

Oparure Quarry South-Western Pit: Karst and Riparian Management Plan

✦ Prepared for

Graymont (NZ) Ltd

✦ July 2026



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GRAYMONT (NZ) LTD - OPARURE QUARRY SOUTH-WESTERN PIT: KARST AND RIPARIAN
MANAGEMENT PLAN

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1.0 Introduction

Graymont (NZ) Ltd (Graymont) engaged Pattle Delamore Partners (PDP) to prepare a Karst and Riparian Management Plan (KRMP), in support of the Oparure Quarry South-Western Pit ('SW Pit'). The SW Pit is located west of the Oparure Quarry at Oparure Road, Te Kuiti.

The KRMP details the methodologies for restoring and enhancing areas identified in the South-Western Pit Ecological Betterment Plan ('EcoBP'), including ongoing monitoring and maintenance activities.

The information in this KRMP is based on reports from PDP (2023, 2025), Boffa Miskell (2022a; 2022b) and Ecology NZ (2022a, 2022b).

1.1 Ecological Outcome Statement

This objective of this KRMP is to enhance the ecological values of the following areas:

- ✧ **Improved Site Connectivity:** Linking existing forest remnants will reduce edge effects and create contiguous habitat, enhancing overall landscape connectivity.
- ✧ **Enhanced Habitat Structure and Diversity:** Restoring the vegetation's structure and diversity will provide valuable food and habitat resources for native birds, reptiles, and invertebrates, supporting their populations.
- ✧ **Support for Natural Regeneration:** Acting as a nurse crop, the restoration will shelter shade-tolerant species and augment natural regeneration processes.
- ✧ **Protection of Rare Ecosystems:** Special attention will be given to safeguarding identified karst and cave entrance ecosystems, ensuring their long-term health.
- ✧ **Weed Control and Soil Protection:** Preventing the establishment of weeds and enhancing soil stability will help protect the land and maintain its integrity.

As per the EcoBP, the specific restoration and enhancement measures detailed within this KRMP include:

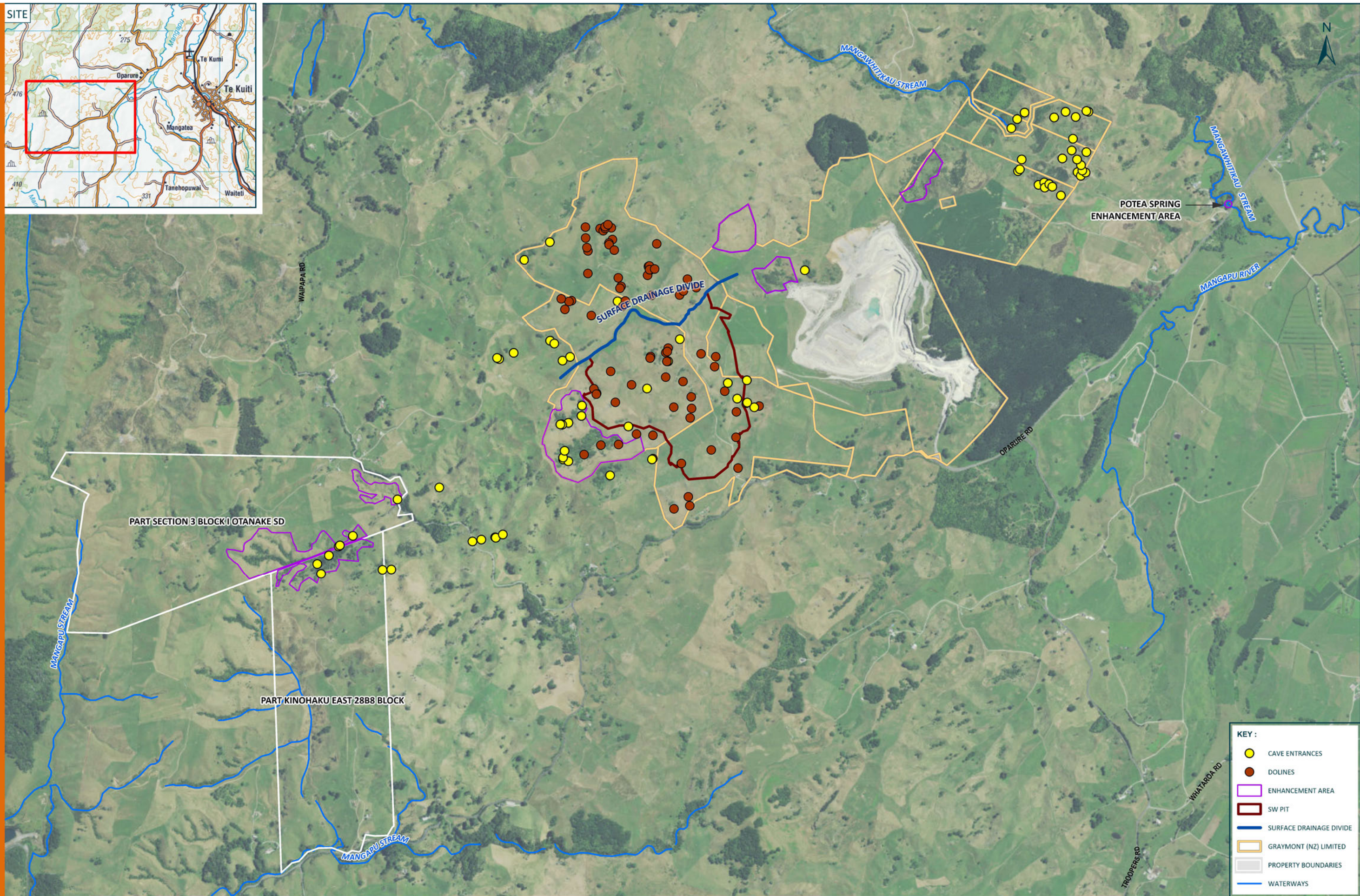
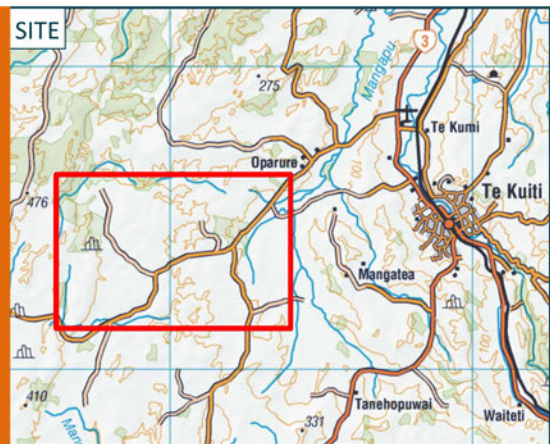
- ✧ Methods to be implemented to reduce the sediment load entering the Camelot Stream Catchment through riparian planting;
- ✧ Eco-sourced native planting that is to be undertaken and maintained by the consent holder in the riparian margins around Gate (Pōtea) Spring;

