Attachment 8

Known and Anticipated Adverse Effects

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1 Overview

This attachment addresses section 21(5)(c) of the Fast-track Approvals Act 2024 (FTAA) and summarises the actual and potential adverse effects of the Project. Section 21(5)(c) states *the reasons to decline a referral application under subsection (4) include, without limitation, the following:*

> *(c) the project may have significant adverse effects on the environment:*

The Project has Resource Management Act 1991 (RMA) applications to Environment Canterbury Regional Council (CRC) and Waimakariri District Council (WDC) on hold. The applications were publicly notified, submissions received and both councils prepared s42A reports.

The CRC section 42A reports identified a number of areas of uncertainty and concern relating to matters such as wetlands, terrestrial ecology, stormwater management, containment performance, monitoring, adaptive management responses and long-term post-closure risks. The WDC section 42A report concluded that the proposal, as then presented, would have more than minor adverse effects on cultural values and terrestrial ecology, particularly lizards (at [179]).

Since preparation of those reports, the Applicant's experts have undertaken further assessment of those matters and refined the Project design, technical assessments, management plans, monitoring framework, Trigger Action Response Plan (TARP)[1] and proposed conditions. The Project has now been subject to several years of technical investigation and review by a multidisciplinary team of specialists in groundwater, surface water, geotechnical engineering, landfill design, ecology, stormwater, air quality, noise, transport, landscape and planning. Through the process to-date, potential adverse effects, design assumptions, modelling approaches, monitoring programmes, management plans and proposed mitigation measures have been scrutinised, tested, challenged and refined through technical review, submissions, requests for further information and council reporting.

Accordingly, this attachment reflects not only the original application material, but also the subsequent expert review process and the Applicant's responses to the issues raised through that process.

Unless otherwise stated, the levels of effect identified in this attachment represent the residual level of effect after application of the Project design, mitigation measures, monitoring requirements, adaptive management measures, and proposed conditions. The assessment therefore reflects the anticipated effects of the Project as proposed, rather than an unmitigated scenario.

Where appropriate the technical assessments have also considered highly conservative or low-probability failure scenarios to test the resilience of the proposed containment, monitoring and management systems. Those assessments are important in understanding risk and informing contingency measures, but they do not represent the expected operation or performance of the Project. The effects identified in this attachment

[1] The TARP is a proactive monitoring and adaptive management mechanism that ensures any abnormal trends or emerging effects are detected early and responded to before significant environmental effects occur. It forms part of the project's layered mitigation approach

therefore distinguish between the anticipated residual effects of the Project as proposed and the consequences of unlikely failure events.

Having regard to the original application material, ongoing technical work, responses to matters raised through the consent process, while some section 42A authors identified areas of uncertainty or concern, the overall conclusion of the Applicant's technical assessments is that all identified adverse biophysical, amenity and infrastructure effects can be appropriately avoided, remedied or mitigated through the proposed design, management plans, monitoring programmes and conditions. Cultural effects are addressed separately in section 11.

The list of adverse effects considered, the applicable regional and district local authority with the function under the RMA to consider that effect, and an upfront corresponding level of effect conclusion (after mitigation) with the key reasons is provided in Table 1.

Detailed assessments of adverse effects are set out in sections 2 through 14. Where an effects topic is addressed at greater length, an Overview and Summary are included to assist navigation and enable the key issues and conclusions to be readily identified without first working through all of the supporting detail. The proposed monitoring programme (Trigger Action Response Plan, TARP) is attached**.**

Table 1: Actual and potential adverse effects considered, applicable authority and overview of effect level with reasons

EFFECT ASSESSED	REGIONAL	DISTRICT	LEVEL OF EFFECT	KEY REASONS
Effects on water quality	√		Minor	Use of a Class 1 liner, underdrainage system, leachate collection system, monitoring and TARP reduce leakage risks. Conservative modelling demonstrates no material effects under likely leakage scenarios and no exceedance of drinking water standards. Stormwater discharges are to be mitigated with respect to both metals and sediment loads through adoption of appropriate source controls and ESC measures for the site
Effects on water quantity	√		Less than minor	Groundwater modelling predicts limited changes to groundwater levels and baseflows, no measurable effects on downstream water users, and wetland monitoring and remediation measures are proposed.
Effects on aquatic ecology	√		Minor and positive net gain for some features	Limited ecological disturbance is proposed, while replacement of the ford with a bridge, riparian enhancement, wetland restoration, ecological monitoring and improved stormwater management result in long-term ecological benefits and net gains for the Karetu River and freshwater fauna.
Effects on water users	√		Less than minor	No measurable drawdown effects on existing takes are predicted and water quality modelling demonstrates adequate protection of downstream water supplies even under highly conservative scenarios. Notwithstanding this, a water quality monitoring programme is proposed.
Effects on terrestrial ecology	√	√	Vegetation – net gain Terrestrial - less than minor Wetlands - minor to negligible Aviafauna – less than minor Herpetofauna – net gain	Habitat losses are limited and offset through lizard translocation, habitat creation, wetland enhancement, pest control, indigenous planting, biodiversity management plans and long-term protection of ecological areas, resulting in net biodiversity gains.
Effects on land stability		√	Minor	Geotechnical assessments demonstrate acceptable slope stability, seismic risks are very low, containment systems are conservatively designed, and detailed design review and independent peer review are proposed.
Effects from fire and flood hazards	√	√	Less than minor	Waste acceptance controls, site management procedures, firefighting resources and hydraulic modelling demonstrate low risk. The managed

				fill is located well above modelled flood levels and is not susceptible to flood inundation.
Effects on air quality and human health	√		Minor on environment and persons (dust)	Dust management measures, wind-triggered operational controls, asbestos handling procedures, monitoring requirements and compliance with air quality standards minimise effects.
Effects of transportation		√	Minor	Traffic volumes remain well below District Plan thresholds, the road network has capacity to accommodate projected traffic, and mitigation measures are proposed for road safety, site access and road maintenance.
Effects on Te Ngāi Tūāhuriri Rūnanga values	√	√	More than minor, with Ngāi Tūāhuriri identifying potential for significant and long-lasting cultural effects	Many of the concerns are connected to potential effects on water quality, wetlands, freshwater ecology, mahinga kai, taonga species and long-term containment. Distinct concerns also arise from the location and nature of the activity within a culturally significant landscape and the lack of involvement at site selection, affecting the exercise of rangatiratanga and kaitiakitanga. Those separate concerns are not resolved solely by the proposed biophysical mitigation.
Effects on landscape values and natural character		√	Less than minor during development Positive post closure and rehabilitation	Activities occur largely within an existing quarry. Landscape rehabilitation, revegetation, removal of infrastructure, enhancement of ecological features and restoration of a more natural landform result in positive long-term outcomes.
Effects on amenity and recreation values	√	√	Less than minor	Noise complies with applicable standards, dust can be managed through operational controls, odour effects are negligible, and replacement of the ford with a bridge improves the Karetu River environment over time.
Containment failure risks	√	√	Minor	Conservative design assumptions, multiple containment barriers, monitoring programmes, adaptive management measures, operational controls and contingency responses significantly reduce both the likelihood and consequences of containment failure.

The following reports and management documents have been prepared for the Project and are referred to or have been relied upon in assessment of the adverse effects:

- WSP (2022). Whiterock Lime Quarry - Hydraulic Modelling. Rev1.
- WSP (2023). Whiterock Lime Quarry and Landfill - High-level Transport Assessment. Rev0.
- WSP (2024). Waste Acceptance Criteria for Proposed Managed Fill (Class 3) Landfill. Rev0.
- WSP (2024). Whiterock Lime Quarry and Landfill - Geotechnical Report. Rev2.
- WSP (2024). Whiterock Lime Quarry and Landfill - Groundwater and Surface Water Effects Assessment. Rev0.
- WSP (2024). Whiterock Lime Quarry and Landfill - Landfill Slope Stability Report. Rev0.
- WSP (2024). Whiterock Lime Quarry and Landfill - Landfill Design Report. Rev0.
- WSP (2024). Whiterock Lime Quarry and Landfill – Preliminary Design Drawings. Rev1.
- WSP (2024). Whiterock Lime Quarry and Landfill - Stormwater Management. Rev0.
- WSP (2024). Whiterock Lime quarry and landfill - Ecological Impact Assessment. Rev0.
- WSP (2024). Whiterock Limestone Quarry and Landfill - Technical Air Quality Assessment. Rev 2
- WSP (2024). Whiterock Lime Quarry and Landfill - Noise Impact Assessment. Rev 3
- WSP (2024). Monitoring Programme and Triggers for an Action Response Plan (TARP). Rev A.
- WSP (2024). Containment Risk Assessment. Rev0.
- WSP (2024). Whiterock Lime Quarry and Landfill – Landscape and Visual Assessment. Rev0.
- Singers Ecological (26 February 2025). Whiterock Quarry - Wetland assessment. NSES Ltd Report Number 57:2024/25.
- Protranz (2024). Whiterock Lime Quarry and Landfill - Site Management Plan. Draft B.

2 Effects on Water Quality

2.1 Overview

Potential effects on water quality associated with the Project include the unintended leakage of leachate from the liner and the discharge of the various forms of stormwater.

A Groundwater and Surface Water Effects Assessment has been undertaken which addresses these effects in detail. A Stormwater Management Report has also been completed which addresses stormwater discharges.

The key effects considerations from these reports are discussed below.

2.2 Liner Leachate Leakage

Groundwater from the site ultimately flows to the Karetu River. The leakage of liner leachate or potential larger amounts of leachate arising from a managed fill liner or infrastructure failure therefore has the potential to impact water quality in both groundwater and the Karetu River receiving environment.

No leachate is intended to be discharged to the Karetu River; it is to be trucked off site. The underdrainage system installed below the liner (i.e., does not capture leachate) may discharge to or near the river, as this is expected to capture clean groundwater. Detection sensors in the underdrainage catchpit will divert underdrainage water to the leachate pond, in case leachate enters the underdrainage system through a liner breach.

The eastern boundary watercourse is ephemeral for the majority of its length and perched above the managed fill site and is unlikely to be impacted and has no material aquatic ecology values.

The Managed Fill Design Report sets out the proposed design. It has been designed with multiple layers of protection intended to minimise both the likelihood of leachate generation and the potential for any leachate to reach the receiving environment. These include:

- A Class 1 municipal landfill standard composite liner system comprising a geomembrane and compacted low permeability soil liner.
- A leachate collection and drainage system located above the liner.
- A dedicated leachate storage pond.
- A groundwater underdrainage system beneath the liner that maintains separation between groundwater and the managed fill.
- Continuous water quality monitoring within the underdrainage system with automated diversion capability.
- A Trigger Action Response Plan (TARP) providing for investigation, corrective action and contingency responses should abnormal conditions be detected.

The design report provides predictions of the highest, lowest and average leachate generation for scenarios to represent a reasonable upper estimate for leachate generation. This was undertaken using HELP [2] modelling which for soil wastes graded to maximise stormwater runoff and diversion is likely to overestimate average annual leachate generation rates. This HELP model estimates leachate collection at the managed fill base.

The Groundwater and Surface Water Effects Assessment estimated potential leachate leakage through the liner using an analytical approach which incorporates aspects such as liner defects, wrinkles in the liner, and

[2] United States EPA (Hydrologic Evaluation of Landfill Performance) [HELP] version 3.95D.

differing levels of contact (good and poor contact) of the HDPE layer with the compacted cohesive soil liner. The approach applied a highly conservative level of head (i.e., height of water above the liner) of 0.3 m which is the thickness of the drainage layer in the design. This is conservative because the predicted daily annual average volume of leachate, at 15 m^3 per day, if evenly distributed over the entire managed fill floor drainage layer footprint of 2.7 ha would have a depth of less than 1 mm.

Importantly, the assessment considered not only the quantity of potential leakage but also the pathway that any leakage would need to follow before reaching sensitive receptors. Groundwater modelling indicates that any leakage through a liner defect would either be intercepted by the underdrainage system or migrate through the underlying geological sequence before ultimately discharging to the Karetu River. Modelling indicates contaminant migration through groundwater would occur over extended timeframes, with breakthrough to the deeper Karetu silica sands estimated to take approximately 10–15 years. These extended travel times provide substantial opportunity for detection, investigation and implementation of corrective measures before contaminants could reach sensitive receiving environments.

The underdrainage system provides an additional level of protection beyond the liner itself. Groundwater collected beneath the liner will be continuously monitored and directed through a collection sump equipped with water quality monitoring sensors and automated diversion controls. Should trigger levels indicate potential leachate contamination, groundwater collected by the underdrainage system can be automatically diverted to the leachate pond while investigation and remediation actions are undertaken. This provides an active interception and response mechanism capable of managing leakage before off-site effects occur.

To assess potential water quality effects in the receiving environment, the Groundwater and Surface Water Effects Assessment adopted a mass mixing approach to assess potential changes in contaminant concentrations in the Karetu River resulting from various scenarios. A conservative approach was applied to the mass mixing approach which assumes that all the daily leachate leakage would reach the river at a single point and at the same time, that there is constant inflow from the leachate plume to the river it and would occur during mean annual low flow (MALF) estimated at 24.6 L/s (volume past site 10,765 m^3 /day). This is a conservative approach, as in reality leachate leakage through a liner defect would be subject to natural attenuation processes,[3] mainly dispersive mixing, which will result in lowering of contaminant concentrations in the groundwater along the pathway it follows. In case of a leachate pond breakthrough, a leachate spill could reach the river via overland flow but would be detected immediately and mitigated in the order of days by containment (e.g., bunding affected areas) and removal to an appropriate offsite facility.

In reality, while liner leakage entering during MALF is a likely possible scenario, modelling all the contaminants leaking at the same time in a single location is highly unlikely. In more realistic natural attenuation processes, mainly dispersive mixing through groundwater, this would result in the lowering of contaminant concentrations in the groundwater along the pathway it follows. Additionally, dilution of contaminants would also become a factor.

Three conservative leakage scenarios have been assessed as follows, with results provided in Table 2:

1 **Likely liner Contact Case:** Tonlyn C&D [4] leachate concentrations; 300 mm head landfill liner leakage estimate from good liner contact scenario – 474 L/day

2 **Worst Liner Contact Case:** Tonlyn C&D leachate concentrations; 300 mm head landfill liner leakage estimate from poor liner contact scenario – 776 L/day

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[3] Natural attenuation is a variety of physical, chemical, or biological processes that, under favourable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater (USEPA, 1999).

[4] A landfill site in Gisborne that is considered to be the most representative of the proposed Whiterock Managed Fill site. Tonlyn is a Class 2 C&D landfill that accepts contaminated soils that meet the Class A Toxicity Characteristic Leaching Procedure (TCLP) criteria limits.

3 **Failure Case with 100% Leachate Lost:** Tonlyn C&D leachate concentrations; significant failure causes 100% of landfill leachate mixing in the river – 15 m^3 /day

Table 2: Estimated concentrations in the Karetu River following mixing with managed fill leachate under three scenarios.

	As (g/m3)	Zn (g/m3)	Cu (g/m3)	Pb (g/m3)	Al (g/m3)	B (g/m3)	Cd (g/m3)	Cr (g/m3)	Ni (g/m3)	Mn (g/m3)	NH4-N (g/m3)
Karetu River baseline concentrations	<0.0010	0.0015	0.0006	<0.00011	0.0525	0.0245	<0.00005	0.0003	0.0004	0.0017	<0.010
Estimated Karetu River Contaminant Concentrations											
1) Likely Liner Leakage Case:	BD	0.00151	0.00060	BD	0.0525	0.0258	BD	0.00029	0.00038	0.00185	0.036
2) Worst Liner Leakage Case:	BD	0.00151	0.00060	BD	0.0525	0.0267	BD	0.00031	0.00038	0.00198	0.065
3) Failure Case with 100% Leachate Lost	BD	0.0017	0.00063	BD	0.0525	0.0669	BD	**0.0015**	0.00042	0.00798	**1.24**
Guideline Values											
ANZG 2018 95% species protection	0.0240	0.0080	0.0014	0.0034	0.055	0.94	0.0002	0.001	0.011	1.9	0.9
NZ Drinking Water Standards 2022	0.01	-	2	0.01	1	2.4	0.004	0.05	0.08	0.4	-

Notes:
Exceedances of guideline values are in bold text.
BD = Below Detection - estimated concentrations were less than (<) lab detection limits as per the baseline concentrations.

The assessment shows that under both the conservative scenarios of rates of liner leakage in the 'good' and 'poor' contact cases when mixed with the river flow (even at MALF) do not materially increase the concentrations in the river above the observed background concentrations for all contaminants except NH_4-N (ammonium). There is also no cumulative exceedance of ANZG 95% species protection [5].

However, chromium and NH_4-N would exceed guideline values for 95% species protection (ANZG, 2018) in the unlikely case of a liner failure or storage leakage, and aluminium (Al) is close to exceedances of the guideline values for 95% species protection (ANZG, 2018). NH_4-N originates from the anaerobic decomposition of green waste within a landfill. Due to no green waste being accepted at the Whiterock Managed Fill site, this NH_4-N exceedance is unlikely to ever occur.

In addition, the increase in NH_4-N from baseline for the 'good' and 'poor' contact scenarios is likely to be over-represented. The Land and Water Regional Plan (LWRP) limits and National Policy Statement for Freshwater Management "B" Band (95% species protection) specify an annual median of 0.3 and >0.03 and ≤0.24 g/m^3 for NH_4-N - it is unlikely these would be exceeded given green waste or wood waste is not accepted at the facility.

No scenarios are estimated to exceed NZ Drinking Water Standards [6].

