

Aquatic Ecology Impact Assessment

Graymont South-Western Pit



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Graymont NZ LTD

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Prepared by:
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Revision Schedule

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Prepared by:



Signature

Tracey Hooper

Reviewed by:



Signature

Laura Drummond

Approved by:



Signature

Ilze Rautenbach



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Executive Summary

Graymont (NZ) Limited proposes to develop a new South-Western Pit adjacent to the existing Oparure limestone quarry near Te Kūiti, to extend quarry operations and support continued limestone extraction. This Ecological Impact Assessment (EclA) evaluates the potential effects of the project on aquatic ecology values within and downgradient of the site, in accordance with Environment Institute of Australia and New Zealand (EIANZ) EclA guidelines.

The Project Site does not contain permanent surface waterbodies; however, it overlies a subterranean karst system, including Camelot Stream, which flows approximately 80m below ground. Groundwater dye tracing confirms that the subterranean Camelot Stream discharges to Pōtea Spring and, to a lesser extent, Pumphouse Spring, before entering the Mangawhitikau Stream and ultimately the Mangapu River.

Ecological investigations undertaken between 2019 and 2026 indicate that Camelot Stream has high ecological value despite limited species diversity and absence of fish. Pōtea Spring is assessed as having moderate ecological value, with impacts from historical disturbance and agricultural land uses in the catchment. Pumphouse Spring has low ecological value due to its modified, piped nature. Mangawhitikau Stream has high ecological value, supporting diverse aquatic communities including At Risk fish species (e.g. longfin eel and torrentfish), while the downstream Mangapu River has moderate ecological value associated with modification and agricultural land uses in the catchment.

As no surface waterbodies are present within the Project footprint, direct habitat loss will not occur from the Project. Potential effects are indirect and relate to the impact of sediment-laden stormwater during rainfall events. These effects may include temporary increases in suspended sediment and localised deposition downstream. Based on the EclA assessment framework, the level of effect ranges from Negligible to Low due to the short duration, localised extent, and the already elevated sediment inputs from surrounding agricultural and forestry land use.

The Project incorporates a range of avoidance and mitigation measures. These include maintaining a substantial buffer from the inferred Camelot Stream alignment to prevent direct interception until further investigations can be safely undertaken, implementing erosion and sediment control measures, and applying best-practice quarry management to minimise sediment mobilisation. While complete avoidance of stormwater infiltration is not feasible due to the karst geology, these measures will reduce sediment loads entering the subsurface system.

Implementation of the Ecological Betterment Plan will provide for catchment-scale improvements that will contribute to the improvement of water quality and sedimentation. Proposed measures include riparian planting and fencing in upstream source areas, improved sediment control in agricultural land, riparian improvements to Pōtea Spring and pest plant and animal management. These measures are intended to achieve a net reduction in sediment loads and enhance ecological condition over time.

Monitoring will be undertaken to confirm predicted effects and track ecological trends, including periodic surveys of habitat condition, macroinvertebrates, fish (via eDNA), and sediment levels across key sites. This will enable adaptive management if required. Event-based monitoring is also proposed, associated with turbidity triggers when works are to occur in proximity to Camelot Cave.



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Executive Summary

With the implementation of proposed avoidance, mitigation, and betterment measures, residual effects on aquatic ecosystems are assessed as Very Low to Negligible. The Project is expected to achieve no net loss, and over time, net ecological gains are anticipated through catchment restoration and sediment reduction initiatives. This EclA concludes that the residual adverse effects on aquatic ecology values would not constitute a “sufficiently significant adverse impact” such that they need to be taken into account in terms of an assessment under s85 of the FTAA.



1 Introduction

This report outlines and summarises the existing aquatic ecology values within and downgradient of the proposed South-Western Pit (or Project) which will extend the existing Oparure limestone quarry.

This ecological impact assessment (EclA) has been prepared in accordance with the *Ecological Impact Assessment (EclA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems* (EclA guidelines) (Roper-Lindsay, 2018).

1.1 Aim and Scope

Graymont (NZ) Limited has engaged Stantec NZ to provide an updated ecological impact assessment for the site subject to the development of the South-Western Pit (Project Site), in support of a substantive application made under the Fast-track Approvals Act 2024 (FTAA).

The establishment of the South-Western Pit, would extend the Oparure quarry's life and allow the quarrying of limestone to continue. The location of the Project Site is shown on Figure 1-1.

1.2 Site Description

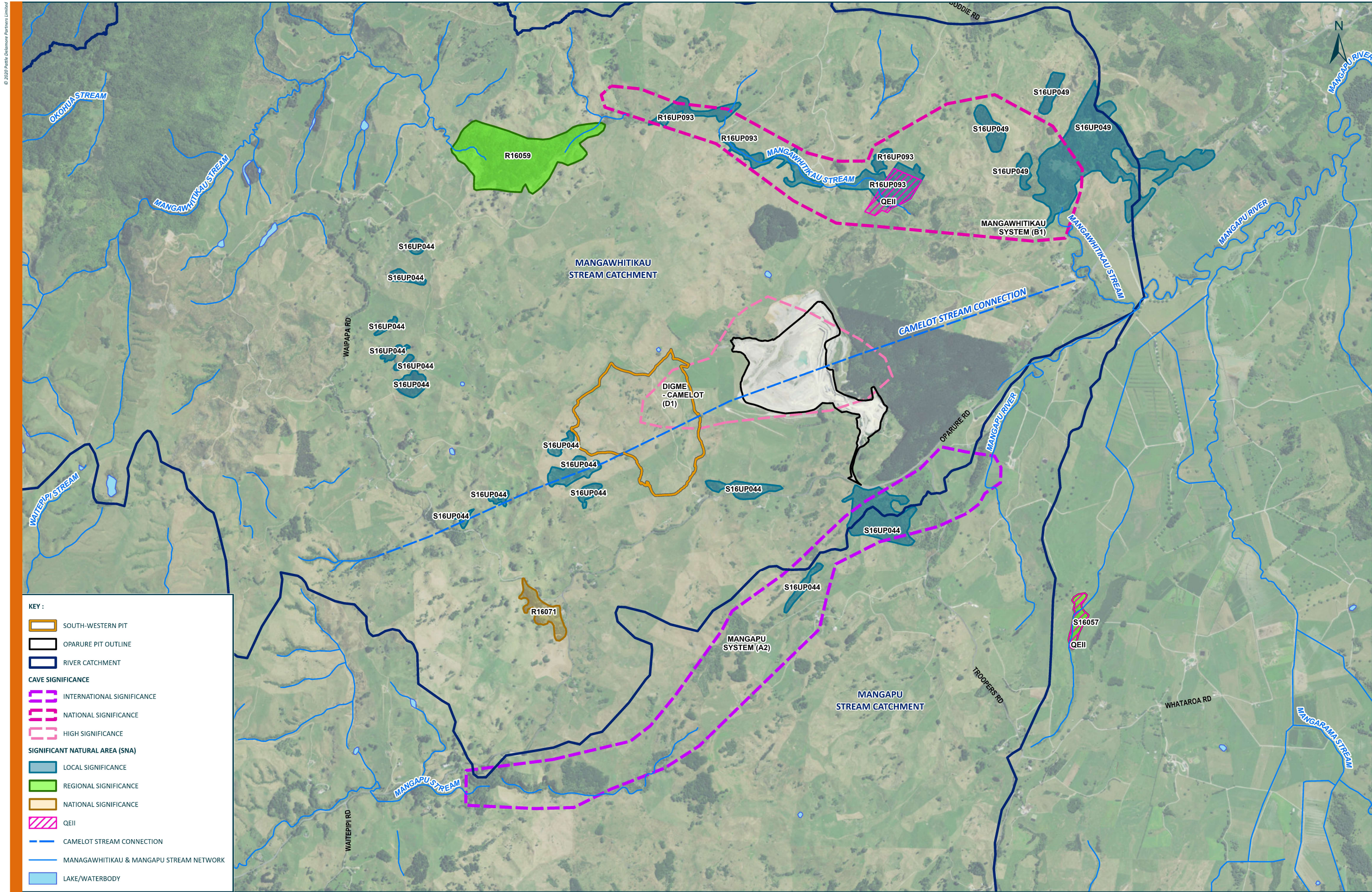
The proposed South-Western Pit is located adjacent to the existing Oparure limestone quarry operations, north of Te Kūiti. The existing Oparure quarry is currently New Zealand's largest single limestone quarry by output. The supply of limestone from the existing site is processed at lime kiln(s) within the Waikato region. Lime and limestone products from the Project Site are supplied to agricultural, animal health, construction, water treatment, environmental and industrial markets of New Zealand and the wider Asia Pacific region.

The Project Site is mainly comprised of grazed pasture with indigenous vegetation concentrated in small bush remnants around large karst rock formations, with scattered mature trees across the site made up of both exotic and native species (Instream, 2024). There are no permanent surface water features within the site, with Camelot Stream, a permanent subterranean stream / aquatic karst feature, flowing in a general west to east direction at an estimated depth of approximately 80m.

There are seven cave features present within the project area, with none greater than 50m long and most crawling access only (Instream, 2024). These caves do not have aquatic values. Terrestrial ecology and project impacts to cave systems are addressed within separate reports forming the application package (Blue Green Ecology, 2026).

The broader area contains significant natural areas and caves of international, national and high significance. The location of these features and areas in relation to the Project Site are shown on Figure 1-1.





- KEY :
- SOUTH-WESTERN PIT
 - OPARURE PIT OUTLINE
 - RIVER CATCHMENT
 - CAVE SIGNIFICANCE
 - INTERNATIONAL SIGNIFICANCE
 - NATIONAL SIGNIFICANCE
 - HIGH SIGNIFICANCE
 - SIGNIFICANT NATURAL AREA (SNA)
 - LOCAL SIGNIFICANCE
 - REGIONAL SIGNIFICANCE
 - NATIONAL SIGNIFICANCE
 - QEII
 - CAMELOT STREAM CONNECTION
 - MANAGAWHITIKAU & MANGAPU STREAM NETWORK
 - LAKE/WATERBODY



0 250 500
METRES

SCALE : 1:25,000 (A3)

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SOURCE:
1. AERIAL IMAGERY (FLOWN 2023-2024) SOURCED FROM NATIONAL INSTITUTE OF WATER AND ATMOSPHERIC RESEARCH
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. SIGNIFICANT NATURAL AREA DATA PROVIDED BY WAITOMO DISTRICT COUNCIL 08/2023.

CLIENT



GRAYMONT

FIGURE

FIGURE 1-1: SITE OVERVIEW

PROJECT

SW PIT - AQUATIC ECOLOGY ASSESSMENT

1.3 Background

Aquatic ecology investigations were previously completed at the Project Site to support the resource consent application for the originally proposed Western Pit. That proposal was subsequently refined and reduced in size, and is now referred to as the South-Western Pit.

The applicable findings and assessment of previous ecological investigations, along with the ecological investigations undertaken by Stantec in 2026 form the basis of this report (site photographs and report provided in Appendix A and B). The previous assessments are:

- Freshwater ecological impact assessment - Proposed Western Pit. Pattle Delamore Partners Ltd (PDP), 2024. (PDP, 2024).
- Graymont Southern Catchment Pit Summary Update. Instream Consulting Limited, 2024. (Instream, 2024).
- Environmental DNA survey of Camelot and Mangawhitikau Streams. Enspire Consulting Limited, 2021. (Enspire, 2021).
- South-Western Pit: Water Assessment. PDP, 2026. (PDP, 2026).

2 Statutory Context

This section summarises the relevant legislation, policy, plans and strategies relevant to the protection, conservation and enhancement of nature conservation interests associated with the Project Site. The ecological values described in this report allow significant ecological issues and adverse effects to be identified as they relate to the Resource Management Act 1991 (RMA). The identification of significant values and subsequent management recommendations to mitigate adverse effects are consistent with standards and objectives of the following legislative, policy statement and regional plan documents.

2.1 Resource Management Act 1991

The purpose of the RMA is to achieve sustainable management. Important elements of this are the maintenance of indigenous biodiversity and protection of significant indigenous vegetation and habitats. The RMA requires that any adverse effects of development be avoided in the first instance, and where avoidance is not reasonably practicable, impacts should be minimised, remedied, or mitigated. These elements are given effect in Sections 5, 6 and 7, and Schedule 4 sets out the requirements for effects assessments.

2.2 National Environmental Standards for Freshwater

The National Environmental Standards for Freshwater 2020 set requirements and regulations for carrying out certain activities that pose risks to freshwater and freshwater ecosystems.

2.3 National Policy Statement for Freshwater Management

The National Policy Statement for Freshwater Management 2020 (NPS-FM) (Ministry for the Environment, 2020) provides direction under the RMA, to local authorities on managing activities that affect the health of freshwater, and provides protections to freshwater bodies, including natural inland



wetlands, includes provisions for monitoring and reporting on freshwater quality and quantity, and for addressing the impacts of land use activities on freshwater resources.

3 Methodology

3.1 EcIA Guidelines Methodology

The EcIA guidelines provide a standardised matrix framework that allows for ecological effects assessments to be clear, transparent and consistent. This assessment framework (Appendix C) allows for effects to be ranked on a gradient from negligible to very high and provides justification to avoid, remedy, mitigate, offset or compensate as appropriate. The framework utilised in this assessment has been adapted from the EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (Roper-Lindsay, 2018).

EcIA guidelines were used for the desktop assessment methodology (Section 3.3), to determine the ecological values (Section 5.2), and the assessment of effects (Section 5.3) of the Project.

3.2 Prior Reporting

PDP Limited (PDP, 2024) provided the original desktop and site-specific survey data that informed the previous consent application under the RMA. Multiple surveys were undertaken between 2019-2023 to obtain data on Camelot Stream, Pōtea Spring, Pumphouse Spring, Mangawhitikau Stream, and the Mangapu River to establish ecological baselines.

Enspire Consulting (Enspire, 2021) undertook spot water quality sampling and eDNA samples within Pōtea Spring, Pumphouse Spring, and Mangawhitikau Stream submergence and resurgence sites in September 2021.

3.3 Desktop Assessment

A desktop review of existing information of the current condition of the environment in the area was undertaken by PDP in 2019 – 2023 and updated by Stantec in 2026. The following information sources were used:

- New Zealand Freshwater Fish Database records
- Land and Water Aotearoa (LAWA; <https://www.lawa.org.nz/>)
- Ministry for the Environment Data Service (<http://data.mfe.govt.nz/data/category/fresh-water/>)
- Waikato Maps- Water classification (<https://waikatomaps.waikatoregion.govt.nz/gallery/>)
- Relevant peer reviewed and grey literature.

3.4 Site Investigations

A summary of the Project Site investigations completed for the Project is provided in Table 3-1 with the sampling site locations shown on Figure 3-1.



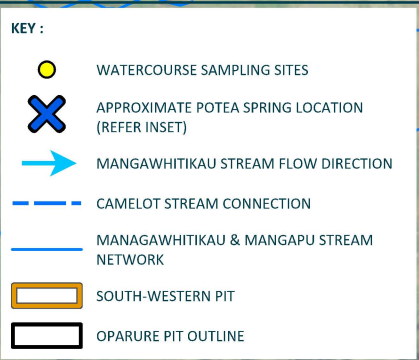


Table 3-1 Summary of sampling sites/locations

Site	Site code	Sampling methods undertaken at each site		GPS coordinates	
		Historic data (2019-2021)	Current data (2026)	Lat	Long
Camelot Submergence	CS	eDNA, habitat	eDNA, habitat	-38.351008	175.037712
Pōtea Spring (Camelot Resurgence)	PS1	eDNA, habitat	eDNA, habitat	-38.331870	175.095899
Pumphouse Spring	PS2	eDNA	eDNA	-38.331381	175.095097
Mangawhitikau Stream Submergence	MS1	eDNA	N/A	-38.326291°	175.074496°
Mangawhitikau Stream Resurgence	MS2	eDNA	N/A	-38.3272021	175.094865
Mangawhitikau Stream 20m upstream	MS3	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3312604,	175.0952933
Mangawhitikau Stream 80/100m upstream ¹	MS4	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3305840	175.0955453
Mangawhitikau Stream 20m downstream	MS5	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3312106	175.0959847
Mangawhitikau Stream 100m downstream	MS6	eDNA, macroinvertebrates, habitat, electric fishing	eDNA, macroinvertebrates, habitat	-38.330938	175.095320
Mangapu River upstream	MR1	Macroinvertebrates, habitat, electric fishing	N/A	-38.353278	175.092804
Mangapu River mid	MR2	Macroinvertebrates, habitat, electric fishing	N/A	-38.336451	175.094733
Mangapu River downstream	MR3	Macroinvertebrates, habitat, electric fishing	N/A	-38.333109	175.101123

A summary of the sampling methods is provided in Table 3-2. The sampling methods for the Stantec 2026 surveys are described in the Graymont Aquatic Ecological Monitoring Report attached as Appendix B.

Table 3-2 Sampling methods

Assessment	2019-2023	2026
Water quality and deposited fine sediment	Flow gauging surveys using Sontek Flowtracker 2 In-situ spot sampling of field parameters: • Temperature • Electrical conductivity	In-situ spot sampling of field parameters: • Temperature • Electrical conductivity • Dissolved oxygen • pH

¹ Originally to be sampled 100m upstream, however access was limited due to dense scrub and fallen willows blocking access to the reach.



