Taupō Swamp is a rare and ecologically rich lowland freshwater wetland in the Wellington region, notable for being the first major wetland protected in the area. It has been formally protected via a QEII covenant since 1988. Its rich biodiversity makes it a vital sanctuary for native plants, birds, fish, reptiles, and insects. Beyond its ecological value, the swamp plays a crucial role in regulating water flow, reducing the risk of flooding, filtering nutrients and sediments from surrounding farmland to improve water quality, and helping to lower greenhouse gas emissions.

Recent ecological surveys highlight its significance: 19 native bird species live in the swamp, six of which are nationally threatened, including historic sightings of the critically endangered bittern. Other at-risk species include the New Zealand pied oystercatcher, red-billed gull, marsh crake, and spotless crake. The plant life is equally diverse, featuring native species such as harakeke (swamp flax), wetland sedges, swamp buttercup, ferns, and marsh willowherb. The swamp also provides habitat for native freshwater fish including longfin eel, banded and giant kōkopu, and giant bully—many of which are also considered at risk.

Taupō Swamp ranks among the top 8% of sites in Wellington for biotic integrity, indicating it is a healthy, thriving wetland ecosystem. (QEII National Trust Website).

2.3.1 Proposed Plan Change 1 to Natural Resources Plan

Under the proposed Plan Change 1 to the Natural Resources Plan (NRP) for the Wellington Region, targets have been developed to improve water quality in a number of streams around Te Awarua-o-Porirua. Relevant target concentrations for Taupō Stream are presented in Table 1 below.

Table 1: Target attribute states in Taupō Stream at Plimmerton Domain[1]

Parameter	Baseline State[2]	Target[3]			Requirement
		Concentration		State[2]	
		Median	95th%ile		
Ammonia (mg/L)	B	≤0.03	≤0.05	A	Improve
Nitrate (mg/L)	B	≤1	≤1.5	A	Improve
Suspended fine sediment (black disc, m)	A	≤0.93	-	A	Maintain
Dissolved inorganic nitrogen (mg/L)	-	≤1.03	-	-	Improve
Dissolved reactive phosphorous (mg/L)	-	0.017	0.047	-	Maintain
Dissolved copper (ug/L)	D	≤1	≤1.8	B	Improve
Dissolved zinc (ug/L)	C	≤2.4	≤8	A	Improve

Notes:

1. *Data obtained from Table 9.2 Target attribute states for rivers from Plan Change 1 from NRP (GRWC, 2023b)*
2. *A, B, D and D states to be assigned on the basis of fish community health reflecting an excellent, good, fair and poor state of aquatic ecosystem health respectively.*
3. *Targets to be achieved by 2040.*

2.4 Te Awarua-o-Porirua Harbour – downstream receptor

Te Awarua-o-Porirua Harbour is located downstream of both the Taupō Swamp and the Kakaho Stream catchment. Improving the health of this water body is one of the strategic priorities of Porirua City Council's (PCC) long-term plan. It is of key concern due to the volume of sediment and contaminants entering the harbour and the reduction in the diversity and health of the ecosystems associated with it (PCC, 2023).

2.4.1 Proposed Plan Change 1 to Natural Resources Plan

Te Awarua-o-Porirua is included in proposed Plan Change 1 to the NRP for the Wellington Region. The Taupō Stream discharges into the harbour and is included as the 'Open Coast' in the Coastal Water Management Units (Map 82) in the plan change (GWRC, 2023b). Whilst there are no numerical targets for the Open Coast in the plan change, it does require the maintenance or improvement of concentrations of the following key pollutants: copper and zinc in sediment, muddiness and sedimentation rate.

The Kakaho Stream discharges into the Pāuatahanui Inlet in the Porirua Harbour, and the relevant target concentrations are presented in Table 2.

Table 2: Coastal water objectives for the Pāuatahanui Inlet

Parameter	Unit	Intertidal/subtidal Target
Enterococci	cfu/100 ml	<200
Macroalgae (EQR)	Latest score	Maintain or improve
Copper in Sediment (mg/kg)	Mean of replicate samples	Maintain or improve
Zinc in Sediment (mg/kg)	Mean of replicate samples	Maintain or improve
Muddiness (%>50% mud)	Latest score	Maintain or improve
Sedimentation Rate (mm/y)	5 year min	2

Note:

1. *Data obtained from Table 9.1 Coastal Water Objectives from NRP (GRWC, 2023b)*

2.5 Geology and Hydrogeology

The regional geological map (Begg and Johnson, 2000) indicates that the northwest section of the site is underlain by loess-covered alluvial gravel deposits, overlying greywacke bedrock. In the steeper eastern and southwestern sections, the site is predominantly characterized by exposed greywacke. Across ridges, slopes, and plateaus, the greywacke sandstone and mudstone are generally overlain by loess and colluvium, while recent alluvial deposits are present along the axes of gullies and valleys. The Pukerua Fault runs northeast to southwest and is located 600 m to the west of the site.

There is no large-scale regional aquifer present at the site, but groundwater is likely to be present in fractures and weathered horizons within the greywacke bedrock and in the alluvial gravel deposits. Groundwater from the site is likely to discharge into the lower perennial reaches of the streams contributing to surface flows from the site.

There are no bores or groundwater, or surface water takes within the catchment.

2.6 Climate

The annual rainfall of the Wellington region is highly variable and is largely driven by the local topography. However, with the exception of the central Tararua Range and Wairarapa Plains, the majority of the region typically experiences 1,000 to 1,200 mm/year (Chappell, 2014). In lieu of site-specific data, data collected at the closest regional rain gauge at the Taupō Stream at the Whenua Tapu site (GWRC, 2025) indicates that the average annual rainfall in the general site area is approximately 1,040 mm/year (data available from 1991 to present) see Figure 5. Rainfall occurs year-round but is lowest between February and May (Figure 6).

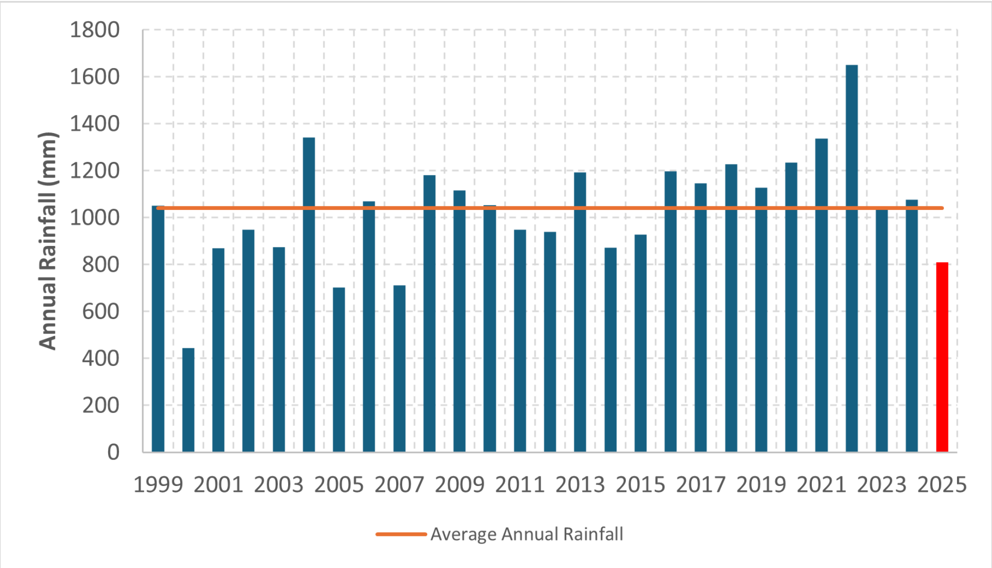

Figure 5: Annual Rainfall at Taupō Stream Whenua Tapu (red columns indicate <300 days recorded data)

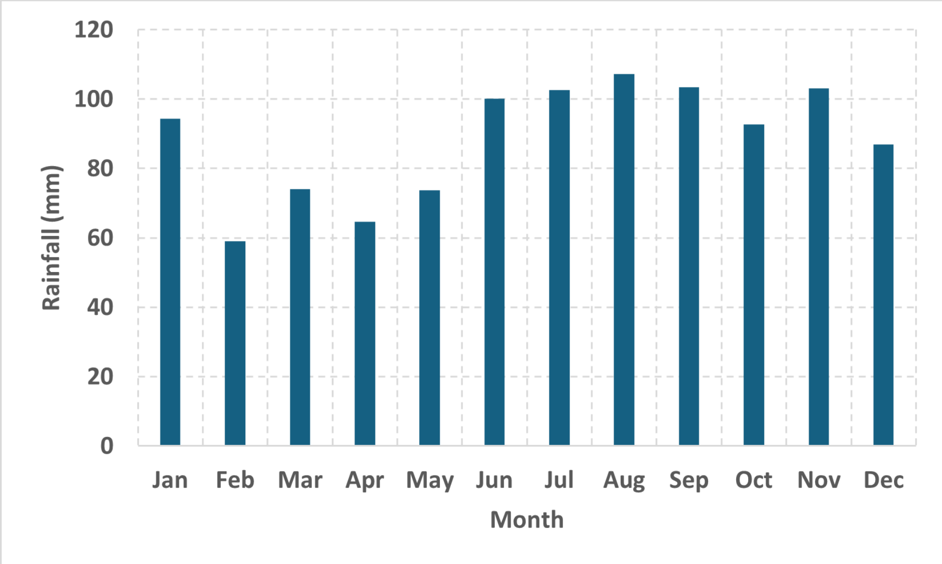

Figure 6: Seasonal variation in Rainfall Monthly Average Rainfall (1999 - 2025)

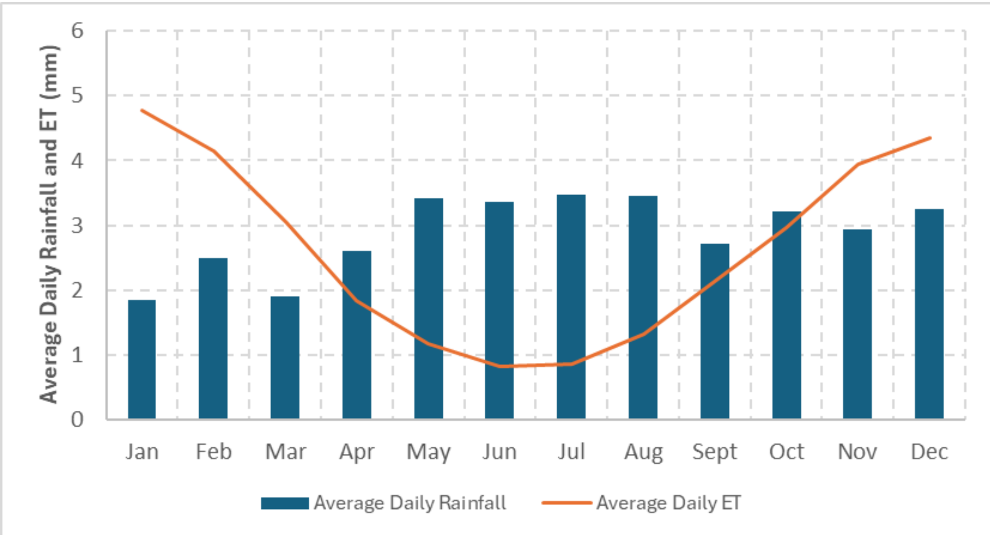

Figure 7: Seasonal variation in Rainfall and Evapotranspiration (1999-2025)

The nearest potential evapotranspiration data is available from the Porirua Elsdon Park and Paraparaumu Aero weather stations (NIWA, 2025). The average annual potential evapotranspiration in the region is approximately 936 mm, which is lower than the annual rainfall. However, there is significantly more seasonal variation in potential evapotranspiration, with most occurring between September and April (Figure 7).

2.7 Wetlands

Wetlands on site have previously been identified by Boffa Miskell Limited (Boffa Miskell Limited, 2023) and reviewed and updated by Blue Green Ecology in 2025 (see Figure 8 for locations). Extensive earthworks are planned as part of the development, with approximately 15,626 m² of natural inland wetland falling within the designated earthworks boundary and removed. It is proposed to offset 5,249 m^2 and remediate 6,098 m^2. The offset and enhancements proposed to mitigate this loss are detailed in the values assessment and offset calculations reported elsewhere (BlueGreen Ecology Limited, 2025).

The retained wetlands can be split into two groups based on the hydrology:

1. Wetlands in the upper gully systems which are fed principally by direct rainfall and run-off, and may dry out periodically in the summer months; and
2. Wetlands in the valley floors, which are fed by direct rainfall and run-off, but also have contributions from groundwater discharge and stream flow/flooding, which are likely to have more stable water levels (albeit with some seasonal variation).