Leachate quality monitoring (occurring monthly on commencement of filling) in the leachate pond is proposed to validate the modelling assessments, and the assumptions relating to the lesser strength of NH_4-N with the inert only waste accepted and non-acceptance of green waste. As outlined in Section 5.5 below, continuous groundwater quality monitoring of the underdrainage system will also occur. Should electrical conductivity

[5] ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. – Adopted as Karetu River is a 'Hill-fed Lower' class river.

[6] Taumata Arowai, 2022

(and other parameters) in groundwater indicate any leachate leakage and a subsequent risk, underdrainage water will be redirected to the leachate pond until the leachate risk and cause has been addressed.

Leachate quality and continual underdrainage monitoring, quarterly monitoring of wells and the Triggers for an Action Response Plan (TARP) (see Appendix A) for any changes from a normal state is expected to avoid potential for long term risks to freshwater fauna within the Karetu River as far as practicable.

Overall, given the very low probability of a total failure occurring, and accounting for the Class 1 liner proposed for this Class 3 inert waste types, the interception capability of the underdrainage system, the monitoring being implemented, and TARP proposed, the risk of leachate leakage occurrence is considered as acceptable and the resultant effect on aquatic ecology will be less than minor.

In the context of the likely leachate concentrations from the inert waste, the Class 1 liner, baseline water quality conditions, the results of conservative modelling under a range of scenarios and taking into account the monitoring and controls proposed, the actual and potential effects on water quality have been mitigated.

2.3 Stormwater Discharge

The principal high probability risks to water quality associated with the discharge of stormwater from the Project are associated with increased concentrations of Total Suspended Solids (TSS), turbidity and metal containing contaminants from buildings.

Management strategies for stormwater management are summarised in Attachment 2 (Project Description & Activities).

The Project introduces a comprehensive stormwater management system incorporating clean water diversion, sediment retention ponds, stabilised discharge points, erosion and sediment controls, source control measures and ongoing monitoring. Consequently, the Project is expected to result in an improvement in the management of stormwater and sediment discharges relative to the existing environment.

A fundamental component of the design is the separation of clean water, dirty water and managed fill contact water. Stormwater from active managed fill areas is not discharged as stormwater. Rainfall that contacts waste is managed as leachate and collected separately within the leachate management system. Clean stormwater from stabilised areas is diverted around operational areas, while sediment-laden stormwater is directed through treatment systems prior to discharge. This separation significantly reduces the potential for contaminants associated with managed fill operations to enter the receiving environment via stormwater pathways.

Hydraulic modelling and proposed erosion and sediment controls reflect the current bunding on the western boundary of the site and proposed bridge. These results show that one shed at the north of the site could be impacted during the 50yrCC (CC is climate change), 100yr, 100yrCC, 250yr, and 250yrCC events. The potential risk of flooding affecting the storage building can be mitigated through targeted localised interventions. The proposed managed fill itself is situated well above the flood elevation of the river and will not be inundated or subjected to fluvial erosion, given the proposed managed fill is set into a natural rock escarpment. A minimum 10 m earthworks setback from the wetlands in the eastern water course is proposed. Sediment-laden stormwater treated in sediment retention ponds before discharge to the eastern boundary watercourse.

The discharge of metal containing contaminants is limited to stormwater arising from zinc-coated iron roofing on existing buildings at the site. Currently the roofs are unpainted. The painting and maintenance of these roofs as a source control is estimated to result in a 91% reduction in zinc yield [7].

[7] Using the Auckland Council Version 2 (2010) Contaminant Load Model from a combined roof area of 2,700m²

A conservative [8] mass mixing assessment was also undertaken to assess the zinc loading into the Karetu River from onsite buildings after painting during intermittent storm events. Results indicate a discharge quality of 0.00612 g/m³ being below the ANZG 2018 95% species protection guideline value of 0.008 g/m³. Provided the roofs remain painted over time, the existing zinc baseflow concentrations (possibly leaching from impacted soils) in the Karetu River downstream may reduce over time. The Project therefore has the potential to result in a positive long-term effect on surface water quality through a reduction of zinc in surface water.

The discharge of construction phase stormwater from a large catchment of quarry and managed fill disturbance works presents a high risk to surface water quality if not managed appropriately for the relative scale and nature of the various activities occurring on site.

As part of the Erosion and Sediment Control Plan (ESCP) the Sediment Retention Ponds (SRPs) will be designed and sized to achieve sediment and suspended solids removal. Additionally, the pH range currently observed in surface water (pH 7.8 dry and pH 8.8 wet weather) in the Karetu River [9] is already naturally above a neutral state being in a low alkaline state (refer Figure 1) due to the extensive limestone geology in the catchment.

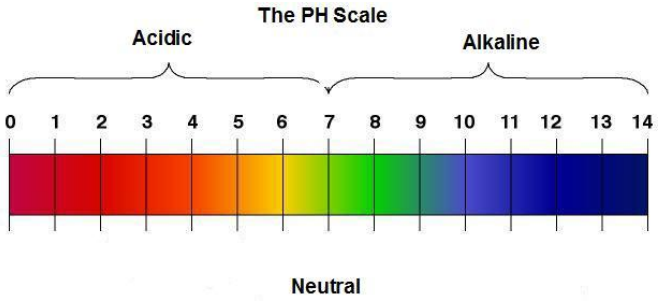


Figure 1: pH scale.

Run-off of lime impacted stormwater from the quarry could increase the pH in the Karetu River, although this is shown to be already high naturally given the limestone geology in the catchment, so the impact is expected to be minimal. The water monitoring programme proposed (refer Attachment 2) and proposed conditions) will include monitoring of pH in the discharge from the SRPs.

Through implementation of formal erosion sediment controls that will be constructed and maintained in accordance with Environment Canterbury's online Erosion and Sediment Control Toolbox (ESCT), it is expected that sediment loads from the site will be reduced compared to the current situation.

There is a low probability risk for contamination of stormwater from inadequate isolation of areas being filled with the managed fill or through leachate seepage. The resultant scenario effects have already been assessed in the leachate section above.

The proposed monitoring framework is intended not merely to measure environmental performance but to provide an adaptive management mechanism. Continuous and routine monitoring of stormwater quality, together with the TARP, enables potential issues to be identified at an early stage and corrective actions implemented before significant adverse effects occur.

Electrical conductivity (EC) monitoring has been added to the SRP monitoring requirements as a basic leachate contamination indicator. Additionally, environmental wet weather monitoring of the Karetu River is also proposed to have twice annual water quality monitoring of trace metals and metalloids that will also be able to determine any unforeseeable migration of leachate in stormwater to surface water.

Taken together, the proposed stormwater management regime represents a substantial improvement over the existing site environment through the introduction of formal treatment infrastructure, separation of clean water

[8] Refer to Section 4.3.3 Stormwater Management in Appendix C for the assumptions used in the assessment.

[9] The LWRP sets a pH range for the Karetu River at 6.5 – 8.5 pH units.

and managed fill contact water, staged erosion and sediment controls, continuous monitoring and adaptive management responses. Accordingly, the risk of adverse effects on the Karetu River from stormwater discharges is expected to be lower than under the existing quarry operation.

2.4 Summary

Only in the highly unlikely event of total failure of the liner and 100% leachate loss, using the mass mixing approach, would there realistically be a cumulative exceedance of the ANZG 2018 95% species protection guideline values for chromium. All other scenarios and contaminants showed no exceedances other than for ammonium which is not a likely contaminant resulting from the inert types of waste accepted at this managed fill site. All modelled scenarios showed no exceedances of the NZ Drinking Water Standards from potential leachate leakage.

Stormwater discharges are expected to be mitigated with respect to both metals and sediment loads through adoption of appropriate source controls and ESC measures for the site. Overall, when considering the very low probability of a total failure and the associated controls that will be in place, the effect of the ongoing quarry and proposed managed fill site development and operation on water quality is assessed as being minor.

3 Effects on Water Quantity

3.1 Overview

Potential effects on both groundwater and surface water quantity have been assessed.

The Groundwater and Surface Water Effects Assessment addresses effects of the managed fill site development on groundwater quantity. The Stormwater Management report addresses the effects of the development on surface water quantity.

The current quarrying activities and operations and processing plant area will broadly remain unchanged in terms of imperviousness and construction phase stormwater will not materially increase in rate and volume. Additionally, the SRPs have an attenuation function (to achieve water quality outcomes), so construction phase stormwater is not considered to have any material water quantity effects.

3.2 Groundwater Quantity

The impervious lining of the managed fill site will reduce rainfall recharge to groundwater over an approximate 4 ha area, and the cap may influence groundwater levels and surface and flows due to reducing rainfall infiltration and localised replenishment of groundwater.

Existing conditions are drawing on the aquifer beneath the site when groundwater is pumped out to control onsite pond water levels. The larger quarry pit excavations and seepage drainage in general (and latterly the pumping of the quarry pit pond) has drawn down the groundwater table beneath the site and in the surrounding area. The quarry pit pond is to be backfilled, and the fill site has been designed so that the base (i.e., the liner at the bottom) is at least 1 m above the existing groundwater table. Therefore, groundwater will be allowed to rise but will be controlled via an underdrainage system to maintain groundwater to at least 1 m below the bottom geomembrane liner.

Numerical modelling indicates the current drainage rate (32 m^3/day) will remain unchanged as a result of the Project.

While the drainage rate will be unchanged and groundwater will rise to a small degree, a reduction of rainwater infiltration will however occur beneath the managed fill footprint. The resultant net drawdown effect has been modelled as depicted in Figure 2.

Groundwater levels will be drawn down by more than 0.1 m up to a maximum distance of 700 m to the east of the site where several wetlands and streams are present. See Figure 2 for the location of these wetlands and streams.

Modelling predicts a reduction of groundwater baseflows from the current state (with the existing pit pond) to these eastern wetlands and streams caused by a reduction in rainfall recharge and the underdrainage system as follows:

- Lower wetland (southern end of the site): 19% (0.06 L/s or 5 m^3 per day) loss
- Stream 1 (south of the site): no measurable change in baseflows compared to current state (i.e, < 4%)
- All other streams and upper wetland: No change.

Subsequent modelling applying a pre-quarry pit state showed a 51% loss of baseflow to the lower wetland.

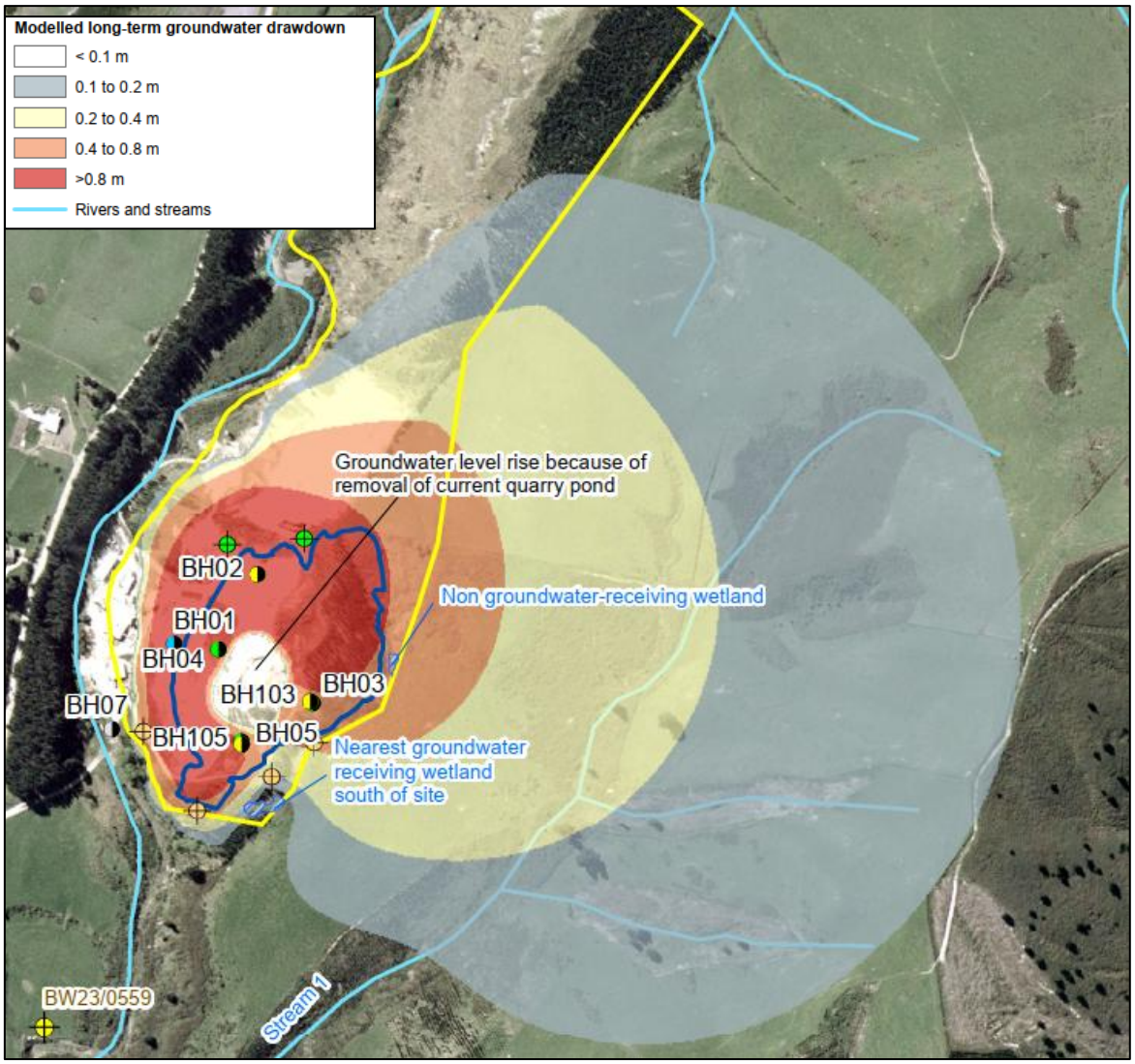


Figure 2: Modelled long term groundwater drawdown.

The modelled reduction will however be gradual and take several years to fully manifest itself, therefore the resultant effect on seepage flows to streams in practice may not be measurable. It is anticipated the only noticeable effect will be on the lower wetland. Wetland remediation is proposed (refer Section 6.3).

An increase in drainage rate (up to 74 m³/day) via temporary site dewatering may also occur during the construction phases of the managed fill site to install the underdrainage system (and discharged to the river). This is expected to be very short term in duration (several weeks) and will not lead to a noticeably different reduction in baseflows to nearby wetlands and streams.

3.3 Surface Water Quantity

In accordance with the LWRP definitions, the take of shallow groundwater for domestic use has a direct hydraulic connection to surface water given the manhole gallery (“bore’) is only 1.5 m in depth and within 15 m of the Karetu River. The LWRP Regional Rule 5.111 provides for a permitted activity pathway for surface water takes of rates less than 5 L/s and a volume of 2 m³/day which is proposed. The application of a permitted baseline is appropriate in this instance, as the groundwater water take will effectively be from the Karetu River.

3.4 Stormwater Quantity

The contoured rehabilitated site to a more natural form will reduce stormwater runoff rates and volumes directly to the Karetu River but will increase rates and volumes to the eastern boundary watercourse that flows into the Karetu River. No material net increases in stormwater quantity are considered to occur during the development,

The Stormwater Management Report assesses the site area of the contributing catchment for rainfall runoff to the eastern watercourse will increase by 16% (from current situation). When accounting for the stabilised vegetation cover above the capping layer, the overall contributing flow during a 10% AEP storm event to the eastern watercourse will remain similar to the existing state and will be in line with pre quarrying (1940s).

Proposed discharge outlets from clean water diversion channels to the eastern boundary will be stabilised to minimise localised erosion within the eastern watercourse while the proposed riparian margin enhancement planting will further prevent potential scouring and erosion within the watercourse.

3.5 Summary

The Project will reduce rainfall recharge beneath the approximately 4 ha managed-fill footprint. Modelling predicts that the current overall drainage rate will remain unchanged, that there will be no measurable change to most streams or the upper wetland, and that baseflow to the lower wetland will reduce 51% relative to the modelled pre-quarry state or a fall of 44% compared to 2023. The change is expected to occur gradually, and wetland monitoring and remediation are proposed. Stormwater quantity effects are not expected to be material, with flows to the eastern watercourse remaining similar to existing and pre-quarry conditions. Overall, water-quantity effects are assessed as less than minor, with effects on the lower wetland addressed separately in the terrestrial-ecology section.

4 Effects on Aquatic Ecology

4.1 Overview

The Project includes various activities that have the potential to affect aquatic ecology values identified within the Karetu River as discussed in the Ecological Impact Assessment. These activities include managed fill waste exposure risks, bed disturbance associated with construction activities, and discharges from stormwater. These effects are assessed under the corresponding subsections below.

A summary of the ecological features, their values, magnitude of effect, level of effect, post-mitigated magnitude of effect and residual level of effect are provided in Table 3.

Table 3: Summary of impact assessment for each feature on-site.

Feature	Value	Pre-mitigated magnitude of effect	Pre-mitigated level of effect	Post-mitigated magnitude of effect	Residual level of effect
Karetu River	High	Positive	Net Gain	Positive	**Net Gain**
Eastern boundary watercourse	Moderate	Moderate	Moderate	Low	**Low**
Wetlands	Moderate	Moderate	Moderate	Low	**Low**
Freshwater fauna	High	Low	Low	Positive	**Net Gain**

The leachate leakage impacts within the water quality Section 2 included comparison against the ANZG 2018 95% species protection for aquatic ecosystems. The effects from leachate leakage are not repeated or reassessed within this section however are considered in the overall effect on aquatic ecology.

4.2 Managed Fill Waste Exposure

Potentially severe rainfall events could erode intermediate cover exposing areas of compacted waste that could be entrained in runoff and end up as bed load in the Karetu River. The design of the managed fill site, including the: minimum slopes of the managed fill form, intermediate cover grade, and design depth, compaction and content of intermediate cover, stormwater controls with 100-year Annual Recurrence Interval (ARI) event capacity, has considered this risk.