Assessment	2019-2023	2026
	- Dissolved oxygen - pH	- Total suspended solids (TSS) - Turbidity (NTU) Sediment Assessment Method 2 (SAM2)
eDNA	Samples were collected were filtered using kits provided by Wilderlab NZ Limited.	In accordance with the National Institute of Water & Atmospheric Research Ltd (NIWA) Environmental DNA guidelines and field protocols for lotic systems (NIWA, 2023). TICI scores (Wilkinson et al, 2024) and values were provided by Wilderlab NZ Limited.
Macroinvertebrates	Undertaken in accordance with the Protocols for Sampling Macroinvertebrates in Wadeable Streams (Stark et al, 2001) following protocol C2: Soft-bottomed, Semi-quantitative for Pōtea Spring, Pumphouse Spring and Mangapu River. Mangawhitikau Stream samples were collected in accordance with Protocol C1. Macroinvertebrate values were compared to Stark and Maxted (2007) stream health values and the National policy statement for freshwater management 2020 (Ministry for the Environment, 2020) attribute values. Samples were processed following processing in accordance with Protocol P2 (Stark et al, 2001). Drift nets (250 and 500 µm) were installed in the channel immediately downstream of Pōtea Spring and Pumphouse Spring.	Undertaken in accordance with the Protocols for Sampling Macroinvertebrates in Wadeable Streams (Stark et. al., 2001) following protocol C2: Soft-bottomed, Semi-quantitative. Following collection of samples they were processed in accordance with Protocol P2. Macroinvertebrate values were compared to Stark and Maxted (2007) stream health values and the National policy statement for freshwater management 2020 (Ministry for the Environment, 2020) attribute values.
Fish	Electrofishing in Mangawhitikau Stream and Mangapu River. Sampling of fish was semi-qualitative i.e. single pass with a pole seine net placed downstream of the surveyed area	-
Periphyton cover	See habitat assessment	Visually assessed in accordance with the Sampling and Measuring periphyton in Wadeable Rivers and Streams (NEMS, 2022)
Habitat assessment	At each watercourse site aquatic habitat was assessed based on instream, riparian and bank features. Instream features – four transects along a 50m representative reach of stream at each site. Recording, depth, substrate, presence of macrophytes, periphyton or wood debris. Riparian and bank features – parameters including width and protection of the riparian vegetative zone, bank stability and channel alteration were rated out of 20.	Rapid Habitat Assessment (RHA) in accordance with Rapid Habitat Assessment protocol for wadeable streams (Cawthron Report No. 2649) (Clapcott, 2015).

4 Existing Environment

The Project Site does not contain any permanent surface waterbodies. A permanent subterranean stream / aquatic karst feature, Camelot Stream, flows in a general west to east direction and at the cave entrance is at a depth of approximately 80m (PDP, 2024).



Surface waterbodies are present downgradient of the Project Site and include watercourses and springs (Instream, 2024: PDP, 2024). Dye tracer testing undertaken in 2020 (PDP, 2026) indicated that all water infiltration within the South-Western Pit will flow into the Camelot Stream catchment (Instream, 2024). This water surfaces at the Pōtea and Pumphouse Springs, located in the lower Mangawhitikau Stream reach, upstream of Oparure Road. This flow path is also the current subsurface flow for the existing Oparure Quarry operations.

From the results of the dye tracer testing (PDP, 2024: PDP, 2026), waterbodies requiring assessment for the project are:

- Camelot Stream.
- Pōtea Spring.
- Pumphouse Spring.
- Mangawhitikau Stream.

The Mangawhitikau River flows into the Mangapu River, downgradient of the existing quarry and proposed South-Western Pit. It was therefore considered for cumulative effects.

These waterbodies and their identified ecological values are discussed in the following sections. Photos of each of the aquatic features assessed are provided in Appendix A.

4.1 Camelot Cave and Stream

Camelot Cave forms part of the wider Digme-Camelot cave system which is part of the largest autogenic karst system known in the North Island. The cave was first surveyed in 1985, with 490m of the cave traversed and mapped at that time (PDP, 2024: PDP, 2026). The Digme-Camelot cave system is listed as being of high significance under the Waitomo District Plan (Waitomo District Council, 2009), as the only example of gypsum rope in New Zealand (in Digme cave). Gypsum rope is an aggregate of crystals in a fibrous or filament-like rope formation (National Speleological Society, 1995 - 2026).

Literature review and discussions with local cavers identified that the watercourse identified to be flowing through Camelot Cave (Camelot Stream) has the potential to provide habitat for a range of aquatic stygofauna, including stygophiles and stygobites. When surveyed in the 1980s, troglobitic hydrobiids were also recorded. It is expected that other locally common species will also be present (PDP, 2024).

An attempt was made in 2020 by a team of experienced local cavers to undertake a survey of the cave extent and collect ecological samples, however, the attempt was abandoned due to significant health and safety concerns associated with low oxygen levels. Flow within the cave at the time was estimated between 20-30l/s with minor turbidity and minor settled sediment. A variety of mesohabitats were observed, including pools, riffles and a waterfall (c.3m high) (PDP, 2024). Further attempts to survey the cave were also made by caving experts with respirators to mitigate low oxygen levels but had to be abandoned due to concerns with emergency egress (PDP, 2026).

Dye tracer testing undertaken in 2020 identified that an unnamed stream submerging into the ground approximately 1.6km southwest of the Project Site, referred to as Camelot Stream submergence site, is likely to be a significant source of flow into the stream (PDP, 2026). This feature, and the estimated flow



direction, are shown on Figure 3-1, with further information provided in the South-Western Pit: Water Assessment (PDP, 2026).

Based on the dye tracer testing results undertaken by PDP, it is expected that stormwater infiltration into the ground at the Project Site will move through the karst system and emerge approximately 3km to the northeast at Pōtea Spring and Pumphouse Spring (PDP, 2026).

4.1.1 Physical Habitat

In 2026 Stantec completed a rapid habitat assessment at the Camelot Stream submergence site, resulting in a 'Good' condition category. The detailed assessment is provided in Appendix B. The site is in a headwater site, draining agricultural land, however native riparian vegetation is present adjacent to the watercourse within the incised gully upstream of the Camelot Cave entrance.

Water quality data within the Camelot Stream cannot be obtained from the area directly below the Project Site as it is subsurface and inaccessible. Due to this, water quality monitoring sites, upstream and downstream, represent the closest locations upstream and downstream of the Project which are safely accessible for monitoring. The detailed physico-chemical data obtained by the installed sondes is presented in Appendix E of the PDP South-Western Pit: Water Assessment Report (PDP, 2026). The key findings from this data as detailed by PDP (2026) are:

- Turbidity in Pōtea Spring, as measured at 15-minute intervals, consistently remains within the Waikato Regional Council (WRC) excellent band (Waikato Regional Council, 2020).
- Higher turbidity at the Camelot Stream headwaters upstream (three to five times greater) reduces in a downstream direction, indicating effective attenuation within the catchment prior to discharge at Pōtea Spring. This suggests that sediment settles within the subsurface karst or is filtered out during its entry through tomos or dolines, resulting in less sediment reaching Pōtea Spring.
- Although downstream flow may promote dilution, the higher turbidity concentrations recorded upstream suggest that the upper catchment is a primary source of sediment to the Camelot Stream receiving environment.
- Peak turbidity concentration at Pōtea Spring was recorded 5 hours and 45 minutes after the maximum recorded concentration recorded at the upstream site at the Camelot Stream tributary.
- Dissolved oxygen concentrations (within 1%) and pH were similar between both upstream and downstream sites.
- During rainfall events, pH increases at the Pōtea Spring due to passing through the limestone geology increasing the alkalinity of the water. In the upstream Camelot Stream tributary, the pH decreases during rainfall events due to the rainwater (naturally 6.5 pH) and the native forestry catchment.

Spot water quality sampling undertaken in the Camelot Stream headwater site in 2026 (Stantec, 2026) indicates temperature and dissolved oxygen (DO) within the 'Excellence' category for the WRC guidelines, while pH was in the 'Satisfactory' category and exceeded the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG guidelines) (ANZG, 2018). The elevated pH levels are likely due to the surrounding geology which is rich in limestone. Total suspended solids in the upper catchment where the Camelot Stream is located fall within the 'Unsatisfactory' category within the



WRC guideline (Waikato Regional Council, 2020) and exceeded the ANZG guidelines (ANZG, 2026). This is expected to be a result of the agricultural land use in the upper catchment.

Median deposited fine sediment scores for the Camelot Stream submergence site from the single sampling event by Stantec in 2026 are below the NPS-FM national bottom-line value (Appendix B); however, noting that the NPS-FM is based on monthly sampling over 5 years. Values are suggestive of a high impact of fine sediment on instream biota.

During the 2026 survey (Appendix B) the average periphyton % cover for the Camelot Submergence was 39% and was predominantly Thin Light Brown periphyton.

4.1.2 Aquatic Fauna

To provide information on the aquatic values of Camelot Stream, eDNA sampling was undertaken in 2021 (Enspire, 2021) and in 2026 by Stantec (Appendix B).

Seven pollution-sensitive taxa known as EPTs (Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)) were detected in the 2021 sampling comprising three mayfly genii, three stonefly genii, and one caddisfly genus (Enspire, 2021). In addition, one dipteran taxon (Psycholidae), microcrustacea, mollusc, and worm taxa were identified (PDP, 2024).

The Taxon-Independent Community Index (TICI) is a metric provided by Wilderlab for riverine eDNA 2026 samples that are processed with a comprehensive freshwater assay panel. TICI scores strongly correlate to 5-year median Macroinvertebrate Community Index (MCI) values with an adjusted R² value of 0.825 (Wilkinson, et al., 2024). In 2026 Camelot Stream was rated as 'Excellent' (113.5).

The 2021 eDNA sampling results show no fish species present. In 2026, freshwater crayfish/kōura (*Paranephrops planifrons*) was the only species recorded. This strongly suggests that there is no fish passage through the subterranean Camelot Stream, including for strong climbing species such as eels (*Anguilla sp.*). This may be due to underground diffuse flows (i.e. no flowing channel) or subterranean waterfalls. As the Camelot Cave system is unsafe to access and survey, the exact cause is unknown. A summary of the eDNA results is provided in Table 4-1.

Overall, the 2021 and 2026 eDNA results indicate a limited diversity in Camelot Stream and at the Camelot Submergence.

4.2 Pōtea Spring and Pumphouse Spring

Pōtea Spring has been determined as the resurgence site for Camelot Stream and therefore the main receiving surface waterway for infiltration within the Project Site. The spring source is a large (~4-5m deep) pool with clear water observed during the site surveys in 2020 and 2026.

Pōtea Spring has stock excluded with fencing on both sides of Mangawhitikau Stream, is heavily shaded and has clear flows under baseline conditions. The channel is impacted by previous land use, with evidence of material dumping observed.

Pumphouse Spring, along with Pōtea Spring, is located on the true right bank of Mangawhitikau Stream, downstream of the Mangawhitikau resurgence. Pumphouse Spring is smaller than Pōtea Spring, with the spring piped and used as a water supply for a nearby property. This has largely modified the spring



from its natural state (PDP, 2024). Pumphouse Spring receives water from the infiltration within the proposed Project Site; however, it is noted that the volume of water discharged from the pipe is much lower than that discharging at Pōtea Spring. The piped nature of this spring also limits its ecological connections and therefore values.

4.2.1 Physical Habitat

PDP noted during its surveys (PDP, 2024) that the condition of Pōtea Spring and its downstream channel is mixed. While the spring itself is in good condition, with established riparian vegetation, no stock access and clear water under base flow conditions, the Pōtea Spring channel has an old vehicle embedded within both the bank and the channel substrate (true left bank), with exposed wires and vehicle body visible (see Appendix A for photos). It was also recorded that there was evidence of historical dumping of materials within the channel (such as plastic material) (PDP, 2024).

During the 2026 surveys Pōtea Spring was observed as having gravel, sand, silt, mud and abundant organic debris. The RHA score (64) indicates good quality instream habitat (Table 3-4 of Appendix B).

Physico-chemical data is presented in Appendix E of the PDP South-Western Pit: Water Assessment Report (PDP, 2026) with the key findings for Pōtea Spring summarised in Section 4.1.1 of this report. Spot water quality sampling undertaken on-site in 2026 indicates overall good water quality (Table 3.5 of Appendix B).

Temperature was within the excellence category of the WRC guideline, DO mg/L within Attribute Band 'A' of the NPS-FM and % saturation of DO was within the excellence category for WRC guidelines. Conductivity exceeded the ANZG guidelines. pH at Pōtea Spring was within the 'excellence' category for the WRC guidelines, and within the limits for ANZG guidelines. Total suspended solids were higher in Pōtea Spring than at the Camelot Stream Submergence site, with the 328 g/m³ measured within the 'unsatisfactory' category within the WRC Guidelines and exceeded the ANZG guidelines.

The median fine deposited sediment score for Pōtea Spring is well below the NPS-FM national bottom-line value (Appendix B) (noting that the NPS-FM is based on monthly sampling over 5 years). This is indicative only. Both values are suggestive of a high impact of fine sediment on instream biota.

4.2.2 Aquatic Fauna

PDP (PDP, 2024) collected macroinvertebrate samples of both the benthic community (kick net sampling) and the water column leaving the spring (drift net sampling). The results show the benthic macroinvertebrate community in the channel downstream of the spring was depauperate and dominated by *Potamopyrgus* snails. The MCI score of 89, representative of 'fair' stream health with probable moderate pollution was likely skewed by the limestone substrate and macrophyte beds (PDP, 2024).

Sensitive EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa were present, with %EPT taxa recorded at 33% (PDP, 2024). Drift net samples had high levels of crustacea, with copepods and *Paraleptamphopus* recorded. *Paraleptamphopus* are a common and widespread freshwater amphipod taxon, ubiquitous in both surface and groundwater systems (Fenwick, 2000) and one of two genera within the New Zealand endemic family Paraleptamphopidae and is common in many slow flowing soft-bottomed streams. Their MCI score of 5 (for hard bottomed streams only) indicates they reside in streams with moderate to good water quality.



All invertebrate samples from the 2021 sampling were processed by John Stark (Stark Environmental Ltd), who has extensive experience in macroinvertebrate identification and was specifically looking for rare taxa, including stygofauna. Mr Stark confirmed that the presence of *Potamopyrgus doci* (a Threatened – Nationally Critical aquatic snail species known only to reside in one spring at the nearby Ruakuri Cave) is unlikely and that there is a lack of known morphological features available to identify to this species (PDP, 2024). Wilderlab, who undertook eDNA analysis of the 2021 samples, advised that although in the past they had used the eDNA signature of *Potamopyrgus doci*, it had been removed from the analysis suite as it was unreliable.

Potamopyrgus doci has the threat status of threatened – nationally critical (Grainger et al. 2018) as this species is only known to be present in one location, a spring pool at the exit of Ruakuri Cave, in the Waitomo Caves, approximately 9km (linear) from Pōtea and Pumphouse Springs, with total area of occupancy ≤ 1 ha (0.01km²). The presence of *Potamopyrgus doci* in the Pōtea and Pumphouse Springs is considered unlikely. Pumphouse Spring does not have pooled habitat, with the spring discharging directly into the Mangawhikau mainstem, while the spring head pool at Pōtea Spring is not in pristine condition, with historical land use impacts and evidence of historical dumping of materials within the bed and banks (PDP, 2024). It is also noted that if the range is larger within the Waitomo area, this would reduce its threat ranking.

The Wilderlab TICl score at Pōtea Spring was rated as 'Good' (105.2) for the 2026 eDNA sampling. PDP (PDP, 2024) installed drift nets during December 2020, which recorded ostracods and the common and widespread freshwater amphipod taxa *Paraleptamphopus*. Mayflies (*Deleatidium*), collembola and mites were also recorded.

During the PDP investigations (PDP, 2024) it was noted that fish composition within Pōtea Spring and its downstream channel is expected to be similar. However, it is also expected to be lower than that recorded in Mangawhikau Stream at the confluence to Pōtea Spring due to there being a slight passage barrier at the confluence, that could prevent movement from the mainstem for some species, and the channel being much smaller (average width 1.5 m). eDNA sampling in 2021 detected the presence of longfin eel (*Anguilla dieffenbachia*) only. However, this sample was taken immediately downstream of the spring head and therefore may have underestimated species present further downstream in the channel.

A summary of the eDNA results from the 2021 and 2026 sampling is provided in Table 4-1.

Table 4-1 Pōtea Spring eDNA sampling results²

Scientific Name	Common Name	Threat classification ³	2021	2026
<i>Anguilla australis</i>	Shortfin eel	Not Threatened	-	Present
<i>Anguilla dieffenbachia</i>	Longfin eel	At Risk – Declining	Present	Present

²² Trace results for yellow eye mullet (*Aldrichetta forsteri*) and goldfish (*Carassius auratus*) were recorded at both the Pōtea Spring and Mangawhikau Stream 100m downstream, respectively. As these were only trace eDNA they have been discounted as cross contamination, or due to bird movement.

³ (Dunn, et al., 2026)



Scientific Name	Common Name	Threat classification ³	2021	2026
<i>Cheimarrichthys fosteri</i>	Torrentfish	At Risk - Naturally Uncommon	-	-
<i>Galaxias argenteus</i>	Giant kōkopu	At Risk – Declining	-	
<i>Gobiomorphus basalis</i>	Cran's bully	At Risk - Naturally Uncommon	-	Present
<i>Gobiomorphus cotidianus</i>	Common bully	Not Threatened	-	-
<i>Oncorhynchus mykiss</i>	Rainbow trout	Introduced and Naturalised	-	-
<i>Retropinna retropinna</i>	Common smelt	At Risk – Declining		
<i>Paranephrops planifrons</i>	Kōura	Not Threatened	-	Present
<i>Salmo trutta</i>	Brown trout	Introduced and Naturalised	-	-

4.3 Mangawhitikau Stream

The Mangawhitikau Stream system is a nationally significant karst feature (Hayward, 2018) (Waitomo District Council, 2009), including both surface and subsurface stream reaches. The system is described as the largest river cave in the North Island, with very high recreational values and high tourism use. Over 8km of cave passages are present.

The system is comprised of a classic two-tiered geomorphic development and dry valley leading to a former stream cave. There is historic use of the associated cave, and the system includes a long-slit gorge upstream. The system includes Mason's Dry Cave, Flood Caverns, Mason's Glowworm cave, Mangawhitikau Gorge and a variety of other small caves (Waitomo District Council, 2009) (Waitomo District Council, 2025).