At present, the wetlands are unfenced and can be accessed by cattle grazing at the site.

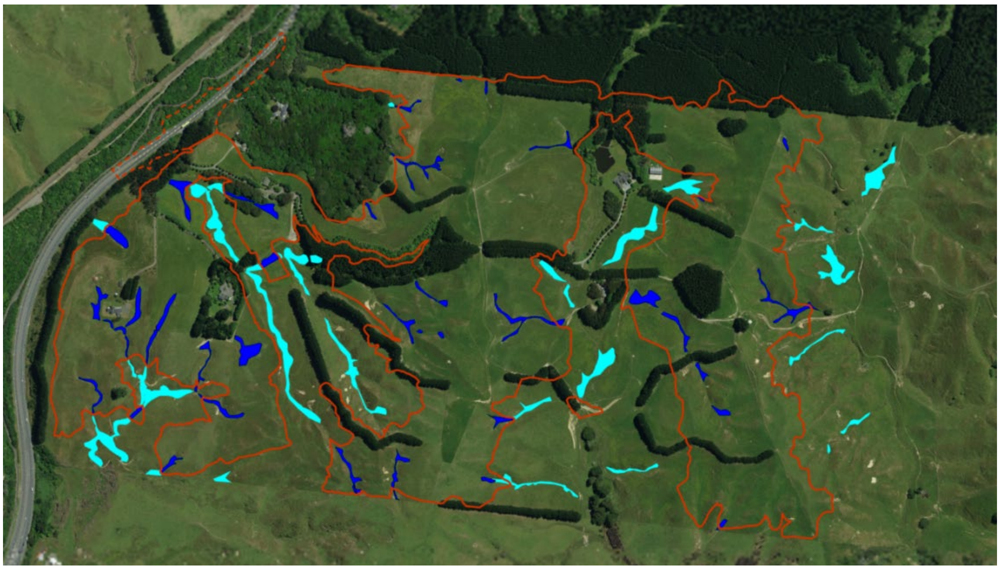

Figure 8: Wetland Extents (dark blue will be removed and light blue retained)

3.0 Monitoring Network

3.1 Offsite monitoring

There are two main catchments at the site, with the western one discharging west and south into the upstream end of Taupō Stream and Swamp and the eastern one discharging south into Kakaho Stream, which flows into the Pauatahanui Arm of the Te Awarua-o-Porirua Harbour. The site is located in the upper catchments of both streams.

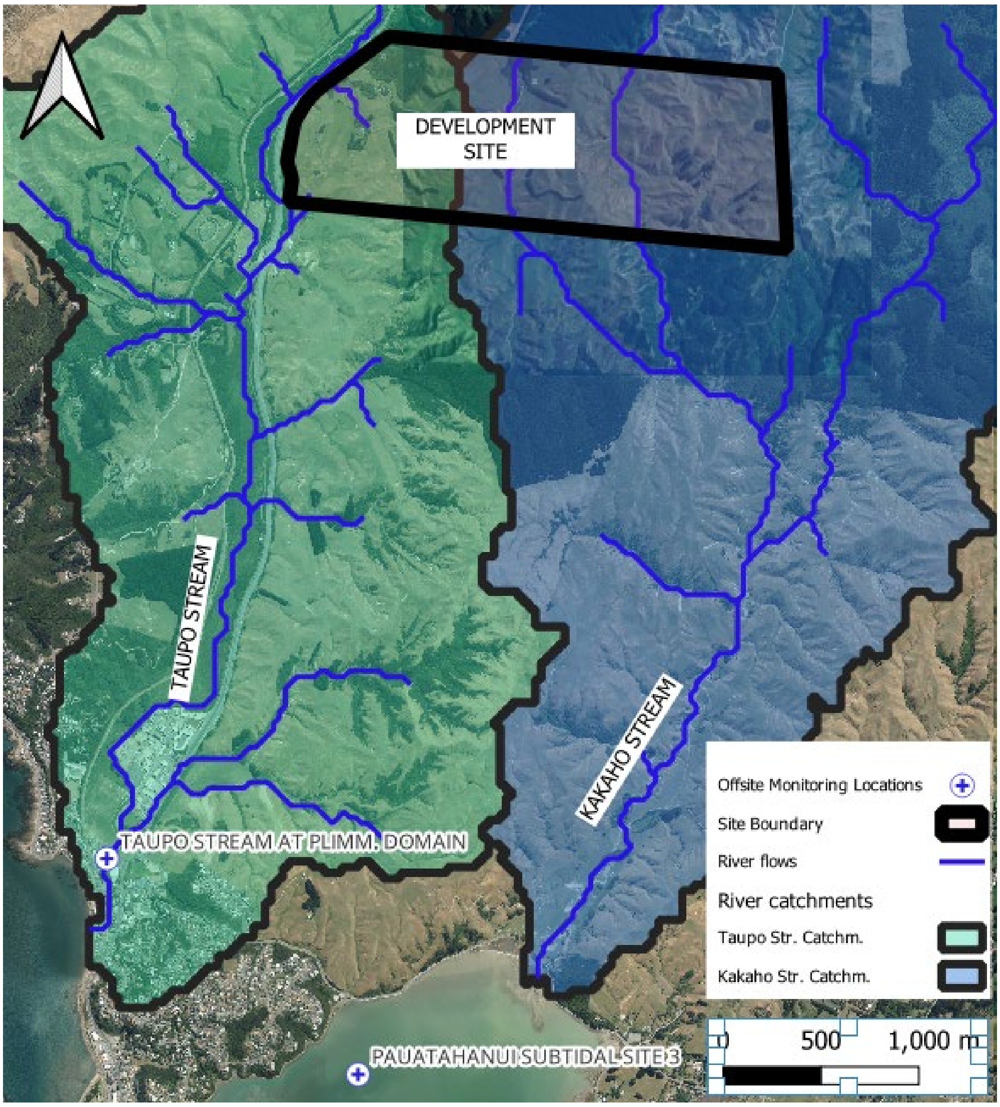

Figure 9: Catchments overlapping the development site, and offsite monitoring locations

3.1.1 Taupo Stream Catchment

Since July 2020, GWRC has been conducting monthly surface water quality monitoring in Taupō Stream at the Plimmerton Domain. The monitoring site is located downstream of the proposed subdivision, the Taupo Swamp, another subdivision development currently under construction, and the industrial estate at Plimmerton, and therefore captures discharges from the majority of the catchment. Ideally, data from upstream within the Taupō Swamp complex would be available to more accurately characterise the water quality within this sensitive receptor; however, no publicly accessible information exists for that area. As such, the downstream site is considered representative of surface water quality within the swamp complex. The monitoring location is shown in Figure 9.

Water quality data from the last five years of monitoring (between July 2020 and August 2025) was used to characterise the baseline quality of surface water from Taupō Stream and Taupō Swamp complex. A summary table of the results is included in Appendix A. Due to the regular monitoring of selected parameters, it is assumed that the water quality samples are representative of seasonal variations.

3.1.2 Kakaho Stream Catchment

No monitoring stations are available within the Kakaho Stream catchment, therefore no data is available to characterise the baseline parameters. The Kakaho Stream discharges into the highly sensitive estuarine environment of the Pāuatahanui arm of the Porirua Harbour downstream of the site.

According to GWRC’s 2023–2024 assessment of monitoring data for Te Awarua-o-Porirua Harbour, estuary quality has declined over the past decade, with a consistent trend of increasing or persistently high mud content and elevated deposition rates—signs of excessive sediment entering the Harbour.

GWRC (Greater Wellington Regional Council) focuses primarily on sediment monitoring in Te Awarua-o-Porirua Harbour because sedimentation is one of the most significant and persistent environmental pressures affecting the estuary's ecological health. As for water quality, GWRC does monitor temperature and enterococci levels, particularly for recreational safety. However, broader water quality parameters (like nutrients, turbidity, or heavy metals) are not consistently monitored in the harbour itself.

The sediment quality monitoring site closest to the Kakaho Stream estuary is the Pāuatahanui Subtidal Site 3. It is monitored for metals, sediment nutrients and muddiness every five years. This site is rated as ‘poor/high risk’ due to mud content in the seafloor exceeding the 25% guideline; however, no metal contaminants were detected (see summary table in Appendix A).

3.2 Onsite monitoring

To understand the existing hydrological conditions at the site, PDP has installed water quality baseline monitoring stations within the wetlands and streams discharging from the site (Figure 10). The monitoring sites of relevance to this report are three surface water monitoring locations (SW01, SW02 and SW03 in Figure 10), which continuously measure stage and turbidity in the streams.

Additionally, four quarterly site monitoring visits are scheduled to collect water samples at all three surface water monitoring locations for laboratory analysis. Parameters to be analysed include pH, electrical conductivity, anions, cations, heavy metals and nutrients.

Monitoring started in August 2025 so a limited amount of site-specific baseline data is available at this stage. The available data includes:

- One-month continuous stream turbidity and stage from SW01, SW02, SW03;
- Lab results for the first quarterly sampling of environmental parameters at SW01, SW02 and SW03 (collected on 26/08/2025).

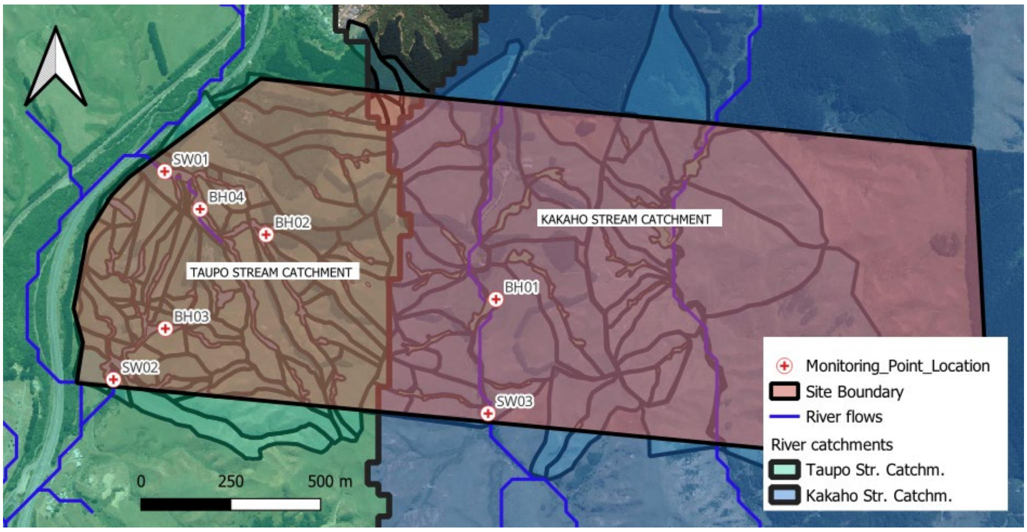

Figure 10: On site monitoring stations

4.0 Onsite and Offsite Baseline Water Quality Data Review

The on-site water quality monitoring data collected to date were compared with publicly available data from the downstream receptor to help characterise baseline water quality. As monitoring progresses, a clearer understanding of site conditions will continue to emerge.

4.1 Surface water at Mount Welcome

The results of water quality monitoring at SW01, SW02 and SW03 at Mt Welcome are summarised in Appendix A and included in the graphs presented in Appendix B for reference. At the current stage, only data from the first quarterly monitoring sampling is available. Therefore, the baseline data is limited and does not allow for a comprehensive characterisation of water quality at the site. However, the key preliminary findings are:

- Water quality between SW01 and SW02 (both within the Taupo catchment) is very similar; no parameters show significant differences between the two locations, which is unsurprising given they are situated along the same stream.
- The parameters monitored at SW03 (located in the Kakaho Stream catchment) are also consistent with those at SW01 and SW02 (both in the Taupo Stream catchment), with only a slight variation observed in Nitrate Nitrogen concentrations (1.08 g/m^3 at SW03 compared to 0.57–0.55 g/m^3 at SW01 and SW02, respectively). At this stage, the dataset is too limited to determine the cause of the observed variation.
- The Nitrate-Nitrogen concentration monitored at SW03 exceeds the ANZ, (2018) freshwater guideline values for 99% species protection, while remaining slightly lower than the 95% threshold. In contrast, concentrations at SW01 and SW02 are below the 99% species protection guideline.
- Zinc concentrations at all three locations (sampled 26/08/2025) marginally exceeded the default freshwater guideline values for 99% species protection from Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ, 2018).
- The measured copper concentrations at SW01 and SW02 slightly exceeded the ANZ (2018) default freshwater guideline values for 99% species protection, whereas the concentration at SW03 remained below this threshold.
- Chromium concentrations in SW01, SW02 and SW03 exceeded the 99% species protection from Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ, 2018), while remaining well below the 95% threshold.
- All other parameters tested are lower than the ANZ, (2018) freshwater guideline values for 99% species protection.
- All parameters are lower than the Maximum Acceptable Value (MAV) as defined by the New Zealand Drinking Water Standards (2022).