Additionally, there will be temporary stabilisation techniques and SRPs in place until the intermediate cover is fully stabilised with grass. Weekly inspections for the duration of the managed fill operation, pre forecast wet weather inspections of the cover and stormwater controls will ensure the cover is adequately stabilised and erosion resistant via good coverage of healthy and uniform grass vegetation.

4.3 Bed Disturbance from Construction Activities

Construction activities in the bed and margins of Karetu River including for the removal of an existing ford crossing, installation of a one lane bridge, and the placement of new outfall structures (if required) have the potential to cause temporary elevated sediment within the Karetu River.

Elevated sediment will result in a temporary decrease in water clarity, potentially influencing the behaviour of invertebrates, fish, macrophyte growth. It also has the potential to compromise the feeding abilities of visual feeders and clog the gills of fish and invertebrates.

The magnitude of effect depends on the duration and scale of bed disturbance and the resultant concentration of TSS relative to the receiving environment. Construction works will be undertaken outside of flowing water once temporary instream diversion methods have been established.

The scale and duration of instream works is negligible and is expected to affect a limited number of fish. Stream biota in this catchment already has some ability to cope with occasional decreases in clarity as a result of naturally occurring high flows from storm events.

Given the scale of instream works and corresponding duration, a potential TSS increase is likely to be consistent with a small storm event. Currently, access to the site is via a ford crossing. Therefore, the receiving environment is already subjected to potential short-term decreases in water clarity. In the context of the baseline environment and scale of proposed activities, the proposed short term and small-scale instream works will be minor only.

Removal of the ford and the inclusion of a bridge structure over the river is expected to have a short-term adverse effect and a long-term positive effect on freshwater fauna within the Karetu River. This is through the removal of vehicle movements through the waterway and the need for ongoing maintenance of the ford. Additionally, removal of the rock armouring associated with the ford is expected to improve fish passage through removal of this barrier.

In summary, while the proposed bridge construction may result in temporary and localised sediment disturbance during construction, implementation of erosion and sediment controls and avoidance of works within flowing water will ensure any effects remain short-term and minor. The permanent removal of the ford and associated armouring is expected to improve fish passage opportunities and connectivity within the river, particularly during low flow conditions, providing a long-term ecological benefit beyond the mitigation of construction effects. Overall, the proposed bridge installation and subsequent removal of the existing ford will have positive effects for aquatic ecology.

4.4 Stormwater Discharges

Currently unmanaged stormwater from compacted hardstand areas and other areas of the site will be transporting limestone sediment into the Karetu River. Improved quarry pit and disturbed soil erosion and sediment control / stormwater management collection and discharge via SRPs, with possibly new outfalls into the Karetu River (for roofs and haul road management) will reduce the offsite mobilisation and migration of sediments from the existing aggregate hardstand. Additionally, the painting of galvanised iron roofs onsite will minimise heavy metals (mainly zinc) entering the Karetu River.

Minimising sediment and heavy metals from entering the river from existing infrastructure and activities will reduce existing impacts to the Karetu River on substrate and freshwater fauna habitat, which is expected to have a permanent positive effect to freshwater fauna within the Karetu River.

Stormwater from the ongoing quarrying and proposed managed fill site construction will be treated via onsite SRPs prior to conveyance into the Karetu River. This proposed management will minimise sediment runoff to Karetu River, which will be an improvement compared to baseline conditions where sediment and limestone have been observed entering and accumulating within Karetu River.

In addition to reducing suspended sediment concentrations, the proposed stormwater management regime introduces a level of treatment, monitoring and adaptive management that is currently absent from the site. Existing quarry operations have resulted in sediment accumulation within the Karetu River, particularly adjacent to stormwater discharge locations and downstream of the ford. The Project introduces formal erosion and sediment controls, stormwater treatment devices, monitoring requirements and response procedures that are expected to reduce the delivery of fine sediment and associated contaminants to the river over time. This is expected to improve benthic habitat quality, maintain macroinvertebrate community health and support habitat for indigenous fish species.

The proposed erosion sediment controls and stormwater management (mainly via source control) for the site is expected to have long-term positive effects on freshwater habitat quality and availability, indirectly benefiting freshwater fauna.

Ecological health monitoring of macroinvertebrates and fine sediment in the Karetu River is proposed to validate the performance of the controls, as well as wet weather monitoring for TSS, turbidity and visual clarity.

4.5 Summary

The adverse effects for each activity on aquatic ecology are minor and for the Karetu River and freshwater fauna a positive net gain is expected due to implementing the following measures:

- Implement an Erosion and Sediment Control Plan (ESCP) to prevent sediment entering waterways.
- Avoiding significant instream works and disturbance of the stream bed.
- Replace the existing ford with the Karetu Bridge, eliminating ongoing vehicle crossings and associated impacts on freshwater habitat, fish, and sediment deposition.
- Implement ecological monitoring to establish baseline conditions and identify any adverse changes in stream health or fish populations.
- Implement the Trigger Action Response Plan (TARP) to manage and avoid leachate contamination risks.
- If instream works are required, a Freshwater Fish Management Plan will be implemented to reduce effects on fish species.
- Restoration of any disturbed riverbed and riparian areas following bridge construction.

5 Effects on Existing Water Users

The Groundwater and Surface Water Effects Assessment addresses effects on existing water users. Potential effects to water users have the potential to arise with respect to both reduced quantity and quality of water within the Karetu River.

Two registered water takes within 2 km of the site draw water from the Karetu River and are hydraulically connected to shallow groundwater. Neither of these takes are within the 0.1 m net drawdown contours (Figure 2) caused by the managed fill liner reducing the rainfall recharge of the previous quarry pit. Therefore, no measurable groundwater drawdown or well interference effects will occur in these takes.

The nearest downstream Community Drinking Water Protection Zone (CDWPZ) to the site is 20 km downstream of the site and located across the Ashley River adjacent to Rangiora.

Unregistered but known shallow water supply wells or infiltration galleries supplying landowners adjoining the Karetu River are located further downstream and are unlikely to be affected by the minor groundwater drawdown given they are outside the modelled interference (refer Figure 2).

The shallow ground water take directly connected to the Karetu River is within a direct surface water take permitted activity threshold.

No adverse water quantity effects are anticipated on the aforementioned takes.

Water quality could be potentially impacted if uncontrolled leachate from the managed fill site enters the Karetu River which in theory could affect downstream water takes. However, as assessed above (Section 2), there are still no exceedances of the NZ Drinking Water Standards even under the highly unlikely total failure of the liner event. This represents a scenario of 100% of the daily managed fill leachate entering the river in an instance and under low flow conditions, also considered highly unlikely.

Stormwater discharges from the site affecting water quality will also be negligible with respect to human health. There are no takes within proximity of the site which would be affected by turbidity while zinc is not a toxicant of concern for human health as it does not have a maximum acceptable value in the Drinking Water Standards for New Zealand Regulations 2022.

Potential adverse effects on water users relative to the site from both a water quantity and quality perspective are considered to be less than minor. Notwithstanding this, a water quality monitoring programme is proposed (refer Appendix) which includes monitoring to detect any leachate entering groundwater at the managed fill and migrating off site, and implementation of mitigation measures to minimise the risks of water quality effects.

6 Effects on Terrestrial Ecology

6.1 Overview

The Environment Institute of Australia and New Zealand (EIANZ) guidelines for undertaking an Ecological Impact Assessment were used to assess ecological impacts of the Project. An Ecological Impact Assessment was undertaken which provides a comprehensive assessment of all ecological values pertaining to the site and immediate surrounds. A further Wetland Assessment was undertaken to assess the impacts on the wetlands near the site.

A summary of the ecological features, their values, magnitude of effect, pre-mitigated level of effect, post-mitigated magnitude of effect and residual level of effect are provided in Table 4.

Table 4: Summary of impact assessment for each feature on-site.

Feature	Value	Magnitude of effect	Pre-mitigated level of effect	Post-mitigated magnitude of effect	Residual level of effect
Bats	Nil	-	-	-	-
Birds	Low	Negligible	Very Low	Positive	Net Gain
Lizards	High	Negligible	Very Low	Positive	Net Gain
Mammalian pests	Negative	Negative	Negative	Positive	Net Gain
Vegetation & Habitats	Negligible	Low	Very Low	Positive	Net Gain

6.2 Vegetation General

Earthworks associated with the managed fill site development and track widening is likely to result in the clearance of scattered exotic shrubs and some amenity plantings around the fringes of the existing excavated area equating to approximately 5 ha. Previous bund improvements to manage flood risk associated with the Karetu River required the removal of a small number of exotic trees and shrubs.

Due to the minor shift away from the existing baseline condition of the site, the magnitude of effect is however low with changes arising from the loss or alteration of vegetation within the site being discernible. On closure of the managed fill site, the vegetation cover across the site will be substantially increased and well in excess of the 5 ha removed during the construction phase. A Vegetation Management Plan (VMP) will be prepared to guide the restoration and enhancement of indigenous vegetation across the site. The VMP will specify eco-sourced plant species appropriate to the ecological district, including hydroseed mixes, tussocks, vascular plants and riparian planting, and identify planting locations, densities and remediation requirements. Existing indigenous vegetation, particularly around the Karetu River, eastern watercourse and wetlands, will be retained wherever practicable, with stock exclusion fencing installed to protect indigenous habitats and the proposed conservation covenant area. The VMP will also provide for the restoration of disturbed areas following construction, including rehabilitation of wetlands and watercourses to maintain their ecological values, and guide final contouring and revegetation of the managed fill area to achieve outcomes consistent with the site's ecological character.

In combination with negligible baseline values, the increase of vegetation cover at Project completion, the addition of stock exclusion fencing around the Significant Natural Area (SNA) and proposed enhancement planting around riparian margins with indigenous planting, the resultant effect on vegetation is considered positive with there being a net gain.

6.3 Wetlands

Quarrying to date, through drawdown of groundwater via a pit pond, has been estimated to have reduced groundwater levels to the lower wetland. The upper wetland is perched above the ground water level and is unlikely to have been affected.

For clarity the two potential wetlands (Figure 3a and 3b) were identified as the ‘upper wetland’ (northernmost) and ‘lower wetland’ (southernmost) relevant to their location within the eastern boundary watercourse catchment.



Figure 3a: Upper wetland.



Figure 3b: Lower wetland.

If the Project proceeds, mainly through a managed fill liner and cap preventing direct recharge of groundwater, and groundwater level control, the projected percentage reduction of groundwater to the lower wetland is expected to have a cumulative decline totalling 51% compared to the pre-quarrying state. The reduction will be 44% compared to the 2023 state that already accounts for some reduction. If a further decline in groundwater flow does occur, this is likely to occur after five years of the stage 1 liner being fully installed and preventing groundwater recharge.

To understand how baseflows to the nearest wetland to the south and an unnamed tributary will change, it is relevant to describe and assess how historic activities at the quarry have caused changes to baseflows in nearby wetlands and streams. The assessment shows:

- **Site conditions during early quarrying:** Quarrying at Whiterock started in the 1950s. The earliest available aerial imagery dates to 1963 and shows some site clearing and excavations. The birds-eye view photography from the 1960s (Figure 4) provides a better quality image of the site. In theory, deeply incised gullies could have been naturally present at the site, which would have naturally drained groundwater locally and suppressed the groundwater table. However, Figure 4 does not show clear evidence of this being the case. Based on this available photography, it has been assumed that any excavation during this time to have been above the groundwater table and no groundwater drainage would have been required. As such, it is unlikely earlier stages of quarrying (before 2003) would have altered groundwater levels or flows at the site.
- **Site conditions in 2003:** Aerial photography and ground elevations from a Digital Elevation Model (DEM) based on survey data is available for 2003 (Figure 6). The quarry excavations were mainly above the groundwater table. Pine trees were planted adjacent to the open excavation to the south and east but were still in a juvenile state in 2003. Modelling shows only a small area in the middle of the site would have required groundwater drainage. A quarry pond is visible in Figure 6, however, this appears to be a collection pond for upslope stormwater runoff and groundwater drainage.
- **Site conditions since 2015:** the quarry pond at its current location was established around 2015 and is still present to date. The current quarry pond is cut below the groundwater table and draws groundwater continuously.

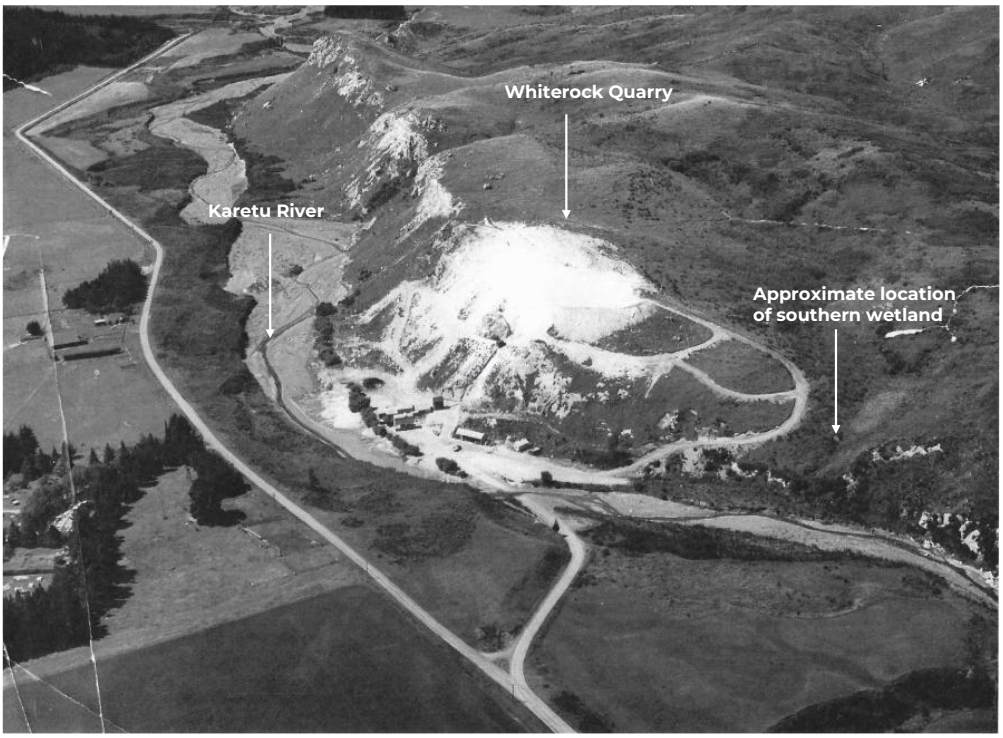


Figure 4. Birds eye view of Whiterock Quarry in the 1960s.

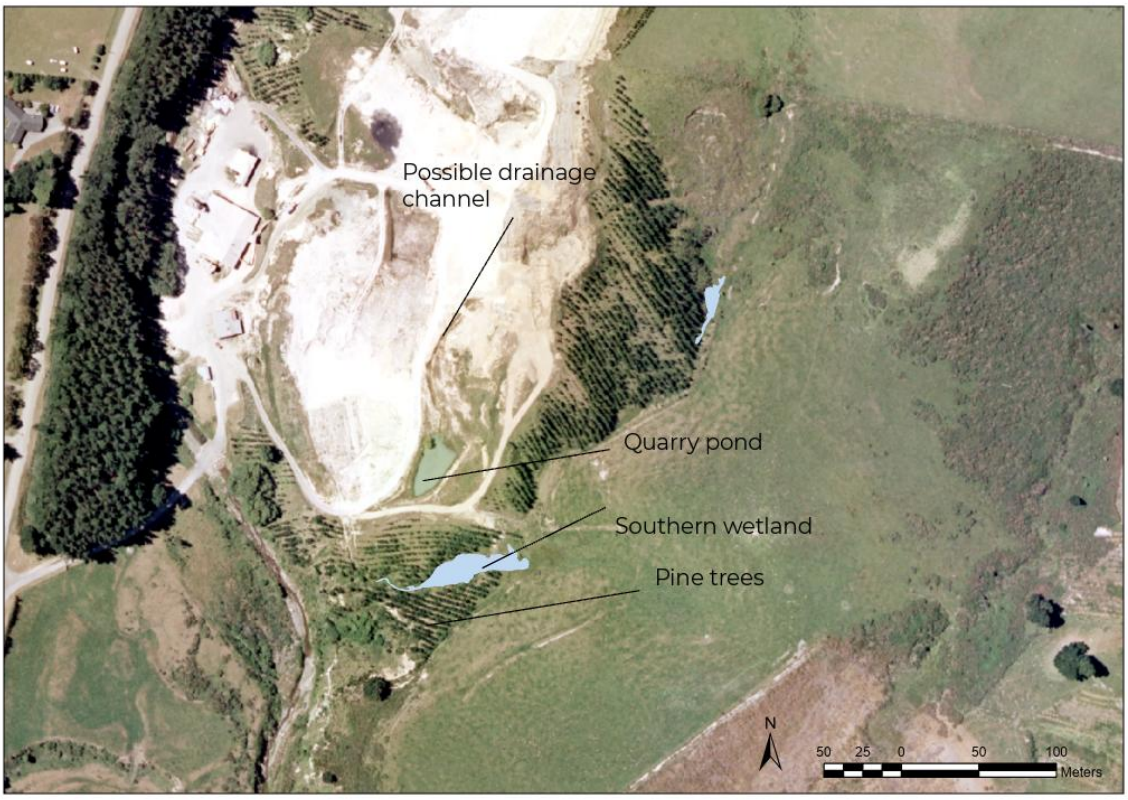


Figure 6. Whiterock quarry in 2003 (note: location of southern wetland has been superimposed on the aerial photo).