- ✧ Restoration and enhancement of two Significant Natural Areas (SNA), planting of a 2.5 ha linking area¹ which involves karst ecosystem protection and enhancement and planting and fencing of another 4.5 ha of adjoining pasture;
- ✧ Methods to be implemented to reduce the sediment load entering the Mangawhitikau Stream Catchment through planting of steep catchment slopes;
- ✧ Identification, protection, and enhancement of no less than 21 cave entrances; and,
- ✧ Protection of ecological value via fencing and pest management.

The actions for each planting zone are outlined in the respective chapters, with detailed plans and planting schedules provided for each area. In Section 7.0, the general restoration strategies are further elaborated and prescribe site preparation and planting method requirements. This section covers the steps involved in preparing the site for planting, including clearing the area, soil improvements, and ensuring proper spacing and plant selection.

The ecological betterment projects associated with the SW Pit and the detailed in the EcoBP are located in a mix of Graymont property and private landowner property. Landowner agreements are in place, as necessary. The locations of all betterment initiatives are shown in Figure 1.

¹ It is noted that 0.5 ha of lizard translocation habitat will be located within the 2.5 ha vegetated link area. Details on this can be found in the Lizard Management Plan (Tocher 2024) and summarised in section 4.1.



KEY :	
	CAVE ENTRANCES
	DOLINES
	ENHANCEMENT AREA
	SW PIT
	SURFACE DRAINAGE DIVIDE
	GRAYMONT (NZ) LIMITED
	PROPERTY BOUNDARIES
	WATERWAYS



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FIGURE

FIGURE 1: SITE OVERVIEW

PROJECT

KARST AND RIPARIAN MANAGEMENT PLAN

2.0 Upper Camelot Stream Catchment

2.1 Site Setting

Camelot Cave Stream is a subsurface watercourse that flows below the SW Pit. It surfaces at Pōtea Spring, located on the true right bank of the Mangawhitikau Stream, upstream of Oparure Road. As part of site investigations, the source of flow for this site, including the location where the stream changes from surface flow to subsurface flow, was determined. The Camelot Stream submergence site (referred to as the Upper Camelot Stream Catchment) was identified approximately 1.5 km west of the SW Pit. The area to be planted and fenced is 11.8 ha. These locations are shown in Figures 2 and 3, with the overview in Figure 1. Current land use in the Upper Camelot Stream Catchment has resulted in high potential for sediment runoff during rainfall events, which enters the stream through dolines and cave entrances.