4.1.1 Turbidity

One month of instream turbidity data is available for the site and the available data for SW02 and SW03 is presented in Appendix B. There were data collection issues with the SW01 monitoring point, which are currently being resolved. The data indicates that during low flows turbidity is generally between 5 and 20 NTU, but increases significantly during rainfall events. There is also significant noise in the data due to the activities of livestock and freshwater fauna in the streams.

4.2 Taupō Swamp and Taupō Stream

Water quality has been monitored regularly by GWRC at Taupō Stream at Plimmerton Domain since July 2020 (GWRC, 2023). Appendix B presents a summary of the baseline water quality data and key findings include:

- All parameters are lower than the Maximum Acceptable Value (MAV) as defined by the New Zealand Drinking Water Standards (2022).
- Zinc concentrations consistently exceeded the default freshwater guideline values for 99% species protection from Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ, 2018) and occasionally exceeded the 95% threshold.
- Baseline copper concentrations are generally at or near the 99th percentile, and have occasionally exceeded the default freshwater guideline values for 95% species protection, as outlined in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).

4.2.1 Turbidity

The turbidity of Taupō Stream at Plimmerton Domain is monitored monthly along with the other water quality parameters. Turbidity is typically less than 20 NTU at the monitoring site, with only four exceedances of this value in the past five years (71 NTU, 145 NTU, 38 NTU and 37 NTU). Peaks in turbidity appear to be linked with high flow events following rainfall. On 13 June 2022, 69.4 mm rainfall was recorded at Taupō Swamp (Taupō Stream at Whenua Tapu) and a turbidity of 145 NTU was measured at the Plimmerton Domain. However, it is noted that continuous turbidity monitoring is not undertaken so a true understanding of the variation in turbidity associated with rainfall events is possible from the data available.

4.3 Kakaho Stream

No data is available to characterise the Kakaho Stream catchment. For the purpose of assessing potential effects on downstream receptors, the baseline data collected at SW03 will be compared with the data in the Taupo Stream catchment as this is the water quality monitoring site closest to the Kakaho Stream catchment.

4.4 Te Awarua-o-Porirua - Pāuatahanui Inlet

Greater Wellington has conducted annual environmental monitoring of sediment at three subtidal sites in the Pāuatahanui Inlet since 2004 (Pāuatahanui Sites 1, 2, and 3). In 2008, two additional intertidal sites—Pāuatahanui A and B—were added to the monitoring programme (source: LAWA website). For the purpose of this report, data collected at Pāuatahanui Subtidal Site 3 is presented in Appendix A, as it is the closest monitoring site to the Kakaho Stream outlet.

No default guideline values for toxicants in sediments (based on freshwater and marine water quality guidelines) are exceeded for heavy metals. However, the value for total DDT (Dichlorodiphenyltrichloroethane) exceeds the guideline, and the mud content—48% in the most recent monitoring in 2020—indicates that the macrofauna community is unbalanced.

GWRC is also undertaking continuous sediment monitoring within the Porirua, Pāuatahanui and Horokiri Streams in an attempt to quantify the annual and event-based sediment deposition in the harbour (GWRC, 2022). A monitoring site has not been set up on the Kakaho Stream at this time.

4.5 Comparison of baseline water quality

Due to the currently limited water quality monitoring data at Mount Welcome, a high degree of characterisation of the baseline quality of surface water leaving the site was not possible. However, on the basis of the sampling carried out on 26/08/2025 some key similarities and contrasts to the baseline data collected by GWRC at Taupō Stream at Plimmerton Domain have been noted.

Graphs 1 to 14 in Appendix B display the results from key parameters at SW01, SW02, SW03 and Taupō Stream:

- Nitrate-Nitrogen levels at all three monitoring stations are considerably higher than the mean value at Taupo Stream. However, the highest measured value (at SW03 1.08 mg/L) is below the recommended guideline value of 1.1 mg/L for 95% species protection in moderately disturbed ecosystems but higher than the 99% level (0.64mg/l) (see Appendix A). This may be due to land use of the area as a deer farm. The transition to residential land use, combined with strategic planting on the steep slopes, is expected to help reduce these concentrations over time.

- Zinc concentrations measured on-site were similar to the ones in Taupō Stream and exceeded the 99% species protection value (ANZ 2018) at all three sampling locations while remaining below the 95% threshold.
- Copper concentrations were within the same range as those in Taupō Stream and exceeded the 99% species protection value (ANZ 2018) at sites SW02 and SW03, while remaining below the 95% threshold.
- Calcium and magnesium (and consequently hardness) measured on site were lower than the mean values at Taupō Stream.
- Electrical Conductivity (EC) and dissolved reactive phosphorus on site is significantly lower than at Taupō Stream. However, only one measurement per site is available and this is not sufficient to make any final statement concerning trends of EC or phosphorus on site.
- The pH values on site appears to be in the same range or slightly higher than at Taupō Stream.

4.5.1 Turbidity

Turbidity at SW02 and SW03 between 26/07/2025 and 26/08/2025 appears to have a baseline of 5 to 10 NTU, which is slightly higher than the baseline turbidity at Taupō Stream (below 5 NTU). Turbidity peaks at sites SW02 and SW03 reached approximately 450 NTU in response to rainfall events, compared to a peak of 140 NTU observed at Taupō Stream.

However, turbidity at SW02 and SW03 is telemetered, with readings taken every 15 minutes, while Taupō Stream is monitored approximately monthly. This difference in monitoring frequency makes direct comparisons difficult. Without more frequent data from Taupō Stream, it is challenging to accurately characterise turbidity during high flow events, and actual peak turbidity is likely to be higher than currently estimated.

The turbidity levels at the site are as expected higher than in Taupō Stream due to the nature of the catchment characterised by steep, highly erodible slopes used as pasture, which contributes to elevated turbidity during rainfall and high flow events. The Taupo Stream monitoring point is downstream of Taupo Swamp, which will naturally filter a large portion of the sediment from stream flows before it reaches the monitoring point.

5.0 Existing Effects on Downstream Receptors

5.1 Taupo Stream and Taupo Swamp

Taupo Swamp is a regionally significant wetland. It has a largely indigenous vegetation cover and contains regionally unique and diverse vegetation communities, supporting native fauna and flora species (GWRC, 2020).

Based on the limited baseline water quality data available, the discharge from the site catchment into the Taupō Stream does not appear to negatively affect the water quality of the stream or swamp, with the possible exception of the following:

- Nitrate-Nitrogen, which was detected at concentrations below the 95% species protection value at sampling locations SW01 and SW02."The overall turbidity, where the nature of the catchment characterised by steep, highly erodible slopes used as pasture, could contribute to elevated turbidity during rainfall and high flow events, particularly following localised slips.

5.2 Kakaho Stream

As explained above no public data is available to characterize the baseline water quality data for this catchment. It has therefore been assumed that the effects of the existing catchment to the baseline water quality of the Kakaho Stream are similar to the ones of the Taupo Stream.

In particular, the measured Nitrate-Nitrogen value at SW03 is higher than the recommended guideline value of 0.64 mg/L for 99% species protection as outlined in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). Therefore, it can be assumed that the existing catchment within the development site boundary might contribute to the Nitrate values in the stream.

5.3 Porirua Harbour - Te Awarua-o-Porirua

The key concerns in the harbour are the build-up of sediment and increases in heavy metal concentrations. The limited existing site data indicates that the current concentrations of metals in the streams discharging from the site are likely to have a negligible impact on the harbour.

Regarding sediment erosion, the turbidity values measured at the site indicate that sediment can become mobilised during rainfall events. This is likely to contribute to sedimentation in the harbour to some degree, particularly for the Kakaho Stream, which is not buffered by the Taupo Swamp. However, given the size of the catchments and the overall input of the Taupo and Kakaho Streams to sedimentation in the Harbour, which is presumably much lower than that of the Horokiwi and Pāuatahanui Streams, the contribution from the catchment within the development site boundary to the overall sediment load in the Harbour is likely to be limited.

The Kakaho Stream catchment represents approximately 12% of the total catchment area of streams discharging into the Pāuatahanui Inlet. Within this catchment, the site comprises around 1.4%. Given these proportions, it is reasonable to conclude that contribution from the site is likely to have a limited impact on the volume of sediment transported into the Pāuatahanui Inlet.

6.0 Proposed development

The Mount Welcome site is located at 422 State Highway 59 near Pukerua Bay. The project involves subdividing the existing site into 950 residential allotments and a neighbourhood centre. Site access will be provided from State Highway 59.

The project also includes the development of land for open space, ecological offsetting, restoration, protection and enhancement. Supporting infrastructure, including roads and reserves, accessways and three-waters services will also be constructed. Given the existing topography of the site, significant earthworks are planned during development, leading to 15,626 m^2 of natural inland wetland likely to be affected. The offset and enhancements proposed to mitigate this loss are detailed in the values assessment and offset calculations reported elsewhere (BlueGreen Ecology Limited, 2025).

6.1.1 Proposed stormwater infrastructure

The proposed stormwater infrastructure and treatment is detailed in drawings 1753-02-4000 to 1753-02-4156 and the draft Stormwater Management Plan to be provided by Envelope Engineering. All stormwater runoff from the impervious parts of the development (lots and roads) will be treated through raingardens before being discharged into onsite streams and wetlands.

Four existing wetland areas will be transformed into stormwater retention wetlands and will receive treated stormwater via the raingardens. These will feature a permanent central body of standing water, with excess flows directed downstream via culverts designed to limit discharge rates. There will also be a constructed stormwater retention wetland on the northern boundary to control discharges into the Muri Road block and Waimapihi catchment.

7.0 Assessment of effects during construction

The key potential impacts on water quality during construction are:

- Erosion from exposed slopes and excavations during earthworks and construction causing sediment to be deposited in the wetlands or carried off site via the streams.
- Oil and fuel spills from construction vehicles working on the site releasing hydrocarbons into the water ways.
- Release of cement or other potentially toxic construction materials (e.g. glues).

Should contaminants at the site be released or washed into the waterways, there is a risk that there could be impacts on the wetlands at the site and the downstream receptors. However, standard control measures during construction will significantly reduce the risks.

In accordance with conditions in the GWRC NRP, oil and fuel need to be stored clear of wetlands and watercourses. Further, any oil, fuel or chemical spills will be cleaned up immediately, and measures will be instigated to ensure the risk of contaminants entering waterways is minimised.

The most likely risk to water quality for on-site and off-site receptors during construction is the release of sediment into the waterways. This will be managed on site via an Erosion and Sediment Control Plan (ESCP) prepared by Envelope Engineering. Detailed controls, monitoring, mitigation measures and remediation requirements are presented in the ESCP, which should be read in conjunction with this report. In summary these will include but are not limited to:

- Buffer zones around wetlands and streams where earthworks will be avoided, outside of consented works within wetland areas.
- Limiting the open area of the earthworks in alignment with best practice and Council guidance documents. to reduce the risk of sediment release.
- Installation of sediment retention devices, such as decanting earth bunds, silt fences, and sediment retention ponds.
- Placement of sediment retention devices upstream of wetland areas to capture and divert sediment away from on-site wetlands.
- Continuous monitoring of the turbidity in the main streams leaving site throughout the construction program (SW01, SW02 and SW03). This monitoring is currently in place to obtain baseline information.

With these control measures in place, the impact of construction on the water quality at the onsite and offsite receptors is likely to be less than minor.

8.0 Assessment of effects post-construction

8.1 Causes

The following changes at the site could potentially impact upon the water quality at the on and off-site receptors:

- Change in land use from grazing farmland to residential lots
- Presence of roads and other infrastructure
- Materials used to construct the houses and infrastructure
- Changes in vegetation

- Stabilisation of hillslopes because of development and planting
- Change in stormwater treatment, run-off and retention

8.2 Effects on receptors

8.2.1 Change in land use

The removal of deer and cattle from the site, combined with the proposed slope planting, construction of retention wetlands, enhancement of existing wetlands and ecological offset measures will help reduce erosion and sediment runoff. This, in turn, will lower the levels of suspended sediments and turbidity in the downstream Taupo and Kakaho Streams following rainfall events.

Additionally, elevated Nitrate-Nitrogen concentrations observed at monitoring points SW01, SW02, and SW03—compared to levels in the Taupo Stream—suggest nutrient runoff from livestock. Currently, livestock (cattle and deer) have access to most stream and wetland areas, and riparian planting is minimal, allowing nutrients to enter waterways with little filtration.