Several factors will have contributed to changes in the groundwater regime at the site:

— The planting of production forest such as pine trees will cause an increase in evapotranspiration and thus lowering of the groundwater table. Conversely, removing pine trees will cause increased net groundwater recharge and an increase in groundwater levels.

— Excavations below the groundwater table will result in water ponding on the quarry floor and this is typically managed by drainage in quarries to maintain workable conditions. Drainage leads to lowering of the groundwater table.

— Liners installed to capture leachate and subsequent capping of managed fill cells post-closure of the managed fill, will fully remove any groundwater recharge from infiltrating rainwater. This will cause a lowering of the groundwater table.

These changes to the groundwater conditions at the site are incorporated into the Whiterock numerical groundwater model to represent how the groundwater regime changes over time:

— **State during early quarrying:** no excavations below the groundwater table and thus no groundwater drainage. Land use around the quarry and the southern wetland comprises grass and shrub land, with no mature production forest (i.e., pine trees) present.

— **State in 2003:** minor excavations below the groundwater table in a small area of the quarry. Pine trees have been planted around the southern wetland. A small pond is visible in the 2003 aerial photograph at the southern end of the quarry (Figure 6), which appears to be a collection pond for upslope stormwater runoff and groundwater drainage.

— **State in 2015:** aerial photographs from around 2015 show the quarry pond that is still present to date. This quarry pond is cut below the groundwater table and draws groundwater continuously. The pond is frequently drained under gravity to the Karetu River. The pine trees around the southern wetland are still present around the southern wetland but are now mature.

— **Current state (2023):** the groundwater draining quarry pond is still present. The pine trees around the southern wetland have been removed, which would have led to an increase in groundwater levels.

— **Stage 1 Managed fill:** filling is assumed to commence in 2028. At that time the managed fill bottom liner would cover the full extent of the Stage 1 footprint and the underdrainage system is in operation.

— **Stage 2 Managed fill:** after about 12 years, the managed fill footprint will be expanded to include the Stage 2 area. At that time the combined footprint of Stage 1 and 2 would be covered with a liner. The underdrainage system remains operational.

— **Post-closure:** the managed fill is expected to be at capacity after 25 years, after which the managed fill is capped. The underdrainage system remains operational.

The updated modelling results have been used to assess the change in baseflows to nearby wetlands and streams caused by the proposed managed fill by comparing these with the current and previous states. Figure 6 shows the graph of the changes of groundwater inflows to the southern wetland.

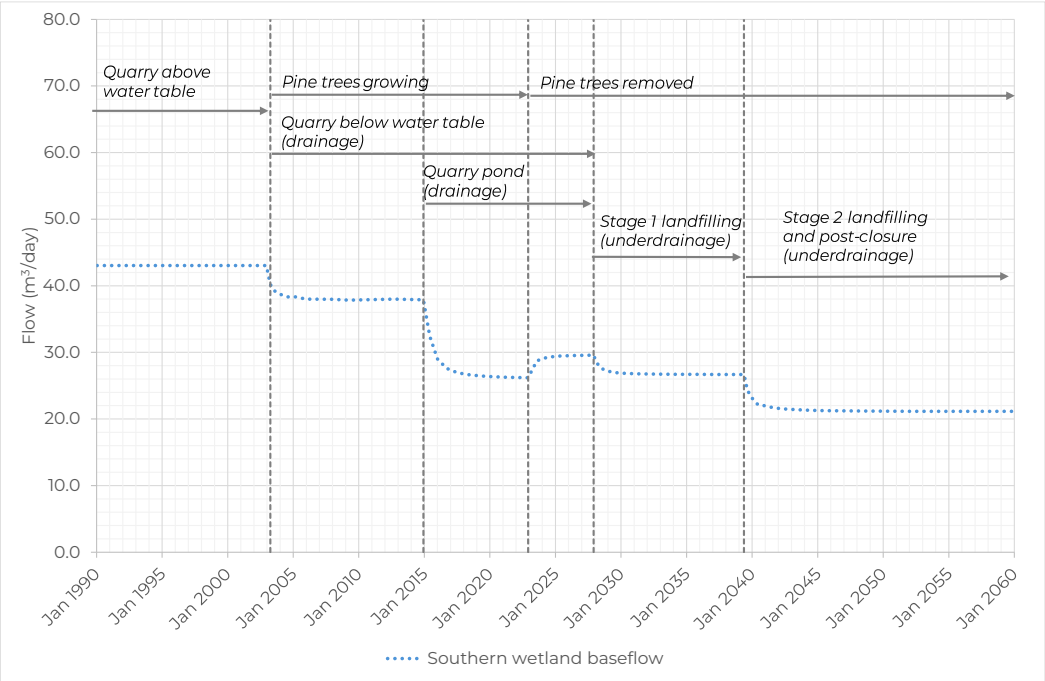


Figure 6. Modelled changes to groundwater inflows to the southern wetland.

A Wetland Assessment has been undertaken, the more recent delineation in November 2024 showed that in the lower wetland, groundwater upwellings influences the hydrology in the lower 20% extent of the wetland. This covers an area of approximately 230 m^2 where there is the permanent wetness, of the total 1,330 m^2 lower wetland extent. The overall ecological values of the two wetlands were similar and have been assessed as moderate.

The Wetland Assessment advises that given that most of the upper part of the lower wetland extent is not connected or dependent on groundwater and that intermittent wetland rautahi sedgeland has been recovering, it is not expected that a reduction in the total wetland extent will occur with further reduction of ground water baseflows. A fall in the groundwater height or reduction in baseflow volumes potentially may result in a minor contraction of the extent of permanently wet habitat (20% area). The potential effect of this would likely result in a decrease in the permanently wet part and a subsequential increase of intermittently wet part.

Given the predicted effects, the main issue to be addressed is the potential loss of ecological values that would be restricted to the small number of indigenous plants within the 230 m^2 area (20% area) of permanently wet habitat. Applying the National Policy Statement for Freshwater Management 2020 (NPS-FM) effects hierarchy, remediation is the most appropriate action, to enhance and maintain indigenous biodiversity values associated with the area of permanently wet habitat.

Further restoration of the other parts of the wetland and its fringes is also proposed to address impacts of previous stock grazing due to poor fencing and forestry removal causing damage to the lower wetland, and the upper wetland.

A wetland monitoring programme (WMP) is proposed as part of the Monitoring Plan and TARP that includes:

- Monitoring of water levels in both wetlands.
- Fixed-point photography of both wetlands to account for wetland boundary and cover changes.
- Vegetation monitoring plots.
- Reporting at least once every five years including baseline monitoring reports immediately after consent and within 12 months before commencement of managed fill construction and operation.
- Remedial actions should wetland values decrease as a result of project activities, e.g. potential responses should wetland extent reduce or should the reduced extent of the permanent zone result in localised vegetation die-off.

With the implementation of the Wetland Restoration Plan activities, including the recommendations above and the indigenous plantings described in the Project Description and Activities (Attachment 2) the effects of the Project and previous activities are considered to be remediated.

6.4 Avifauna (Birds)

In combination with an existing low ecological value and a resultant negligible magnitude of effect on avifauna, a pre-mitigated level of effect on avifauna is assessed as very low. Avifauna utilising the SNA to the north are not expected to experience any disturbance from proposed activities due to the distance from the Project site.

While some grassland, exotic tree and shrub habitat will be removed, the affected habitats are highly modified and predominantly support common indigenous and introduced bird species. The Project avoids the SNA and associated higher-value habitats to the north, which provide the most suitable habitat for indigenous bird species. Consequently, the scale of habitat loss is not expected to adversely affect bird populations at the ecological district scale.Notwithstanding a very low level of effect on avifauna, a Bird Management Plan (BMP), incorporated within the overarching Ecology Management Plan, will be implemented for all vegetation clearance and habitat disturbance activities. The BMP includes species-specific nesting periods, pre-clearance survey requirements, nest avoidance procedures, species-specific buffer distances, and accidental discovery procedures where protected bird species are encountered.

Particular regard will be given to kārearea, which have been recorded utilising the site. Although nesting on the Project site is considered unlikely, suitable grassland and quarry habitats will be inspected prior to works undertaken during the breeding season. Where an active kārearea nest is identified, works will cease within the relevant buffer area and appropriate avoidance measures implemented in accordance with the BMP and Wildlife Act requirements.

The BMP Is will also include an Accidental Discovery Protocol (ADP) for all ‘Threatened’ and ‘At Risk’ species that could utilise vegetated habitats onsite during development. Example protocols include site walkovers pre-vegetation clearance.

6.5 Herpetofauna (Lizards)

Since the WDC s42A report was prepared, which raised concerns regarding the adequacy of the lizard survey information, additional lizard surveys and trapping were undertaken across the site. These investigations enabled lizard habitat to be comprehensively mapped and classified as high- and low-quality habitat for skinks across the entire site. The updated assessment identified that approximately 2.3 ha of lizard habitat may be affected by the Project, including approximately 1.3 ha of high-quality habitat. The additional survey work has therefore provided a much more robust understanding of the location, extent and quality of lizard habitat than was available when the s42A report was prepared and has informed the refinement of the Lizard Management Plan (LMP), habitat creation, translocation and long-term enhancement measures.

The Lizard Management Plan (LMP) has been developed to manage impacts to indigenous lizards and their habitat associated with the Project. The NPS-FM effects management hierarchy has been applied to avoid, minimise, and remediate adverse effects as well as appropriate management pursuant to the Wildlife Act 1953 and key principles for lizard salvage and transfer in New Zealand.

An authorisation (107310-FAU) has been issued under the Wildlife Act subject to conditions and the approved LMP. The LMP provides a comprehensive framework for the management of indigenous lizards during project construction and operation, including pre-construction surveys, habitat preparation, salvage and relocation methodologies, habitat enhancement requirements, monitoring and adaptive management measures.

Management measures include a variety of methods for the active capturing of indigenous lizards which will sufficiently minimise the risk to lizards during construction works associated with the Project. Releasing lizards

into an existing SNA to be protected in perpetuity by a registered conservation covenant under the Reserves Act 1977 ensures their long term protection.

Habitat creation and site remediation requirements outlined within the LMP and pursuant to the Ecological Impact Assessment will result in the creation of high-quality lizard habitat far in excess of that to be lost due to the Project. Fencing around the lizard release area and lizard habitat creation area will ensure long-term protective benefit to the lizards, while also benefiting indigenous vegetation within the SNA located on 170 Quarry Road.

Specifically, the permanent loss of approximately 2 ha of Canterbury grass skink, is expected to be appropriately offset with:

- The development of approximately 3.9 ha of high-quality grassland habitat east of the SNA where the previous forestry was harvested.
- Weed control within the proposed covenant area.
- Creation of approximately 0.6 ha of low-quality lizard habitat adjacent to the unnamed eastern boundary watercourse, and
- Creation of approximately 9.2 ha of high-quality lizard habitat following capping and remediation of the managed fill site.

Almost 4 ha of skink habitat to be created in the short-term and a total of more than 13.5 ha of permanent skink habitat upon project completion resulting in more than a 680% increase in habitat. Therefore, the permanent loss of 2 ha of significant habitat will be offset by the permanent development of more than 13.5 ha of significant grassland habitat able to be colonised and utilised by Canterbury grass skink.

On the basis of the additional survey information, LMP implementation and long-term protection measures, the Applicant's ecological expert considers that the effects on lizards have been appropriately assessed and can be managed such that it is expected to result in a positive conservation outcome and an overall net gain for indigenous lizards on-site.

6.6 Summary

Overall, the effects on terrestrial ecology are considered to be less than minor due to adoption of the following measures:

- Implementation of a Bird Management Plan, Lizard Management Plan and Vegetation Management Plan.
- Appropriate management of protected birds and lizards prior to habitat impacts.
- Pest control reducing predation on lizards and potentially birds, having a positive effect within the short term and throughout the duration of the project.
- The development of lizard habitat within the short term, following the removal of the exotic pine plantation on-site.
- The construction of a stock exclusion fence within the short term, providing permanent protective benefit to the SNA, and the flora and fauna within it.
- Biodiversity enhancements through indigenous vegetation plantings within short to medium term timeframes, associated with the unnamed eastern boundary watercourse, wetlands and the Karetu River.
- The expected short to long term population increase in Canterbury grass skinks following pest reduction and habitat increase.
- In the future, the managed fill remediation will create a large area of lizard and grassland nesting bird habitat resulting more than 650% habitat creation for Canterbury grass skinks.

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7 Effects on Land Stability

A Geotechnical assessment and Landfill Slope Stability assessment have been completed for the Project to inform the potential effects on land stability including the risks associated with seismic hazard.

No large-scale areas of instability have been observed onsite nor have any karstic features, such as sink holes. Onsite overburden/spoil material is considered very stiff and in accordance with the New Zealand Geotechnical Society guideline for the field classification and description of rock and soil for engineering purposes. Indications are that there is not a significant proportion of cobbles or boulders that may present difficulties for construction or achieving required compaction. Reuse of onsite materials is therefore suitable.

Parameters for pit slopes including batter face angles, bench height and width, and overall slope angles for different material have been recommended and incorporated within the preliminary design. Further geotechnical stability analysis will occur during detailed design for each stage based on the proposed excavation/filling arrangement in relation to the engineered fill on the side slopes of the landfill. Detailed design will also assess how the placement of waste can achieve waste stability during construction and operation, as well as during closure and post closure.

In relation to seismic hazards, there are no New Zealand standards or geotechnical design guidance developed specifically for the seismic design of landfills, particularly the acceptable permanent slope displacement criteria. An Importance Level 3 structure has therefore been adopted based on Table 3.2 in NZS 1170.0:2002. A design working life of 100 years has been used.

The return period for fault rupture of the active faults in the receiving environment is in the order of hundreds of thousands of years. A fault rupture is therefore very unlikely during the design life of the landfill and unlikely to affect any containment structures.

The United States Environmental Protection Agency (USEPA, 1995) guidance for seismic stability and deformation analysis is the industry standard and considers permanent displacements in the order of up to 0.15 m (150 mm) are generally acceptable for the design of geosynthetic liner systems.

Slope stability assessments using GeoStudio software indicate the proposed final landfill face, access track and the leachate pond slope achieves the acceptable factor of safety (FoS) under both static and serviceability limit state (SLS) seismic cases. Under the damage control limit state (DCLS) case for the final landfill slope under a worst-case scenario [10] modelling however returned a displacement of up to 180 mm. While an exceedance of the USEPA 150 mm guideline, the stability assessment states:

> *Given the broad range of possible displacements and the conservative parameters used, the minor exceedance for the worst-case scenario (i.e., 180 mm vs the 150 mm guideline) is deemed acceptable.*

In terms of general land stability, these displacements are not considered notable, however they do generate risks of liner failure and increase risk of leachate leakage.

The potential for development of significant leachate head in high sloping wall areas is however unlikely. The potential leakage rate for leachate defects in the highwall liner is lower than in floor areas.

The worst-case scenario for leachate leakage under a seismic event is therefore displacement around the leachate pond. Under the DCLS, the FoS for the slope beneath the leachate pond are less than the normally accepted 1.0. However, the estimated marginal exceedance of <10 mm displacement is assessed as acceptable.

The leachate pond is double lined which includes a between liner leakage collection layer comprising Geonet (3-dimentional drainage structure that does not crush). The Geonet will direct any leakage through the primary

[10] Cross Section 01 (Final Landfill Slope) steepest section running NW-SE.

geomembrane liner (top geomembrane) to a leak detection and collection system and will limit potential leachate head buildup on and therefore leakage through the secondary liner.

A modelled scenario of a total liner failure case (i.e. DCLS) returned effects on water quality that do not exceed NZ drinking water standards with only two parameters exceeding the ANZG 2018 95% species protection.

The risks of a liner rupture (including pond liner) due to seismic displacement are also considered within the Containment Risk Assessment along with the design mitigation.

Based on further geotechnical stability analysis occurring in detailed design, a very low probability of seismic occurrence and resulting marginal exceedance of the DCLS for the final landfill slope and leachate pond, the adverse effect is assessed as minor.

Furthermore, independent peer review of the final designs of the landfill construction will be carried out by a Suitably Qualified Environmental Practitioner (SQEP) in landfill design while additional stability analysis will occur during detailed design (refer to the Project Description - Attachment 2).

In the event of an earthquake, procedures to be followed will be outlined within a certified Site Management Plan (SMP) (refer to Attachment 2 for more details).

The potential for existing landslides to move further and enter the quarry area is considered to be low risk, on the basis that the slope between the landslides and quarry is considerably flatter than the slope that the landslides have previously moved on.

8 Effects from Fire and Flood Hazards

8.1 Fire Hazard

Fire hazard risk at the site could eventuate from the unexpected combustion of landfill waste material, operation of the onsite kiln or from externally induced wildfires on surrounding property.

Unlike municipal landfills, the proposed managed fill site will be receiving a high content of incombustible material such as soils and gravels. The lack of putrescible material will significantly reduce the risk of high temperatures that can be generated within a municipal landfill. Municipal landfills also receive a very wide range of wastes and there are reports of fires from lithium batteries that can catch fire in the moist environment of a municipal landfill. This potential risk is limited as lithium batteries would not meet the acceptance criteria for the proposed managed fill site. It is also noted that fuel sources such as plantation forestry have been removed to the immediate east of the site, and grass will be regularly cut within the site to reduce the grass fire risk.

The most effective strategy to be adopted for firefighting within the managed fill footprint will therefore be to smother the fuel sources.

The Project includes the permanent presence of large earth moving machinery that can be quickly utilised to address any fire. Experience from other sites suggest that the availability of large earth moving equipment is one of the most important resources that can be used to fight fires, and the lack of availability of earth moving equipment is often a major impediment to firefighters dealing with fires in rural areas.