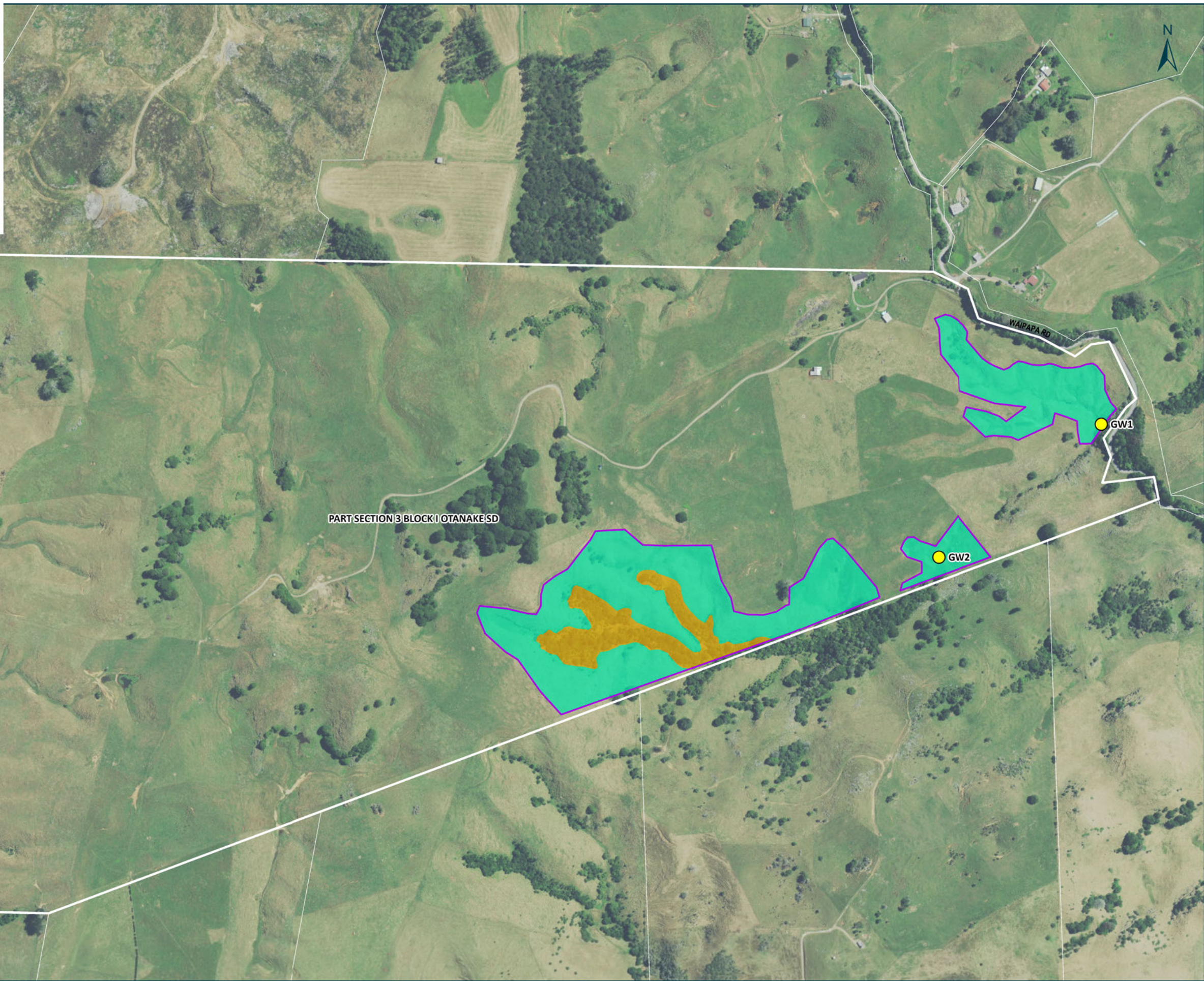
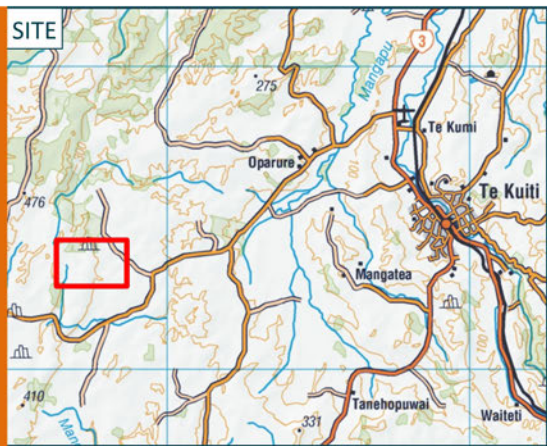
2.2 Ecological Management Actions