The decommissioning of the deer farm and subsequent replanting efforts are expected to significantly reduce nutrient runoff. These changes are likely to improve water quality within the site's wetlands and streams, as well as in downstream receiving environments.

It is noted that some farming of the valley floor of the Kakaho catchments may continue post development, on neighbouring land albeit on a smaller scale than at present. However, it is understood that riparian planting is proposed along portions of this stream which will increase filtration and reduce the impacts of this activity.

8.2.2 Roads and infrastructure

The presence of roads and other infrastructure increases the risks of fuel spills and oil leaks occurring at the site. At present the site is accessed solely by the farmer and other residents so vehicle movements are low. On completion of the development there will be more vehicles regularly using the roads and parking within the development. In theory this increases the risk of hydrocarbon and heavy metals contamination at the site running off into streams or wetland areas and potentially migrating off site.

However, at present vehicular access is unpaved with no management of run-off or treatment. On completion of the development, all the access roads and parking areas will be paved and linked to the stormwater management system, with associated treatment measures to remove hydrocarbon and heavy metals contaminations through raingardens. Therefore, provided the raingardens are sized and managed effectively, the risk of significant hydrocarbon and heavy metal contaminants entering the waterways and impacting upon on site and downstream receptors is considered low.

8.2.3 Materials

Stormwater runoff onsite could result in an increase in heavy metals from the construction materials used to construct the buildings and roads. Cadmium, chromium, nickel, lead, copper, zinc and iron are all key heavy metals that can be present in stormwater runoff from residential areas. Baseline concentrations of these contaminants at the site are low, although zinc concentrations periodically exceeded the default freshwater guideline values for 99% species protection from Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ, 2018) and copper concentrations occasionally exceeded the default freshwater guideline values for 95% and 99% species protection.

Due to the ecological risks associated with heavy metals, particularly on the downstream environment, the proposal includes restricting the use of exposed copper and zinc materials. This will reduce the risk of increased metals in run-off at the site. Furthermore, all stormwater run-off from buildings and roads will be collected by the stormwater management system and treated prior to discharge into the streams and wetlands present at the site.

8.2.4 Changes in vegetation

At present the site is covered primarily with rough pasture, with occasional pockets of native bush and unfenced wetland areas. The pasture is frequently cropped extremely short by livestock, leading to erosion and visible scour, and the wetlands are pugged and grazed reducing the height and extent of vegetation.

Large areas of wetland will be retained and enhanced, and there will also be appropriate vegetated offsetting areas as part of the development. Native planting of batter slopes and hillslopes above the wetlands is also proposed. Four of the retained wetlands will be transformed into retention wetlands with an appropriate planting plan.

It is acknowledged that there will be significantly more impervious surface, reducing the overall green cover at the site. However, in areas where buildings are not proposed the vegetative cover will be significantly improved over the existing conditions by preventing grazing and strategically replanting key slopes. The planting of native plants and bush upon batter slopes will provide natural treatment to run-off (treated or otherwise) entering the streams and wetlands by filtering sediment and absorbing nutrients and metals.

The riparian planting along the Kakaho Stream will also naturally retain more sediment and absorb nutrients, whilst restricting access of livestock to the stream to reduce pugging and sediment disturbance. The removal of livestock from the remainder of the site, will allow areas where no additional planting is proposed to recover and over time bushland will also develop across these slopes via natural seeding from the planted areas.

On balance, it is considered likely that the changes in vegetation will lead to an improvement in water quality.

8.2.5 Slope stabilisation

At present the hillslopes are not particularly stable, with recent and older slump features visible across the site. Turbidity monitoring has indicated that following rainfall events suspended solids currently do leave the site and could potentially impact downstream receptors.

The development will recontour large parts of the site, installing batter slopes with associated drainage, and controlling run-off via the stormwater management system.

In general, most of the fill slopes will be planted with suitable native vegetation to reduce erosion and stabilise the soil, while cut slopes will be re-grassed using hydroseeding. The remaining areas of the site, where grazing will no longer occur, are expected to naturally regenerate with gorse and native bush. The landscape urban design strategy report, along with the landscape and ecology drawings, detail the extent of the replanting effort (Blac Projects, 2025). Stormwater discharges will be constructed to minimise erosion risks and reduce scour from the slopes.

It is therefore considered that the development will increase the stability of the slopes and reduce the risk of sediment run-off in the long term.

8.2.6 Stormwater treatment, run-off and retention

Land use at the site will change from farmland to residential housing and access roads, interspersed with areas of open space.

The stormwater treatment and management systems proposed are designed to minimise any negative impacts on water quality at downstream receptors.

Envelope Engineering Limited has designed 30 raingardens in accordance with the guidelines for the design of Stormwater Management Devices in the Auckland Region. These structures are not designed to provide retention due to the geotechnical constraints of the site, but rather to improve the water quality of the run-off before being discharged to downstream receptors. The retention wetlands, located downstream of the raingardens, will retain the flows from the site to ensure peak flows are lower than predevelopment, reducing the risk of large-scale sediment mobilisation.

Envelope Engineering provided calculations demonstrating that the total capacity of the raingardens can accommodate the expected Water Quality Flow (WQF) from the impervious surfaces in the lots and roads. Based on this information, it has been assumed that the raingardens will treat the stormwater in accordance with the estimated removal rates provided in the Stormwater Treatment for Road Infrastructure (NZTA 2010).

Table 3: Raingarden treatment performance – WWL treatment device design guideline

Parameter	Estimated Removal Rates
TSS	90%
Total Nitrogen	40%
Total Phosphorus	60%
Zinc	90%
Copper	90%

Note:
1. *Data obtained from Stormwater Treatment for Road Infrastructure, NZ Transport Agency 2010*

Removal of the contaminants in line with these estimates is likely to be sufficient to minimise any effects on downstream receptors. Nitrogen and phosphorus will naturally be reduced by the change in land use from livestock to residential so the treatment rates should further reduce the impacts from these parameters.

The presence of roads is likely to increase the zinc and copper discharge from stormwater run-off from the site before treatment. Whilst the restrictions to construction materials will help reduce this increase, the raingardens will be critical for removal of these contaminants. Provided that raingardens operate to the design criteria, this is considered sufficient to ensure there is no increase in average discharge of heavy metals from the site.

Following construction, there will be more surface run-off due to the increase of impervious surfaces and water use at the site. However, at present there is limited retention of stormwater at the site, with discharge being relatively rapid following rainfall events. The proposed development will include storage that will reduce runoff, filter, and slow the discharge from the site. This will include the four wetland retention areas through which the majority of water will flow before leaving the site. These areas will act as natural wetlands and slow the discharge from the site and spread out the downstream effects over a longer time period, reducing the risk of a significant initial contaminant flush. There will also be one constructed stormwater retention wetland which, whilst not a natural wetland, will act in a similar manner.

While these retention wetlands are not intended to treat pollutants, they will reduce flow velocity and naturally filtering materials.

8.3 Mitigation and Control Measures

8.3.1 Stormwater design

The proposed stormwater design and management is detailed in the Operational Stormwater Management Plan and Infrastructure Report provided by Envelope Engineering, which in combination, details the infrastructure and treatment measures. A high-level summary of the key stormwater run-off controls include:

- Stormwater runoff from roads and other impervious surfaces will be collected and treated in raingardens prior to discharge into the natural wetlands on site.
- Once treated, stormwater runoff will discharge into existing natural wetlands, some of which will be converted into natural retention wetlands, where further treatment will occur via natural and chemical biological processes resulting in further nutrient and sediment absorption and uptake. As wetlands are valuable onsite receptors themselves, no untreated stormwater will be discharged into these sensitive ecosystems.

According to the calculations provided by Envelope, the stormwater management system has been designed to ensure an appropriate level of treatment before the water is discharged into the natural environment. The presence of the natural wetlands on site will mean that the water will be further filtered before being discharged to downstream receptors. It is therefore considered that the potential negative effects on the Taupō Stream, Kakaho Stream and Te Awarua-o-Porirua Harbour will be less than minor.

8.3.2 Ecological and planting

The proposed development involves substantial earthworks, which are expected to affect approximately 15,626 m^2 of natural inland wetland. To mitigate this impact, 0.69 ha will be restored as ecologically valuable retention wetlands, with additional offsetting and restoration efforts resulting in a net gain of over 50,000 m^2. Details of the proposed offsets and ecological enhancements are outlined in the Mt Wellington Station Ecology 2025 report by BlueGreen Ecology Limited.

Additionally, as mentioned above, most of the fill areas will be replanted with native species, while the remainder will be re-grassed. Cut areas will be predominately re-grassed using hydroseeding. The nature of the development means that grazing will occur on a much smaller area, with livestock excluded from the Taupo and Muri Road catchments and parts of the Kakaho West catchment. This will allow gorse and native bush to naturally colonise these areas over time, thereby enhancing sediment retention and ecological value (refer to Landscape Urban Design Strategy Report, along with the landscape and ecology plans).

Buffer planting is also proposed around the retained and retention wetlands. The vegetation selected has been chosen to enhance the natural environment, provide diversity and to stabilise slopes where appropriate.

These plants will reduce run-off and erosion from the hillslopes following rainfall events. This will lead to a reduction of suspended sediment in the surface water leaving the site, reducing the impact on downstream receptors.

8.4 Downstream receptors

8.4.1 Taupō Stream

Baseline data indicates the water quality in Taupō Stream and the site is similar. Following construction, the quality of the discharge entering Taupō Stream is considered likely to be an improvement on the existing discharge. Sediment and nutrients, in particular nitrate should be significantly reduced, and on-site treatment should negate any increase in metals or hydrocarbons from stormwater run-off.

8.4.2 Kakaho Stream

As explained above no data is available to characterize the baseline water quality data for this catchment. We have therefore used a basis of the effects of the existing catchment to the baseline water quality of the Kakaho Stream are similar to the ones of the Taupo Stream.

Whilst some parts of this catchment within this site will still be used for livestock, the number and area will be significantly reduced. Furthermore, riparian planting is proposed along the stream and around the key wetlands which will provide additional filtration. Given the proposed stormwater retention and treatment systems, it is considered likely that the effects of the development on water quality on the Kakaho Stream will be less than minor.

8.4.3 Te Awarua-o-Porirua Harbour

The key risks posed to the marine receiving environments are increased sedimentation during and post construction. During construction this risk will be managed and mitigated using the measures detailed in the ESCP. Post-construction suspended solids in water leaving the site are expected to be reduced by 90%, in accordance with Stormwater Treatment for State Highway Infrastructure (2010), provided the raingardens are appropriately sized and constructed. Additionally, a further offsite reduction in sediment mobilisation can be anticipated due to increased slope stability resulting from planting and the reduction in peak flows from the retention wetlands.

Therefore, it is considered likely that, following construction, there will be a decrease in the volume of sediment leaving the site and discharging into the harbour.

9.0 Conclusions and Recommendations

A review of the available data for the site and surrounding catchments and receiving environments has been completed. There is limited data for the site at this stage as only the first quarterly monitoring round is available. As a result, the baseline dataset is limited and does not allow for a comprehensive characterisation of water quality at the site.

There is data available for the Taupo Stream, albeit significantly downstream of the site, Taupo Swamp, and the industrial estate at Plimmerton. There is no baseline water quality data available for the Kakaho Stream catchment. GWRC does test the harbour for key parameters, and this information has been reviewed.

The results indicate that under current conditions nitrate concentrations at all three on site monitoring stations are significantly higher than the mean value recorded at Taupō Stream, though they do not exceed the default freshwater guideline values for 95% species protection as outlined in the Australia and New Zealand Guidelines for Fresh and Marine Water Quality. This may be attributed to the site's land use as a deer farm.

Measured concentrations of copper and zinc on-site slightly exceeded the default freshwater guideline values for 99% species protection, according to the ANZ Guidelines (2018), while complying with the 95% threshold.

The limited available turbidity data at SW02 and SW03 showed a baseline of 5–10 NTU, slightly higher than Taupō Stream's baseline (<5 NTU), with higher peaks during rainfall events. More elevated turbidity at the site is expected due to steep, erodible pasture slopes, while Taupō Stream benefits from sediment filtration by Taupō Swamp upstream of the monitoring point.

The proposed development is expected to improve downstream water quality due to the following changes:

- Removal of livestock from the majority of the site, reducing the nutrient loading and erosion of slopes.
- Treatment of runoff from impervious surfaces within the lots and along the road via raingardens to remove/reduce sediment, metals and nutrients in run-off.
- Replanting of slopes with native species and riparian buffers to increase filtration and decrease erosion.
- On-site retention wetlands reduce peak flows from the site and therefore the sediment mobilisation during large scale rainfall events.