For fires occurring outside of the managed fill footprint such as within buildings on the lower terrace of the site, adequate onsite water storage and couplings for the delivery of water for firefighting purposes will be available.

Water storage near the managed fill footprint can be provided as additional firefighting controls for the waste. Gypsum products are a prohibitive waste material therefore the application of large volumes of water to the sorted inert C&D waste will not have the potential to generate hydrogen sulphide.

Based on the waste types received and firefighting resources available at the site and the onsite controls outlined within the SMP, the effects associated with fire hazard are considered to be less than minor.

8.2 Flood Hazard

Flood risk from the Karetu River to the site has been modelled [11] under 50 year, 100 year and 250 year Annual Return Interval (ARI) events with and without climate change (refer Figure 7:).

[11] Using NZVD2016 vertical datum and GD2000 Mt Pleasant Circuit projection.

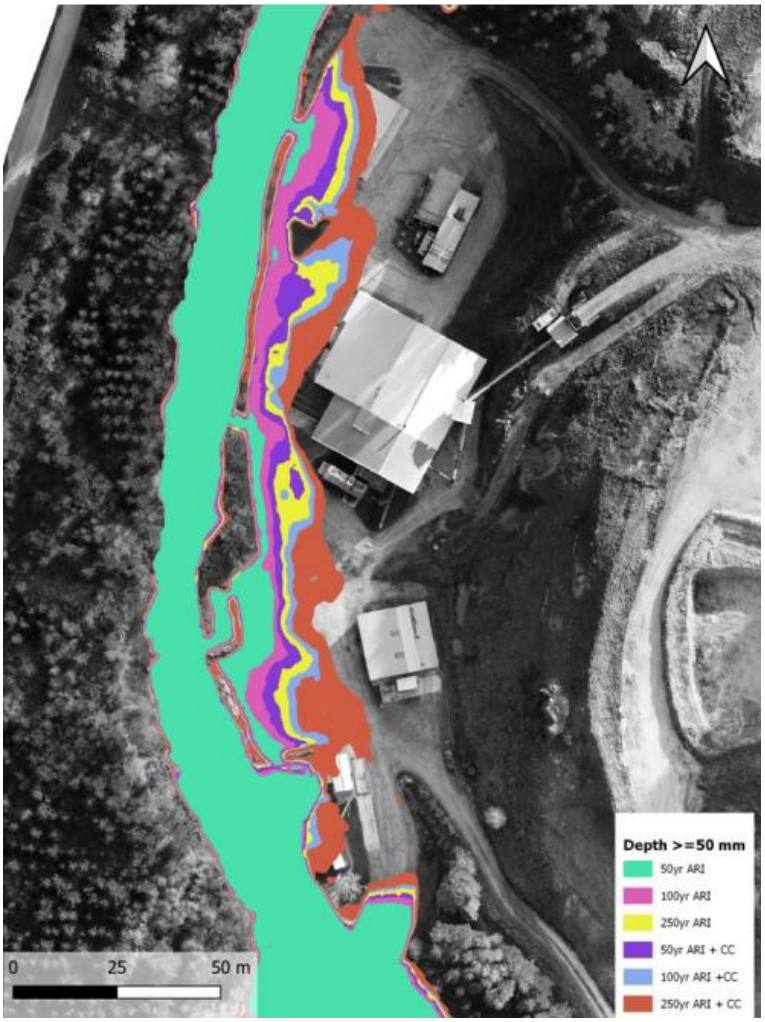


Figure 7: Flood modelling from Karetu River

When incorporating building floor levels into the model, there is a minimum of ~200 mm freeboard during the 100 year ARI existing climate event. The modelled surface elevations exceed the floor level in the northern building under a 100 year ARI climate change event. Modelling also indicated a portion of the trafficable area on the western boundary would have flood depths greater than 50 mm in 50 year ARI event both with and without climate change. However, it is expected that the reinstatement of the existing bund along the western boundary has alleviated flooding of these areas or diverted flows away from buildings.

With only a single building (used for extracted lime storage) partially susceptible to flood risk during a 100 year ARI climate change scenario, and as the risk can be suitably mitigated through onsite bund improvements, the risk is considered acceptable with a resultant minor effect.

Importantly, the flood modelling confirms that the active quarry and proposed managed fill footprint remain well above the modelled flood levels associated with the Karetu River. The managed fill area is located approximately 20 metres above the river and is therefore not susceptible to inundation, erosion or disturbance by floodwaters, including during extreme flood events. As a result, floodwaters are not expected to come into contact with managed fill materials, the liner system or the leachate collection and storage infrastructure.

There is therefore no direct flood risk to the active quarry and managed fill area. This finding is significant given concerns raised during the resource consent process that flooding could damage containment systems, spread contaminated materials, expose waste, overwhelm leachate management infrastructure or otherwise compromise the integrity of the managed fill. The hydraulic assessment concluded that these outcomes are highly unlikely because the managed fill itself is located outside the modelled flood extent and well above the predicted flood elevations associated with the Karetu River, even during extreme flood events. Flood-related containment failure mechanisms that could result in contaminant mobilisation are therefore not considered

credible for the site. The SMP also includes a flood contingency procedure in case access to the site for standard heavy vehicles to cart leachate off site via the access bridge is compromised or in the unlikely event bridge access is prevented for a period of weeks or more. Contingency measures are available to manage leachate storage and disposal until access is reinstated. Numerous feasible options to regain access and remove stored leachate if it was at risk of exceeding contingency storage.

Taking into account the substantial elevation difference between the managed fill and the Karetu River, the limited extent of flooding predicted by the hydraulic modelling, the reinstated western bund, and the proposed flood contingency procedures, the Project is considered resilient to flood hazards. Accordingly, the effects associated with flood risk are considered to be less than minor.

9 Effects on Air Quality and Human Health

9.1 Overview

A Technical Air Quality assessment of the effects on air quality was undertaken.

The surrounding land use is dominated by rural activities, predominantly agriculture and forestry. A review of the receiving environment identified two residential dwellings (on the same property) to the west at 70 m and 155 m of the site boundary that are likely to be sensitive receivers. A third receiver is 40 m from the site boundary. Distances are shown in Table 5.

Table 5: Distances to sensitive receptors

Receptor	Address	Distance to site boundary	Minimum distance to the quarry and managed fill face	Distance to processing plant
R1	161 Quarry Road	70 m	115 m	95 m
R2	161 Quarry Road	155 m	190 m	180 m
R3	144 Quarry Road	40 m	150 m	290 m

Other dwellings are more than 500 m away and not expected to be affected by site operations.

A weather station with an anemometer [12] to measure wind speed and direction was installed in 2023 at exposed and elevated position above natural ground level with continuous data recording. The site manager / managed fill operator will have real time access to data to inform site operations (e.g., dust suppression requirements). Risk levels associated with increased wind events will be managed in accordance with the wind speed trigger and response identified in Table 6.

Table 6: Wind speed restriction triggers

Category / Risk Level	Wind Speed	Notification Actions	Response
Calm to light / None	< 4 m/s (<14.4 km/hr)	N/A	N/A
Gentle / Low	4 - 5 m/s (14.4 - 18 km/hr)	Brief Operational Staff Real time - weather station - inbuilt alert system text & email	Prepare for mitigation and actions, visual inspection of dust discharges and implement water application for dust suppression if required
Moderate to Fresh / Medium	5 to 10 m/s (18 - 36 km/hr)	Brief Operational Staff and Drivers / Contractors prior if forecast Real time - weather Station - inbuilt alert system text & email	Receipt, handling, spreading, and compaction of asbestos waste is to cease (refer specific triggers in Section 9.4). Operators to use dust mitigation measures for non-asbestos containing waste and cleanfill operations as appropriate

[12] Installed in accordance with AS/NZD 3580.14:2014 Methods for sampling and analysis of ambient air – Part 14: Meteorological monitoring for ambient air quality monitoring applications.

Category / Risk Level	Wind Speed	Notification Actions	Response
Strong to Gale / High	10 to 20 m/s (36 - 72 km/hr)	Brief Operational Staff and Drivers / Contractors prior as will be forecast Real time - weather Station - inbuilt alert system text & email	In addition to above, tipping of light weight material to the landfill face to cease until appropriate mitigation methods can be undertaken. Wetting of waste soils at the source prior to dispatch to Whiterock
Strong Gale + / Very High	>20 m/s (> 72 km/hr)	Brief Operational Staff and Drivers / Contractors prior as will be forecast. Real time - weather Station - inbuilt alert system text & email	All landfilling must cease immediately, and the landfill may be required to close

The primary discharge into air from the site is considered to be particulate matter (dust) associated with quarrying, managed waste filling, and lime processing operations. Human health risks associated with receiving asbestos at the site are also considered.

As the site will not accept putrescible waste, odour is not expected to be noticeable from the proposed managed fill site. The dryer and diesel fired furnace (associated with lime processing) gives rise to finer particulate matter emissions (primarily PM_{10} and $PM_{2.5}$), as well as nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) from the dryer emission control system which have also been assessed.

9.2 Limestone Drying Kiln

The fuel source for the lime drying furnace and kiln has recently been changed from coal to diesel. The diesel burning emissions are a permitted activity under the regional plan and does not require resource consent under the National Environmental Standards for Greenhouse Gas Emissions as the yearly carbon dioxide emissions classify the site as a low-emissions site.

The residual air quality effects associated with particulates from the lime drying rotary kiln emissions have been modelled for the three sensitive receptors with low levels of all pollutants predicted at all modelled locations. The results show that that effects of air discharges from the diesel-fired rotary kiln on the off-site ambient environment are negligible.

Although unlikely, if any exceedances of the criteria occur mitigation can be added such as particulate emission reduction technology.

9.3 Dust arising from Quarrying and Managed Fill Activities

There are two residential dwellings (R1 & R2) within in 250 m of the quarry / managed fill area that are considered to be highly sensitive. Locations beyond 250 m of the site are unlikely to experience any offensive or objectionable dust impacts given the scale of the site operations and normal mitigation measures. The notional boundary of R3 is at least 600 m from the area of quarrying and managed fill activities and is not included in the assessment.

A seasonal based frequency analysis of wind data has been carried out on the two residential receptors (refer Table 7). Due to separation distance and the application of good management practices and mitigation measures as outlined in the SMP, the risk of high intensity impacts is relatively low.

Based on the type of dust, it is not considered that the activity is likely to be offensive in context of the receiving environment. Predicted duration of potentially dusty winds in dry and strong wind conditions will mainly occur over a period of 1-3 hours.

Table 7: Percentage of annual hours that a receptor is downwind of the site during dry conditions under strong winds.

Receptor	Frequency of downwind dry hours (all wind speeds)			Frequency of downwind dry hours with strong (>5 m/s) wind conditions		
	Annual total	Oct to Apr	May to Sep	Annual total	Oct to Apr	May to Sep
R1	6 % (565 hours/year)	5 % (465 hours/year)	1 % (100 hours/year)	0.14 % (12 hours/year)	0.14 % (12 hours/year)	0
R2	5 % (456 hours/year)	4 % (384 hours/year)	1 % (72 hours/year)	0.14 % (12 hours/year)	0.14 % (12 hours/year)	0

In consideration of the FIDOL [13] factors there is the potential for low dust impacts to occur in dry and both windy and light/moderate wind conditions. Potential impacts are more likely to occur between October to April.

A conservative approach was adopted in the air quality assessment assuming that all excavated / managed fill / overburden areas would be open throughout the year. This would however not be the case with extraction works and the managed fill site being progressively completed and stabilised.

Potential dust discharges from the site are likely to occur from excavation, loading, filling and haulage areas. Standard dust mitigation measures for quarries and managed fill can readily achieve avoidance of dust effects beyond the site boundary.

The SMP will detail the low moderate and high dust generating activities, and the appropriate mitigation and actions required to be carried out to minimise any potential for offsite dust quality effects.

9.4 Asbestos

Handing and deposition of asbestos will be undertaken in accordance with the requirements of the Health and Safety at Work (Asbestos) Regulations 2016.

The SMP will outline the requirements for transporting asbestos waste material to the site which includes the lining of the waste material within 200 µm gauge plastic and wetted during loading so the moisture content of the material will be at least 15% throughout the load. Liners will be taped and then covered with retaining cover/tarpaulin before transport to the site.

Detailed procedures for the placement, compaction and covering of asbestos waste will be in the SMP. To verify the effectiveness of these procedures, monthly ambient air monitoring will be undertaken when asbestos materials are being received, tipped and deposited on site.

Asbestos will not be accepted to the site (handled, disturbed or deposited) when wind speed at the site is greater than 5 m/s (18 km/hr) averaged over a 60-minute period and / or if peak wind speed exceeds 7 m/s (25.2 km/hr) averaged over a 60-minute period. Wind speed trigger levels and responses are outlined in Table and further within the SMP. Wind speeds will be informed by the onsite weather station to be installed.

With the above procedures and controls in place to protect human health at the location of asbestos material deposition (i.e. within the managed fill), it is highly unlikely that there will be any migration offsite via wind dispersal or vehicles / machinery.

[13] Frequency, Intensity, Duration, Offensiveness and Location.

9.5 Summary

In the absence of mitigation, quarrying, haul road use and managed fill activities have the potential to result in moderate adverse dust effects on neighbouring properties within 500 m of the site. However, with the implementation of the proposed dust management, mitigation and monitoring measures will reduce these effects to a low level. Emissions from the lime processing plant are predicted to result in negligible off-site air quality and human health effects, with concentrations remaining well below relevant health-based standards and guidelines. Overall, the Project is anticipated to result in low adverse air quality effects on neighbouring properties, primarily associated with dust nuisance and amenity, and negligible adverse effects on human health.

10 Effects of Transportation

The operative district plan provides a basis for determining the transport effects associated with the Project and the level of traffic generation which is anticipated by the plan for each zone or activity. A High-Level Transport Assessment has been undertaken for the Project to a level of detail that corresponds to the scale of the effects that the activity may have on the environment and to which the district plan provisions anticipate within a rural zone.

A high level transport assessment considered traffic safety effects associated with increased vehicle movements on Quarry Road and Loburn Whiterock Road, including potential effects on North Loburn School, pedestrians, cyclists, existing one-lane bridges, the site access and the wider road network. The assessment concluded that the existing road network is capable of accommodating the forecast traffic volumes and that existing crash patterns are characteristic of a rural road environment, with no identified crash trends involving heavy vehicles that would be expected to be exacerbated by the Project.

The assessment included a review of crash history in the vicinity of the site to determine any existing underlying irregularities and whether the project is likely to create any new impacts or possibly exacerbate any existing issues. Due to low traffic volumes along Quarry Road, a 10 year period and an extended distance of 20 km of roading was reviewed.

Based on reported crash history (5 reported within the 10 year period) there is a trend of loss of control type crashes during hours of darkness which is not uncommon for rural roads. Notably all crashes involved light vehicles and did not involve heavy vehicles. Crash records do not reveal existing hazards that would be expected to be exacerbated by the Project.

The threshold of vehicle movements[14] that requires resource consent under the operative district plan as a high trip generating activity is where the number of movements exceeds 250 vehicles per day. This threshold sets an important permitted baseline with respect to trip generation associated with the Project.

For completeness, the proposed district plan also defines high traffic generation thresholds for activities within a rural zone as follows:

- Greater than 200 vehicle movements per day (average).
- Greater than 50 heavy vehicle movements per day (average).

The project will result on average 36 vehicle movements per day which equates to approximately 14% of the threshold that the operative district plan anticipates before consideration is given to a high trip generating activity. Based on forecast traffic volumes within the range assessed by the Transport Assessment, vehicle movements on Quarry Road are expected to increase relative to existing conditions, while increases on Loburn Whiterock Road will be proportionally lower due to the higher existing traffic volumes on that road. In all scenarios assessed, traffic volumes remain well below both operative and proposed District Plan thresholds for high traffic-generating activities.

Particular consideration was given to traffic passing North Loburn School. The transport assessment noted that while additional heavy vehicle movements will occur on Loburn Whiterock Road, the increase in overall traffic volumes is small in the context of the existing road network. In addition, while the existing situation of 100 km/hr speed limit outside of North Loburn School is not satisfactory, a change to the speed limit is proposed to decrease to 60 km/hr (WDC Speed Management Plan 023/27). Similarly, Quarry Road and Loburn Whiterock Road are used by recreational cyclists and occasional pedestrians. While any vehicle-cyclist interaction on a rural road can potentially result in serious consequences, both the transport assessment and the District Council s42A review concluded that the likelihood of conflict remains low given the relatively low traffic volumes and the modest increase in vehicle numbers associated with the Project.

[14] Either entering or exiting a site per day

While the Project will increase heavy vehicle movements, Quarry Road already accommodates quarry, farming and forestry traffic. The transport assessment concluded that the increase in traffic volumes is unlikely to materially affect pavement lifespan, particularly when considered within the context of existing heavy vehicle use.

A range of mitigation measures are proposed to further reduce transport effects. These include widening and sealing the site entrance to reduce the tracking of mud and debris onto Quarry Road, installation of “Trucks Operating” signage in advance of the site entrance, limits on heavy vehicle movements associated with the managed fill operation, and a pavement assessment and the applicant contributing to any additional repair costs. Quarry Road is currently a Grade 3 chipseal. It is proposed to contribute the additional cost when the road is resealed to reseal the road with a second coat of seal.

Overall, the transport assessment concludes that the surrounding road network has sufficient capacity to accommodate the forecast traffic volumes, that no existing road safety issues are expected to be materially exacerbated, and that potential effects on road safety, cyclists, pedestrians, school traffic and road condition can be appropriately managed through the proposed mitigation measures and consent conditions. Accordingly, transport effects associated with the Project are expected to be low and within the range anticipated for rural road environments.