4.3.1 Physical Habitat

Physico-chemical data is presented in Appendix E of the PDP South-Western Pit: Water Assessment Report (PDP, 2026). The baseline water quality indicates that Mangawhitikau Stream shows water quality effects from a highly erodible limestone catchment and impacts from agricultural land-use. The Upper Mangawhitikau Stream also has a greater suspended sediment concentration during flood events than the Pōtea Spring monitoring location (PDP, 2026).

Spot water quality sampling was undertaken at four locations on Mangawhitikau Stream during the Stantec surveys in 2026 (Appendix B). The results indicate generally good water quality, noting that nutrients were not sampled. Of note is that pH at all sites was in the 'Satisfactory' category and exceeded the ANZG guidelines. The elevated pH levels may be due to the surrounding geology which is rich in limestone. Total suspended solids were higher in the lower catchment (all Mangawhitikau Stream sites), than in the upper catchment where the Camelot Stream is located, with all sites in the 'Unsatisfactory' category of the WRC guideline and exceeded the ANZG guidelines.

Aquatic assessments were completed by PDP in 2020 (PDP, 2024) upstream and downstream of the confluence of Pōtea Spring, to assess deposited sediment and macroinvertebrate communities within the lower Mangawhitikau Stream upstream and downstream of the Pōtea Spring confluence. At the time of this survey, average deposited fine sediment cover (<0.5 cm) upstream of Pōtea Spring was recorded at 41.5% and 12.1% of the streambed, while downstream of Pōtea Spring fine sediment cover



was recorded at 55% and 16% of the streambed. PDP (2024) noted that at the time of the survey, higher deposited sediment cover was localised, present adjacent to and downstream of bank erosion along both banks of the lower Mangawhitikau Stream.

In 2026 Stantec undertook surveys at four sites on Mangawhitikau Stream both upstream and downstream of the confluence of Pōtea Spring. The full results are provided in Appendix B. The results indicate that the upstream sites have some impact from high levels of deposited fine sediment, however, Mangawhitikau Stream downstream sites indicate no impact to instream biota from deposited fine sediment. The change in average percentage sediment cover between upstream and downstream sampling sites of the Mangawhitikau Stream at the time of the Stantec survey, indicates that sediment cover decreases from upstream to downstream, despite existing high sediment load during rainfall events within the Camelot Submergence and Pōtea Spring.

The 2019 PDP survey (PDP, 2024) observed low levels of periphyton and macrophytes at the downstream site (0 – 20 % and 0 - 5 % cover, respectively). The assessment undertaken by Stantec in 2026 identified that the Mangawhitikau Stream sites had average percentage covers ranging from 13 to 65% with three predominant periphyton types across the four sites: Thin Light Brown, Thick Green/ Light brown and Thin Green. Periphyton cover increases significantly in the downstream sites of the Mangawhitikau Stream. The 2026 Stantec survey noted that the Mangawhitikau Stream was in general widest in the upstream sampling sites, when compared to the downstream sampling sites with depth being inconsistent, changing across the sampling sites.

At the downstream Mangawhitikau Stream site PDP (2024) noted that no bedrock was observed, and substrate was a mixture of gravels and sand/silt. Riffles and pools were present, with variation of velocity and depth regimes. There was a moderate variety of instream habitat types present including pools, instream woody debris, riffles, macrophytes and spring input channels.

The RHA scores indicate good quality instream habitat across all four 2026 sampling locations (Table 3-4 of Appendix B).

4.3.2 Aquatic Fauna

Overall, the 2026 eDNA results indicate a relatively diverse population at Mangawhitikau Stream 100m downstream and reflect the 2021 eDNA sampling, which showed similar results. A summary of the eDNA results for Mangawhitikau Stream from the 2021 and 2026 sampling is provided in Table 4-2.

During the site assessment common bully (*Gobiomorphus cotidianus*) was observed at the 80m upstream site, and rainbow trout (*Oncorhynchus mykiss*) at the 20m downstream site.

Table 4-2 Mangawhitikau Stream eDNA sampling results



Graymont South-Western Pit
4 Existing Environment

Scientific Name	Common Name	Threat classification ⁴	2021 Mangawhitikau Stream Resurgence	2026 Mangawhitikau Stream 100m DS
<i>Anguilla australis</i>	Shortfin eel	Not Threatened	-	Present
<i>Anguilla dieffenbachii</i>	Longfin eel	At Risk - Declining	Present	Present
<i>Cheimarrichthys fosteri</i>	Torrentfish	At Risk - Naturally Uncommon	Present	Present
<i>Galaxias argenteus</i>	Giant kōkopu	At Risk - Declining	-	Present (Trace)
<i>Gobiomorphus basalis</i>	Cran's bully	At Risk - Naturally Uncommon	Present	Present
<i>Gobiomorphus cotidianus</i>	Common bully	Not Threatened	Present	Present
<i>Oncorhynchus mykiss</i>	Rainbow trout	Introduced and Naturalised	-	Present
<i>Retropinna Retropinna</i>	Common smelt	At Risk - Declining	Present	-
<i>Paranephrops planifrons</i>	Kōura	Not Threatened	-	Present
<i>Salmo trutta</i>	Brown trout	Introduced and Naturalised	-	Present

All 2026 MCI scores indicated 'Excellent' stream health (Stark and Maxted, 2007). This is an improvement from the 2020 sampling (PDP, 2024), where the upstream site (Mangawhitikau Stream Resurgence) was rated as 'Excellent', and the downstream site as 'Good'. When compared to the NPS-FM (2020) National Objectives Framework (NOF) Attribute Bands, for the 2026 MCI results, the 80m upstream site was within the 'A' attribute band and the other three sites were in attribute band 'B'.

Quantitative Macroinvertebrate Community Index (QMCI) scores ranged from 4.04 to 5.81 (2020) to 5.20- 5.99 (2026). All but one of the 2026 QMCI scores indicated 'Good' stream health (Stark and Maxted, 2007). One was rated as 'Excellent'. This is up from the 2020 sampling, where three were rated as 'Good' and two as 'Poor'.

In addition, for the QMCI scores in the NOF attribute bands, 80m upstream was within band 'A', 20m upstream and 100m downstream were within band 'B' and 20m downstream within band 'C'. No MCI or QMCI stream scores in 2026 were below the national bottom line.

The MCI and QMCI scores, summarised in Table 4-4 of Appendix B include that the 2026 results are broadly consistent with the 2020 results (within a 20% range) and do not suggest any significant trends.

The 2019 macroinvertebrate sampling indicated lower scores than the sampling in 2020 (PDP, 2024) and overall, there appears to be a trend on increasing stream health based on macroinvertebrate scores. However, further sampling rounds are required to account for temporal trends.

The TICI score for the Mangawhitikau Stream 100m downstream site was rated as Good (104.5).

⁴ (Dunn, et al., 2026)



4.4 Mangapu River

The Mangapu River originates from a spring-fed watercourse west of the Project Site and consists of the Mangapu system which is the second largest underground river in the North Island.

The system is recorded in Schedule 8 (Outstanding Natural Features) of the PWDP and described as *“Claimed to be the second largest underground river in North Island. Many important speleothems including the only calcite shields and the only aragonite speleothems so far recognised in North Island. Major use for tourism and recreation. Two side caves nearby have some of densest straws and best calcite speleothem assemblages in New Zealand. Best example of karst window in New Zealand.”*

Results of the field survey undertaken by PDP in April 2019 (PDP, 2024) show that upstream of the Mangawhitikau Stream confluence the channel is uniform with high levels of sedimentation, flat hydraulic conditions and little variation in velocity and depth. Downstream channel conditions are similar; however, the substrate included the presence of some gravels/cobbles and a lower level of sedimentation, this represents the contribution of coarser substrate from the Mangawhitikau Stream (PDP 2024).

4.4.1 Physical Habitat

The detailed physico-chemical data is presented in Appendix E of the PDP South-Western Pit: Water Assessment Report (PDP, 2026). The baseline water quality indicates that, along with Mangawhitikau Stream, the Mangapu River shows water quality effects from a highly erodible limestone catchment and the impacts from agricultural land-use (PDP, 2026).

Spot water quality sampling was undertaken on-site at the three sampling sites on the Mangapu River in 2019 (PDP, 2024). The parameters have been compared to the relevant guidelines where available; the WRC Guidelines and the ANZG (2026) Default Guideline Values, and the NPS-FM (2020). It is noted however that the NPS-FM is based on monthly sampling over 5 years so values from the spot sampling are indicative only.

Temperature was within the ‘Excellent’ category of the WRC guideline. pH values were above the ANZG (2026) upper guideline value, and within the ‘Satisfactory’ category for the WRC Guidelines. The elevated pH levels are likely due to the surrounding geology which is rich in limestone. Dissolved oxygen (% saturation) values measured were all within the ‘Excellent’ category for the WRC guidelines. Dissolved oxygen concentrations were within the NPS-FM NOF Attribute Band ‘A’ for all monitoring sites. Specific conductivity ranged from 202.7 to 305.3 µs/cm on the Mangapu River and was above the ANZG (2026) guideline for conductivity.

All sites had clear water and were within the ‘excellent’ category in the WRC guidelines for turbidity. All sites were also within the ANZG (2026) default guideline values for turbidity, and calculated water clarity values were within the NPS-FM (2020) NOF Attribute Band ‘A’ for all monitoring sites.



4.4.2 Aquatic Fauna

Seven fish species were recorded across the three sites during the Mangapu River electrofishing survey undertaken by PDP in 2019 (PDP, 2024).

Table 4-3 Mangapu River electrofishing survey results

Scientific Name	Common Name	Threat classification ⁵	Notes
<i>Anguilla australis</i>	Shortfin eel	Not Threatened	Downstream site
<i>Anguilla dieffenbachii</i>	Longfin eel	At Risk - Declining	Downstream and upstream sites
<i>Geotria australis</i>	Lamprey	Threatened – Nationally vulnerable	Macrophthalmia stage was recorded at the downstream site
<i>Gobiomorphus cotidianus</i>	Common bully	Not Threatened	Upstream site
<i>Gobiomorphus</i> sp.	Unidentified bully	-	Downstream and mid reach sites
<i>Paranephrops planifrons</i>	Kōura	Not Threatened	Mid reach and downstream sites
<i>Salmo trutta</i>	Brown trout	Introduced and Naturalised	Observed at the mid reach site

PDP (2024) assessed that based on the 2019 survey results the MCI for the lower and upper sites on the Mangapu River indicate 'good' stream health (Stark and Maxted, 2007). The upper and mid sites are within the NPS-FM (2020) Attribute State C and D, respectively, indicating moderate and severe organic pollution or nutrient enrichment, while the downstream site is within Attribute State B indicating mild organic pollution or nutrient enrichment.

QMCI scores for the three sites on the Mangapu River indicate 'fair' stream health, with probable moderate pollution when using this index. Upstream and downstream sites on the Mangapu River were classified by the 'C' Attribute Band, and the mid-reach site was classified by the 'D' Attribute Band (PDP, 2024). PDP (2024) note that additional assessments completed in December 2020 recorded lower QMCI values than those recorded in April 2019, likely a result of seasonal differences.

⁵ (Dunn, et al., 2026)



5 Assessment of Effects

5.1 Methodology

The EIANZ guidelines (Roper-Lindsey 2018) methodology used to assess the ecological effects of the proposed South-Western Pit is detailed in Section 3 and Appendix C of this report.

5.2 Aquatic Ecological Values Assessment

The known and inferred physical and ecological characteristics of Camelot Stream, Pōtea Spring, Pumphouse Spring, Mangawhitikau Stream, and Mangapu River, were assessed against the matters and attributes outlined in the EIANZ EcIA guidelines (Roper-Lindsey 2018) (Appendix C).

In summary, the ecological values associated with Camelot Stream have been assessed as high, while Pōtea Spring and Pumphouse Spring are assessed as moderate and low ecological value. The ecological values of the downgradient surface watercourses (Mangawhitikau Stream and Mangapu River) are assessed as high and moderate, respectively, due to the presence of Threatened and At-Risk fish species.

A summary of this assessment is provided in Table 5-1.

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Table 5-1 Aquatic ecological valuation summary based on EIANZ criteria (PDP, 2024)

Aquatic ecological feature	Representativeness	Rarity/Distinctiveness	Diversity and Pattern	Ecological Context	Overall Value
Camelot Stream	High Although subterranean streams are a relatively common feature of the local karst landscape the Digme-Camelot cave system is known as the largest autogenic karst system (streamflow sourced from rainfall within the karst area) in the North Island. The current state of the Digme Cave is impacted due to historical activities including land use in the catchment upgradient from the Project Site.	High As field surveys could not be completed for the submerged section of the stream and there is limited research available on stygofauna in the Waitomo District, eDNA results have been used to set a high score for rarity/distinctiveness (PDP, 2024).	Moderate A moderate score has been given for diversity as eDNA sampling in 2021 and 2026 confirmed no fish being present. This is likely due to a natural barrier in Camelot Stream or its source stream.	Moderate A moderate score has been given for pattern and ecological context. While the cave stream appears intact it is impacted by upgradient agricultural land use and has no fish presence due to barriers moving upstream from Pōtea Spring.	High
Pōtea Spring	Moderate Pōtea Spring is a known resurgence area for subterranean flow from upgradient of the site, as well as the current Oparure Quarry infiltration. A moderate score has been assigned due to its linkages, pathways and contribution to ecological networks.	Moderate There is potential for drift of invertebrates from cave streams and groundwater to surface streams at this location as indicated by drift net samples and eDNA sample results (PDP, 2024: Stantec, 2026). The catchment has however been historically impacted by agricultural land use which has likely impacted subterranean communities. It is considered that Pōtea Spring rates moderate for rarity and distinctiveness.	Moderate See Representativeness	Moderate See Representativeness	Moderate
Pumphouse Spring	Low	Low	Low See Representativeness	Low See Representativeness	Low



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Aquatic ecological feature	Representativeness	Rarity/Distinctiveness	Diversity and Pattern	Ecological Context	Overall Value
	Pumphouse Spring has been identified as a resurgence area for upgradient subterranean flow, as well as the current Oparure Quarry infiltration. A low score has been assigned due to its modified piped nature and use as a water supply.	There is potential for drift of invertebrates from cave streams and groundwater to surface streams at this location as indicated by drift net samples and eDNA sample results (PDP, 2024 and Stantec, 2026). The catchment has however been historically impacted by agricultural land use which has likely impacted subterranean communities. It is considered that this location rates low for rarity and distinctiveness.			
Mangawhitikau Stream	Moderate Instream physicochemical conditions, habitat, and wider catchment characteristics result in this scored as moderate in representativeness.	High Natural barriers to upstream fish passage are present and was considered when describing the instream community composition.	High Due to the presence of the 'At Risk-Declining' longfin eel and the 'At Risk – Naturally Uncommon' torrentfish (Dunn et al., 2026) and the rare nature of the karst system, and with consideration of natural fish passage barriers Mangawhitikau Stream has received a high score for diversity and pattern.	Moderate A moderate score was given for ecological context due to effects from agricultural, forestry and industrial land use effects.	High
Mangapu River	Moderate Mangapu River provides year-round habitat for instream biota however, land-use practices within the catchment have resulted in degradation of critical habitat, a degraded riparian zones, homogeneous flow conditions, and substantial fine	High A high score has been given due to the presence of the 'Threatened- Nationally vulnerable' lamprey and the 'At Risk-Declining' longfin eel (Dunn et al., 2026).	Low There is low taxonomic richness of fish and macroinvertebrates therefore a low score has been assigned.	Moderate The ecological context score of moderate is due to the dominant agricultural land use within the catchment and degraded habitat features.	Moderate



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Aquatic ecological feature	Representativeness	Rarity/Distinctiveness	Diversity and Pattern	Ecological Context	Overall Value
	sediment deposition. Macroinvertebrate index scores fall within Attribute State bands B to D (NPS-FM 2020). Mangapu River is considered moderately representative of natural, unmodified conditions.				



5.3 Aquatic Effects Assessment

As no surface waterbodies exist within the Project footprint, no direct impacts or loss of surface waterbodies will occur from the proposed works. Aquatic environments that have the potential to be affected by the project are assessed as Camelot Stream, Pōtea Spring, Pumphouse Spring, Mangawhitikau Stream downstream of the springs, and Mangapu River (PDP, 2024).

As detailed in the South-Western Pit: Water Assessment (PDP, 2026), when rain events occur, water from the proposed site is expected to migrate underground through cracks and fissures into the underlying groundwater system and Camelot Stream prior to resurfing at Pōtea Spring, and to a lesser extent at Pumphouse Spring, which are located approximately 3km downstream of the project.

Indirect effects associated with stormwater discharge to ground cannot be fully avoided (Instream, 2024) due to the nature of the Project. Potential effects associated with the infiltration of stormwater to ground within the Project Site include:

- Elevated suspended sediment within the water column downgradient which may lead to increased invertebrate drift, fish avoidance, reductions in fish feeding and growth, and mortality of fish (at high turbidity levels (>2000 NTU)).
- Elevated deposited fine sediment and streambed smothering leading to reduction in available habitat for benthic species and reduction in available food sources for fish.

A level of effects assessment for each of the aquatic ecological features is provided in Table 5-2.