2.2.1 Sediment Reductions

To reduce sediment mobilisation to the Camelot Stream during rainfall events, ephemeral gullies west of Waipapa Road will be fenced and their margins restored with native planting. If after initial fencing and planting high sediment mobilisation is still occurring, steeper gullies may require sediment detention pits to be installed. This is to be determined after 3 years of monitoring. If sediment detention pits are utilised, they will require ongoing maintenance to clean accumulated sediment to function effectively during rainfall events and a further five years of monitoring shall be undertaken to assess their performance. Any detention pits shall be checked after major rainfall events, and seasonally, to determine if removal is required. Access to the sediment detention pits will be required for machinery to remove accumulated sediment.

2.2.2 Planting

Three riparian zones have been identified for enhancement, as shown in Figure 2 and Figure 3. In riparian areas, species naturally found along river terraces will be planted, focusing on those that can tolerate periodic flooding. This ensures the establishment of resilient vegetation that can thrive in fluctuating water levels, providing long-term stability. The planting will prioritise species that endure both submerged and exposed conditions, such as riparian shrubs, grasses, and trees. This selection supports the natural dynamics of the river terraces while enhancing water filtration, bank stabilisation, and habitat provision. Details on planting strategies like site preparation and required maintenance are provided in Sections 7.0 and 8.0.



KEY :	
	CAVE ENTRANCE
	PROPOSED PLANTING
	EXISTING BUSH BLOCKS
	ENHANCEMENT AREA AND PROPOSED FENCELINE
	PROPERTY BOUNDARY



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METRES
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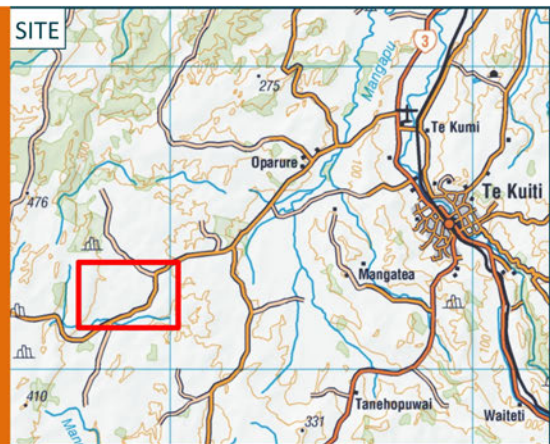
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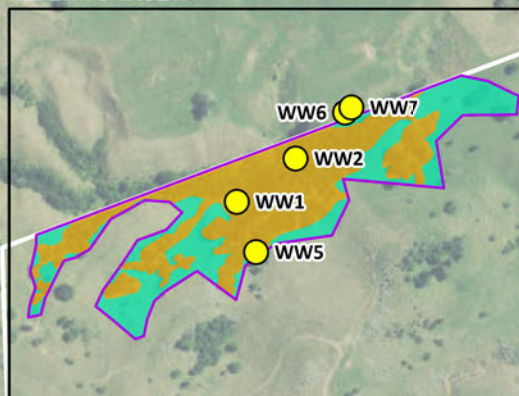


FIGURE
FIGURE 2: ENHANCEMENT AND FENCING - NORTHERN AND SOUTHERN (BALL)