- Natural wetlands at the site (both retention and in gully systems) offer additional filtration and retardation of contaminants, although no untreated stormwater run-off from impervious surfaces will be discharged into these systems.

It is therefore considered that the effects of the development on the water quality of the downstream receptors—Taupō Stream, Kakaho Stream, and Porirua Harbour—will be less than minor. However, it is recommended that further baseline water quality monitoring at the site is undertaken to more effectively characterise the existing water quality prior to construction. This is underway and will be continue to at least June 2026 and will provide a basis for comparison during and post construction.

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Appendix A: Tables

Table 4: Water quality sampling result summary – Taupo Stream at Plimmerton Domain and SW01, SW02, SW03

Water Quality Sampling Results Summary									
Analyte	Unit	Taupo Stream			SW01 [1]	SW02	SW03	**ANZ Guidelines for Fresh Water Quality [3]**	
		min	max	mean	26/08/2025			95% Species Protection	99% Species Protection
Total Hardness	g/m^3 as $CaCO_3$	39	112	66	39	33	29		
Sum of Anions	meq/L				2.6	2.4	2.1		
Sum of Cations	meq/L				2.8	2.6	2.2		
pH	pH	6.6	7.8	7.2	7.3	7.3	7.3		
Turbidity	NTU	1.2	145	9.604					
Total Alkalinity	g/m3 as $CaCO_3$				37	32	25		
Bicarbonate	g/m3 at 25°C				45	39	30		
Electrical Conductivity (EC)	µS/cm	194	502	316	29.1	28	23.7		
Calcium (Ca)	g/m3	4.8	21	11					
Dissolved Calcium	g/m^3	4.8	21	10.9	5.2	5	4.6		
Dissolved Magnesium	g/m^3	3.6	14.3	7.67	6.4	5.1	4.4		
Dissolved Potassium	g/m^3				1.93	1.78	1.69		
Dissolved Sodium	g/m^3				45	44	36		
Chloride (Cl-)	g/m^3				52	54	44		
Sulfate (SO_4^{2-})	g/m^3				15.1	12.4	13.3		
Ammonia as N (NH3N)	g/m^3	0.003	0.099	0.03	0.03	0.033	0.044	0.9	0.32
Nitrate-N (NO_3-N)	g/m^3	0.001	0.76	0.101	0.57	0.55	1.08	1.1	0.64
Nitrite-N (NO_2-N)	g/m^3	0.001	0.015	0.004	0.007	0.01	0.009		
Nitrate-N + Nitrite-N	g/m^3	0.001	**0.76**	**0.76**	0.58	0.56	**1.08**	1.1	0.64
Dissolved Inorganic Nitrogen	g/m^3	0.007	0.790	0.135					
Total Nitrogen (TN)	g/m^3	0.18	1.72	0.57					
Total Phosphorus (TP)	g/m^3	0.022	0.22	0.056					
Dissolved Reactive Phosphorus (DRP)	g/m3	0.0095	0.056	0.02	< 0.004	0.005	0.006		
Dissolved Organic Carbon	g/m^3	4.6	14.9	9.3					
Dissolved Oxygen	% sat	16.8	95.8	63.06					
Dissolved Oxygen Field	mg/l	1.73	10.04	6.69					
Fine Sediment Cover	%Cover	23.3	99.7	44					
Suspended Sediment Concentration	g/m^3	5	115	12.7					

Heavy Metals, trace									
Dissolved Arsenic	g/m3				< 0.0010	< 0.0010	< 0.0010		
Dissolved Cadmium	g/m^3				< 0.00005	< 0.00005	< 0.00005		
Dissolved Chromium	g/m^3				< 0.0005	< 0.0005	< 0.0005		
Dissolved Copper (Cu)	g/m^3	0.0005	0.002	0.00082	0.0007	0.0008	0.0006		
Dissolved Lead	g/m^3				0.00012	0.00011	< 0.00010		
Dissolved Nickel	g/m^3				< 0.0005	0.0005	< 0.0005		
Dissolved Zinc	g/m3	0.001	0.0057	0.002	0.0011	0.0011	< 0.0010		
Total Metals									
Total Arsenic	g/m3				< 0.0011	< 0.0011	< 0.0011	0.024 [4]	0.001 [4]
Total Cadmium	g/m3				< 0.000053	< 0.000053	< 0.000053	0.0002	0.00006
Total Chromium	g/m3				**0.00069**	**< 0.00053**	**0.00065**	0.001	0.00001
Total Copper	g/m3	0.00053	**<u>0.004</u>**	**0.00101**	**0.0012**	**0.00115**	0.00091	0.0014	0.001
Total Lead	g/m3				0.00099	0.0005	0.00051		
Total Nickel	g/m3				0.0007	0.00076	0.0006	0.011	0.008
Total Zinc	g/m3	0.001	**0.023**	**0.0038**	**0.0045**	**0.0029**	**0.0034**	0.008	0.0024
Microbial Parameters									
E. coli	cfu/100ml	20	11000	883.333					

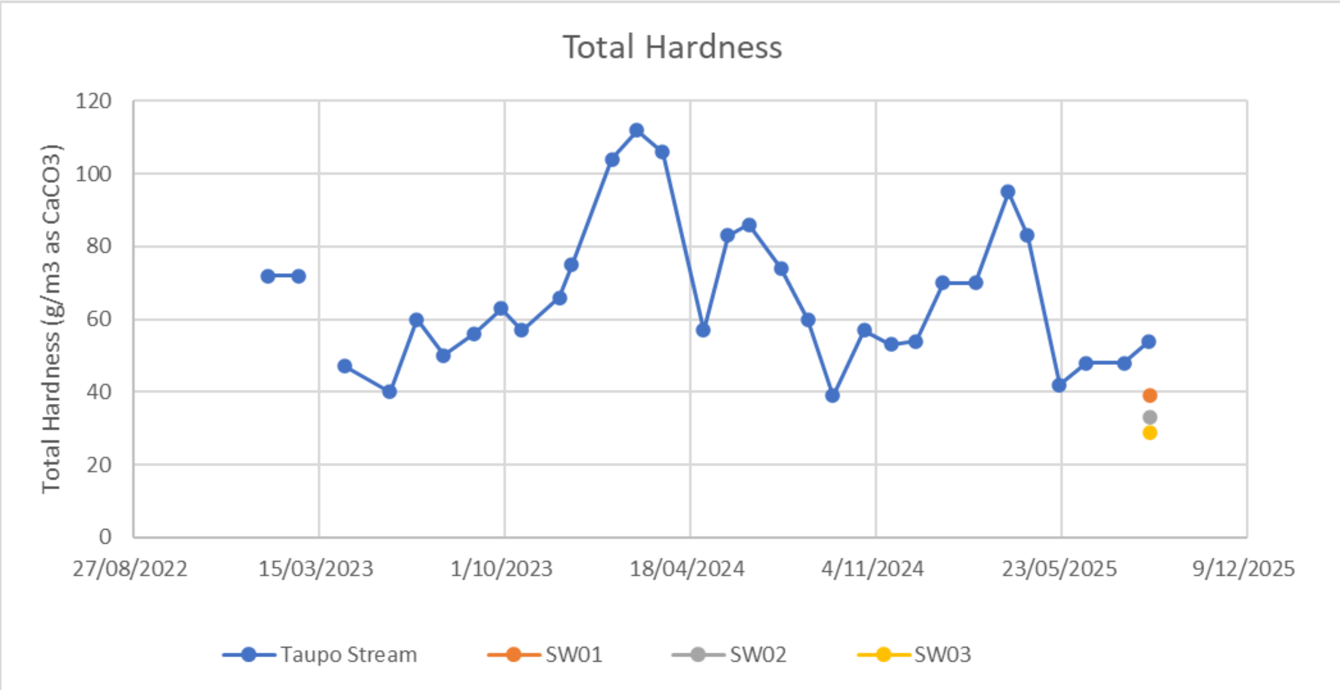
Note: Bold exceeds 99% and underlined exceeds 95% species protection

Table 5: Sediment sampling results - Pāuatahanui Subtidal Site 3

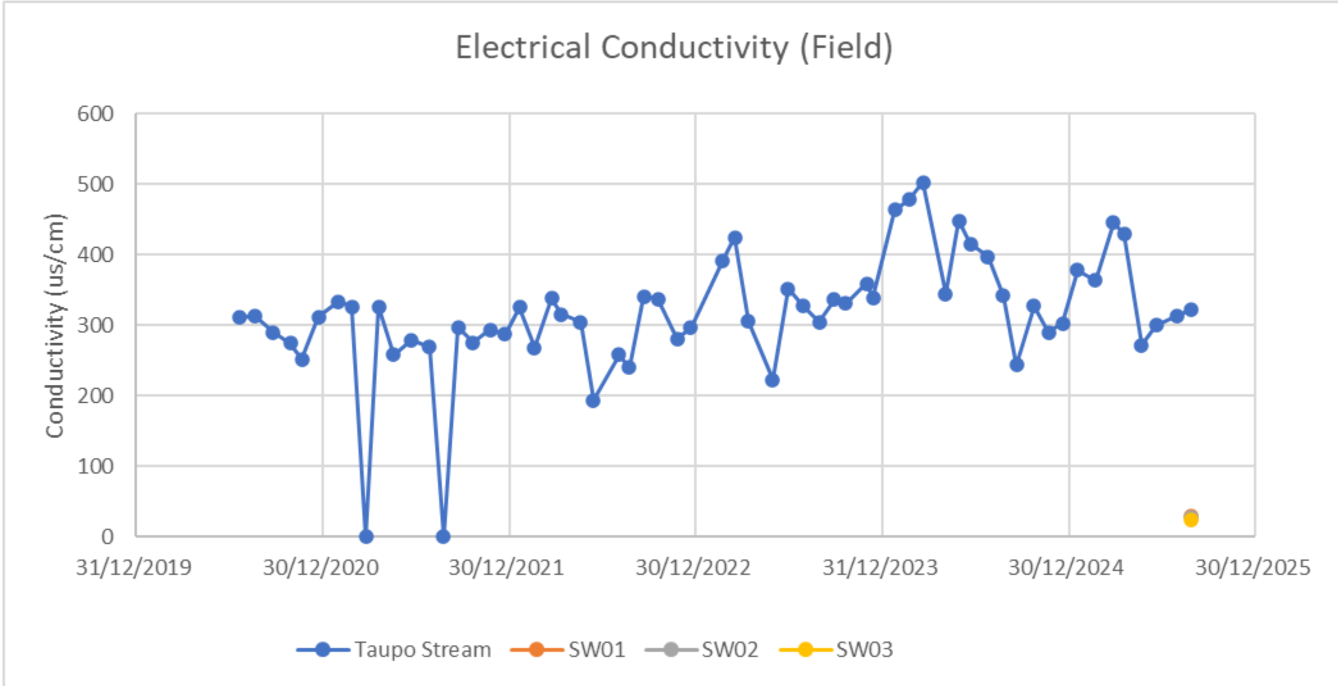
Date sampled	10/11/2010	10/11/2015	20/11/2020	Default guideline values for toxicants in sediments
Heavy Metals				
Arsenic (mg/kg)	7	8.3	9.1	20
Cadmium (mg/kg)	0.041	0.041	0.036	1.5
Chromium (mg/kg)	14.1	15.1	15.1	80
Copper (mg/kg)	7.7	8	7.9	65
Lead (mg/kg)	15.6	16	13.6	50
Mercury (mg/kg)	0.063	0.05	0.05	0.15
Nickel (mg/kg)	9.6	9.8	11	21
Silver (mg/kg)		0.1		1
Zinc (mg/kg)	62	62	68.7	200
Other Contaminants				
Total DDT (ug/kg at 1% TOC)		**4.2**		1.2
Mud Content (%)	25.37	24.80	**48.25**	10-30% (Diversity of macrofauna reduced and less resilient to disturbance). 30-60% (Macrofauna community is unbalanced and dominated by a small number of tolerant species).