Table 5-2 Level of effects for each aquatic ecological feature (PDP, 2024)

Aquatic ecological feature	Overall ecological value*	Magnitude of effect	Level of effect	RMA Level of Effect
Camelot Stream	High	Low Camelot Stream is known to flow under the Project Site at a depth of approximately 80 m below ground level. An identified cave entrance (Camelot Stream submergence) is approximately 2km upstream of the Project Site (Figure 3-1). The surrounding agricultural land use has resulted in rapid infiltration of water to ground and existing high level of turbidity entering Camelot Stream in the vicinity of the Camelot Stream submergence. The project will maintain a buffer of between the engineered quarry pit and Camelot Stream so there will be no intersection of the underground stream by the quarry operation. In addition, sediment detention structures within the quarry will be designed and operated to minimise elevated sediment loads leaving the Project Site. eDNA sampling at Camelot Stream submergence and resurgence sites recorded no fish presence (Section 4.1.2), likely due to a natural barrier upstream from Pōtea Spring. Aquatic invertebrate diversity is not high and although stygofauna and other aquatic cave dwelling invertebrate species have the potential to reside in Camelot Cave, drift net samples from Pōtea Spring and Pumphouse Spring recorded only the amphipod taxa Paraleptamphopus, as well as copepods and ostracods, which are relatively common in this landscape (PDP, 2024). While not reported in eDNA results, the subterranean section of Mangawhitikau Stream contains a large population of glow worms (<i>Arachnocampa luminosa</i>),	Low The effects are considered low as the potential periods of increased suspended sediment are localised and only occur for approximately one day after a rainfall event. This habitat is also the receiving environment of surrounding agricultural land use, which results in elevated levels of suspended sediment (PDP, 2024).	Less than minor



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Aquatic ecological feature	Overall ecological value*	Magnitude of effect	Level of effect	RMA Level of Effect
		which may also be present within Camelot Cave. Potential effects to this population from any changes to the suspended or deposited sediment levels because of short-term rainfall related discharge from the South-Western Pit are expected to be very small/undetectable when mixed with the mainstream (PDP, 2024) as there is no aquatic life stage of the glow worm. The magnitude of effect on aquatic invertebrate fauna (including stygofauna) that could be utilising this habitat from elevated suspended sediment and vibration associated with quarry blasting is considered low.		
Pōtea Spring	Moderate	Low Measured suspended sediment concentrations at Pōtea Spring are lower than those measured in Camelot Stream upgradient of the site. However, it is acknowledged that the existing Oparure quarrying activities and the proposed South-Western Pit have the potential to increase sediment load within site stormwater runoff (PDP, 2026). Elevated turbidity associated with rainfall events could alter species composition within spring systems, as sensitive taxa have the potential to reside in these habitats. However, it is noted that the surrounding catchment is dominated by agricultural land uses, which have historically contributed elevated suspended sediment levels. The magnitude of effect from discharges at Pōtea Spring is considered low due to the localised nature of the effect (rainfall events), short temporal nature (dye tracing from the Project Site put peak flow within 16 hours) and the existing condition of the spring, which is in good physical condition despite the	Low The effects are considered low as the potential periods of increased suspended sediment are localised, only occur for a short duration (approximately one day after rainfall), and these habitats are also the receiving environment of infiltration from surrounding agricultural land use, which results in elevated levels of suspended sediment.	Less than minor



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Aquatic ecological feature	Overall ecological value*	Magnitude of effect	Level of effect	RMA Level of Effect
		contributing agricultural and quarrying catchment loads and past human activities which have resulted in vehicle and other debris buried within the Pōtea Spring channel.		
Pumphouse Spring	Low	Low It is recognised that elevated turbidity associated with rainfall events could increase at Pumphouse Spring from the project. However, as previously noted the catchment is dominated by agricultural land uses which contribute to elevated suspended sediment levels to Pumphouse Spring during rainfall events. The magnitude of effect from discharges at Pumphouse Spring is considered low due to the localised nature of the effect (rainfall events), surrounding agricultural land inputs and limited ecological value of this piped spring discharge.	Very Low The effects are considered very low as the potential periods of increased suspended sediment are localised, only occur for a short duration (approximately one day after rainfall), and these habitats are also the receiving environment of infiltration from surrounding agricultural land use, which results in elevated levels of suspended sediment.	De minimis
Mangawhitikau Stream	High	Very Low-Low Water that infiltrates the proposed pit floor during rainfall events at the Project Site will enter the Mangawhitikau Stream at Pōtea Spring, and to a lesser extent Pumphouse Spring (PDP,2024). The potential effects associated from sediment discharges during rainfall events to ecological values of the Mangawhitikau Stream from the proposed South-Western Pit are considered low. Elevated suspended sediment can affect freshwater invertebrates and fish directly and indirectly. To assess indirect effects, PDP (2024) reviewed existing research on the effects of turbidity on native fish (Rowe et al., 2002) and juvenile rainbow trout (Rowe et al., 2003). The findings of this research have been used to assess the magnitude of effects for the project. The research has shown that in laboratory experiments there was no reduction in the feeding	Negligible-Low Level of effects to Mangawhitikau Stream are considered negligible for suspended sediment and low for deposited sediment. Suspended sediment will be undetectable once mixed in Mangawhitikau Stream and any effect of deposited sediment will be localised and common to the watercourse which has signs of eroded banks within the immediate area (PDP, 2024). This is further supported by the fact that Mangawhitikau Stream at this location supports high ecological values after decades of quarrying activity at Oparure Quarry. Effects to aquatic systems in the Mangapu catchment are considered very low, as no direct or indirect effects are considered to occur.	Negligible - Less than minor



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5 Assessment of Effects

Aquatic ecological feature	Overall ecological value*	Magnitude of effect	Level of effect	RMA Level of Effect
		rate of juvenile rainbow trout at turbidity levels up to 160 NTU (Rowe et al., 2003). It is therefore not expected that adverse effects will occur if turbidity levels up to 160 NTU occur for short term duration (e.g., no more than 24 hours). Turbidity level is therefore not expected to adversely impact fish within the Mangawhitikau Stream mainstem more than that already occurring. Their mobile nature and the type of species caught during the site surveys indicate that fish can tolerate the existing short term elevated turbidity levels that occur during rainfall events (PDP, 2024: PDP, 2026). The effect of suspended solids to the Mangawhitikau Stream past the mixing zone (20m from the confluence with Pōtea Spring) has been determined to be negligible relative to wider land-use impacts within the catchment (PDP, 2024: PDP, 2026). There is potential for sediment to be deposited on the stream bed; however, due to the substrate composition within the stream along with bank erosion in the lower reaches, the very fine sediment associated with the quarry is not expected to become deposited on the stream bed and therefore have adverse effects to instream ecology (PDP, 2024). Only localised areas of deposition expected after rainfall events within the mixing zone, if any, similar to that occurring in upstream reaches of the Mangawhitikau Stream and in streams from surrounding catchments. Impacts to the subsurface section of the Mangawhitikau Stream are low with mixing expected to occur within 20m of the spring flows joining the mainstem (PDP, 2024). The benthic invertebrate community in the Mangawhitikau Stream submergence reach has been recorded as being a subset of the surface		



Graymont South-Western Pit

5 Assessment of Effects

Aquatic ecological feature	Overall ecological value*	Magnitude of effect	Level of effect	RMA Level of Effect
		communities, with decreasing richness with distance underground (Watson 2010). No effects are expected to this aquatic community from the very small increase in suspended sediment associated with rainfall events (PDP, 2024). When mixed with the flow in the Mangawhitikau Stream, the magnitude of effect in terms of suspended sediment concentration on instream communities is assessed as negligible as it will be similar to background levels (PDP, 2024). The effects of deposited fine sediment are considered to be low.		
Mangapu River	Moderate	Negligible Suspended sediment concentrations are not expected to effect Mangapu River, as dye tracer testing did not detect dye at the Mangapu River and full mixing is anticipated at this point (PDP, 2026). Therefore, the magnitude of effect in terms of fine sediment (suspended and deposited) in the Mangapu River is negligible.	Very Low Effects to aquatic systems in the Mangapu catchment are considered very low, as no direct or indirect effects are considered to occur (PDP, 2024).	De minimis

* Overall ecological value from Table 5-1



6 Effects Management

The assessed EcIA level of effect on aquatic ecological values (pre mitigation but including avoidance) resulting from the project range from negligible to low, which results in RMA effects of de minimis to less than minor.

An assessment of the effects management hierarchy to avoid, remedy, mitigate, offset or compensate these effects is provided below, with the aim of providing ecological betterment to ecological habitats and lessening the overall magnitude of ecological effects.

6.1 Avoid

The design and operation of the South-Western Pit will avoid direct physical impacts to Camelot Cave, and in turn Camelot Stream, as assessed in the Geotechnical Assessment. However, it is not possible to avoid the infiltration of rainwater with suspended sediment from the proposed quarry activities.

Graymont's intent is to condition a 200m wide buffer zone (Camelot Cave Buffer Zone) around the projected extension of Camelot Cave beneath the South-Western Pit. This zone would exclude excavation activities in the early stages of pit development until further investigation of the Camelot Cave can be safely undertaken.

This gives time for Graymont to conduct further investigations to ensure that any potential impact on the Camelot Cave system is minimised. After this work has been done, and subject to compliance with set blasting acceleration levels, Graymont proposes to implement a Blast Vibration Restriction Zone, and No Blast Zone to protect the cave. I support this approach.

Further detail on the geotechnical approach to Camelot Cave is provided in the Geotechnical Assessment appended to the substantive application.

6.2 Remedy

No remediation options are considered appropriate at the site while the location is an active quarry. Site restoration and rehabilitation will be required following the closure of the active quarry.

6.3 Mitigate

Due to the high infiltration capacity of the strata, the capture and treatment of all stormwater runoff within an active limestone quarry is impractical and not feasible to achieve. Therefore, there will always be stormwater runoff that cannot be contained, with the potential of some migration of contaminants into the receiving environment, as currently occurs.

To minimise the amount of sediment lost from the Project Site, a robust Erosion and Sediment Control Plan (ESCP) will be prepared and implemented during project activities. This would include a regular schedule of inspections and maintenance for onsite sediment controls and updating the plan as required to incorporate learnings and changes that may be flagged during implementation of the ESCP.

The South-Western Pit: Water Assessment (PDP, 2026) provides practical steps, to be implemented by Graymont during site activities, to reduce the risk to Camelot Stream and in turn downgradient receptors



from infiltration to ground. These measures include the management of stormwater runoff to reduce the potential for sediment mobilisation. The proposed measures include the implementation of erosion and sediment control measures within the quarry, the redirection of stormwater from areas with stock away from the pit, and the implementation of good on-site management practices.

It is therefore considered that stormwater will be managed as effectively as possible, to mitigate potential effects.

6.4 Offsetting and Compensation

The assessed negligible and less than minor effect of the Project (Table 5-2) for all aquatic ecological features means that offsetting and/or compensation is not considered required. However, it is noted that mitigation/ offsetting and/or compensation to achieve an improved/neutral sediment load discharge from the Project Site is proposed and detailed in the South-Western Pit: Water Assessment (PDP 2026).

The South-Western Pit Ecological Betterment Plan (Betterment Plan) prepared by PDP (2025) includes measures that Graymont will implement to:

- a) Compensate for the loss of indigenous terrestrial, karst and any impacts on aquatic (freshwater) habitat as a consequence of the Proposal and provide betterment in accordance with the Vision and Strategy for the Waikato River.
- b) Reduce the net contribution that the site of the Proposal makes to the contaminant (sediment and nutrient) load that is discharged to the downstream surface and groundwater resources.
- c) Advance measures and initiatives to address the actual and potential cultural effects of the Proposal.

To achieve ecological betterment the following initiatives are proposed by Graymont:

- Improved sediment control for Camelot Stream headwater inputs by reducing overland runoff to ephemeral gully streams through riparian planting and fencing.
- Improved sediment control within steep pastoral land (targeted slope of >20 degrees) within the Mangawhikau Stream catchment to reduce sediment loads entering downgradient waterways⁶.
- Pest and predator management (including fencing) of significant forested areas, tomos and at entrances to caves.
- Restoration and enhancement of proposed Significant Natural Areas (SNAs) under the proposed Waitomo District Plan.
- Gate Spring native riparian enhancement.

The Oparure Quarry South-Western Pit: Water Assessment (PDP, 2026) concludes that implementation of the proposed betterment measures detailed in Table 6-1 will achieve an estimated sediment load reduction of approximately 185,022 kg/year by Year 13 (102% of target). This is designed to offset the modelled peak sediment load entering the karst system from the South-Western Pit (180,837 kg/year, projected to occur in Year 13), thereby supporting the no net loss outcome described in this report. There will also be additional net sediment reductions to those detailed here following rehabilitation of the Oparure Pit, at which time continuation of cropping field management currently associated with that

⁶ Further detail on sediment load calculations is provided in the Water Assessment report (PDP 2026).



activity will provide ongoing benefit beyond the period of quarrying activities at Oparure (PDP, 2026). Those measures will also mitigate adverse cumulative effects on aquatic ecology values within the catchment.

A summary of the key components and commitments of the Betterment Plan is provided in Table 6-1 below and shown on Figure 6-1.

Table 6-1 Summary of key measures for sediment load reductions and ecological betterment initiatives

Native planting in the catchment (streams/caves/steep slopes)	Pest and predator control of vegetation and/or cave entrances (including fencing)
• Upper Camelot Stream catchment (11.8 ha planting and fencing: Balls + Boddies). This will result in a sediment load reduction rate of 6,731 kg/ha/year and a sediment load reduction of 79,488 kg/year. • Planting between and around Significant Natural Areas (6.7 ha). This will result in a sediment load reduction rate of 6,463 kg/ha/year and a sediment load reduction of 43,302 kg/year. • 9.4 ha. This will result in a sediment load reduction rate of 6,627 kg/ha/year and a sediment load reduction of 62,294 kg/year. • Pōtea Spring riparian vegetation restoration • Shelterbelt plantings – totara shelterbelt and alder shelterbelt (short-term) • Implementation of the Riparian and Karst Plant Management Plan, Plant and Animal Pest Management Plan and Fauna Management Plans (Bird, Bat and Lizard)	Implementation of Plant and Animal Pest Management Plan.

6.4.1 Camelot Stream

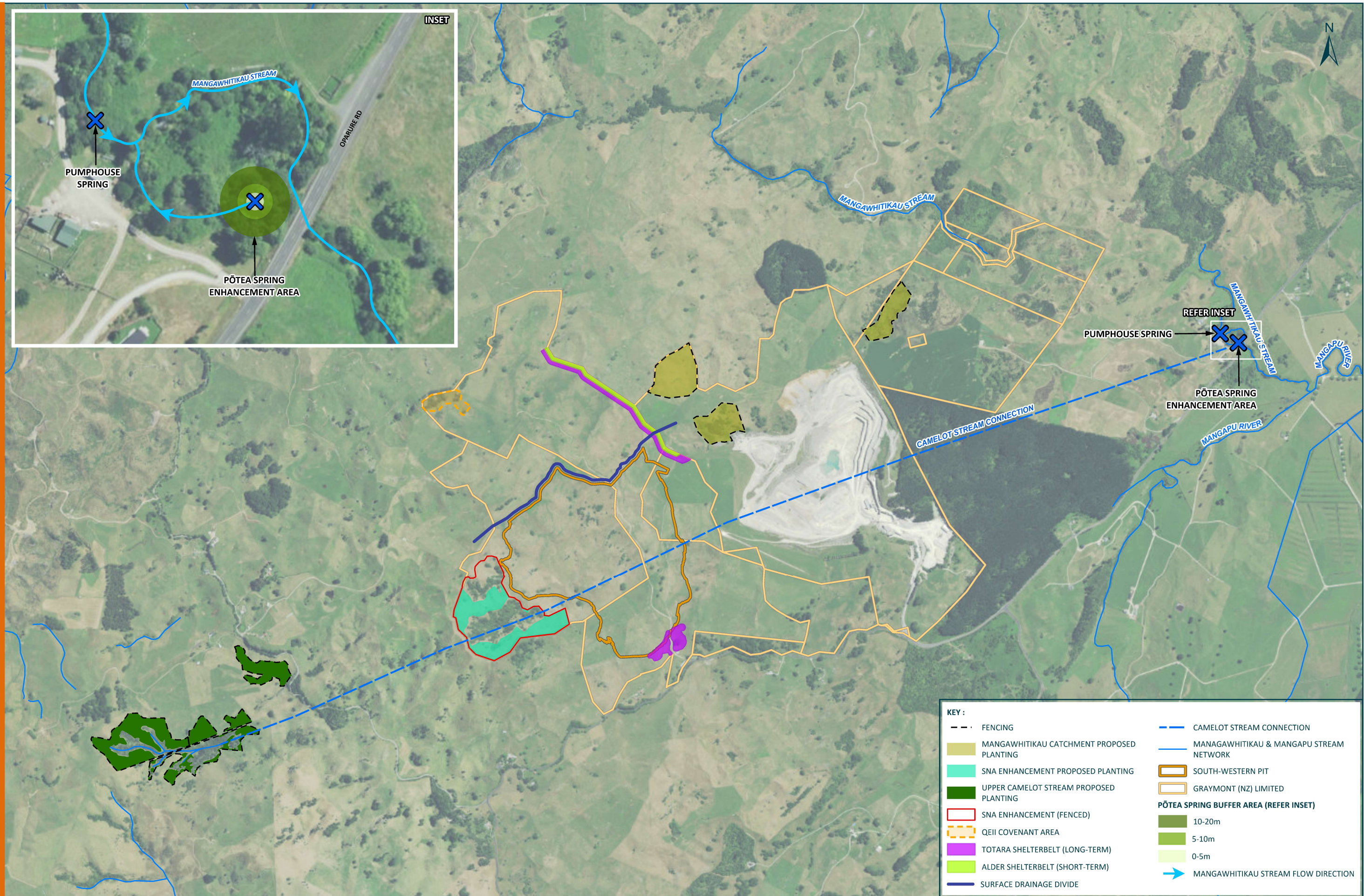
Graymont will implement measures to avoid, where practicable, impacts to the subsurface Camelot Stream. However, impacts from suspended sediment migration during rainfall events and vibration from blasting and excavating activities would result in a low overall level of effect, prior to mitigation. For the Project, with the implementation of measures detailed in an ESCP, residual effects will reduce to very low.

Ecological betterment through the measures outlined in the Betterment Plan included in the application package and summarised in Table 6-1 will also reduce sediment input to Camelot Stream, in particular the level of sediment entering in the upper catchment.

6.4.2 Pōtea Spring

This assessment identified a low EclA level of effect from the project on Pōtea Spring. The proposal has however identified that there are opportunities for enhancement of the values of the spring. Terrestrial vegetation restoration is proposed and would be undertaken sequentially in three buffer zones 0-5 m, 5-10 m and 10-20 m from the spring. These measures are detailed in the Betterment Plan.