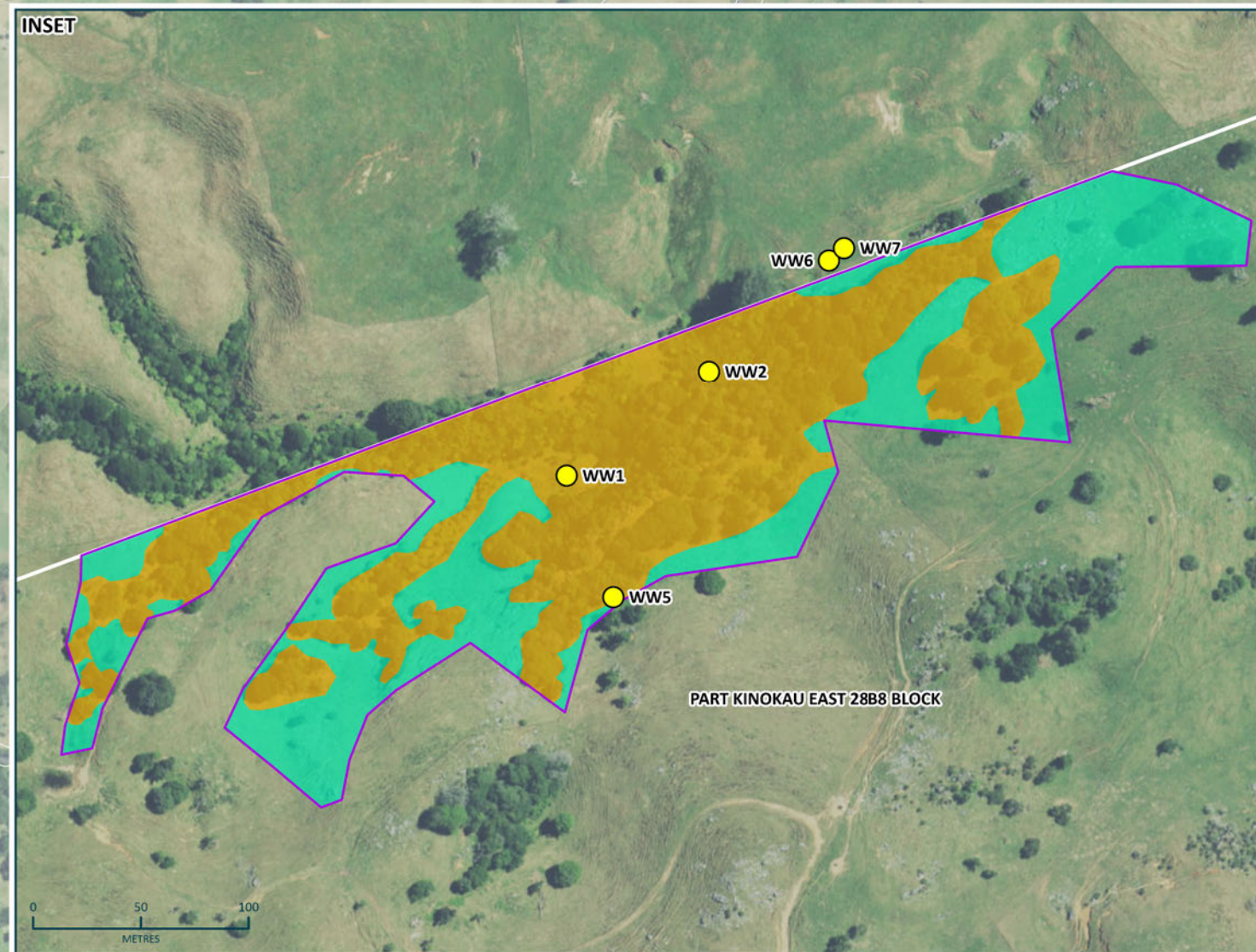
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KARST AND RIPARIAN MANAGEMENT PLAN



REFER TO INSET



INSET



KEY :	
	CAVE ENTRANCE
	EXISTING BUSH BLOCK
	PROPOSED PLANTING
	ENHANCEMENT AREA AND PROPOSED FENCELINE
	PROPERTY BOUNDARY



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FIGURE

FIGURE 3: ENHANCEMENT AND FENCING – EXTENDED (BODDIE)

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KARST AND RIPARIAN MANAGEMENT PLAN

The following planting schedules (Table 1; Table 2; Table 3) provide species, plant spacing (density), and proportion requirements. Section 7.0 provides restoration guidance and preparation strategies. Post planting maintenance is outlined in Section 8.0. The average density shall be 1.5 plant per m². Selected species will be planted with a minimum 5 m spacing between individuals of the same species while maintaining the standard 1.5 m spacing from all other species.