Note: Bold exceeds guideline values

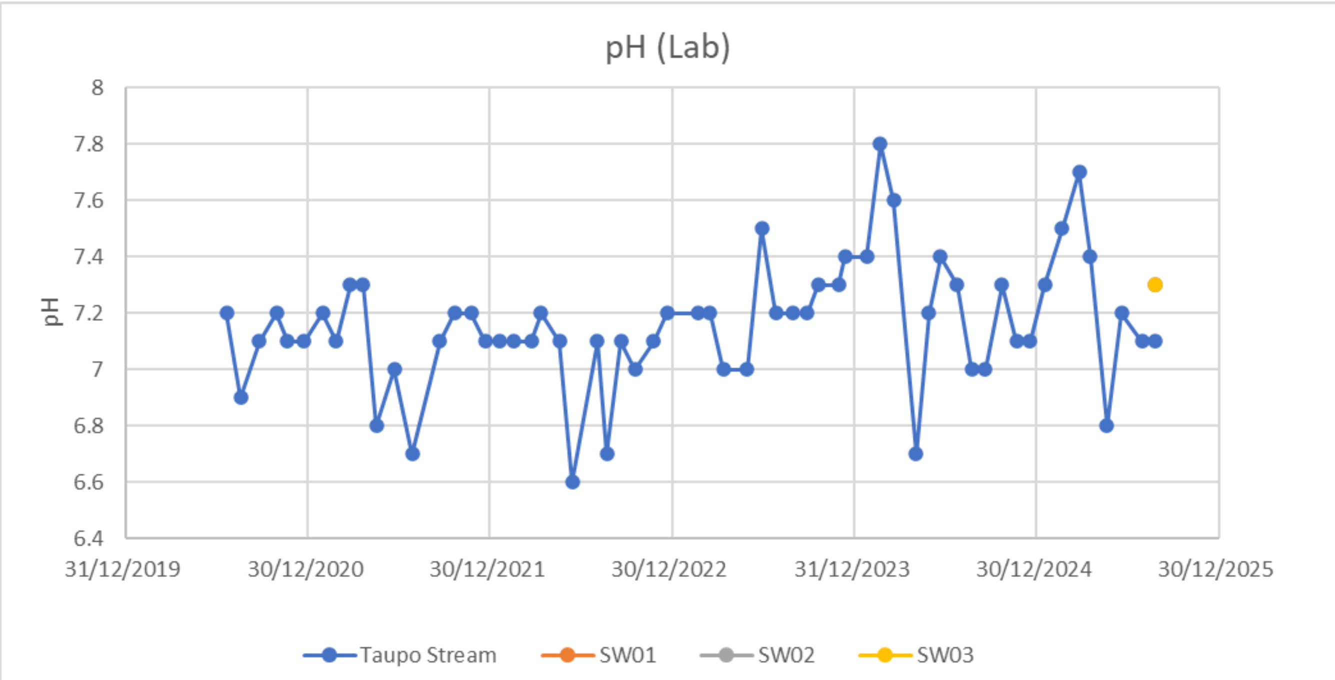
Appendix B: Graphs



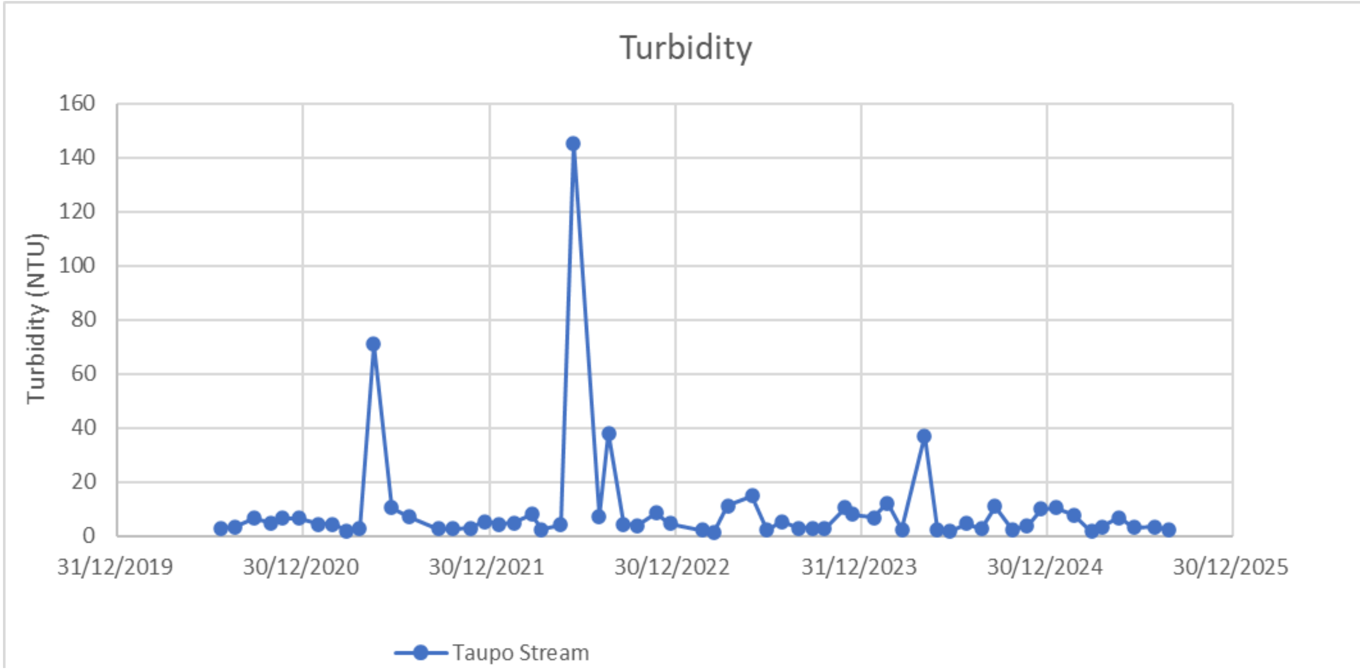
Graph 4: Total Hardness



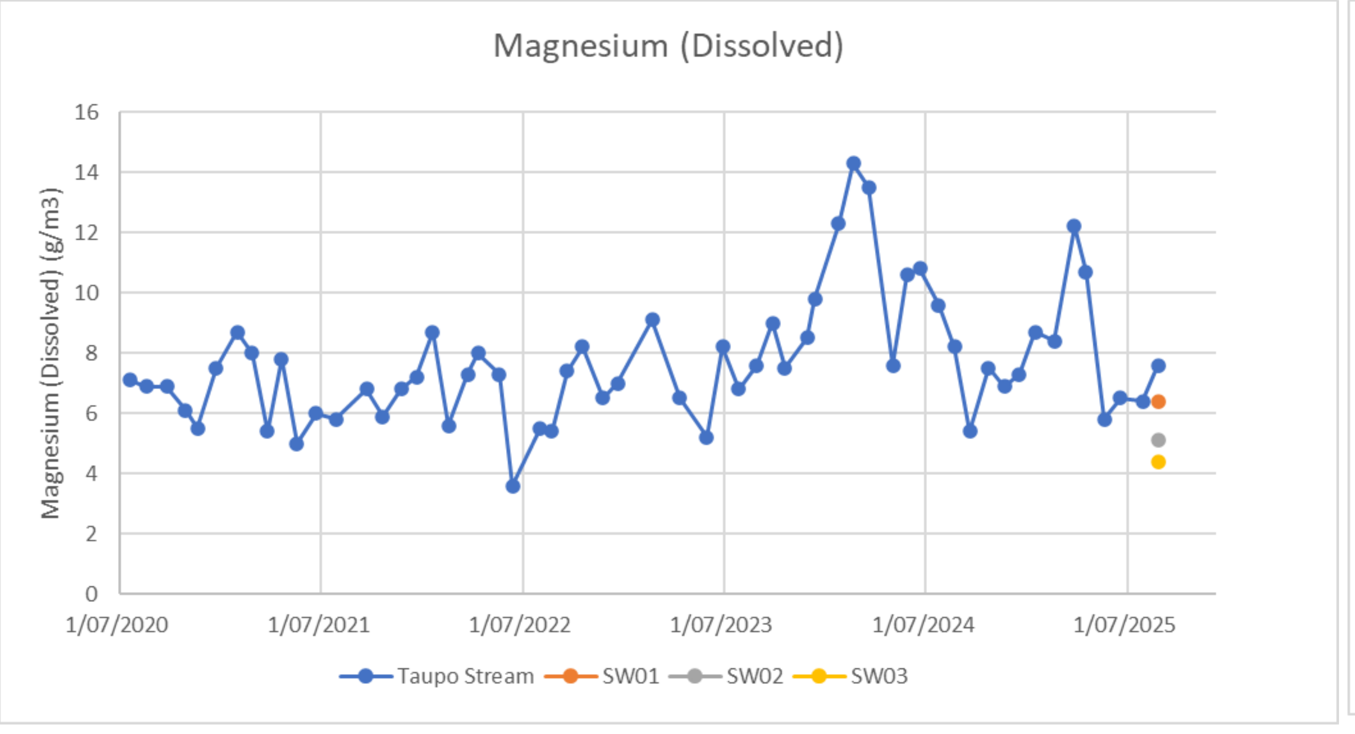
Graph 3: Electrical Conductivity



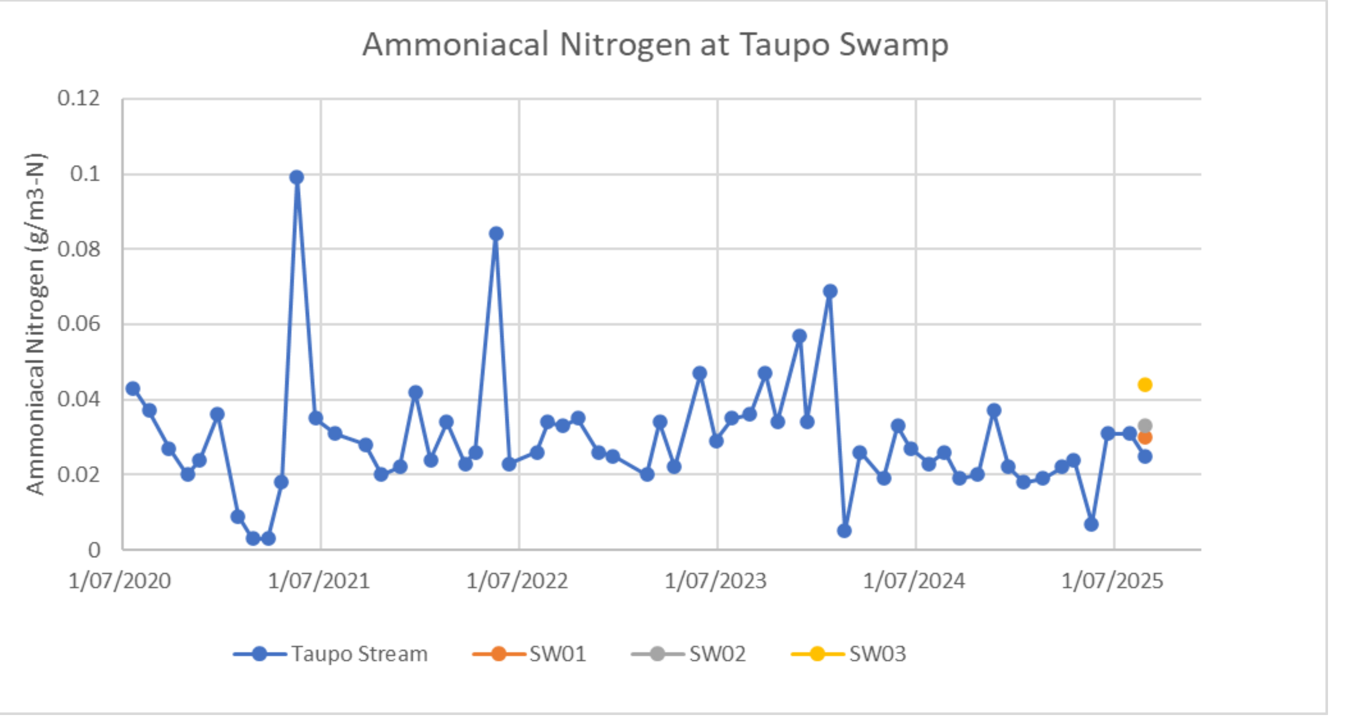
Graph 1: pH