0 250 500
Meters
SCALE : 1:17,500 (A3)

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A	ISSUED FOR REVIEW	JUN 26	MS
NO.	REVISION	DATE	BY

SOURCE:
1. AERIAL IMAGERY (FLOWN 2023-2024) SOURCED FROM NATIONAL INSTITUTE OF WATER AND ATMOSPHERIC RESEARCH
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.
3. WATERWAYS SOURCED FROM LINZ.
4. PROPERTY PARCELS SOURCED FROM LINZ.

CLIENT



GRAYMONT

FIGURE

FIGURE 6-1: BETTERMENT PLAN OVERVIEW

PROJECT

GRAYMONT - BETTERMENT PLAN (SW PIT)

6.5 Condition Monitoring

Annual ecological surveys, by a suitably qualified and experienced freshwater ecologist, of the below watercourse sites will be completed for the first five years of the Project. It is then proposed to reduce the surveys to every three years:

- Camelot Stream submergence site
- Pōtea Spring channel
- Pumphouse Spring⁷
- Mangawhitikau Stream
 - 20 m upstream of Pōtea Spring channel confluence
 - 100 m upstream of Pōtea Spring channel confluence
 - 20 m downstream of Pōtea Spring channel confluence
 - 100 m downstream of Pōtea Spring channel confluence

These ecological surveys would include, at minimum:

- Physical habitat surveys (Rapid Habitat Assessments) (Clapcott, 2015)
- Deposited fine sediment surveys (percent cover and depth) using the SAM2 method (Clapcott et al., 2011)
- Macroinvertebrate sampling (quantitative sampling for MCI and QMCI metrics)
- eDNA sampling (6-replicate surveys)
- Periphyton and macrophyte surveys (percent cover and type - NEMS Sampling and Measuring periphyton in Wadeable Rivers and Streams).

The results from these surveys are intended to provide a record of condition changes due to the Project, as well as the effectiveness of proposed betterment, detailed in the Betterment Plan, in the upgradient source stream catchments.

This monitoring is in addition to water quality monitoring proposed in the water assessment report (PDP 2026).

Event-based monitoring is also proposed, once physical works (excavations, quarrying or disturbance activities) associated with the South-Western Pit commence within the Camelot Cave Buffer Zone or the Blast Vibration Restriction Zone. When continuous turbidity monitoring triggers at Pōtea Spring are reached, a series of actions will be undertaken, including alerting the consent holder so that onsite activities can be recorded, sediment controls checked, data trends tracked and reporting undertaken.

If the trigger exceedance continues, actions are to include ecological assessments of eDNA at Pōtea Spring, and deposited fine sediment and benthic invertebrate surveys within the Mangawhitikau Stream (20 and 100 m up and downstream of the confluence with Pōtea Spring) using the methods described in the annual monitoring above. This event-based monitoring is intended to provide an assessment of if

⁷ eDNA sampling only at the piped outlet.



unexpected discharge events result in adverse ecological events. A report is to be prepared, investigating the actual and potential short- and long-term effects of the activity and recommending next steps. Further detail is provided within the conditions.

6.6 Summary of Residual Level of Effects

Based on the proposed avoidance, mitigation, offsetting and compensation, and ongoing monitoring detailed in this section, it is considered that the residual EclA level of effect to Pōtea Spring and Mangawhitikau Stream will be very low, which can be considered negligible under the RMA.

With the strategy developed to reduce effects to downgradient watercourses and provide ecological betterment for the low level of effect under the EclA framework, the residual EclA level of effect is very low and can be considered negligible under the RMA.

A summary of the residual level of effects is provided in Table 6-2.

Table 6-2 Summary of residual level of effects

Ecological feature	EclA Level of Effect	RMA effect level	EclA Level of Effect - Residual Effect	RMA effect level- Residual Effect
Camelot Stream	Low	Less than Minor	Very Low	Negligible
Pōtea Spring	Low	Less than Minor	Very Low	Negligible
Pumphouse Spring	Very Low	De minimis	-	-
Mangawhitikau Stream	Negligible – Low	Negligible - Less than minor	Very Low	Negligible
Mangapu River	Very Low	De minimis	-	-

7 Conclusions

Graymont proposes to expand its quarrying activities with the establishment of the proposed South-Western Pit adjacent to the existing Oparure quarry, north of Te Kūiti. This report provides an EclA for aquatic ecology values associated with the proposal.

As no surface waterways are present within the South-Western Pit footprint, effects are limited to the temporary discharge of suspended sediment associated with rainfall events to the subsurface Camelot Stream, downgradient resurgence points for this subsurface flow, and cumulative effects of suspended sediment input to downgradient watercourses. Therefore, any effects are expected to be localised and of short duration.

Opportunities to avoid, remedy and mitigate adverse effects associated with the proposed quarry operations have been assessed within this report. The operation of the South-Western Pit will avoid direct impacts to Camelot Stream, noting that further investigation is required to confirm the alignment. Mitigation for the low level of effect from stormwater discharges to downgradient waterways through the pit floor will be provided through best management practices for the quarry operation and erosion and sediment control, as outlined in Section 6.3.



To provide ecological betterment for potential residual impacts to Camelot Stream and Pōtea Spring, habitat restoration of source stream catchments to the west of the site is proposed. As detailed in the Betterment Plan and summarised in Section 6.4, these locations will be protected with fencing, native planting, sediment and erosion control, and pest/predator control. This will result in a reduction in sediment entering the subsurface karst environment upgradient of the proposed project area and will improve the ecological condition and biodiversity values of these areas. To provide ecological betterment for Pōtea Spring, native riparian restoration of the springhead is proposed.

There are not considered to be effects that reach the threshold of a “sufficiently significant adverse impact” such that they need to be taken into account in terms of an assessment under s85 of the FTAA 2024. With the detailed betterment in place, it is considered that no net loss will occur, and over time net ecological gain is predicted. It is acknowledged, however, that there will be a time lag for these betterment initiatives to become established; it is therefore proposed that betterment works will be carried out prior to pit development. Monitoring is also proposed, as detailed in Section 6.5, to confirm projected effects to waterways, identify unexpected effects (thus enabling measures to be developed and deployed should a response be warranted) and monitor betterment initiatives.



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Appendices



Appendix A Site Photos

Camelot Stream



Photo 1: Camelot Stream at submergence



Photo 2: Camelot Stream Cave at submergence



Photo 3: Camelot Stream substrate



Photo 4: Sediment accumulation at edge of Camelot Stream



Pōtea Spring – photos from PDP (2024)



Photo 5: Pōtea Spring, stream resurgence



Photo 6: Pōtea Spring, stream resurgence



Photo 7: Channel downstream of Pōtea Spring with drift net installed



Photo 8: Rubbish debris within channel banks and bed downstream of Pōtea Spring



Photo 9: Vehicle debris within channel banks downstream of Pōtea Spring

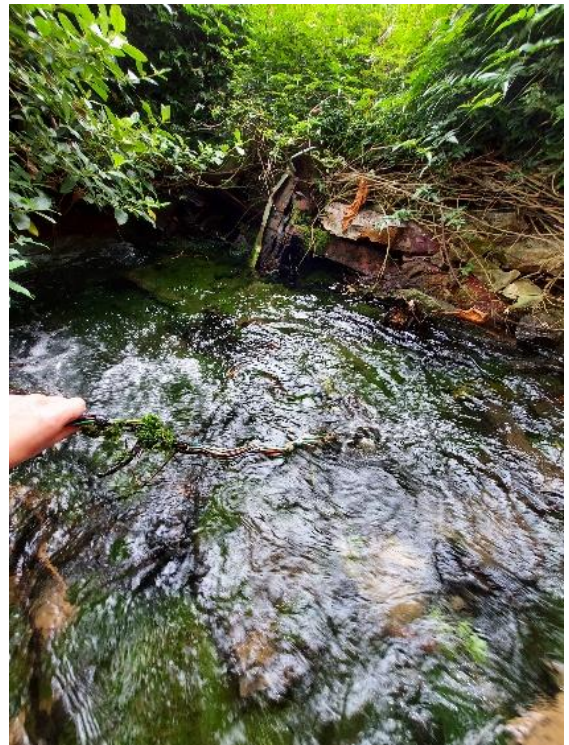


Photo 10: vehicle debris including wiring within channel banks and bed downstream of Pōtea Spring



Photo 11: Active erosion of channel banks downstream of Pōtea Spring



Photo 12: Pōtea Spring resurgence at Mangawhitikau confluence

Pumphouse Spring – photos from PDP (2024)



Photo 13: Pumphouse Spring at Mangawhitikau confluence

Mangawhitikau Stream – photos from PDP (2024)



Photo 14: Mangawhitikau Stream, approximately 80 m upstream of Pōtea Spring, facing downstream



Photo 15: Woody debris in Mangawhitikau Stream, approximately 80 m upstream of Pōtea Spring, facing upstream.



Photo 16: Cobble and woody debris within the Mangawhitikau Stream 80m upstream Pōtea Spring, facing upstream.



Photo 17: Woody debris within the channel altering flow and promoting local sediment deposition, approximately 80m upstream, facing upstream.

Graymont South-Western Pit
Appendix A Site Photos



Photo 18: Clean cobble substrate within the Mangawhitikau Stream, approximately 20 m upstream of Pōtea Spring.



Photo 19: Erosion of Mangawhitikau Stream bank, approximately 20 m upstream of Pōtea Spring. Photograph facing upstream.



Photo 20: Mangawhitikau Stream, approximately 20 m downstream of Pōtea Spring. Photograph facing downstream.



Photo 21: Mangawhitikau Stream, approximately 20 m downstream of Pōtea Spring. Photograph facing downstream.



Photo 22: Exposed willow roots (pink) along the Mangawhitikau Stream, approximately 20 m downstream of Pōtea Spring.



Photo 23: Clean cobble substrate within the Mangawhitikau Stream, approximately 20 m downstream of Pōtea Spring.

Graymont South-Western Pit
Appendix A Site Photos



Photo 24: Large woody debris approximately 100 m downstream of Pōtea Spring. Photograph facing upstream.



Photo 25: Approximately 100 m downstream of Pōtea Spring. Water is noticeably more turbid than upstream.



Photo 26: Well sorted cobble, with less turbid water, and woody debris, approximately 100 m downstream of Pōtea Spring. Photograph facing upstream.

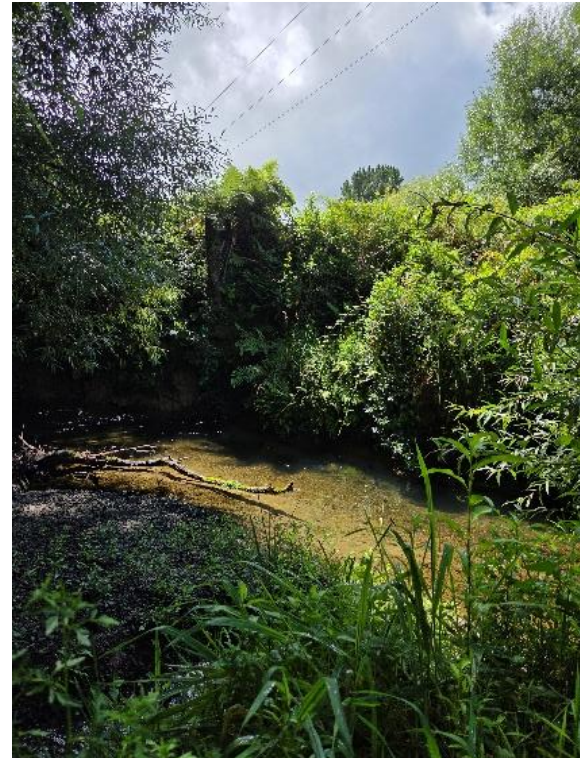


Photo 27: Extended view of the stream, further south of previous figure image.



Photo 28: Lower reach. Photograph facing upstream



Photo 29: Lower reach. Photograph facing downstream

Mangapu River – photos from PDP (2024)



Photo 30: Upper reach. Photograph facing upstream



Photo 31: Upper reach. Photograph facing downstream



Photo 32: Mid-reach. Photograph facing upstream



Photo 33: Mid-reach. Photograph facing downstream



Photo 34: Lower reach. Photograph facing upstream



Photo 35: Lower reach. Photograph facing downstream

Appendix B Graymont Aquatic Ecological Monitoring Report



South-Western Pit: Aquatic Assessment Methods and Results



Prepared for:
Graymont NZ LTD

Date:
30 June 2026

Prepared by:
Rombout Ruiterkamp, Georgia Woodall

Project/File:
310003484

Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer	Independent Reviewer	Project Manager Final Approval
1	30/4/2026	Draft	RR & GW	DS	LD	IR
2	26/6/2026	Final Draft	RR & GW	DS	LD	IR
3	30/6/2026	Final	RR & GW	DS	LD	IR

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Prepared by:



Signature

Rombout Ruiterkamp

Reviewed by:



Printed Name



Signature

Georgia Woodall and Laura Drummond

Printed Name

Approved by:



Signature

Ilze Rautenbach

Printed Name



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Graymont Southern Pit Aquatic Ecology Surveys

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Appendix D Periphyton Results



1 Introduction

Stantec New Zealand (Stantec) was commissioned by Graymont New Zealand Limited (Graymont) to provide an updated summary of the ecological values of aquatic receiving environments associated with the South-Western Pit, west of Te Kuiti in the Waikato.

This involved consolidation of previous desktop assessments and field survey results (collected between 2019 and 2021) into a standalone document. The intention of this is to provide updated information on aquatic ecological values for the Ecological Impact Assessment (Stantec New Zealand, 2026), prepared for the Fast Track Approvals Act (FTAA) application for the development of the South-Western Pit, as shown in (Figure 1-1) below.



Figure 1-1: Graymont Quarry (Lot2DPS77130) and the proposed haul road (green), proposed Southern Catchment Pit extent (pink) and divide line (blue). Figure retrieved from (Instream Consulting, 2024)

1.1 Background

Aquatic ecology investigations have been undertaken on the proposed South-Western Pit's aquatic receiving environments in the past by PDP Limited, Enspire Consulting Limited, and Instream Consultants Limited. Fieldwork was undertaken between 2019 to 2021 to inform an Ecological Impact Assessment(s) related to the previous Western Pit expansion plans, but no further information has been collected since. In order to adequately assess and address potential impacts associated with the proposed South-Western Pit, further information on the current instream ecological values was required.

1.2 Aim and Scope

This report provides a synthesis of past and present aquatic ecological data, inclusive of comparisons to the prior data. Previous data was collected from the following reports:

1. PDP Limited. (2024). *Freshwater Ecological Impact Assessment – Proposed Western Pit*. Report No. C03870503R00 Appendix B (Aquatic Assessment Methods and Results).
2. Enspire Consulting Limited. (2021). *Environmental DNA survey of Camelot and Mangawhitikau Streams*.

The purpose of the updated field surveys was to provide a comparison between temporal ecological value changes (if any), that could impact the effects and application of the Effects Management Hierarchy for the Ecological Impact Assessment (EclA) report, and to provide more robust ecological data to inform consent monitoring conditions.

2 Methods

2.1 Desktop Review

A desktop review of existing information was performed by PDP in 2019 to assess the current condition of the aquatic receiving environment. A summary of this review is provided, along with additional up to date information. The following information sources were used:

- New Zealand Freshwater Fish Database (NZFFD) records
- Land and Water (Lawa; <https://www.lawa.org.nz/>)
- Ministry for the Environment Data Service (<http://data.mfe.govt.nz/data/category/fresh-water/>)
- Waikato Maps- Water classification (<https://waikatomaps.waikatoregion.govt.nz/gallery/>)
- Relevant peer reviewed and grey literature

2.2 Field Surveys

PDP undertook previous site-specific freshwater surveys, including spot water quality, habitat, benthic macroinvertebrate (kicknet and drift) and fishing in 2019 and 2020, to obtain data on aquatic receiving environments downgradient of the site. Watercourses sampled included the Pōtea Spring, Pumphouse Spring, Mangawhitikau Stream and Mangapu River, to establish ecological baseline conditions.

Enspire Consulting (2021) undertook spot water quality sampling and eDNA sampling within the Pōtea Spring, Pumphouse Spring, the identified Camelot Cave Stream submergence, and the Mangawhitikau Stream submergence and resurgence sites in September 2021. The intention of this sampling was to gain a wider understanding of ecological values upstream and downstream of subsurface stream sections (within caves), as entry to Camelot Cave could not occur due to health and safety concerns.

Updated field surveys were undertaken in 2026 to provide an update to previous surveys and act as a 'pre-impact' monitoring event that can be replicated over time. Sites were selected based on the results of previous surveys and known subsurface flow paths. Surveys included spot water quality, habitat surveys (rapid habitat assessments, deposited fine sediment periphyton % cover), benthic



macroinvertebrates and eDNA. Watercourses sampled included the Camelot Stream Submergence, Pōtea Spring, Pumphouse Spring and Mangawhitikau Stream.

2.2.1 Sampling Sites

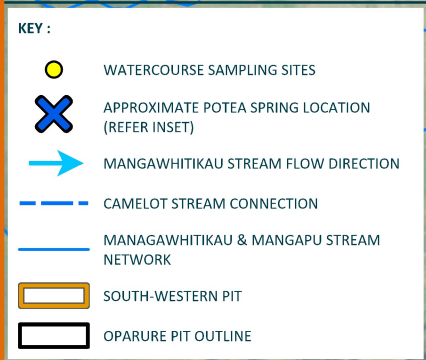
Monitoring sites were selected based upon their relevance to the South-Western Pit and the suitability to compare to prior survey efforts. The aquatic ecology sample sites are summarised below in Table 2-1 and shown in Figure 2-1.