Table 1: Planting Schedule for Riparian Area - Northern			
Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Houhere	<i>Hoheria angustifolia</i>	1.5	5%
Kānuka	<i>Kunzea ericoides</i>	1.5	30%
Karamū	<i>Coprosma robusta</i>	1.5	10%
Kōwhai ¹	<i>Sephora tetraptera</i>	1.5	10%
Māhoe	<i>Melicytus ramiflorus</i>	1.5	5%
Makomako, wineberry	<i>Aristotelia serrata</i>	1.5	10%
Putaputawētā	<i>Carpodetus serratus</i>	1.5	5%
Tarata, lemonwood	<i>Pittosporum eugenoides</i>	1.5	5%
Tī kōuka	<i>Cordyline australis</i>	1.5	5%
Whauwhaupaku, five finger	<i>Pseudopanax arboreus</i>	1.5	10%
Notes. 1. 5 m spacing applies to individuals from the same species.			

Table 2: Planting Schedule for Riparian Area 2 (Southern and Extension)			
Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Heketara	<i>Olearia rani</i>	1.5	10%
Kānuka	<i>Kunzea ericoides</i>	1.5	10%
Mangeao ¹	<i>Litsea calicaris</i>	1.5	10%
Māpou	<i>Myrsine australis</i>	1.5	10%
Mingimingi	<i>Coprosma propinqua</i>	1.5	5%
Porokaiwhiri, pigeonwood	<i>Hedycarya arborea</i>	1.5	10%
Rangiora	<i>Brachyglottis repanda</i>	1.5	5%
Thin-leaved coprosma	<i>Coprosma areolata</i>	1.5	5%
Titoki ¹	<i>Alectryon excelsus</i>	1.5	15%
Whauwhaupaku, five finger	<i>Pseudopanax arboreus</i>	1.5	10%
Notes: 1. 5 m spacing applies to individuals from the same species.			

2.2.3 Fencing

To support successful long-term restoration outcomes, stock must be excluded from the area. Approximately 1,550 m of fencing is proposed around the Upper Camelot Stream catchment site, with installation occurring before any restoration planting begins. The fence will be a minimum 7-wire post and batten type, effectively excluding both sheep and cattle. Larger pest species such as wild goats and deer will also be excluded once the fence is in place. The alignment of the fence is depicted in Figure 2 and Figure 3. The fence will be inspected every six months while the quarry is operating or after significant weather events to maintain its integrity.

3.0 Pōtea Spring Enhancement

3.1 Site Setting

To provide ecological betterment for Pōtea Spring, the resurgence site for Camelot Stream, enhancement of the current riparian planting around the spring head will occur. The spring is located within the Mangawhitikau Stream riparian zone, which is fenced to exclude stock. Riparian vegetation is present but is predominantly exotic vegetation.

3.2 Ecological Management Actions

Enhancement planting of native vegetation suitable for spring margins (i.e., tolerant to wetted conditions) will occur within a 20 m buffer of the springhead. To avoid the adverse effects of vegetation removal, such as reduced shade and overhanging vegetation, progressive removal over a five-year period of exotic species is planned as the native vegetation establishes. The 20 m buffer is indicative, as there may be areas where the 20 m includes the Mangawhitikau Stream or Oparure Road, which are close to the spring head. The restoration area and the planting stages described below are depicted in Figure 4.

As the planting will be progressively completed over time, the following schedule has been developed. Pest plant control of the area will occur for the first 5 years as per the Pest Management Plan.

- ∴ **Year 0-1:** Clearance² of exotic understory vegetation within the spring head pond, followed by planting of suitable native species tolerant to wet soils. Retaining the exotic tree canopy will maintain shading to the waterbody and provide protection to native plantings.

² Hand clearance of vegetation is required as the area is wet and in close proximity to sensitive waterways. Herbicides may be suitable if the area is first assessed by a suitably qualified ecological restoration contractor (defined as having had a minimum of three years of relevant experience in ecological restoration)

- ∴ **Year 3:** Clearance of exotic trees from the edge of the spring head pond and understory vegetation from the wider riparian and wetland area, followed by planting of suitable native species for wet soils and riparian margins. Infill and enrichment planting of the Year 1 planting zone to be undertaken.
- ∴ **Year 5:** Clearance of exotic trees from the wider riparian and wetland area, followed by planting of suitable native species (Table 3). Infill and enrichment planting of the Year 1 and Year 3 planting zones to be undertaken.

No fencing is required at this site as the Mangawhitikau Stream corridor at this location is already excluded from stock access.

General planting strategies from Section 7.0 will be applied where appropriate³ and maintenance and monitoring for this site should be conducted in line with Section 8.0. The average density shall be 1 plant per m².