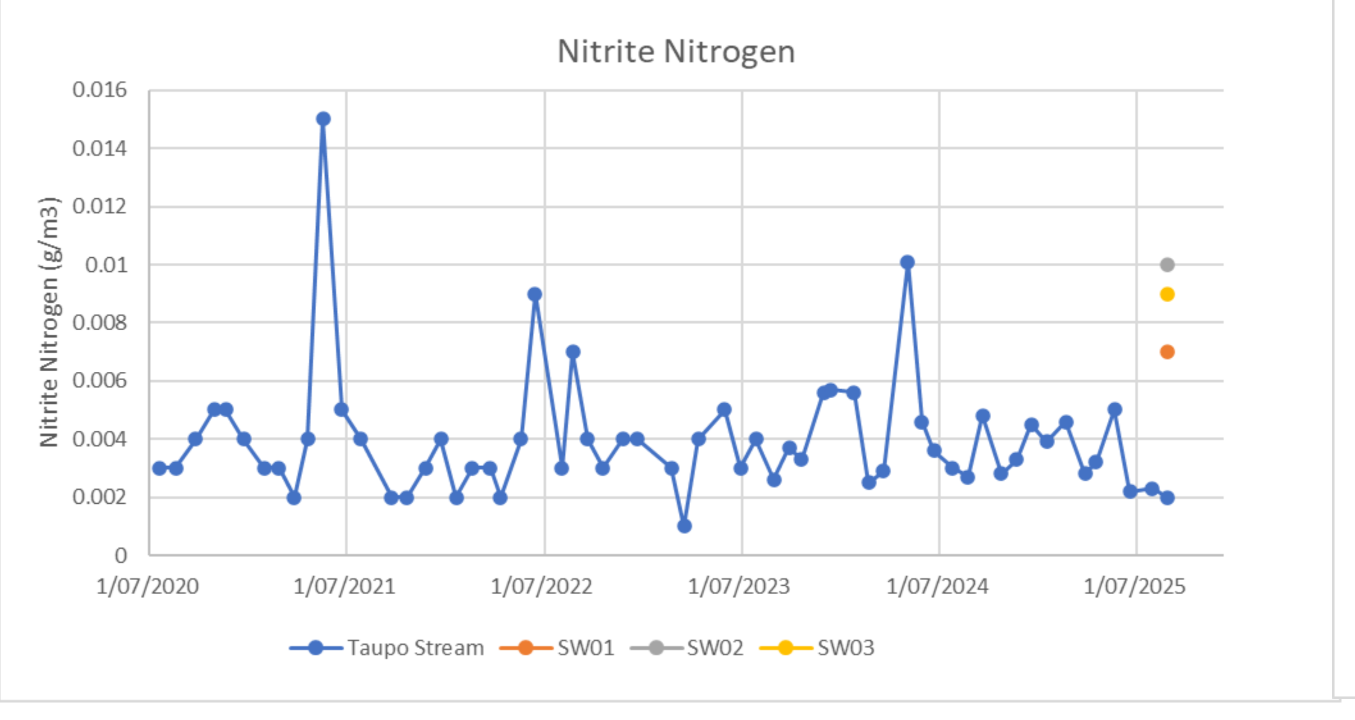
Graph 2: Turbidity



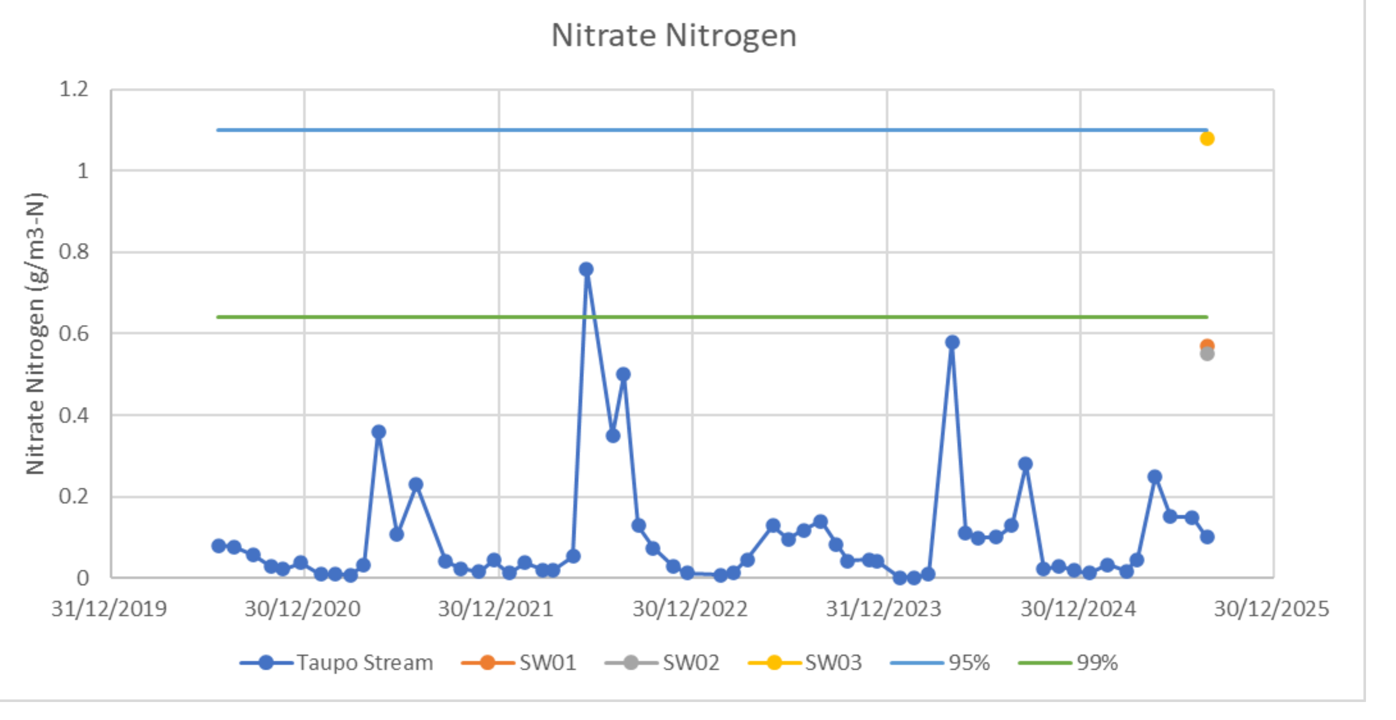
Graph 8: Magnesium



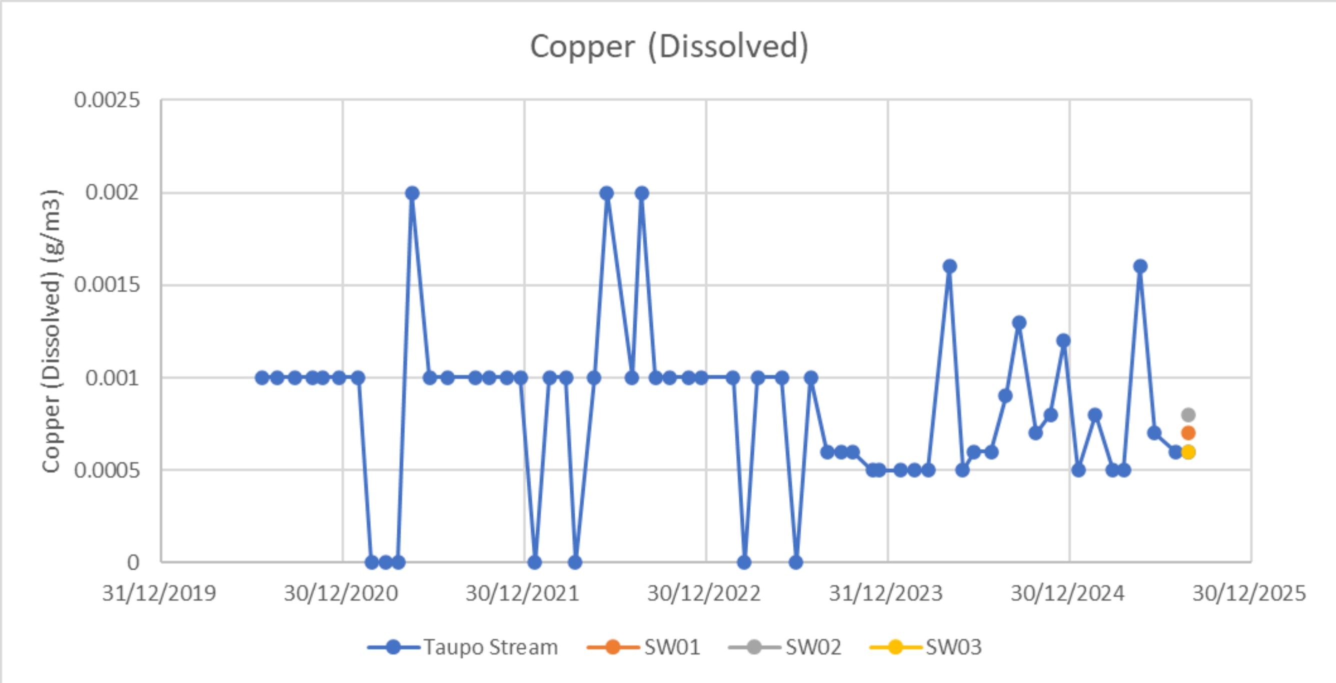
Graph 7: Ammoniacal Nitrogen



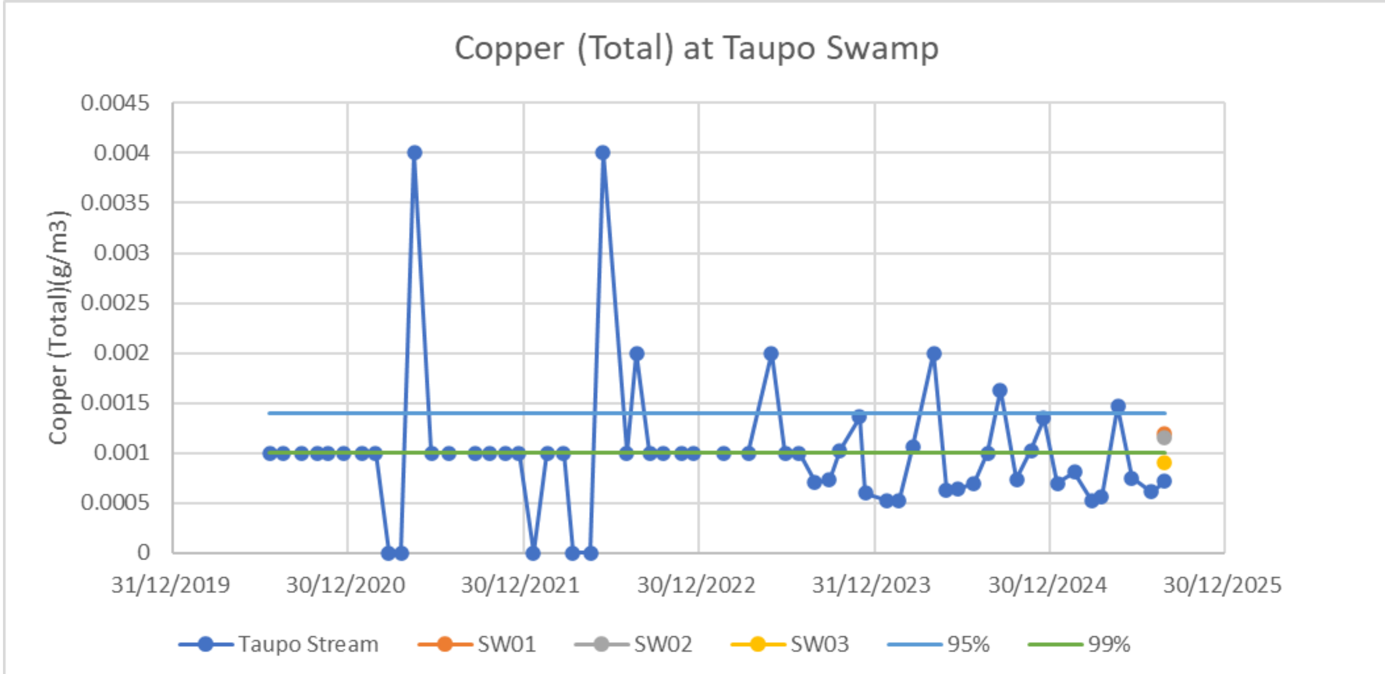
Graph 6: Nitrite Nitrogen



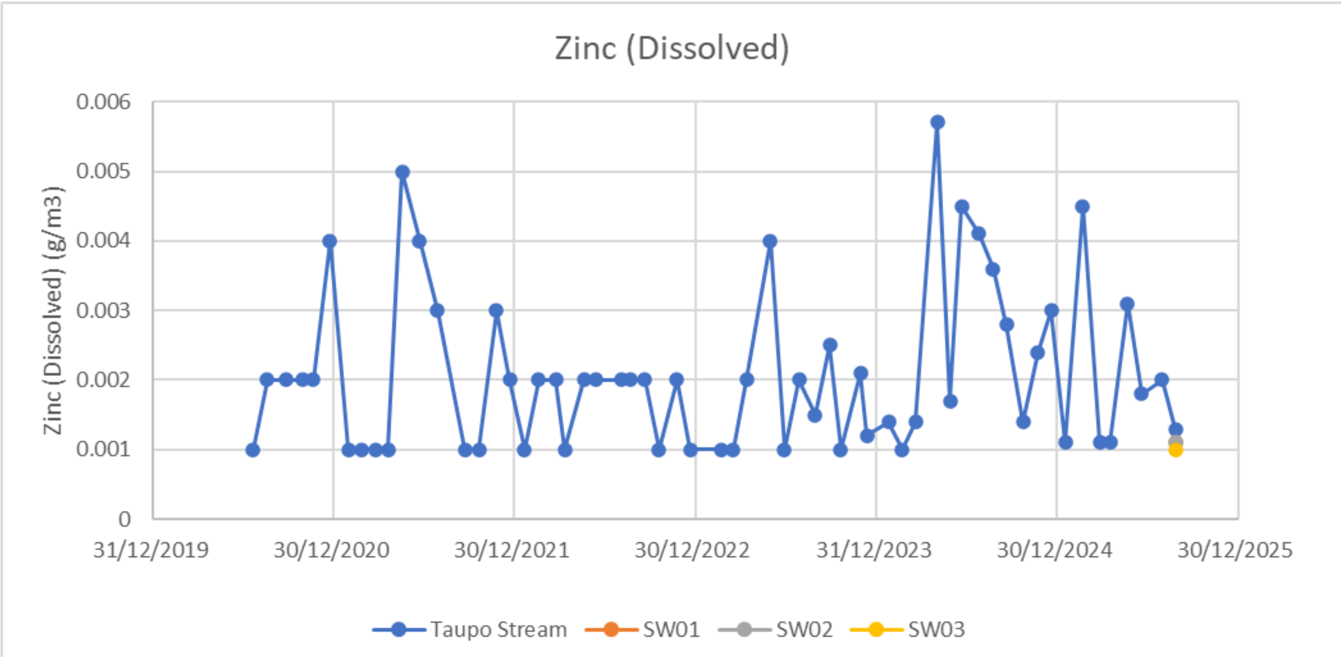
Graph 5: Nitrate Nitrogen