Table 2-1: Summary of sampling sites/locations

Site	Site code	Sampling methods undertaken at each site		GPS coordinates	
		Historic data (2019-2021)	Current data (2026)	Lat	Long
Camelot Submergence	CS	eDNA, habitat	eDNA, habitat	-38.351008	175.037712
Pōtea Spring (Camelot Resurgence)	PS1	eDNA, habitat	eDNA, habitat	-38.331870	175.095899
Pumphouse Spring	PS2	eDNA	eDNA	-38.331381	175.095097
Mangawhitikau Stream Submergence	MS1	eDNA	N/A	-38.326291°	175.074496°
Mangawhitikau Stream Resurgence	MS2	eDNA	N/A	-38.3272021	175.094865
Mangawhitikau Stream 20m upstream	MS3	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3312604,	175.0952933
Mangawhitikau Stream 80/100m upstream ¹	MS4	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3305840	175.0955453
Mangawhitikau Stream 20m downstream	MS5	Macroinvertebrates, habitat	Macroinvertebrates, habitat	-38.3312106	175.0959847
Mangawhitikau Stream 100m downstream	MS6	eDNA, macroinvertebrates, habitat, electric fishing	eDNA, macroinvertebrates, habitat	-38.330938	175.095320
Mangapu River upstream	MR1	Macroinvertebrates, habitat, electric fishing	N/A	-38.353278	175.092804
Mangapu River mid	MR2	Macroinvertebrates, habitat, electric fishing	N/A	-38.336451	175.094733
Mangapu River downstream	MR3	Macroinvertebrates, habitat, electric fishing	N/A	-38.333109	175.101123

¹ Originally to be sampled 100m upstream, however access was limited due to dense scrub and fallen willows blocking access to the reach.





SOURCE:
1. AERIAL IMAGERY (FLOWN 2023-2024) SOURCED FROM NATIONAL INSTITUTE OF WATER AND ATMOSPHERIC RESEARCH
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.

2.2.2 Methods

2.2.2.1 Habitat Assessment

Rapid Habitat Assessments (RHA) (Clapcott J. , 2015) were undertaken on January 6th and 7th at all site locations to assess the instream features. Four transects were evenly spaced across a 50m representative reach at each site. Across each transect, depth and width measurements were collected, and substrate was recorded, along with woody debris, periphyton and any macrophytes present. Additionally, riparian habitat, fish and macroinvertebrate habitat was assessed, as well as shading and other factors. Ten metrics were assessed with a score between 1-10, a final score out of 100 was then allocated to the site and compared to RHA scoring bands (Table 2-2).

Table 2-2: Habitat quality classes and descriptions for interpreting RHA scores

Habitat condition	Score range
Excellent	>75
Good	>50 and ≤75
Fair	>25 and ≤50
Poor	≤25

2.2.2.2 Spot Water Quality

Spot water quality measurements were taken in conjunction with habitat assessments. Field parameters measured include temperature, conductivity, dissolved oxygen, pH, total suspended solids (TSS) and turbidity (TNU). Results were compared to relevant regional and national guidelines outlined in Table 2-3 and National Policy Statement – Freshwater Management (NPSFM 2020) Attribute bands.

Table 2-3: Relevant water quality guidelines

Parameters	Unit	Waikato Regional Council Surface Water Class Standards			ANZG (2018) Default Guideline Values
		Excellent	Satisfactory	Unsatisfactory	
pH	-	7 – 8	6.5 – 7 or 8 - 9	<6.5 or >9	7.2 - 7.7
Temperature	(°C)	<16	16-20	>20	-
Conductivity	(µs/cm)	-	-	-	115
Dissolved Oxygen	(% sat)	>90	80 - 90	<80	92 - 103
Turbidity	(TNU)	<2	2-5	>5	5.2
Total Suspended Solids	(g/m ³)	<2	2-5	>5	1.8

2.2.2.3 Water Quantity

PDP undertook flow gauging in 2019 (PDP Limited, 2024) using a Sontek Flowtracker 2, at each of the 2019 sampling sites.



2.2.2.4 Deposited Fine Sediment

Deposited fine sediment cover was assessed using Sediment Assessment Method 2 (SAM2) (Clapcott, et al., 2011) at the four sample locations within the Mangawhitikau Stream and one at the Camelot Stream Submergence site in order to determine the visual deposition of suspended sediments across the surface area of the stream bed. Assessments were undertaken using a portable bathyscope to assess the stream bottom using transects across representative 50m reaches, in conjunction with periphyton assessments.

2.2.2.5 Periphyton

Periphyton cover was visually assessed in accordance with the NEMS Sampling and Measuring Periphyton in Wadeable Rivers and Streams (National Environmental Monitoring Standards, 2022). Results recorded as percent cover and type at the four sample locations within the Mangawhitikau Stream in order to determine the visual deposition of suspended sediments. Assessments were undertaken using a portable bathyscope to assess the stream bottom using transects across representative 50m reaches, in conjunction with deposited fine sediment assessments.

2.2.2.6 eDNA

Environmental DNA (eDNA) sampling undertaken following Wilderlab methodology for active sampling on 30 September 2021 at five sites: the Camelot Stream submergence, Pōtea Spring, Pumphouse Spring and at two locations on the Mangawhitikau Stream, the submergence and resurgence (as shown in Figure 2-1). The intention of the submergence and resurgence sites was to identify community changes upstream of the cave stream section, for comparison to the Camelot Stream.

eDNA sampling in 2026 was undertaken in accordance with the National Environmental Monitoring Standards (NEMS) Environmental DNA guidelines and field protocols for lotic systems (Greenwood, 2023). Passive eDNA sampling was undertaken at the Camelot Stream Submergence site, Pōtea Spring and the Mangawhitikau Stream 100m Downstream site, and active sampling was undertaken at the Pumphouse Spring. Passive samplers were deployed on the 6th of January and retrieved on the 7th of January. Three active samples were taken on the 6th, followed by 3 on the 19th of January, due to mechanical failure of both eDNA syringes on the 6th. Presence/absence of freshwater fish species was determined in accordance with the environmental DNA guidelines.

Additionally, Taxon-Independent Community Index (TICI scores (Wilkinson S. P., 2024)) and values were provided by Wilderlab within the output of the 2026 data. The TICI score is a metric used to determine instream ecological values using indicator scores in a similar fashion to macroinvertebrate data.

Site scores are compared against national instream ecological health benchmark scores (Appendix A-1). TICI scores strongly correlate to 5-year median MCI values with an adjusted R² value of 0.825 (Wilkinson, et al., 2024).

2.2.3 Macroinvertebrates

Benthic macroinvertebrate sampling was undertaken in accordance with the Protocols for Sampling Macroinvertebrates in Wadeable Streams (Stark, Boothroyd, Harding, Maxted, & Scarsbrook, 2001). Three replicate samples were taken following protocol C2: Soft-bottomed, Semi-quantitative. Following



collection of samples, they were sent to Environmental Impact Assessments Ltd for processing in accordance with Protocol P2 (200 individual fixed count with scan for rare taxa). Output metrics include:

- Taxa richness
- %EPT taxa
- %EPT abundance
- MCI
- QMCI

Macroinvertebrate values were compared to Stark & Maxted (Stark J. &, 2007) stream health values and National Policy Statement – Freshwater Management attribute bands (Ministry for the Environment, 2020). Scores and attribute values can be found contained within tables located in Appendix A-2.

Driftnet sampling was undertaken by PDP in 2020 (PDP Limited, 2024). Drift nets were installed in the channel immediately downstream of Pōtea Spring and Pumphouse Spring. 250 and 500 µm nets were staked mid-way within the water column at Pōtea Spring and at substrate level at Pumphouse Spring (due to low water levels and piped outlet). The nets were set and left for three days/ nights before retrieval. Samples were collected, processed and stored in 70% ethanol, before being sent to Stark Environmental Ltd for processing following the Protocol P2, 200 fixed count with scan for rare taxa. Driftnet sampling was not replicated in 2026. As updated sampling methods and sites were selected to provide a 'pre-impact' monitoring event, ongoing use of driftnet sampling was considered a risk to future compliance for Graymont Ltd, as nets at this mesh size are not available in New Zealand. eDNA sampling was selected as a practicable method to provide species richness data long-term at each of the monitoring locations.

2.2.3.1 Electric Fishing

PDP (2024) conducted electric fishing surveys in 2019 within the Mangawhitikau Stream. Within the stream, five sites were chosen and a 100m reach was electrofished at each site, working in an upstream direction. Fishing was conducted prior to and downstream of water quality, flow gauging or ecological habitat assessments to avoid disturbance to the fish community and survey results.

All electric fishing was conducted using a Kainga EFM300 backpack electric fishing machine by three trained operators. Semi-quantitative single pass sampling was performed at all sites, using a pole seine net placed downstream of the surveyed area. Stunned fish were collected within the operator's dip net, or in the pole seine. Collected fish were placed into a bucket of well oxygenated water before being identified, measured and returned to the stream at an appropriate location downstream of the sampling.

3 Results

3.1 Desktop Review

In a desktop review undertaken by PDP (2024) both the Mangawhitikau Stream and the Camelot Stream exhibit intermittent surface flows, with sections of each watercourse flowing subsurface through limestone geology. The Mangawhitikau Stream is classified by Waikato Regional Council (WRC) as 'surface water' and 'contact recreation', with portions identified as 'natural streams' and 'priority 1 stock exclusion' areas in the headwaters. The tributaries flow through native bush.



The Mangawhitikau Stream flows into the Mangapu River, which travels approximately 14 km (linear distance) before merging with the Mangaokewa Stream. From there, the watercourse continues downstream and joins the Waipa River approximately 6km downstream of Otorohanga. Along this reach, the Mangapu River is classified as 'surface water', 'indigenous habitat', and 'trout habitat'.

3.1.1 Water Quality

The LAWA (Land and Water Aotearoa) website² was completed for water quality and ecological records of nearby watercourses. The closest monitoring site to the quarry is the Mangaokewa Stream at the Lawrence Street Bridge (LAWA, 2026 (a)). Additional monitoring sites were identified as Mangarama Stream at Gadsby Road (LAWA, 2026 (b)) and Waitomo Stream at Tumutumu Road (LAWA, 2026 (c)). These three sites are not directly related to the proposed South-Western Pit, or the existing quarry site, however they provide context for water quality within the wider area.

Median concentrations (5-year median), improving/degrading trends (across 5 years) and NPS-FM bands (where provided) are presented in Table 3-1. Ecological data is not recorded at these sites. These water quality results are representative of the surrounding landscape and land use, with some parameters (i.e., *E. coli* and dissolved reactive phosphorus) showing elevated levels.

² [Land, Air, Water Aotearoa \(LAWA\) - The homepage](#)



Graymont Southern Pit Ecological Surveys
3 Results

Table 3-1: Nearby LAWA water quality sites summary gathered 2026

Parameter	Unit	Mangaokewa Stream at Lawrence Street Bridge			Mangarama Stream at Gadsby Road			Waitomo Stream at Tumutumu Road		
		5-year median	Attribute Band	Trend	5-year median	Attribute Band	Trend	5-year median	Attribute Band	Trend
<i>E. coli</i>	(n/100ml)	605	E	Likely Improving	Not assessed	-	Not assessed	360	E	Likely Improving
Clarity	(m)	0.9	D	Indeterminate	Not assessed	-	Not assessed	0.9	D	Likely Degrading
Turbidity	(NTU)	5.35	-	Indeterminate	14.05	-	Not assessed	5.2	-	Indeterminate
Total Nitrogen	(mg/L)	0.9	-	Likely Degrading	1.305	-	Not assessed	0.71	-	Likely improving
Total Oxidised Nitrogen	(mg/L)	0.62	-	Likely Degrading	0.965	-	Not assessed	0.6	-	Likely improving
Ammoniacal Nitrogen	(mg/L)	0.0145	A (toxicity)	Likely Improving	0.021	A (toxicity)	Not assessed	0.01	A (toxicity)	Not assessed
Nitrate Nitrogen	(mg/L)	0.62	A (toxicity)	Likely Degrading	0.965	A (toxicity)	Not assessed	0.6	A (toxicity)	Likely improving
Dissolved Reactive Phosphorus	(mg/L)	0.012	C	Very Likely Improving	0.01	B	Not assessed	0.008	B	Very likely Degrading
Total Phosphorus	(mg/L)	0.0345	-	Likely Improving	0.042	-	Not assessed	0.019	-	Indeterminate



3.1.2 Fish

A search of the New Zealand Freshwater Fish Database (NZFFD) (NIWA, 2026) for the Mangawhitikau Stream catchment resulted in four detections of native freshwater fish/ invertebrates, two for longfin eel (*Anguilla dieffenbachia*; At Risk- Declining) and one each for kōura (*Paranephrops planifrons*: Not Threatened), redfin bully (*Gobiomorphus huttoni*; At Risk- Uncommon), and banded kōkopu (*Galaxias fasciatus*; At Risk- Uncommon). In addition, there was a record for brown trout (*Salmo trutta*; *Introduced and Naturalised*). The Waikato River has historic records of 17 species of native fish and 14 introduced fish species. As this river is connected to the Mangawhitikau Stream, these species also have the potential to occur in the Mangawhitikau Stream.

3.1.3 Caves

Desktop review undertaken by PDP (2024) and summarised below, reported three known cave systems within and nearby to the proposed South-Western Pit. These include the Digne-Camelot Cave Systems, the Mangawhitikau Cave Systems, and the Mangapu Cave Systems. Part of the Camelot Cave is located beneath the quarry footprint. There is limited information available on this cave system and multiple attempts were made to gain further information by sending caving experts into the system to take samples. These efforts were abandoned due to safety concerns relating to low oxygen levels and safe emergency egress.

Within the Waikato District Plan (Waikato District Council, 2009) the Digne-Camelot cave system is listed as “High Significance”, the Mangawhitikau Cave system as “National importance”, and the Mangapu Cave system as “International Importance”.

Limited information is available on aquatic fauna associated with autogenic streams, springs and seeps in the Waitomo area, including stygofauna. Stygofauna are groundwater-associated organisms ranging from incidental surface species to highly specialised subterranean taxa, commonly classified as stygoxenae, stygophiles and stygobites. Knowledge of New Zealand stygofauna remains limited compared with other regions, with only 102 species described as of 2004, despite an estimated total of several hundred species (Fenwick & Scarsbrook, 2004). Sparse sampling, limited taxonomic resolution, and the prevalence of short-range endemics restrict reliable assessment of biodiversity, community structure and ecological condition.

Due to the safety constraints preventing direct surveys of the sub-surface section of Camelot Stream, and the limitations of eDNA for characterising stygofaunal communities, potential aquatic fauna have been inferred from regional studies and local knowledge. Cave and resurgence habitats in the Waitomo area typically support gastropod snails, amphipods and isopods, with biodiversity highest near cave entrances and communities within stream-fed caves generally forming depauperate subsets of surface assemblages (Fenwick, 2000; Watson, 2010). Regional surveys identified common taxa such as *Paraleptamphopus*, with no rare aquatic species recorded, although some cave-associated snails of conservation concern, such as *Potamopyrgus doci* may be present (Environment Waikato 2008; Millar, unpublished). Conversion of land from forest to pasture is known to adversely affect cave ecosystems through increased sedimentation and reduced organic inputs (Williams 1993). Based on available information, nearby cave stream surveys and existing land use, aquatic communities within Camelot Stream are unlikely to support high numbers of rare or sensitive taxa; however, this conclusion is indicative only due to the absence of site-specific surveys.



3.2 Field Surveys

3.2.1 Habitat Sampling

The Mangawhitikau Stream was in general widest in the upstream sampling sites, when compared to the downstream sampling sites (Table 3-2). Water depth was inconsistent across the sampling sites, ranging from 0.04m to 0.84m. The Camelot Stream headwater site was observed to have significant undercutting at switch hook and meanders. The substrate was varied, consisting of boulders, large and small cobbles, large and small gravel, amongst mud and silt. Organic material was also found in the channel. The Pōtea Spring had gravel, sand, silt, mud and abundance organic debris. Overall, the Mangawhitikau Stream was characterised by small to medium gravel, small cobbles, sand and silt. There were large amounts of woody organic debris throughout the channel and reaches sampled.

Baseflow within the Mangawhitikau Stream was measured by PDP in 2019 (PDP Limited, 2024), with a flow of 0.056 m³/s at the upstream site (upstream of the Mangawhitikau submergence) increasing to 0.123 m³/s at the downstream site, upstream of Oparure Road (Table 3-3). This represents the gaining reach within the subsurface section of stream.

Table 3-2: Summary stream depth and width data (2026)

Parameter	Measurement	Camelot Submergence	Pōtea Spring	Mangawhitikau Stream			
				20m US	80m US	20m DS	100m DS
Width (m)	Min	0.35	1.85	4.20	4.20	2.28	2.15
	Average	0.50	4.49	4.68	7.54	3.14	2.44
	Max	0.81	10.00	5.10	13.50	5.10	2.66
Depth (m)	Min	0.00	0.02	0.04	0.04	0.06	0.06
	Average	0.13	0.52	0.25	0.31	0.22	0.26
	Max	0.40	1.60	0.83	0.55	0.48	0.69

Table 3-3: Summary flow gauging data (April 2019 (PDP 2024))

Parameter	Measurement	Stream width (m)	Average depth (m)	Max depth (m)	Average velocity (m/s)	Gauged Flow (m ³ /2)
Mangawhitikau Stream	MWH-DS	3.45	0.23	0.33	0.154	0.123
	MWH-US	3.95	0.12	0.24	0.116	0.056

The Rapid Habitat Assessment (RHA) scores indicate good quality instream habitat across all sampling locations. RHA results are provided below in Table 3-4. The difference between RHA deposited sediment scores and SAM2 scores is noted and is the result of SAM2 including sand as fine sediment for the assessment, whereas the RHA does not factor in sand.