11 Effects on Ngāi Tūāhuriri Values

11.1 Overview

The Project lies within the rohe of Te Ngāi Tūāhuriri Rūnanga. Ngāi Tūāhuriri hold and exercise rangatiratanga within this area and have identified the Karetu River, Ōkūkū River and Rakahuri River catchments as being of significant cultural importance. These waterways have historically supported mahinga kai values and continue to be important to the exercise of tikanga, kaitiakitanga and the maintenance of cultural identity and connection with ancestral lands and waters.

Ngai Tūāhuriri oppose the Project and consider that they are adversely affected. A substantial part of the cultural concerns they identify is connected to the biophysical effects assessed elsewhere in this attachment, particularly effects on water quality, wetlands, freshwater ecology, mahinga kai, taonga species and long-term containment and management of waste.

Those concerns are not, however, confined to the biophysical effects. Ngāi Tūāhuriri also identify effects arising from the location and nature of the activity within a culturally significant landscape at the head of the catchment, including effects on the mauri and mana of the waterway, their relationship with ancestral lands and waters, and the exercise of kaitiakitanga. They also consider that, because Ngāi Tūāhuriri were not involved during the site selection process, their ability to exercise rangatiratanga and kaitiakitanga at that stage was constrained.

The Project has incorporated measures intended to avoid, minimise and manage the biophysical effects underlying many of the concerns raised by Ngāi Tūāhuriri, including effects on water quality, freshwater ecology, wetlands, fish passage and taonga species. The Applicant acknowledges, however, that technical mitigation alone does not determine the resulting cultural effects and that engagement now cannot replicate Ngāi Tūāhuriri involvement at the site-selection stage.

Attachment 9 records the Applicant's efforts to engage with Ngāi Tūāhuriri, including approaches through Mahaanui before the resource consent applications were lodged and further direct invitations following the Ngāi Tūāhuriri submission and during the FTAA referral process. Ngāi Tūāhuriri advised in May 2025 they did not wish to meet and would maintain their opposition and no response was received to the most recent notice and invitation in June 2026. The Applicant nevertheless remains willing to engage directly with Ngāi Tūāhuriri, through their preferred representatives, before lodging any substantive FTAA application.

Although the site has been selected, there remains scope for that engagement to influence the Project's detailed design, environmental and cultural monitoring, management plans, proposed conditions and long-term review arrangements. The purpose of the engagement would be to identify whether further measures can appropriately respond to the cultural values and concerns identified, including opportunities for cultural health monitoring and mana whenua involvement in monitoring and review. That engagement would not assume Ngāi Tūāhuriri support for the Project or diminish the position they have expressed.

The Applicant recognises that Ngāi Tūāhuriri may continue to decline engagement, but considers it important that the opportunity remains available, particularly given the further technical work undertaken and the aspects of the Project that remain capable of being influenced.

11.2 Summary

At this referral stage, effects on Ngāi Tūāhuriri values are assessed as more than minor. While the Applicant's updated technical assessments indicate that the biophysical effects underlying many of the concerns raised can be appropriately managed, distinct cultural concerns remain regarding the cultural landscape, the location and nature of the activity, and the absence of Ngāi Tūāhuriri involvement during site selection. The Applicant will continue to offer direct engagement before any substantive FTAA application is lodged, so that Ngāi

Tūāhuriri have a meaningful opportunity to influence those aspects of the Project that remain capable of change.

12 Effects on Landscape Values and Natural Character

A Landscape and Visual Assessment (LVA) was undertaken to assess the effects of the Project on landscape character, visual amenity and natural character. The assessment considered the existing landscape context, visibility of the site from public and private viewpoints, the nature and scale of the proposed activities, and the extent to which the Project would alter existing landscape values.

The Project site lies within a highly modified rural landscape at the interface between the Canterbury Plains and foothills. The surrounding landscape is characterised by a mosaic of agricultural land, plantation forestry, shelter belts, farm buildings, rural infrastructure and areas of existing quarrying activity. The site itself has been subject to quarrying since the early 1940's and has been progressively quarried to the present day. The character of the landscape at the site is well defined by the quarrying activity, processing plant, stockpiles and access tracks.

The site is not identified as an Outstanding Natural Landscape, Outstanding Natural Feature or Significant Landscape within either the Operative or Proposed District Plan. While the site adjoins areas of ecological value, including a Significant Natural Area (SNA) to the north, the quarry footprint itself is assessed as having low to very low landscape value due to the extent of previous modification.

The Landscape and Visual Assessment found that visibility of the quarry is generally limited. As the Project is largely confined to the existing quarry footprint it does not introduce a new industrial activity into an otherwise undeveloped landscape. Rather, it utilises an existing quarry void and progressively rehabilitates that area over time. During operation, the landscape changes associated with the Project will largely occur within areas already modified by quarrying. Although earthworks machinery and managed fill activities will continue to be visible from some nearby locations, these activities will not represent a substantial departure from the established quarrying character of the site.

The existing quarry area can only be occasionally glimpsed from Quarry Road and Taaffes Glen Road. For the Quarry Road and Taaffes Glen Road users, the effective viewing time is short and transient. This is in part due to topography and in part due to an array of shelter belts. While the Applicant has no control over the shelter belts outside of their owned property, due to the provision of shade and shelter, it can reasonably be expected that there would be no wholesale removal of these trees. Once past (north of) 144 Quarry Road, topography screens the Project from road users. At a distance, for example from the DOC tracks within the Mt Thomas Conservation Area, the changes brought about by the Project will be indiscernible.

The proposed works are of a small scale when taken in the context of the larger and complex receiving environment. Additionally, the Project will not represent significant change when compared to the current quarrying activity. The LVA concludes that locating the managed fill primarily within the existing quarry reduces the potential for additional adverse effects on natural character so overall, the magnitude of change during the operation of the Project will be at most, low (or less than minor).

A comparison of the sites current state and the digitised visualisation of the post capping and vegetated state is provided in Figure 8. The imagery depicts a landscape transformed to a state which harmonises with the surrounding landscape. The post closure plan will specify removal of buildings on site. At the end of the Project after disestablishment, effects will be very low, with positive effects derived from the return of the landscape to a more natural form (and associated revegetation), the removal of structures, and enhancement of the SNA, wetlands and riparian environment improving the natural character.



Figure 8. Comparison of drone site images current and digitised visualisation (future).

The Project includes a number of measures that will improve landscape values and natural character over time. These include:

- Removal of the existing ford and restoration of a more natural river corridor.
- Implementation of a Vegetation Management Plan (VMP) including indigenous riparian planting along the Karetu River, eastern watercourse and wetland areas. The VMP will include details on sourcing of plants, maintenance and management of plantings (including replacement of unsuccessful plants, pest plant control and pest animal control) be carried out for a minimum of 5 years or until 80% canopy closure is achieved, whichever is the longer.
- Fencing, protection and enhancement of the adjoining Significant Natural Area.
- Removal of buildings, processing infrastructure and redundant access tracks at closure.
- Restoration of the quarry void to a landform that better reflects the surrounding rolling hill landscape.
- Progressive capping, revegetation and rehabilitation of the managed fill footprint.

The proposed final landform has been specifically designed to integrate with the surrounding rolling foothill landscape. With the exception of the retained limestone escarpment, the rehabilitated site will mimic the form of adjacent pastoral hills and reduce the visual contrast currently created by exposed quarry faces, stockpiles and industrial infrastructure. The visual modelling prepared for the Project indicates that, following closure and rehabilitation, the quarry scar will be substantially reduced, and the site will visually align more closely with the surrounding landscape pattern.

Overall, when assessed against the existing quarry environment, the magnitude of landscape and visual change during operation is low. In the longer term, the Project will result in positive landscape outcomes through rehabilitation of the quarry void, enhancement of riparian and ecological values, removal of industrial infrastructure and restoration of a more natural landform. Accordingly, the adverse effects on landscape values and natural character are assessed as less than minor during operation, with positive effects anticipated following site closure and rehabilitation.

13 Effects on Amenity and Recreation Values

13.1 Overview

Potential effects on amenity and recreational values in the receiving environment are considered to stem from nuisance activities arising during construction and operation, changes to water clarity and colour within the Karetu River and impacts on fishing values.

13.2 Nuisance Odour, Dust and Noise

Odour is not considered a materially relevant effect as the site will not accept any putrescible waste and any odorous materials if present (e.g. hydrocarbons) can quickly be covered at the tipping face of the managed fill to minimise any noticeable odour.

Potential nuisance effects more relevant to the Project include emissions of noise and dust during both construction and operation of the Project.

A Noise Impact Assessment has been undertaken for the project against the operative Waimakariri District Plan and Hurunui District Plan.

The assessment identified five rural residential dwellings as potential noise sensitive receivers relevant to activities occurring on the site. The predicted noise levels at these properties are identified in Table 9:9.

Table 9: Predicted noise levels at potential noise sensitive receivers.

Phases	Predicted Noise Levels (dB $L_{Aeq,15min}$)				
	33 Quarry Rd	49 Quarry Rd	62 Quarry Rd	161 Quarry Rd	361 Quarry Rd
Phase 1[1]	37	39	39	55	28
Phase 2	34	35	35	55	27
Phase 3	34	35	35	55	27
Phase 4[1]	35	37	36	55	27
Criteria	*50*	*50*	*50*	*55*	*55*
Complies?	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

[1] Phase 1 and Phase 4 could be considered 'construction' activities and so the resultant noise criteria would be 70 dB $L_{Aeq,15min}$, and would still fully comply with the noise standards.

Noise emissions are assessed as being acceptable at all five identified noise-sensitive properties. The Noise Impact Assessment concludes that the predicted operational noise emissions from the proposed quarrying and managed fill activities comply with the applicable daytime noise limits of both the Waimakariri Proposed District Plan and the Hurunui District Plan when assessed at the notional boundary of the nearest residential properties. Accordingly, the Project is predicted to comply with the relevant operational noise standards throughout all stages of development.

The predicted noise levels are based on a deliberately conservative assessment methodology. The modelling assumes noise sources are located along the boundary of the proposed quarry/managed fill area closest to

the nearest properties, with all staff arriving and trucks arriving and departing site in a single 15-minute period (i.e. a worst-case scenario). The assessment also assumes worst-case meteorological conditions for noise propagation.

In reality, site activities will generally be distributed across the operational day, equipment will not continually operate at maximum intensity, and noise-generating activities will often occur further within the quarry and managed fill footprint than assumed by the model. Existing quarry topography and the progressive development of the managed fill will also provide terrain screening between many noise sources and surrounding properties. As a result, actual operational noise levels are expected to be lower than those predicted by the assessment in most circumstances.

The nearest potentially affected dwelling is located at 161 Quarry Road. Predicted noise levels at this location achieve, but do not exceed, the applicable daytime noise limit of 55 dB LAeq. All other assessed properties are predicted to experience noise levels significantly below the applicable district plan limits.

On the basis that noise from the Project is predicted to comply with the relevant district plan noise standards which were assessed under a worst-case scenario, the potential noise generated will fall within what is anticipated within the zone.

The District Council's section 42A noise reviewer accepted the findings of the noise assessment and concluded that noise effects can be appropriately managed. The reviewer also agreed that the predicted noise emissions are not unreasonable or out of character for a rural environment and are consistent with the relevant objectives and policies of the district plans.

An assessment of the effects from the Project on air quality from dust was undertaken. Dust from quarrying and managed filling has also been thoroughly assessed which includes risk levels associated with increased wind events and the management response for different triggers.

Potential dust discharges from the site are likely to occur from excavation, loading, filling and haulage areas. Standard dust mitigation measures, that are typically applied to quarries and managed fills, together with controls set out in the Site Management Plan (SMP), can readily achieve acceptable levels of dust discharge potentially occurring at the site.

The SMP prepared for the site details activities, mitigation and actions required to ensure appropriate management and mitigation measures are carried out to minimise any potential for offsite air quality effects (including dust) will be implemented onsite.

Overall, taking into account the conservative assumptions adopted in the assessment, compliance with applicable district plan noise standards, the physical separation distances to neighbouring properties, existing terrain screening, operational restrictions on hours of operation and the conclusions of both the acoustic assessment and the section 42A review, the Project is expected to result in no more than minor adverse effects in relation to noise and dust.

13.3 Water Colour and Clarity

Vehicle access to the site is currently via a ford crossing within the bed of the Karetu River. Existing operations when fully operating result in up to 10 vehicle movements per day disturbing the bed of the Karetu River and giving rise to potential temporary increases in TSS and resultant reduction to water colour and clarity.

Stormwater discharges to the river will be mitigated via source controls and the SRP’s with suspended solid limits. Any liner leakage that mixes with groundwater in the underlying permeable rock and then emerging in surface water will not have any impacts on water colour and clarity.

In combination with the proposed bridge crossing and implementation of source controls and erosion sediment controls (e.g. SRPs) it is expected that both sediment disturbance and loads from the site will be mitigated.

Overall impacts from the project on water colour and clarity in the Karetu River is expected to be less than minor.

13.4 Summary

Overall, the effect on amenity and recreation will be less than minor as noise and dust emissions will comply with relevant standards and be managed through established mitigation measures, while odour effects will be negligible due to the nature of the material accepted. In relation to recreational and amenity values associated with the Karetu River, the replacement of the existing ford with a bridge will remove a continuing source of sediment disturbance, and stormwater and sediment controls will minimise project-related effects on water quality. Consequently, the Project is not expected to result in any measurable reduction in the amenity or recreational enjoyment of the receiving environment and may provide some localised improvements to river conditions over time.

14 Containment Failure Risks

The managed fill design and potential level of effects have been informed by several technical assessments and modelling. The principal risk effect is associated with the potential for a different level of containment failure (i.e. leachate) due to a range of issues resulting in the release or migration of leachate to groundwater or surface water.

A Containment Risk Assessment has been undertaken which assesses the containment losses and failure mechanisms, the environmental consequences that could arise, and and corresponding design, operational and monitoring measures proposed to minimise those risks.

Particular consideration has been given to matters raised through the section 42A review process, including liner integrity, long-term containment performance, preferential groundwater flow paths, potential contaminant migration, flood-related failure mechanisms, and the effectiveness of the leachate collection and management system. These matters have informed both the preliminary design and the monitoring and management framework proposed for the Project.

The possible failure mechanisms considered broadly include:

- Liner tearing or poor contact (manufacturing defect or poor construction)
- Failure of leachate collection, pumping or storage infrastructure
- System failure or lack of intended maintenance over time
- Disposal of waste that does not meet the WAC
- Seismic displacement resulting in a liner failure or landslide that impacts the containment system
- Flood related damage to containment infrastructure
- Long term deterioration of containment system components during the operational and post closure phases

The preliminary design mitigation of these possible failure scenarios, together with the detailed design process and associated quality assurance is set out in the Containment Risk Assessment and supporting design documentation, which will be incorporated into proposed conditions and management plans.

The Project incorporates multiple and independent layers of protection intended to both prevent containment failure and provide early detection should an issue occur. These include a Class 1 landfill-standard composite liner system, leachate collection and storage infrastructure, underdrainage monitoring, groundwater and surface water monitoring, waste acceptance controls, operational quality assurance procedures, and Trigger Action Response Plans (TARPs). Collectively these measures provide multiple barriers between the waste mass and the receiving environment, together with mechanisms for early intervention should any unexpected containment issue arise.

In addition to preventing contaminant migration, the monitoring and response framework has been specifically developed to address uncertainty associated with long-term containment performance, potential preferential groundwater pathways, unexpected leachate characteristics, and changes in contaminant concentrations over time. The proposed monitoring, reporting and adaptive management framework enables any abnormal trends to be identified and responded to before significant environmental effects occur.

The CRC s42A report expressed concern regarding uncertainty associated with long-term post-closure management and the potential future consequences of containment system degradation. However, the Project includes a comprehensive post-closure and aftercare framework that extends beyond the operational life of the managed fill. A Landfill Closure and Aftercare Plan is proposed, which will be prepared, independently reviewed and updated throughout the life of the facility. The post-closure regime includes ongoing maintenance of the cap, leachate collection system and groundwater drainage system, together with continued leachate, groundwater and surface water quality monitoring, contingency measures and adaptive management responses. In addition, the Applicant proposes to establish an enforceable bond mechanism and

dedicated funding arrangements for future monitoring, maintenance and remedial works, with the bond reviewed at five-year intervals. Accordingly, while long-term monitoring and management will continue after closure, the Project includes specific mechanisms to ensure post-closure risks are identified, monitored and managed.

Overall, while it is not possible to completely eliminate risk from any engineered containment system, the combination of conservative design assumptions, multiple containment barriers, operational controls, monitoring programmes and adaptive management measures substantially reduces both the likelihood and consequences of containment failure. On this basis, it is considered that the residual risks associated with the managed fill containment and resulting environmental effects are low and have been demonstrated to be minor.