³ As determined by a suitably qualified ecological restoration contractor



KEY :

- APPROXIMATE PŌTEA SPRING LOCATION
- 0-5m
- 5-10m
- 10-20m
- TITLE BOUNDARY
- MANGAWHITIKAU STREAM



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FIGURE

FIGURE 4: PŌTEA SPRING RESTORATION

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KARST AND RIPARIAN MANAGEMENT PLAN

Suitable species for different soil saturation zones within the Pōtea restoration area are provided in Table 3 below. Species to be planted in Years 3 and 5 as enrichment or secondary species are provided in Table 4.

Table 3: Planting Schedule for Pōtea Spring			
Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Saturated soils (water at, or above, ground level)			
Harakeke	<i>Phormium tenax</i>	1	10%
Pūrei	<i>Carex virgata</i>	1	80%
Giant sedge	<i>Gahnia xanthocarpa</i>	1	5%
Tī kōuka	<i>Cordyline australis</i>	1	5%
Wet soils and lower riparian margins (temporary inundation)			
Harakeke	<i>Phormium tenax</i>	1	10%
Hukihuki	<i>Coprosma tenuicaulis</i>	1	5%
Mānuka	<i>Leptospermum scoparium</i>	1	5%
Mingimingi	<i>Coprosma propinqua</i>	1	15%
Pūrei	<i>Carex virgata</i>	1	60%
Tī kōuka	<i>Cordyline australis</i>	1	5%
Moist soils and upper riparian margins			
Kōwhai ¹	<i>Sophora microphylla</i>	1	
Māhoe	<i>Melicytus ramiflorus</i>	1	20%
Karamū	<i>Coprosma robusta</i>	1	
Mingimingi	<i>Coprosma propinqua</i>	1	15%
Hukihuki	<i>Coprosma tenuicaulis</i>	1	5%
Māpou	<i>Myrsine australis</i>	1	10%
Notes: 1. 5 m spacing applies to individuals from the same species.			

Table 4: Enrichment Planting Species for Pōtea Spring		
Common Name	Botanical Name	Zone/s
Kōwhai ¹	<i>Sophora microphylla</i>	Wet soils and lower riparian margins <i>and/or</i> Moist soils and upper riparian margins
Paratāniwhaniwha	<i>Elatostema rugosum</i>	Saturated soils
Pukatea ¹	<i>Laurelia novae-zelandiae</i>	Moist soils and upper riparian margins
Swamp maire ¹	<i>Syzygium maire</i>	Moist soils and upper riparian margins
Notes: 1. 5 m spacing applies to individuals from the same species.		

4.0 Significant Natural Area (SNA) Enhancement

4.1 Site Setting

The site features several landscape characteristics typical of a karst ecosystem, with rocky outcrops being the most prominent and widespread feature. Additional features observed include tomos, dolines, cliffs, and potential cave entrances. Most of the karst ecosystems within the SW Pit are classified as having low ecological value for terrestrial vegetation, avifauna, herpetofauna, bat habitat and cave terrestrial fauna (BlueGreen Ecology, 2026), with only Karst Landscape features being considered of 'moderate' value. Ongoing agricultural land use and vegetation clearance have reduced the ecological value of these ecosystems, leading to increased light exposure, weed invasion, desiccation, and higher temperatures at cave entrances and shafts.

4.2 Ecological Management Actions

An area identified for enhancement are the two Significant Natural Areas (SNA) to the west of the SW Pit. To improve the ecological integrity and support the restoration of karst features in this area, the two SNA areas will be connected, with an additional 2.5 ha area of native vegetation planting within karst habitat. Within the vegetated link, a 0.5 ha lizard release area will be established. An overview of the site and the location of the areas for enhancement is presented below. The specific areas for enhancement are shown in Figure 5.

4.2.1 Planting

Connecting the two SNAs with a planted corridor will foster habitat connectivity, promote species migration, and increase genetic diversity. This linkage also facilitates important ecological processes such as pollination and seed dispersal, all of which contribute to greater ecosystem resilience.

The planted corridor will enhance climate change resilience, providing species with the ability to adapt to shifting conditions, further strengthening the ecosystem's long-term stability. General planting guidance for this area is provided in Section 7.0 with a plant species list provided below in Table 5.

Effective maintenance and pest control is essential for the success of these restoration efforts (see Section 8.0). By protecting native plants from invasive species, reducing predation on wildlife, and facilitating the growth of native vegetation, pest control contributes to the broader goal of restoring ecological balance. Together, these strategies promote long-term ecological resilience and the sustainability of the restored landscape.