Table 3-4: Rapid habitat assessment results (2026)

Parameter	Camelot Submergence	Pōtea Spring	Mangawhitikau Stream			
			20m US	80m US	20m DS	100m DS
Deposited sediment	4	1	8	8	6	6
Invertebrate habitat diversity	10	10	9	7	10	10
Invertebrate habitat abundance	7	6	2	5	5	4
Fish cover density	10	10	4	3	9	8
Fish cover abundance	4	7	3	5	6	4
Hydraulic heterogeneity	7	7	7	7	9	8
Bank erosion	5	3	7	8	7	6
Bank vegetation	8	5	4	5	5	5
Riparian width	8	7	6	5	8	4
Riparian shade	8	8	6	6	3	4
Total	71	64	56	59	68	59
Condition category	Good	Good	Good	Good	Good	Good

3.2.2 Spot Water Quality

Spot water quality sampling undertaken on-site and the parameters indicate overall good water quality (Table 3-5). The parameters have been compared to the relevant guidelines where available; the Waikato Regional Council Surface Water Class Standards (WRC Guidelines), and the ANZG Default Guideline Values (ANZG, 2026), and the NPS-FM (Ministry for the Environment, 2020). Nutrients were not measured and therefore cannot be compared to the medians off the off-site but the five-year average measurements for nearby streams can be seen in Table 3-1.

Temperature was within the excellence category for WRC guidelines at the Camelot Stream, and Pōtea Spring and 'Satisfactory' for all four of the Mangawhitikau Stream sites.

Dissolved oxygen levels (mg/L) were within attribute band 'A' of the NPS-FM for all of the 2026 sampling sites. It should be noted that this is indicative only as this guideline was not intended for one-off sampling rounds. The % saturation of dissolved oxygen was within the excellence category for WRC guidelines for all sampling sites.

Conductivity exceeded the ANZG guidelines for Pōtea Springs, and all Mangawhitikau Stream sampling sites.

For pH the Pōtea Spring was within the 'excellence' category for the WRC guidelines, and within the limits for ANZG guidelines. All other sampling sites were in the 'satisfactory' category and exceeded the ANZG guidelines. The elevated pH levels may be due to the surrounding geology which is rich in limestone.

Total suspended solids were higher in the lower catchment, than in the upper catchment where the Camelot Stream is located, however all sites were within the 'unsatisfactory' category within the WRC Guidelines and exceeded the ANZG guidelines.



Table 3-5: Summary water quality spot sampling data (2026)

Parameter	Unit	Camelot Submergence	Pōtea Springs	Mangawhitikau Stream			
				20m US	80m US	20m DS	100m DS
Temperature	(°C)	14.8	14.2	16.6	16.5	16.5	16.4
Dissolved oxygen	(% sat)	97.4	94	104	104.2	104.1	102.7
	(Mg/L)	9.85	9.63	10.4	10.17	10.15	10.1
Conductivity	(µs/cm)	69.9	400.8	170.9	170.9	190.4	209
pH	(pH)	8.1	7.6	8.23	8.2	8.11	8.07
Turbidity	TNU	12	0.4	0.27	0.13	0.63	0.56
Total Suspended Solids	(g/m³)	56	328	132	133	151	164

Table notes:

1. Green cells indicate the 'excellence' category under the Waikato Regional Council Surface Water Class Standards (where available), yellow cells indicate 'satisfactory' category and red cells indicate that it falls into the 'unsatisfactory' category.
2. Values in bold indicate exceedance of ANZG (2018) default guidelines for Warm Wet-Low Elevation.
3. Italicised values indicate exceedance of the NPS-M (2020) 'bottom-line' value.
4. No guidelines are available for conductivity.

3.2.3 Deposited Fine Sediment

The median scores for the Camelot Stream Submergence and Pōtea Spring sites are below the NPS-FM national bottom-line value (Appendix A.3) (noting that the NPS-FM is based on monthly sampling over 5 years) (Table 3-6). This is indicative only. Both values are suggestive of a high impact of fine sediment on instream biota.

Mangawhitikau Stream upstream sites indicate some impact from high levels of deposited fine sediment, however, Mangawhitikau Stream downstream sites indicate no impact to instream biota from deposited fine sediment. It is noted that several areas of bank slumping and erosion were observed along the length of the survey reach.

The change in average percentage sediment cover between upstream and downstream sampling sites of the Mangawhitikau Stream, indicates that sediment cover decreases from upstream to downstream (Table 3-7).

Table 3-6: Summary SAM2 deposited fine sediment results (2026)

Site	Camelot Submergence	Pōtea Spring	Mangawhitikau Stream			
			20m US	80m US	20m DS	100m DS
Average	52.5	60.8	20.2	24.5	13.5	18.5
Median	55	55	20	10	0	0
20 th	22	39	9	0	0	0
80 th	82	90	30	46	22	34



Table 3-7: SAM2 % change in deposited fine sediment between upstream and downstream sites of the Mangawhitikau Stream (2026)

Site	Mangawhitikau Stream			
	20m US to 20m DS	20m US to 100m DS	80m US to 20m DS	80m US to 100m DS
% Change in average sediment cover	-33%	-8%	-45%	-24%

3.2.4 Periphyton

The average percent cover for the Camelot Submergence site was 39%, predominantly Thin Light Brown periphyton (Table 3-8). The Mangawhitikau Stream sites had average percentage covers ranging from 13 (20m US) to 65 % (20m DS), with three predominant periphyton types across the four sites: Thin Light Brown, Thick Green/ Light brown and Thin Green.

Periphyton cover increases between up and downstream of the Mangawhitikau Stream (Table 3-9). This difference was likely attributable to differences in substrate morphology (permanent substrate) and increased shading at the upstream site.

Table 3-8: Summary periphyton data (2026)

Site		Average % cover	Median % cover	Predominant periphyton type	Predominant periphyton average % cover
Camelot Submergence		39	20	Thin Light Brown	34
Mangawhitikau Stream	20m US	13	0	Thin Light Brown	10
	80m US	30.5	7.5	Thick Green/Light Brown	20.25
	20m DS	65	100	Thin Green	45
	100m DS	43	30	Thin Green	16.5

Table 3-9: Percentage change in average periphyton cover across the Mangawhitikau Stream sampling sites (2026)

Site	Mangawhitikau Stream			
	20m US to 20m DS	20m US to 100m DS	80m US to 20m DS	80m US to 100m DS
% Change in average periphyton cover	400%	231%	113%	41%



3.2.5 Macroinvertebrate Sampling

3.2.5.1 MCI and QMCI

MCI scores range from 87-128 (2019/2020) and 120-135 (2026). All 2026 MCI scores indicated 'Excellent' stream health (Stark & Maxted, 2007). An increase from the 2019 sampling, where two were rated as 'excellent', two as 'Good' and one as 'poor' (noting Pōtea Spring was not sampled in 2026). MCI and QMCI scores are summarized below in Table 3-10. The 2026 results are broadly consistent with the 2019/2020 results (within a 20% range) and do not suggest any significant trends.

When compared to the NPS-FM (2020) NOF attribute bands, for the 2026 MCI results, the Mangawhitikau Stream 80m upstream site was within band A and the other three sites were within attribute band 'B', indicative of 'excellent' and 'good' water quality values, respectively.

2026 MCI at the Mangawhitikau Stream 80m upstream showed a 23.9% increase compared to the 2020 sampling results. Given the short distance to the 20m upstream site, which did not have any notable changes, this could be associated with localised instream habitat presence, potentially the result of lower habitat availability in 2020, which was a drought year.

QMCI scores ranged from 4.04 to 5.81 (2020) to 5.20- 5.99 (2026). All but one of the 2026 QMCI scores indicated 'Good' stream health (Stark & Maxted, 2007). One site rated as 'excellent' (Mangawhitikau Stream 80m upstream). This is an increase from the 2020 sampling, where three were rated as 'Good' and two as 'poor'.

In addition, for the QMCI scores in the NOF attribute bands, Mangawhitikau Stream 80m upstream was within band 'A', 20m upstream and 100m downstream were within band 'B' and 20m downstream within band 'C'. No MCI or QMCI stream scores in 2026 were below the national bottom line.

The 2026 MCI scores are fairly consistent between sites and shows little change, however QMCI shows some decline from 80m upstream to the 20m upstream and the downstream sites. 2020 macroinvertebrate sampling indicated lower scores than in 2026, as discussed in the MCI section above. Overall, there appears to be a trend on increasing stream health based on macroinvertebrate scores. Additional output metrics are provided in Appendix C, alongside the macroinvertebrate sampling results.

Benthic sampling was not performed at Pōtea Spring in 2026 as the habitat was deemed as not suitable for benthic sampling, being a limestone chute. This was evidenced in the MCI and QMCI scores in 2020 being low and in the poor category.



Table 3-10: Summary of Macroinvertebrate Indices as sampled in 2020 and 2026. Colour coded based on Table A 2 (Appendix A.2) (Stark & Maxted, 2007)

Site		MCI				QMCI			
		2019	2020	2026	%Change (2020-2026)	2019	2020	2026	%Change (2020-2026)
Mangawhitikau Stream	20m US	-	124	127	2.4%	6.37	4.93	5.81	17.8%
	80m US	-	109	135	23.9%	-	5.53	6.50	17.5%
	20m DS	115	117	120	2.6%	6.74	5.78	5.20	-10.0%
	100 m DS	-	128	125	-2.3%	-	5.81	5.99	3.1%
Pōtea Spring		-	89	-	-	-	4.04	-	-
Mangapu Stream	US	107	-	-	-	4.90	-	-	-
	Mid	87	-	-	-	4.09	-	-	-
	DS	110	-	-	-	4.83	-	-	-

Dark blue indicates 'Excellent' stream health, light blue indicates 'Good' stream health, light red indicates 'fair' stream health, and dark red indicated 'Poor' stream health. Underlined/bold results indicate exceedance of national 'bottom line' values as presented within the NOF of the NPS-FM (2020). It is noted that the national bottom line is based on the median of 5 years of sampling, and as such the above should be considered indicative only.

3.2.6 eDNA Sampling

3.2.6.1 Fish Community

Seven species of native fish (including freshwater invertebrate kōura) were detected using eDNA sampling in 2026. A full summary of eDNA results for freshwater fish (2021, Enspire & 2026, Stantec) is provided in Table 3-11, along with the 2019 electrofishing results.

No fish eDNA was recorded at the Camelot Submergence site, however koura/freshwater crayfish (*Paranephrops planifrons*) were detected through eDNA and found on-site during the site assessment in 2026. This strongly suggests that fish passage is severely impacted by the subterranean Camelot Stream section, including for strong climbing species such as eels (*Anguilla sp.*). This may be due to subterranean waterfalls, velocity restrictions, or blockages. As the Camelot Cave system is unsafe to access and survey, the exact cause is unknown, nor is the presence of fish in the lower Camelot Stream system (prior to Pōtea Spring) known.

Shortfin and longfin eel and kōura were recorded at the Pumphouse Spring samples, which is unusual given the lack of suitable habitat, as the spring source is a bore and the springs piped outlet is perched. It is likely that cracking of the pipe, alongside erosion underneath, caused the creation of suitable habitat below the pipe, with the water mixing between the two. There was no freshwater fauna detected in the previous eDNA sampling (2021), which is corroborated by the lack of suitable habitat.



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Trace results for yellow eye mullet (*Aldrichetta forsteri*) and goldfish (*Carassius auratus*) were recorded at both the Pōtea Spring and Mangawhitikau Stream 100m downstream sites, respectively. As these were only trace eDNA they have been discounted as cross contamination, or due to bird faecal input as predatory birds such as cormorants were detected in the samples also.

Giant kōkopu eDNA detection were relatively low, however they were supported by trace detections of giant or shortjaw kōkopu DNA. Given the lack of suitable habitat for shortjaw kōkopu, it is considered likely that this is giant kōkopu DNA.

Electric fishing was not conducted by Stantec in 2026, with the 2019 electric fishing results providing a good basis of fish composition within the Mangawhitikau Stream (PDP Limited, 2024). Results of the 2019 fishing survey are provided in Table 3-11. It is noted that there were many common species between the eDNA detections and the electric fishing results.

Overall, the 2026 eDNA results indicate a limited diversity at the Camelot Stream submergence site and at Pōtea Spring. A relatively diverse population was recorded within the Mangawhitikau Stream downstream of the resurgence, but a limited population upstream of the sub surface cave section³.

These results are supported by the 2021 eDNA sampling and 2019 electrofishing, which showed similar results, with a slight increase in diversity at all sampling sites.

The limited diversity at Pumphouse Spring and Pōtea spring in 2019/2021 indicate no-to-limited fish in the upstream cave system.

During the site assessment koura/freshwater crayfish were observed at the Camelot Stream Submergence site, common Bully at the Mangawhitikau Stream 80m upstream site, and rainbow trout at the Mangawhitikau Stream 20m downstream site.

³ Known waterfall present within the Mangawhitikau cave section



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3 Results

Table 3-11: Summarised eDNA results from the 2021 (PDP Limited, 2024) and 2026 sampling, and the electrofishing results from 2019 (PDP Limited, 2024)

Scientific Name	Common Name	Threat classification (Dunn, et al., 2025)	Camelot Stream Submergence		Pōtea Spring		Pumphouse Spring		Mangawhitikau Stream Submergence	Mangawhitikau Stream Resurgence	Mangawhitikau Stream DS of Pōtea Spring	
			2021	2026	2021	2026	2021	2026	2019	2021	2019	2026
<i>Anguilla australis</i>	Shortfin eel	Not Threatened	-	-	-	Present	-	Trace	-	-	-	Present
<i>Anguilla dieffenbachia</i>	Longfin eel	At Risk - Declining	-	-	Present	Present	-	Present	Present	Present	Present	Present
<i>Cheimarrichthys fosteri</i>	Torrentfish	At Risk - Naturally Uncommon	-	-	-	-	-	-	-	Present	Present	Present
<i>Galaxias argenteus</i>	Giant kōkopu	At Risk - Declining	-	-	-	-	-	-	-	-	-	Trace
<i>Gobiomorphus basalis</i>	Cran's bully	At Risk - Naturally Uncommon	-	-	-	Present	-	-	-	Present	-	Present
<i>Gobiomorphus cotidianus</i>	Common bully	Not Threatened	-	-	-	-	-	-	-	Present	Present	Present
<i>Oncorhynchus mykiss</i>	Rainbow trout	Introduced and Naturalised	-	-	-	-	-	-	-	-	-	Present
<i>Retropinna Retropinna</i>	Common smelt	At Risk - Declining	-	-	-	-	-	-	-	Present	-	-
<i>Paranephrops planifrons</i>	Kōura	Not Threatened	-	Present	-	Present	-	Present	Present	-	Present	Present
<i>Salmo trutta</i>	Brown trout	Introduced and Naturalised	-	-	-	-	-	-	-	-	-	Present
Total Fish Species (inclusive of kōura)			0	1	1	4	0	2-3	2	5	4	8-9



3.2.6.2 TICI scores

The 2026 eDNA TICI score for the Camelot Stream Submergence site was rated as Excellent (113.5), with the rest of the sampling sites were rated as Good (104.5-105.5). These results are similar in ecological health indicator scores to MCI and QMCI scores detailed in Section 3.2.6.1.

No TICI scores were available for the earlier eDNA sampling (Enspire 2021), as this methodology was not available until 2022 (Wilkinson, et al., 2024). Future eDNA sampling can be compared to the 2026 data below.

Table 3-12: Wilderlab TICI scores for 2026 eDNA sampling

Scoring	Camelot Stream Submergence	Pōtea Spring	Pumphouse Spring	Mangawhitikau Stream 100m DS
TICI	113.5	105.2	105.5	104.5
Rating	Excellent	Good	Good	Good

4 Summary

Multiple studies undertaken between 2019 and 2026 by PDP, Enspire, and Stantec have been used to assess the habitat availability and current ecological state of the receiving environments to the proposed South-Western Pit.

Overall, the Mangawhitikau Stream shows good stream health and provides quality habitat to the studied faunal communities. The Mangawhitikau Stream has higher biodiversity levels than the Camelot Stream Submergence site, with no fish presence within the upper Camelot Stream. Pōtea Spring has lower stream health and provides lower quality habitat than Mangawhitikau Stream, this is predominantly associated with limited benthic habitat, lower flow levels, a partial fish barrier downstream and land use impacts (including rubbish debris within the channel). Pumphouse Spring has low habitat quality, due to its piped nature.

The proposed South-Western Pit is not expected to impact aquatic ecology values in downgradient watercourses based on the lack of observable effect from the current Oparure quarry footprint at the discharge point of the Pōtea Spring into the Mangawhitikau Stream. The habitat, deposited sediment, macroinvertebrate, eDNA and periphyton data within this report can be used as a baseline for future impact assessment reports or compliance monitoring.



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Appendices



Appendix A National Standards

A.1 eDNA

Table A 1: TICI score and value interpretation

TICI Score	TICI value
<80	Very Poor
80-90	Poor
90-100	Average
100-110	Good
110-120	Excellent
>120	Pristine

A.2 Macroinvertebrates

Table A 2: Benthic macroinvertebrate indices interpretation (Stark & Maxted, 2007)

Stream Health	Descriptions	MCI	QMCI
Excellent	Clean water	>119	>6.00
Good	Doubtful quality/ possible mild pollution	100-119	5.00-5.99
Fair	Probable moderate pollution	80-99	4.00-4.99
Poor	Probable severe enrichment	<80	<4.00

Table A 3: Attribute states and national bottom-line values for macroinvertebrate indices, from NPS-FM (2020)

Attribute Band	Description	Numeric Attribute States	
		QMCI	MCI
A	Indicative of pristine conditions with almost no organic pollution or nutrient enrichment.	≥6.5	≥130
B	Indicative of mild organic pollution or nutrient enrichment.	≥5.5 and <6.5	≥110 and <130
C	Indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/ nutrient enrichment.	≥4.5 and <5.5	≥90 and <110
National Bottom Line		4.5	90



Attribute Band	Description	Numeric Attribute States	
		QMCI	MCI
D	Indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to inorganic pollution/ nutrient enrichment.	<4.5	<90

Notes: MCI and QMCI scores to be determined using annual samples taken between December and March (inclusive) and with current state calculated as the five-year median score.