Appendix A: Monitoring Programme - Whiterock Limestone Quarry and Managed Fill

Table and Map Revisions – Document Control

Table or Map Number and Name	Revision	Date	Revision Details
Table A. Acronyms and Symbols	A	March 2024	Draft for Consent application
Table B. Monitoring Type, Purpose, Methods and Required Qualifications	B	August 2024	For RFI Response – added wetland perimeter monitoring and changed sediment cover monitoring method
Table C. Monitoring Locations	B	August 2024	For RFI Response - added one more surface water monitoring location, and lower wetland perimeter
Figure A. Monitoring Locations	B	August 2024	For RFI Response - added one more SW location, and lower wetland perimeter location
Table D. Monitoring Parameters	B	August 2024	For RFI Response - added temperature to Stormwater Stressors Indicators, and wetland extent delineation parameters
Table E. Baseline and Standard Monitoring Programme	B	August 2024	For RFI Response- added clarity that groundwater and surface water baseline is to occur for a minimum 12 months, prior to standard monitoring, separated and reduced organic monitoring frequency, added lower wetland perimeter surveys
Table F. Time of Commencement of Triggers	B	August 2024	For RFI Response - added lower wetland extent
Table G. Triggers and Actions and Response Plan (TARP)	B	August 2024	For RFI Response - added temperature triggers, and lower wetland extent reduction triggers
All tables and map	C	November 2025	For FTAA referral application – consideration of s42A report and updated technical report recommendations. PFAS analysis, clarified stormwater quality methods and added Water Treatment Chemicals, added Eco sites, Leachate Pond Quality monitoring point clarified

Table A. Acronyms, Symbols and Unit Abbreviations

Acronyms	
ANZG - ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.	PFAS – Per- and polyfluoroalkyl substances
CaCO3 - Calcium carbonate	
COD - Chemical Oxygen Demand	
DO - dissolved oxygen (percent and % saturation and mg/L)	
DRP - Dissolved Reactive Phosphorus	pH – potential of hydrogen (i.e., a measure of acidity and alkalinity)
EC - Electric Conductivity (i.e., a measure of salinity	QMCI - Quantitative Macroinvertebrate Community Index
ESC - Erosion and Sediment Control	SD - Standard Deviation
GW - Groundwater	SRP - Sediment Retention Pond
LOD - Level of Detection	SVOCs - Semi Volatile Organic Compounds
MCI - Macroinvertebrate Community Index	SW -– Surface Water
N - Nitrogen	TBC - To be confirmed
NEMS - National Environmental Monitoring Standards	TPH - Total Petroleum Hydrocarbons
NH4-N - Ammoniacal Nitrogen	TSS - Total Suspended Solids
N/A - Not Applicable	VOCs - Volatile Organic Compounds
PAHs - Polycyclic Aromatic Hydrocarbons	WAC - Waste Acceptance Criteria
Symbols	**Unit Abbreviations**
% - percent	g O2/m3 - grams of oxygen per cubic metre
< - less than	mg/L – milligrams per litre
> - greater than	mm – millimetres
≤ - less than or equal to,	g/m3 – grams per cubic metre
≥ - greater than or equal to	meq/L - milliequivalents per litre
Δ - change	uS/cm - microsiemens per centimeter

Table B. Monitoring Type, Purpose, Methods and Required Qualifications

Monitoring Type	Purpose	Method	Qualifications Required
Stormwater Quality	SRP performance, potential stormwater contamination from managed fill operation	SRP - Water quality sensor / meters fixed continuous, except grab sampling for any type of contaminants associated with Water Treatment Chemical use	Trained Site Operator
Leachate Quality	Early detection of unexpected leachate quality and longer term potential impacts of recirculation on leachate concentrations	Grab samples	Trained Site Operator
Groundwater Quality, Levels and Flows	Liner leakage detection, underdrainage system performance, track changes in lower wetland hydrological conditions, groundwater direction to support any contaminant transport assessments.	Manhole - Continuous fixed water quality sensor, grab samples Groundwater well sampling shall be undertaken in accordance with National Environmental Monitoring Standards (NEMS) Water Quality - Part 1 of 4: Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data	Suitably qualified environmental practitioner
Surface Water Quality	Wet weather - Impacts of dirty and clean /operational stormwater discharges. Dry weather - Additional environmental monitoring in case of liner leakage leachate detections	Grab samples. All surface water sampling must be undertaken in accordance with the relevant National Environmental Monitoring Standards, Water Quality - Part 2 of 4: Sampling, Measuring, Processing and Archiving of Discrete River Quality Data.	Suitably qualified environmental practitioner
Ecological Health - Macroinvertebrate	Impacts of stormwater discharges. Additional environmental monitoring in case of liner leakage leachate detections	Benthic macroinvertebrate surveys shall be completed following the National Environmental Monitoring Standards, Macroinvertebrates - Collection and Processing of Macroinvertebrate Samples from Rivers and Streams The monitoring reach for each will preferentially measure a 30 m reach to be consistent with Environment Canterbury sampling methodology (note this is not consistent with NEMS).	Suitably qualified freshwater ecologist
Ecological Health - Fine sediment	Impacts of stormwater discharges.	Deposited fine sediment stored in the top layers of the stream bed (suspendable inorganic sediment, SIS) will be measured using the 'Quorer' technique (method 4 in the sediment assessment protocols and guidelines for New Zealand developed by Clapcott et al. 2011). Following these standard guidelines, Quorer sampling at each site (six samples per site plus one control) will be performed in the run habitat immediately upstream of the riffle where macroinvertebrates had been collected. Citation: Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.	
Lower Wetland Extent	Potential impacts of underdrainage take and liner (reducing local recharge) on wetland extent	Wetland delineations will follow the Ministry for the Environments Wetland Delineation Protocols. Wetland extent will be informed by a Rapid Test for vegetation, dominance and prevalence hydrophytic vegetation tests, and a hydric soils and wetland hydrology tool. Citation: Ministry for the Environment. 2022. Wetland delineation protocols. Wellington: Ministry for the Environment.	Suitably qualified terrestrial ecologist

Table C. Monitoring Locations

Monitoring Location Name(s)	Monitoring Type	Location in Relation to Managed Fill Site	Screened Hydrostratigraphic Unit	Location Description	Grid References New Zealand Transverse Mercator 2000 (NZTM) Easting (X)	Northing (Y)
SRP1	Stormwater quality	Adjacent	N/A	West SRP that discharges towards Karetu River, inlet and outlet	1555386	5221533
SRP2	Stormwater quality	Adjacent	N/A	East SRP adjacent to and discharges to eastern boundary watercourse, inlet and outlet	1555468	5221242
WW	Leachate wastewater	Adjacent	N/A	Leachate pond (or alternatively leachate hardstand)	1555415	5221212
GWUD	Groundwater quality and flow	Adjacent	N/A	Managed fill underdrainage system collection sump	1555364	5221314
GW1-1	Groundwater level and water quality	Upgradient	Whiterock limestone	Upgradient location Stage 1 managed fill; 10 m from managed fill footprint.	1555425	5221505
GW1-2	Groundwater level and water quality	Upgradient	Karetu silica sands	Upgradient location Stage 1 managed fill; 10 m from managed fill footprint.	1555425	5221505
GW2-1	Groundwater level and water quality	Upgradient	Whiterock limestone	Upgradient location Stage 1 and Stage 2 managed fill; 10 m from managed fill footprint.	1555514	5221512
GW3-1	Groundwater level and water quality	Downgradient	Whiterock limestone	Downgradient location Stage 1 managed fill; 45 m from managed fill footprint	1555329	5221289
GW3-2	Groundwater level and water quality	Downgradient	Karetu silica sands	Downgradient location Stage 1 managed fill; 45 m from managed fill footprint	1555329	5221289
GW4-1	Groundwater level and water quality	Downgradient	Whiterock limestone	Downgradient location Stage 1 managed fill and leachate pond; 10 m from leachate pond footprint	1555392	5221199
GW4-2	Groundwater level and water quality	Downgradient	Karetu silica sands	Downgradient location Stage 1 managed fill and leachate pond; 10 m from leachate pond footprint	1555392	5221199
GW5-1	Groundwater level and water quality	Downgradient	Whiterock limestone	Downgradient location Stage 1 and Stage 2 managed fill; 20 m from managed fill footprint	1555477	5221238
GW5-2	Groundwater level and water quality	Downgradient	Karetu silica sands	Downgradient location Stage 1 and Stage 2 managed fill; 20 m from managed fill footprint	1555477	5221238
GW6-1	Groundwater level and water quality	Downgradient	Whiterock limestone	Downgradient location Stage 2 managed fill; 10 m from managed fill footprint	1555526	5221277
GW7-1	Groundwater level and water quality	Downgradient	Whiterock limestone	Downgradient location Stage 2 managed fill; 20 m from managed fill footprint	1555363	5221264

Monitoring Location Name(s)	Monitoring Type	Location in Relation to Managed Fill Site	Screened Hydrostratigraphic Unit	Location Description	Grid References New Zealand Transverse Mercator 2000 (NZTM) Easting (X)	Northing (Y)
GW7-2	Groundwater level and water quality	Downgradient	Karetu silica sands	Downgradient location Stage 2 managed fill; 20 m from managed fill footprint	1555363	5221264
GW8-1	Groundwater level and water quality	Downgradient	Whiterock limestone / Berrydale greensands	Cross / downgradient location Stage 1 and Stage 2 managed fill; 70 m from managed fill footprint	1555317	5221434
GW8-2	Groundwater level and water quality	Downgradient	Karetu silica sands	Cross / downgradient location Stage 1 and Stage 2 managed fill; 70 m from managed fill footprint	1555317	5221434
SW1 / Eco1	Surface water and Ecological Health	Upstream	N/A	Karetu River location upstream of all activities	1555540	5221795
SW2 / Eco2	Surface water and Ecological Health	Upgradient / Downstream	N/A	Karetu River location upgradient of the proposed managed fill and approximately 40 m downstream of a Sediment Retention Pond discharge point	1555334	5221572
SW3 / Eco3	Surface water and Ecological Health	Downgradient / Downstream	N/A	Karetu River location immediately after the confluence with the eastern watercourse, and immediately downstream of all activities	1555344	5221112
SW3A / Eco3a	Surface water and Ecological Health	Downgradient / Downstream	N/A	Karetu River location further downstream of all activities, approx. 400 m downstream of SW3	1555235	5220846
Eco4	Ecological Health	Downgradient / Downstream	N/A	Karetu River location further downstream of all activities, approx. 500 m downstream of SW3	1555178	5220794
SW4	Surface water	Downgradient / downstream	N/A	Karetu River location that captures potential long distance emerging groundwater flows from beneath managed fill footprint, and approx. 1 km downstream of SW3	1555060	5220415
WET	Wetland	N/A	N/A	Lower wetland that is fed by groundwater seepage (as well as overland flows)	1555465	5221194

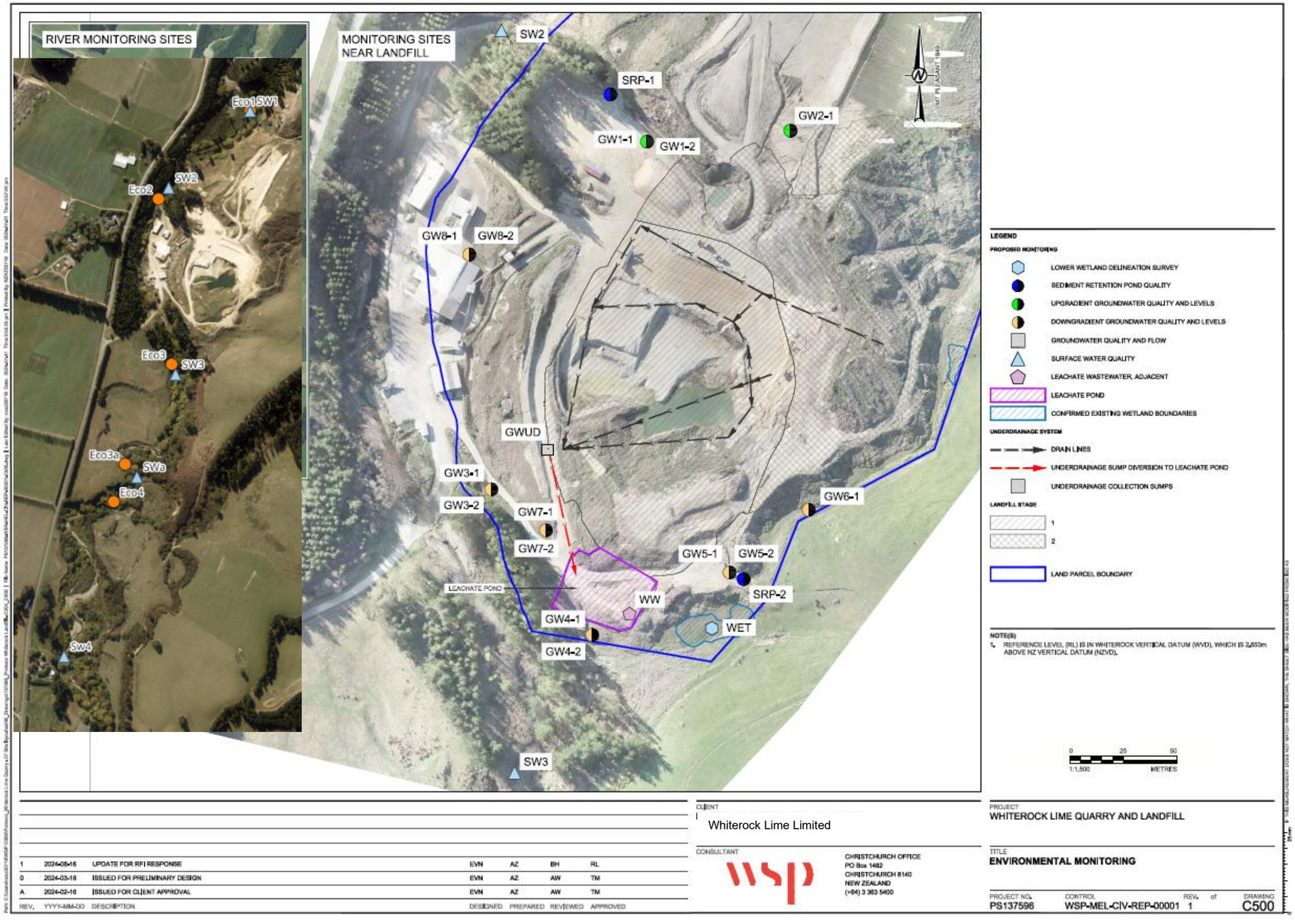


Figure A. Monitoring locations

Table D Monitoring Parameters

Leachate Leakage Indicators			**Leachate Leakage Toxicants (g/m³)**				**Stormwater Stressors Indicators and Toxicants**	**Ecological Health**	**Lower Wetland Extent**	**Cultural Health**
General	Physicochemical	Cation/Anion profiling	Nutrients	Trace Metals and Metalloids (dissolved) [2]		Organics:				
• COD (g O^2/m^3) • EC (uS/cm) • Ammoniacal N (g/m^3)	• Temperature (°C) • Dissolved oxygen (g/m^3) • pH (pH units)	• Cation/Anion profile (meq/L) • Total Alkalinity (g/m^3 as $CaCO_3$) • Total Hardness (g/m^3 as $CaCO_3$)	• Ammoniacal N • DRP • Nitrate-N • Nitrite-N • Total Nitrogen [1] • Total Phosphorus [1]	• Arsenic • Mercury • Cadmium • Chromium • Copper • Nickel • Lead	• Aluminium • Boron • Iron • Manganese • Zinc	• VOCs • SVOCs • PAHs • TPH • PFAS~~P~~	• EC (uS/cm) • Turbidity (NTU) • TSS (g/m^3) • pH (pH units) • Temperature (°C) • Any other potentially ecotoxicity contaminant associated with Water Treatment Chemical use	• Macroinvertebrate ○ MCI ○ QMCI • Fine sediment cover - sediment >2mm diameter [max cover of bed %]	Shapefile/maps depicting the exact wetland extent and total area (m^2) Attributes (from delineation) such as species present and soil types.	[TBC]

Notes:

1. Surface water quality monitoring only
2. Total analysis may be required for leachate disposal off-site by the receiving facility operator
3. PFAS analysis to be based on standard suite of 30 PFAS including PFPrS, PFBS, PFPeS, PFHxS, PFHpS, PFOS, PFNS, PFDS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFOSA, N-EtFOSA, N-MeFOSA, N-EtFOSAA, N-MeFOSAA, N-EtFOSE, N-MeFOSE, 4:2 FTS, 6:2 FTS, 8:2 FTS, and HFPO-DA.