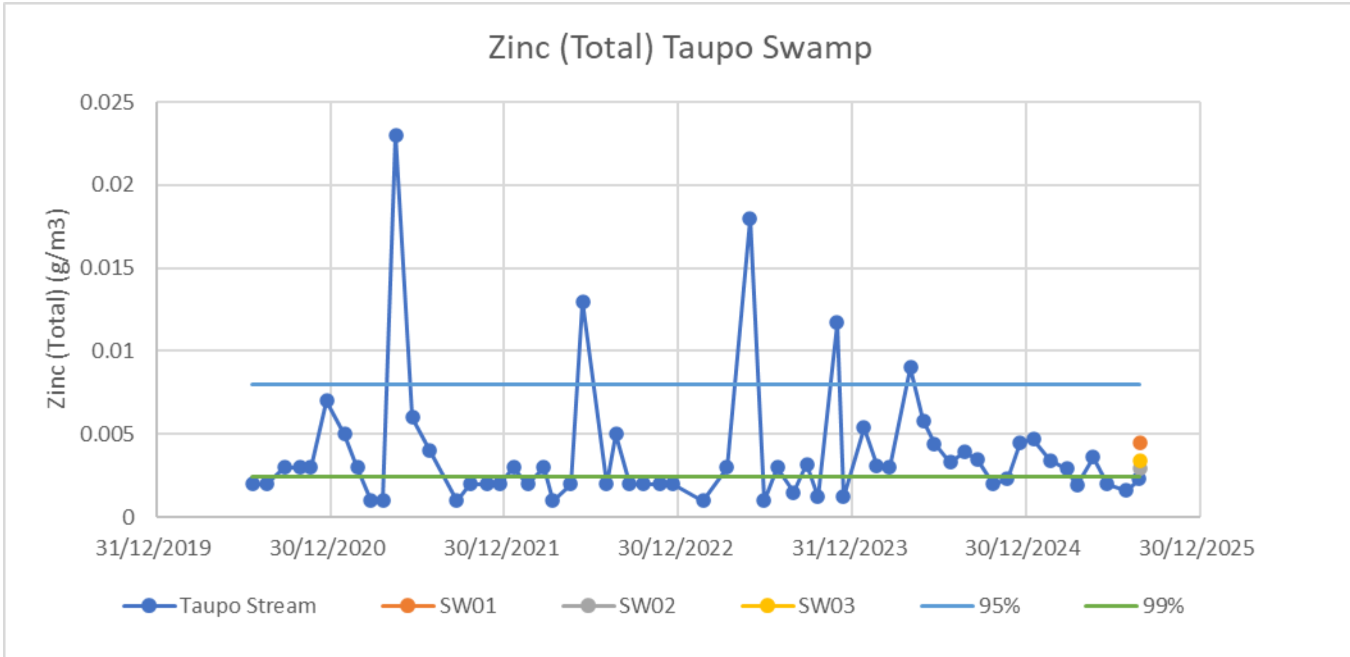
Graph 11: Copper Dissolved



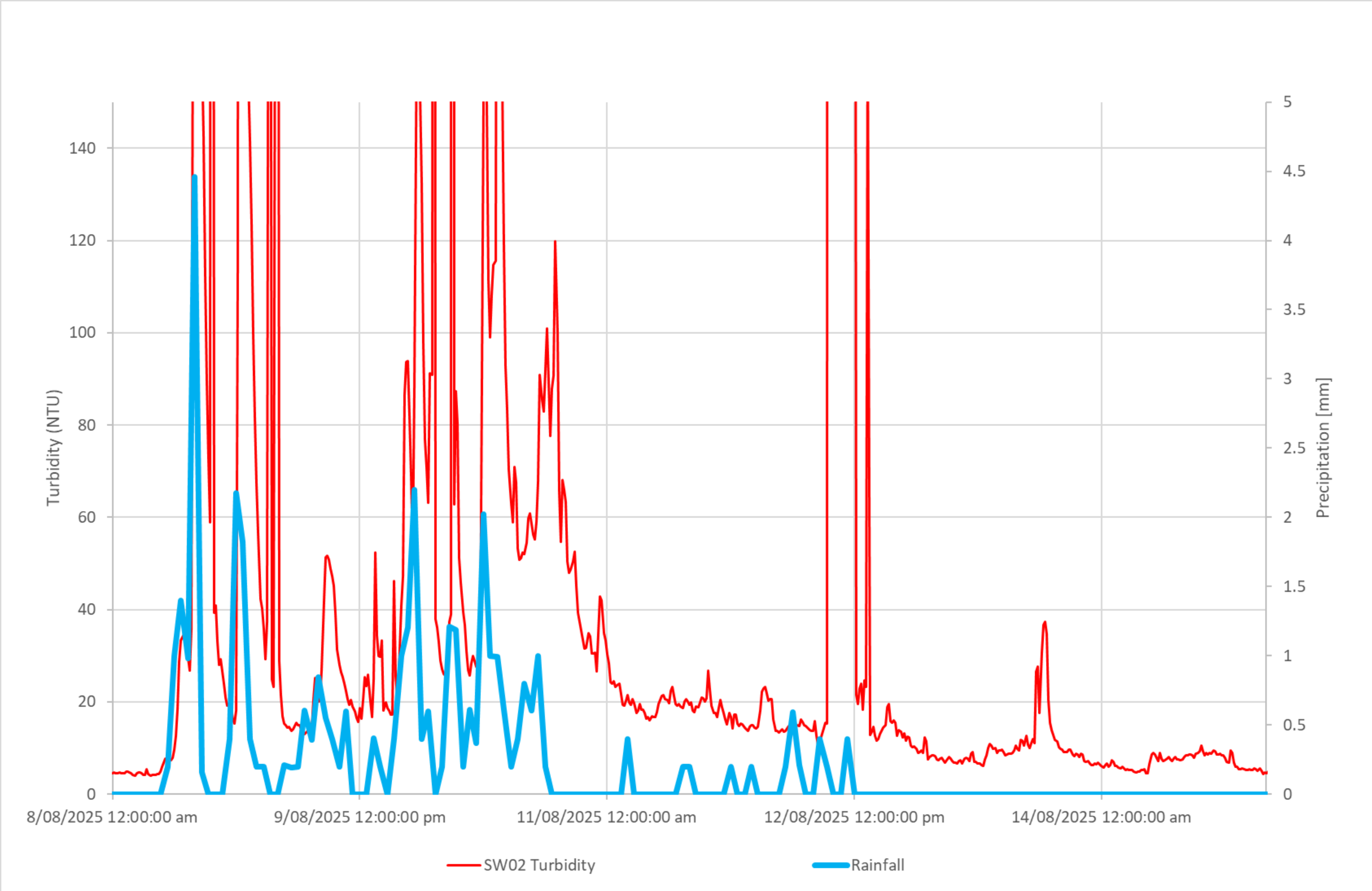
Graph 12: Copper Total



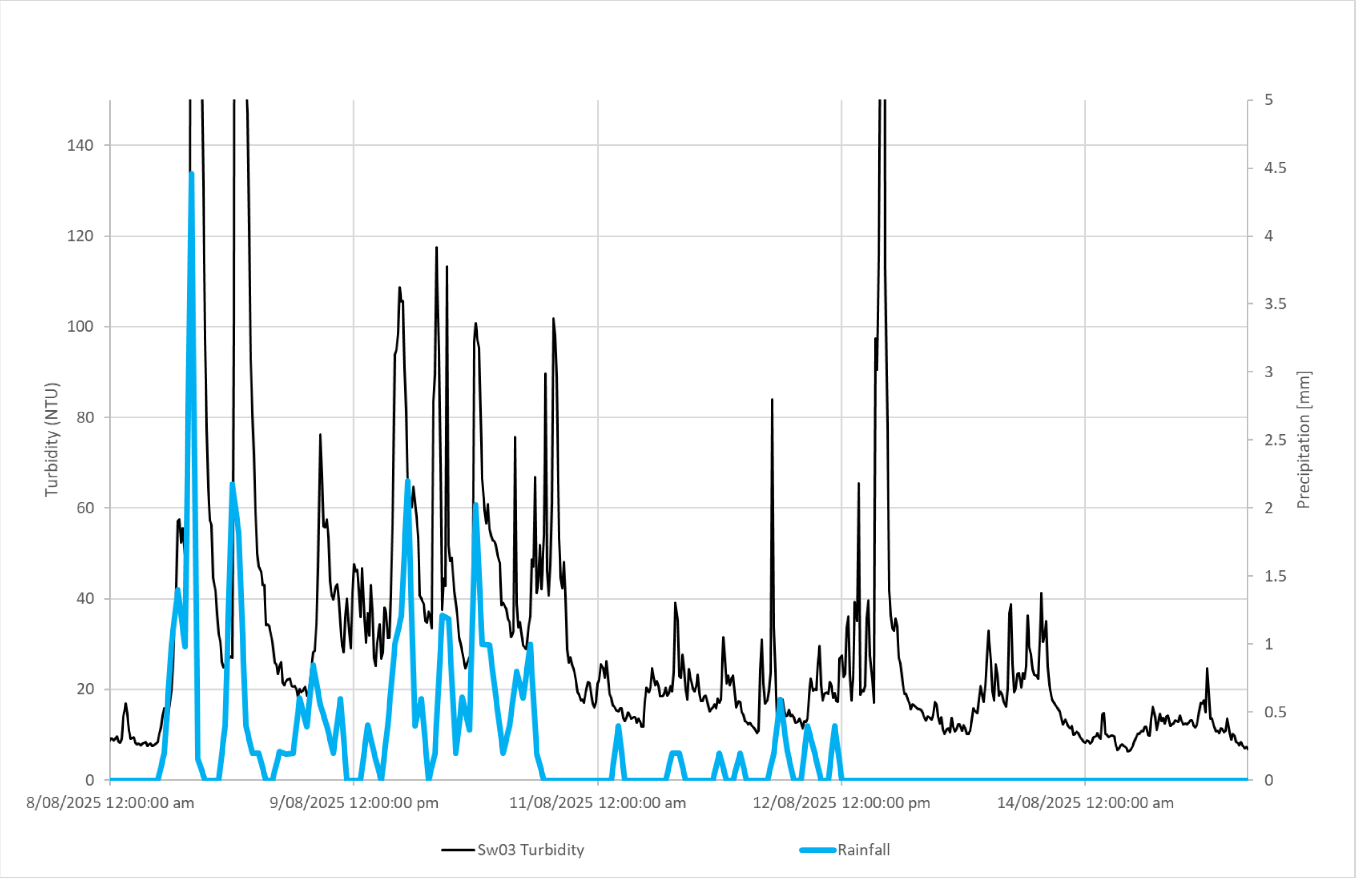
Graph 10: Zinc Dissolved



Graph 9: Zinc Total



Graph 13: Turbidity vs Rainfall at SW02



Graph 14: Turbidity vs Rainfall at SW03