A.3 Sediment

Table A 4: Attribute states and national bottom-line values for deposited fine sediment in wadable rivers, from NPS-FM (2020)

Attribute Band	Description	Numeric attribute state by deposited sediment class (% fine sediment cover)			
		Median			
		1	2	3	4
A	Minimal impact of deposited fine sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions	≤7	≤10	≤9	≤13
B	Low to moderate impact of deposited fine sediment on instream biota. Abundance of sensitive macroinvertebrate species may be reduced.	>7 and ≤14	>10 and ≤19	>9 and ≤18	>13 and ≤19
C	Moderate to high impact of deposited fine sediment on instream biota. Sensitive macroinvertebrate species may be lost.	>14 and <21	>19 and <29	>18 and <27	>19 and <27
National Bottom Line		21	29	27	27
D	High impact of deposited fine sediment on instream biota. Ecological communities are significantly altered and sensitive fish and	>21	>29	>27	>27



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Appendix A National Standards

Attribute Band	Description	Numeric attribute state by deposited sediment class (% fine sediment cover)			
		Median			
		1	2	3	4
	macroinvertebrate species are lost or at high risk of being lost.				

Notes: The indicator score is percentage cover of the streambed in a run habitat determined by the instream visual method, Sam2. Based on monthly monitoring regime where sites are visited on a regular basis regardless of weather and flow conditions. Record length for grading a site based on 5 years.



Appendix B 2026 eDNA results

Scientific Name	Rank	Common Name	Camelot Submergence						Mangawhitikau 100m Downstream						Pōtea Spring						Pumphouse Spring					
			776681	776682	776683	776684	776685	776686	776671	776672	776673	776674	776675	776676	776691	776692	776693	776694	776695	776696	772171	772172	772173	568861	568862	568863
<i>Aldrichetta forsteri</i>	species	Yelloweye mullet; kātaha; aua; kātaka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	
<i>Anguilla</i>	genus	Eels	0	0	0	0	0	0	0	91	0	903	0	492	0	0	0	0	100	0	0	0	0	0	0	
<i>Anguilla australis</i>	species	Shortfin eel; tuna; hao; aopori; hikumutu	0	0	0	0	0	0	0	385	1003	2975	775	944	0	1544	2765	0	0	0	0	99	0	0	0	
<i>Anguilla dieffenbachii</i>	species	Longfin eel; tuna; kūwharuwharu; reherehe; kirirua	0	0	0	0	0	0	0	55025	55522	51060	37955	50479	1353	651	1987	37	3256	2654	0	3350	2290	0	233	367
<i>Anguilliformes</i>	order	Eel; tuna	0	0	0	0	0	0	0	0	151	350	0	595	0	0	0	0	0	0	0	0	0	0	0	
<i>Carassius auratus</i>	species	Goldfish; morihana	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Cheimarrichthys fosteri</i>	species	Torrentfish; panoko; pānokonoko; pānonoko	0	0	0	0	0	0	0	510	40	85	446	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Galaxias</i>	genus	Galaxiids	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	
<i>Galaxias argenteus</i>	species	Giant kokopu	0	0	0	0	0	0	0	27	0	0	62	311	0	0	0	0	0	0	0	0	0	0	0	
<i>Galaxias argenteus/postvectis</i>	species	Giant or shortjaw kokopu	0	0	0	0	0	0	0	0	356	346	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Gobiiformes</i>	order	Gobies and sleepers	0	0	0	0	0	0	0	0	0	260	22	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Gobiomorphus</i>	genus	Bullies	0	0	0	0	0	0	0	72856	56059	56979	51780	56358	6407	8	1934	0	3588	3306	0	0	0	0	0	
<i>Gobiomorphus basalis</i>	species	Crans bully; titikura	0	0	0	0	0	0	0	66744	78486	74832	81747	75138	0	0	965	0	9643	4652	0	0	0	0	0	
<i>Gobiomorphus cotidianus</i>	species	Common bully; tipokopoko; toitoi	0	0	0	0	0	0	0	16279	2502	0	1141	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Gobiomorphus cotidianus/basalis/dinae</i>	genus	Common/Cran/Dinahs bully; titikura	0	0	0	0	0	0	0	2013	229	111	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Oncorhynchus</i>	genus	Salmon/Trout; taraute;tarauta; hāmana; tāmana	0	0	0	0	0	0	0	2475	5258	2160	3596	3796	0	0	0	0	0	0	0	0	0	0	0	
<i>Oncorhynchus mykiss</i>	species	Rainbow trout; taraute;tarauta; hāmana; tāmana	0	0	0	0	0	0	0	9338	5459	9104	5577	7351	0	0	0	0	0	0	0	0	0	0	0	
<i>Salmo</i>	genus	Trout; taraute	0	0	0	0	0	0	0	416	691	590	407	621	0	0	0	0	0	0	0	0	0	0	0	
<i>Salmo trutta</i>	species	Brown trout; taraute; tarauta	0	0	0	0	0	0	0	2682	7730	5448	2918	6757	0	0	0	0	0	0	0	0	0	0	0	
<i>Salmonidae</i>	family	Salmonids	0	0	0	0	0	0	0	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Salmoninae</i>	subfamily	Salmon and trout	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	



Appendix C Macroinvertebrate results

C.1 April 2019- (PDP Limited, 2024)

Parameter	MPU-US	MPU-MID	MPU-DS	MWH-US	MWH-DS
Taxa richness	24	25	6	15	10
%EPT taxa	41.7	28.0	16.7	58.6	41.7
%EPT abundance	24.9	4.1	1.9	62.6	63.6
MCI	107	87	110	127	115
QMCI	4.90	4.09	4.83	6.37	6.74

C.2 Drift Net Sampling December 2020 (PDP Limited, 2024)

Parameter	Upper spring D net	Lower Spring D net	Upper spring Drift net	Lower Spring Drift net
Taxa richness	2	3	4	14
%EPT taxa	0.00	33.33	25.00	28.57
%EPT abundance	0.00	40.00	3.03	11.32
MCI	90	73	110	99
QMCI	4.50	3.60	5.03	4.92

C.3 December 2020 (PDP Limited, 2024)

Parameter	MWH-US US pumphouse	MWH-US Pōtea	MWH DS 1	MWH DS2	Pōtea
Taxa richness	22	17	20	22	9
%EPT taxa	54.55	64.71	55.00	63.64	33.33
%EPT abundance	36.07	29.33	58.77	39.82	2.45
MCI	124	109	117	128	89
QMCI	4.93	5.53	5.78	5.81	4.04

C.4 January 2026 Summarised-Stantec

Parameter	Mangawhitikau			
	20m US	100m US	20m DS	100m DS
Taxa richness	18	16	17	17
%EPT taxa	52.27	61.19	58.36	59.72
%EPT abundance	35.83	38.44	27.92	48.70
MCI	127	135	120	125
QMCI	5.81	6.5	5.2	5.99



C.5 2026 full (also summarised)- Stantec

Parameter	Mangawhitikau Stream											
	20m US			20m DS			100m US			100m DS		
N taxa	16	18	20	14	19	15	14	17	20	18	18	16
EPT value	9	10	9	9	10	10	8	9	13	11	10	10
Abundance	89	205	205	206	205	236	205	205	206	205	205	106
%EPT	49.44	31.71	26.34	45.63	43.41	26.27	8.29	49.27	26.21	51.71	30.24	64.15
%EPT taxa	56.25	55.56	45.00	64.29	52.63	66.67	57.14	52.94	65.00	61.11	55.56	62.50
MCI	135.0	123.3	124.0	138.5	125.2	140.0	121.4	116.4	122.0	127.7	117.7	128.7
	0	3	0	7	6	0	3	7	0	8	8	5
QMCI	6.76	5.32	5.35	6.64	6.79	6.08	4.33	6.08	5.19	6.25	5.20	6.52



Appendix D Periphyton Results

Periphyton on exposed surfaces			Location:		Camelot Stream - upper										Date Sampled:		6/1/26						
			Stone No:		18																		
			Transect 1					Transect 2					Transect 3					Transect 4					
		Peri Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Thin mat/film	Green	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	
(under 0.5 mm thick)	Light brown	10	100	95	0	100	0	100	100	20	0	0	100	10	0	30	0	0	0	0	25	0	
	Black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Medium mat	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(0.5 – 3.0 mm thick)	Light brown	7	0	0	30	0	0	0	0	0	0	0	0	0	20	5	0	0	0	15	0	0	
	Black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	
Thick mat	Green/light brown	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(over 3.0 mm thick)	Black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Filaments, short:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(under 20 mm long)	Brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Filaments, long:	Green	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(over 20 mm long)	Brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
No periphyton	(no colour and not slippery)	no score	0	5	70	0	100	0	0	80	100	100	0	90	80	50	100	100	95	85	75	100	
A: Total % of stone surface covered by all types of periphyton			100	95	30	100	0	100	100	20	0	0	100	10	20	50	0	0	5	15	25	0	
B: Peri Score x % Cover (sum for each stone)			1000	950	210	1000	0	1000	1000	200	0	0	1000	100	140	470	0	0	35	105	250	0	
C: Average Periphyton Score per stone (= B / A)			10	10	7	10	0	10	10	10	0	0	10	10	7	9.4	0	0	7	7	10	0	



Graymont Southern Pit Ecological Surveys

Appendix D Periphyton Results

Periphyton on exposed surfaces			Location: Mangawhitikau (20m)					Date Sampled:														
			Stone No: 12																			
			Transect 1					Transect 2					Transect 3					Transect 4				
Peri Score			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	Green	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 0.5 mm thick)	Light brown	10	0	0	0	0	0	0	0	0	0	0	100	100	0	0	0	0	0	0	0	0
	Black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(0.5 – 3.0 mm thick)	Light brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0
Thick mat:	Green/light brown	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
(over 3.0 mm thick)	Black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, short:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 20 mm long)	Brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, long:	Green	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 20 mm long)	Brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No periphyton	(no colour and not slippery)	no score	100	100	100	100	100	100	100	100	100	100	0	0	100	100	70	100	100	100	100	70
A: Total % of stone surface covered by all types of periphyton			0	0	0	0	0	0	0	0	0	0	100	100	0	0	30	0	0	0	0	30
B: Peri Score x % Cover (sum for each stone)			0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	270	0	0	0	0	120
C: Average Periphyton Score per stone (= B / A)			0	0	0	0	0	0	0	0	0	0	10	10	0	0	9	0	0	0	0	4

Periphyton on exposed surfaces			Location: 80 US					Date Sampled:														
			Stone No:																			
			Transect 1					Transect 2					Transect 3					Transect 4				
Peri Score			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	Green	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
(under 0.5 mm thick)	Light brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	10	0	0	0
(0.5 – 3.0 mm thick)	Light brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0
Thick mat:	Green/light brown	4	100	0	100	100	0	0	30	0	0	75	0	0	0	0	0	0	0	0	0	0
(over 3.0 mm thick)	Black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, short:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 20 mm long)	Brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Filaments, long:	Green	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 20 mm long)	Brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0
No periphyton	(no colour and not slippery)	no score	0	100	0	0	100	100	70	100	60	25	100	100	0	100	90	95	90	60	100	100
A: Total % of stone surface covered by all types of periphyton			100	0	100	100	0	0	30	0	40	75	0	0	100	0	10	5	10	40	0	0
B: Peri Score x % Cover (sum for each stone)			400	0	400	400	0	0	120	0	360	300	0	0	500	0	70	25	50	160	0	0
C: Average Periphyton Score per stone (= B / A)			4	0	4	4	0	0	4	0	9	4	0	0	5	0	7	5	5	4	0	0



Graymont Southern Pit Ecological Surveys

Appendix D Periphyton Results

Periphyton on exposed surfaces			Location: 100 DS										Date Sampled:									
			Stone No:																			
			Transect 1					Transect 2					Transect 3					Transect 4				
		Peri Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	Green	7	0	0	0	100	100	0	0	0	0	0	30	0	0	0	100	0	0	0	0	0
(under 0.5 mm thick)	Light brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	100	0	0	70	0
	Black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	Green	5	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
(0.5 – 3.0 mm thick)	Light brown	7	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0
	Black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thick mat:	Green/light brown	4	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 3.0 mm thick)	Black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, short:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 20 mm long)	Brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, long:	Green	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 20 mm long)	Brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No periphyton	(no colour and not slippery)	no score	100	0	70	0	0	100	100	100	0	100	70	100	100	0	0	0	100	70	30	100
A: Total % of stone surface covered by all types of periphyton			0	100	30	100	100	0	0	0	100	0	30	0	0	100	100	100	0	30	70	0
B: Peri Score x % Cover (sum for each stone)			0	400	210	700	700	0	0	0	500	0	210	0	0	###	700	###	0	210	700	0
C: Average Periphyton Score per stone (= B / A)			0	4	7	7	7	0	0	0	5	0	7	0	0	10	7	10	0	7	10	0

Periphyton on exposed surfaces			Location: 20 DS					Date Sampled:														
			Stone No:																			
			Transect 1					Transect 2					Transect 3					Transect 4				
		Peri Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thin mat/film:	Green	7	0	0	0	0	0	0	0	100	0	100	100	100	100	100	0	100	100	100	0	0
(under 0.5 mm thick)	Light brown	10	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Black/dark brown	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium mat:	Green	5	0	0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0
(0.5 – 3.0 mm thick)	Light brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Black/dark brown	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thick mat:	Green/light brown	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 3.0 mm thick)	Black/dark brown	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, short:	Green	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(under 20 mm long)	Brown/reddish	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filaments, long:	Green	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(over 20 mm long)	Brown/reddish	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No periphyton	(no colour and not slippery)	no score	0	0	100	100	100	0	0	0	100	0	0	0	0	0	100	0	0	0	100	100
A: Total % of stone surface covered by all types of periphyton			100	100	0	0	0	100	100	100	0	100	100	100	100	100	0	100	100	100	0	0
B: Peri Score x % Cover (sum for each stone)			1000	1000	0	0	0	500	500	700	0	700	700	700	700	700	0	700	700	700	0	0
C: Average Periphyton Score per stone (= B / A)			10	10	0	0	0	5	5	7	0	7	7	7	7	7	0	7	7	7	0	0



With every community, we redefine what's possible.

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Stantec New Zealand
Level 15, 10 Brandon Street
Wellington 6011
NEW ZEALAND
Mail to: PO Box 13052, Christchurch 8140
stantec.com

Appendix C Values and Effects Assessment Criteria and Management Hierarchy

Ecological values assessment

Table B-1 Matters that may need to be considered when assigning ecological value to a freshwater site or area (Roper-Lindsay, 2018)

Matters	Attributes to be assessed
Representativeness	• Extent to which site/catchment is typical or characteristic • Stream order • Permanent, intermittent or ephemeral waterway • Catchment size • Standing water characteristics
Rarity/Distinctiveness	• Supporting nationally or locally Threatened, At Risk or uncommon species • National distribution limits • Endemism • Distinctive ecological features • Type of lake/pond/wetland/spring
Diversity and Pattern	• Level of natural diversity • Diversity metrics • Complexity of community • Biogeographical considerations - pattern, complexity, size, shape
Ecological Context	• Stream order • Instream habitat • Riparian habitat • Local environmental conditions and influences, site history and development • Intactness, health and resilience of populations and communities • Contribution to ecological networks, linkages, pathways • Role in ecosystem functioning – high level, proxies



Table B-2 Scoring for sites or areas combining values for four matters (adapted from Roper-Lindsay, 2018)

Value	Description
Very High	Area rates High for three or all the four assessment matters. Likely to be nationally important and recognised as such.
High	Area rates High for two of the assessment matters, Moderate and Low for the remainder, or Area rates High for one of the assessment matters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for two or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for three matters and Moderate, Low or Very Low for remainder.

Aquatic effects assessment

Table B-3 Criteria for describing magnitude of effect (adapted from Roper-Lindsay, 2018)

Magnitude of effect	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR having negligible effect on the known population or range of the element/feature.

Level of effects

Table B-4 Level of effects assessment (adapted from Roper-Lindsay, 2018)

		Ecological value				
		Very high	High	Moderate	Low	Negligible
Magnitude of effect	Very high	Very high	Very high	High	Moderate	Low
	High	Very high	Very high	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Effects management hierarchy

Table B-5 Effects management hierarchy

Hierarchy	Actions
Avoid	• Sensitive design • Siting based on least damage criteria • Avoidance of key areas (e.g. protected habitat) – seek alternative location • Avoidance of key periods (e.g. breeding or migrating season(s)) • Preventing impact generating activities
Remedy	• Reinstatement of habitat • Reseeding habitat • Restoration of damaged habitat • Rehabilitation of site conditions and habitats • Decommissioning of infrastructure • Restoration of damaged biophysical processes
Mitigate	• Emission controls • Noise and light barriers • Screens • Oil interceptors • Controlled access during construction • Wildlife bridges, tunnels, ecoducts • Vehicle speed limits and usage restrictions (e.g. no night driving) • Wildlife fences • Biosecurity procedures (e.g. pest and weed checks, vehicle washings) • Treatment of wastewater discharges • Stormwater treatment • Translocation of plants and/or animals • Translocation of habitat • Erosion and sediment control methods • Installation of barriers to exotic fish encroachment on natural areas • Removal, storage and reinstatement of habitat/species
Biodiversity offsetting for residual adverse effects	• Restoration offset • Averted loss offset • Enhancement offset



Graymont South-Western Pit

Appendix C Values and Effects Assessment Criteria and Management Hierarchy

Hierarchy	Actions
Environmental compensation for residual adverse effects	• Creating new habitat on alternate sites that differs from that at the point of impact • Providing funding for alternate ecological enhancement actions at another site • Providing protection and enhanced ecological management of an area, without ensuring no net loss of biodiversity
Supportive conservation actions	• Research • Public awareness-raising activities • Raising local community capacity to carry out biodiversity conservation work



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Stantec New Zealand
Level 3, PWC Centre
109 Ward Street, Hamilton Central
Hamilton 3204
NEW ZEALAND
Mail to: PO Box 13052, Christchurch 8140
stantec.com