Table E. Baseline and Standard Monitoring Programme (i.e., ongoing monitoring separate from any increase in frequencies as a result of Trigger Exceedances)

Monitoring Type	**Monitoring Frequency**	**Period (if applicable)**	**Sampling Locations**	**Parameters Measured**
Baseline				
Groundwater Quality	Monthly	For at least 6 months prior to managed filling commencing	All GW locations	All Leachate Leakage Indicators and Leachate Leakage Toxicants specifically – Nutrients, Trace Metals and Metalloids (dissolved)
	Quarterly			Leachate Leakage Toxicants specifically - Organics
Surface Water Quality – Dry Weather	Bi-monthly	For at least 12 months prior to managed filling commencing	All SW locations	All Leachate Leakage Indicators and Leachate Leakage Toxicants specifically – Nutrients, Trace Metals and Metalloids (dissolved)

Monitoring Type	Monitoring Frequency	Period (if applicable)	Sampling Locations	Parameters Measured
	Quarterly			Leachate Leakage Toxicants specifically - Organics
Ecological Health	Twice – first year	Summer months (December-March inclusive), in low flow conditions, and no less than 14-days following any major stream flow (>3-fold base flow conditions)	All Eco locations or other upstream and three downstream locations considered more suitable by a suitably qualified freshwater ecologist	Macroinvertebrate, fine sediment cover
Lower Wetland Extent	Twice – first year	Once in summer months (December-March inclusive) and once in winter months (June-August inclusive)	WET	Survey of entire perimeter of wetland
Cultural Health	TBC	TBC	TBC	TBC
Operational - Standard				
Stormwater Quality	Continuous < 5 min periods, when flow through SRP and discharge occurs Grab samples twice during wet weather events, during operational hours when Water Treatment Chemical used	From commencement of managed fill development earthworks and managed filling	SRPs	Selected Stormwater Stressor and Leachate Leakage Quality Indicators – i.e., EC, pH, temperature and TSS (low range meter (0 to 1,500 g/m^3)) For any type of contaminants associated with Water Treatment Chemical use
Leachate Quality	Monthly	From commencement of managed fill disposal	Leachate Pond	All Leachate Leakage Indicators and Leachate Leakage Toxicants specifically – Nutrients, Trace Metals and Metalloids (dissolved)
	Quarterly			Leachate Leakage Toxicants specifically - Organics
Groundwater Quality	Continuous	From commissioning of the groundwater underdrainage system, and at least one month of data capture before managed filling commences	GWUD	Selected Leachate Leakage Indicators - being EC and pH
	Quarterly	From commencement of managed fill disposal	All GW locations (including GWUD)	All Leachate Leakage Indicators and Leachate Leakage Toxicants -specifically Nutrients, Trace Metals and Metalloids (dissolved) GWUD - TSS
	Annually	From commencement of organic toxicants being detected in leachate quality		Leachate Leakage Toxicants specifically – Organics
Surface Water Quality – Dry Weather	Two dry weather events annually	Summer months (December-March inclusive), in low flow conditions, and no less than 14-days following any major stream flow (>3-fold base flow conditions)	SW1, SW2 and SW3	All Leachate Leakage Indicators and Leachate Leakage Toxicants - specifically Nutrients, Trace Metals and Metalloids (dissolved)
Surface Water Quality	Two wet weather events annually	Sampling during a rainfall event that is greater than 2 mm/hr intensity and has generated construction phase stormwater entering the Karetu River	SW1, SW2 and SW3	Stormwater Stressors Indicators and Toxicants Trace Metals and Metalloids

Monitoring Type	Monitoring Frequency	Period (if applicable)	Sampling Locations	Parameters Measured
– Wet Weather		Note: A forecast storm event of an intensity of > 2 mm/hr for a duration of > 6 hrs should be targeted in case predicted rainfall is less than forecast at time of sampling		
Ecological Health	Annually	Summer months (December-March inclusive), in low flow conditions, and no less than 14-days following any major stream flow (>3-fold base flow conditions)	SW1, SW3, SW3A and SW4, or alternative locations determined more suitable during baseline monitoring	Macroinvertebrate
	Twice annually	Once in summer months (December-March inclusive) and once in winter months (June-August inclusive)		Fine sediment cover
Lower Wetland Extent	Twice annually	Once early and once late in the growing season for wetland plants for this locality / district	WET	Survey of entire perimeter of wetland
Cultural Health	TBC	TBC	TBC	TBC

Table F. Time of Commencement of TARP Triggers

Start	Monitoring Type	Notes
Triggers apply on commencement of consent	Stormwater Quality, Surface Water Quality – Wet Weather, Fine sediment cover, Cultural Health - TBC	Stormwater - SRPs need to be operational and managed fill development works occurring
Triggers apply on completion of baseline period	Macroinvertebrate, Cultural Health - TBC	Aim is to see long-term improvements in MCI and QMCI scores over time with stormwater controls and riparian enhancement should upstream catchment and rural / forestry activities from the Quarry and Managed Fill site not be having a significant influence on ecological health
Triggers apply on commencement of managed filling	Lower Wetland Extent (starts at managed fill construction) Leachate Quality, Groundwater, Surface Water Quality - Dry Weather Cultural Health - TBC	

Table G. Triggers and Action Response Plan (TARP)

Monitoring Type and Location	Trigger Level 3 - Normal	Action	Trigger Level 2 – Reduction / Alert	List of Possible Actions and Responses (unless stated otherwise)	Trigger Level 1 – Noticeable Effect	List of Possible Actions and Responses (unless stated otherwise)
Stormwater Quality SRP1 and SRP2	SRP Outlet discharge: • EC ≤ 250 µS/cm • TSS ≤ 100 g/m^3 • pH >6.5 and <9.0 • Temperature ≤ 15°C	Continue standard monitoring programme	SRP Outlet discharge: • EC > 250 and ≤ 500 • TSS > 100 and ≤ 200 g/m^3 • pH <6.5 but ≥ 5, or >9.0 but ≤10. • Temperature > 15 and ≤ 20°C	<u>Mandatory actions:</u> TSS • If safe and practicable, measure exceedance parameters at a location in the receiving waterway upstream of the discharge point. If TSS in waterway < SRP value, check water clarity and colour downstream of discharge and compare to resource consent limits. • Also measure in-flow quality to SRP.	SRP Outlet discharge: • EC > 500 µS/cm • TSS > 200 g/m^3 • pH <5 or >10 • Temperature > 20°C	• Same as Trigger Level 2 Mandatory Actions. • Have an erosion and sediment control / WTC expert review the practices on site and ESCP (in relation to TSS, pH and temperature exceedances). • Have a suitably qualified and experienced landfill engineer review management on site (in relation to EC exceedances).

Monitoring Type and Location	Trigger Level 3 - Normal	Action	Trigger Level 2 – Reduction / Alert	List of Possible Actions and Responses (unless stated otherwise)	Trigger Level 1 – Noticeable Effect	List of Possible Actions and Responses (unless stated otherwise)
				Temperature • If safe and practicable, measure exceedance parameters at a location in the receiving water way upstream and 20 m downstream of the discharge point. If % change is greater than 2°C, take action. Possible Actions (all): • Consider use of WTCs if not already, check WTC dosing. • Consider changing WTCs type if pH is in exceedance or reduce lime ingress into runoff. • Inspect contributing catchments for erosion and possible managed fill leakage. Consider either emptying the SRP water for dust suppression or flushing SRPs with cool freshwater to reduce standing water temperatures regularly or prior to a forecasted storm event. Sampling and analysis of SRP stormwater for Leachate Leakage Toxicants – Nutrients and Metals		• Temperature: either empty the SRP by using the water for dust suppression, or flush the SRPs with cool freshwater to reduce standing water temperatures regularly or prior to a forecasted storm event.
Leachate Pond Quality Trigger levels apply to the rolling 12-month median at leachate pond monitoring point (WW)..	NH4-N and trace metals and metalloids concentrations when applying the conservative poor liner contact mass mixing scenario in the Karetu River, result in < LOD or ≤ 10% increase in their respective baseline value. [values to be calculated and added] Organics: ≤ LOD	Continue standard monitoring programme. If after 2 years there is no exceedance, reduce to bi-monthly	NH4-N and trace metals and metalloids concentrations when applying the conservative poor liner contact mass mixing scenario in the Karetu River, result in a > 10% and ≤ 25% increase in their respective baseline value. [values to be calculated and added] Organics: > LOD and ≤ 20% LOD	• Increase leachate pond monitoring frequency to weekly. • If median of 8 weekly results exceeds the trigger, consider: 1.1.1. Undertaking contaminant transport modelling. 1.1.2. Cessation of leachate recirculation practice. *1.1.3.* Reviewing WAC and proposing changes that could reduce risk to the environment.	NH4-N and trace metals and metalloids concentrations when applying the conservative poor liner contact mass mixing scenario in the Karetu River are > ANZG 2018 95% species protection concentration limit, except for aluminum, copper and chromium for which a >50% above baseline concentration applies. [values to be calculated and added] Organics: >20% of LOD	• Undertake WAC changes to reduce risk to the environment. • Have a suitably qualified and experienced landfill engineer review management on site. • Undertake contaminant transport modelling. • Cease leachate recirculation practice.
Groundwater Quality Trigger levels apply to: GWUD and GW3-1, GW3-2, GW4-1, GW4-2, GW5-1, GW5-2, GW6-1, GW7-1, GW7-2, GW8-1 and GW8-2. Note: The daily average of any continuous measurements at GWUD should be used to compare against the baseline mean. Upgradient reference monitoring at GW1-1, GW1-2 and GW2-1 will also be undertaken for comparison.	Provisional [1] • pH ≤ Baseline Mean +/- 2SD • EC ≤ Baseline Mean +2SD • NH4-N ≤ Baseline Mean +2SD • DO ≤ Baseline Mean -2SD • Trace Metals and Metalloids ≤ Baseline Mean +2SD	Continue standard monitoring programme	Provisional [1] • pH > Baseline Mean +/- 2SD and +/- trend observed • EC > Baseline Mean +2SD and increasing trend observed • NH4-N > Baseline Mean +2SD and increasing trend observed • DO ≤ Baseline Mean - 2SD and decreasing trend observed • Trace Metals and Metalloids > Baseline Mean +2SD and increasing trend observed	• Check laboratory margin of error values. • Inspect bore casings for signs of damage and/or surface contamination. • Immediately inspect the managed fill perimeter in the vicinity of the suspect well for any signs of surface flow that could have caused the contamination, such as leachate breakout. • Review leachate flow meter records for any unusual flows. • Check leachate level indicator to ensure leachate levels on liner are being maintained as low as possible. • Compare results to the leachate pond quality data from past monitoring reports to establish a correlation between past and present data. • Evaluate the spatial (including upgradient wells), and temporal nature of the exceedance and any longer term trends.	Provisional [1] • pH <6.5 or >9.0 • EC > 1,500 µS/cm (existing Baseline Mean + 7.5SD) • NH4-N > 1.15 g/m^3 (existing Baseline Mean +5SD) • Toxicants: GWUD > ANZG DGV for 95% species protection • Toxicants: GW > ANZG DGV for 95% species protection	• Undertake additional monitoring including dry weather surface water at SW1 to SW4, and macroinvertebrate monitoring to further identify the significance and wider impacts of the exceedances. • Undertake additional studies to identify the source, and undertake operational and remedial actions that may include (but are not limited to): 1.1.4. Have a suitably qualified and experienced landfill engineer review management on site. 1.1.5. Shift filling to another area of the managed fill. Place an intermediate capping of low-permeability soil over the affected area to reduce water ingress and leachate generation. 1.1.6. Install leachate abstraction wells at the affected location.

Monitoring Type and Location	Trigger Level 3 - Normal	Action	Trigger Level 2 – Reduction / Alert	List of Possible Actions and Responses (unless stated otherwise)	Trigger Level 1 – Noticeable Effect	List of Possible Actions and Responses (unless stated otherwise)
				• Undertake increased monitoring frequency. • If the exceedance is significant and/or sudden then consider additional studies to identify the source, and possible operational and remedial actions.		1.1.7. Install further bores for monitoring of groundwater downgradient of the affected area. 1.1.8. Install a cut-off trench for leachate interception. 1.1.9. Undertake contaminant transport modelling. 1.1.10. Undertake WAC changes to reduce risk to the environment. 1.1.11. If GWUD is exceeding, direct underdrainage system water to leachate pond. 1.1.12. Treat underdrainage system water before discharging to environment. 1.1.13. Install downgradient groundwater contaminant capture wells between river and managed fill, and treat abstracted water before discharge (also known as 'pump & treat' solution). 1.1.14. Remove the contaminant source(s). 1.1.15. Cease to accept some types of managed fill. *1.1.16.* Close the site.
Surface Water Quality – Dry Weather Upstream, mid-stream and downstream surface water quality monitoring: SW1, SW2 and SW3	Downstream: • pH Δ compared to upstream > 0.5 units and the downstream result is within a range of 6.5 to 9.0 • EC ≤ Upstream + 20% • NH4-N ≤ Upstream + 10% • COD ≤ Upstream + 10% • Turbidity ≤ Upstream + 10% • Trace Metals and Metalloids ≤ Upstream + 10%	Continue standard monitoring programme	Downstream: • pH Δ compared to upstream > 0.5 to ≤ 1.0 units and the downstream results are within a range of 6.5 to 9.0 • EC > Upstream +20% to ≤ Upstream +30% • NH4-N > Upstream +10% to ≤ Upstream +20% • COD > Upstream +10% to ≤ Upstream +20% • Turbidity > Upstream +10% to ≤ Upstream +20% • Trace Metals and Metalloids > Upstream +10% to ≤ Upstream +20%	• Check laboratory margin of error values. • Evaluate the temporal nature of the exceedance and any longer term trends. • Increase monitoring frequency and add parameters including Organic Toxicants. • If the exceedance is significant and/or sudden then consider additional studies to identify the source, and possible operational and remedial actions.	Downstream: • pH Δ compared to upstream > 1.0 units and the downstream results is not within a range of 6.5 to 9.0 • EC > Upstream +30% • NH4-N > Upstream +20% and downstream >0.01 g/m^3 (LWRP Table 8-5 annual median) • Turbidity > Upstream +20% • Trace Metals and Metalloids: > Upstream +20% and downstream result exceeds 25% of the ANZG DGV for 95% species protection value Note: Aluminium results in baseline data at SW2 have been observed as > ANZG 2018 DGV (pH >6.5)	• Same as Groundwater Quality Trigger 3
Surface Water Quality - Wet Weather Construction stormwater and operational stormwater: SW1 (upstream), SW2 (downstream) and SW3 (downstream)	Downstream:: • pH Δ compared to upstream > 0.5 units and the downstream result is within a range of 6.5 to 9.0	Continue standard monitoring programme	Downstream:: • pH Δ compared to upstream > 0.5 to ≤ 1.0 units and the downstream results is within a range of 6.5 to 9.0	• Check laboratory margin of error values. • Evaluate the temporal nature of the exceedance and any longer term trends. • Sample SRP dead storage water or outlet stormwater during discharges. • Increase monitoring frequency and add parameters including Organic Toxicants.	Downstream: • pH Δ compared to upstream > 1.0 units and the downstream results is not within a range of 6.5 to 9.0	• Undertake contingency measure that may include (but are not limited to): 1.1.17. Temporarily ceasing any further land disturbance activities. 1.1.18. Stabilise disturbed soils. 1.1.19. Have a suitably qualified and experienced person review ESC measures and WTC use.

Monitoring Type and Location	Trigger Level 3 - Normal	Action	Trigger Level 2 – Reduction / Alert	List of Possible Actions and Responses (unless stated otherwise)	Trigger Level 1 – Noticeable Effect	List of Possible Actions and Responses (unless stated otherwise)
	• EC ≤ Upstream + 20% • Turbidity ≤ Upstream + 20% • Trace Metals and Metalloids ≤ Upstream + 20%		• EC > Upstream +20% to ≤ Upstream +30% • Turbidity > Upstream +20% to ≤ upstream +30% • Trace Metals and Metalloids > Upstream +20% to ≤ Upstream +30%	• If the exceedance is significant and/or sudden, then consider additional studies to identify the source, and possible operational and remedial actions. • Undertake investigation of ESC and stormwater management measures and use of WTCs to identify the source, and make operational changes and undertake any remedial actions.	• EC > Upstream +30% • Turbidity > Upstream +30% • Trace Metals and Metalloids > Upstream +30% and downstream result exceeds 2x the ANZG DGV for 95% species protection value	1.1.20. Have a suitably qualified and experienced stormwater engineer review stormwater management on site. • Undertake additional monitoring frequencies and types including macroinvertebrate and sediment cover to further identify the significance and wider impacts of the exceedances. • Undertake operational and remedial actions that may include (but are not limited to): 1.1.21. Have a suitably qualified and experienced landfill engineer review management on site. *1.1.22.* Consider WAC changes to reduce risk to the environment.
Ecosystem Health (Aquatic Life) SW1, SW3, SW3A and SW4	• Fine sediment cover adjacent to site and downstream is above the upstream location, and has increased by more than 10% • Adjacent and downstream site Annual MCI and QMCI scores 20% < baseline score for same sites, unless ≥ % reduction observed in upstream site	Continue standard monitoring programme	• Fine sediment cover adjacent to site and downstream is above the upstream location and has increased by more than 15% • Adjacent and downstream site Annual MCI and QMCI scores 30% < baseline score for same sites, unless ≥ % reduction observed in upstream site	• Evaluate the spatial nature of the exceedance. • Identify the possible or likely activity on site (quarry, managed fill, or other) contributing directly or cumulatively to the reduction in scores, and make any necessary operational changes and undertake any remedial actions. • Consider increase in monitoring frequency. • Report findings to the Quarry and Managed Fill Manager.	• Fine sediment cover adjacent to site and downstream is above the upstream location, and has increased by more than 20% • Adjacent and downstream site Annual MCI and QMCI scores 40% < baseline score for same sites, unless ≥ % reduction observed in upstream site	• Undertake contingency measure that may include (but are not limited to): 1.1.23. Temporarily cease land disturbance activities. 1.1.24. Stabilise disturbed soils. 1.1.25. Have a suitably qualified and experienced ESC expert/ stormwater engineer /landfill engineer review stormwater management on site. 1.1.26. Hydrovacing / sand wand removal of any significant accumulated fine sediment under the supervision of a suitably qualified and experienced aquatic ecologist. 1.1.27. WAC changes to reduce risk to the environment. • Increase in monitoring frequency to quarterly until continual improvement of scores over a one-year period occurs.
Lower Wetland Extent Annual average of two surveys	≤ 10% reduction in extent from observed baselines smallest area	Continue standard monitoring programme	>10% to ≤ 20% reduction in extent from observed baselines smallest area	• Review GW4-1, GW5-1 and GW6-1 water level data to determine if there is a drop in measured levels that could be attributing to a reduction in the wetland extent. • Consider if an extended dry period or other climatic conditions was an influence, or whether indigenous planting uptake of water is an influence. • Consider adding or adjusting groundwater seepage flows from upslope.	> 20% reduction in extent from observed baseline's smallest area	• Review GW4-1, GW5-1 and GW6-1 water level data to determine if there is a drop in measured levels that could be attributing to a reduction in the wetland extent. Mandatory: if cause is determined to be as a result of underdrainage take /liner installation (preventing local recharge). • Increase or adjust upslope groundwater seepage flow enhancement measures.
Cultural Health	TBC	TBC	TBC	TBC	TBC	TBC

Table Notes:

1. The provisional nature of the triggers is to reduce the risk of inappropriate triggers being set that are either too lenient or too strict. The triggers are to be reviewed after more baseline monitoring data is obtained and may need to be amended.