The species to be planted in the SNA are set out in Table 5. Planting will be undertaken by an experienced professional ecological restoration contractor who will determine the quantity of plants required. The average density shall be 1.5 plant per m². Selected species will be planted with a minimum 5 m spacing between individuals of the same species while maintaining the standard 1.5 m spacing from all other species.

Table 5: Planting Schedule for Karst Ecosystem Enhancement			
Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Māhoe	<i>Melicytus ramiflorus</i>	1.5	10%
Karamū	<i>Coprosma robusta</i>	1.5	15%
Kōhūhū	<i>Pittosporum tenuifolium</i>	1.5	10%
Putaputawētā	<i>Carpodetus serratus</i>	1.5	10%
Porokaiwhiri, pigeonwood	<i>Hedycarya arborea</i>	1.5	10%
Titoki ¹	<i>Alectryon excelsus</i>	1.5	5%
Kaikōmako	<i>Pennantia corymbosa</i>	1.5	5%
Mangeao ¹	<i>Litsea calicaris</i>	1.5	5%
Rewarewa ¹	<i>Knightia excelsa</i>	1.5	10%
Tawa ¹	<i>Beilschmiedia tawa</i>	1.5	5%
Māpou	<i>Myrsine australis</i>	1.5	5%
Notes. 1. 5 m spacing applies to individuals from the same species.			

4.2.2 Fencing

Approximately 1,000 m of fencing is to be installed around the joint SNA areas. Installation will occur prior to planting and a minimum 7-wire post and batten type, effectively excluding both sheep and cattle. Larger pest species such as wild goats and deer will also be excluded once the fence is in place.

5.0 Cave Entrances

5.1 Site Setting

The SW Pit will require the removal of seven small, short caves. Boffa Miskell (2022) recommended neighbouring caves and cave entrances close to the SW Pit, especially those with some associated native forest remnants, to be a priority for protection and enhancement.

Twenty-one small caves entrances have been identified to be restored to achieve a net positive (betterment) outcome. The offset caves are to collectively provide at least 224 m² of cave floor.

A 10 m radius around the cave entrance is to be planted with cave entrance specific species (As per Table 6). If the cave entrance is within an area with no surrounding native vegetation, further planting to achieve a 25 m radius will be required (Table 7).

5.2 Ecological Management Actions

Each cave entrance type has distinct vegetation, rock cover, and formation characteristics, requiring a tailored enhancement approach. However, the core principles for each approach are consistent:

- ✧ Fencing to exclude livestock.
- ✧ Implementing rat trapping to reduce or eliminate local rat populations (see Pest Management Plan).
- ✧ Revegetating the entrance area with specific plant species within the fenced perimeter.

To ensure recognition, the cave entrance will be located on a map, included in a schedule, and legally protected.

5.2.1 Planting

Revegetating a cave entrance prevents soil erosion, stabilises the area, and enhances biodiversity by providing habitat and food for wildlife. It protects the ecosystem by outcompeting invasive species and regulates water flow, reducing runoff and maintaining groundwater quality. Vegetation also stabilises temperature and humidity, benefiting cave-dependent species.

The species selected for planting are native to the Waikato region and commonly found at tomo and cave entrances, focusing on ferns under ongaonga (*Urtica ferox*). The following planting schedule is only for the 10 m radius around the cave entrance and not further planting in a wider radius.

The proportions and species for planting in the 10 m radius of cave entrances are listed in Table 6. If it is identified that planting is required up to 25 m radius, plants from Table 7 should be used between the 10 – 25 m radius area. The average density shall be 1 plant per m².

Table 6: Planting Schedule for Cave Entrance Enhancement (10 m radius)			
Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Common maidenhair	<i>Adiantum cunninghamii</i>	0.5 - 1	5%
Gossamer grass	<i>Anemanthele lessoniana</i>	0.5 - 1	10%
Kamu, hook grass-	<i>Carex uncinata</i>	0.5 - 1	5%
Karamū	<i>Coprosma robusta</i>	0.5 - 1	5%
Kawakawa	<i>Piper excelsa</i>	0.5 - 1	10%
Nini, lance fern	<i>Austroblechnum lanceolatum</i>	0.5 - 1	5%
Ongaonga	<i>Urtica ferox</i>	0.5 - 1	15%
Paratāniwhaniwha	<i>Elatostema rugosum</i>	0.5 - 1	10%
Rangiora	<i>Brachyglottis repanda</i>	0.5 - 1	10%
Sickle spleenwort	<i>Asplenium polyodon</i>	0.5 - 1	10%
Sweet fern	<i>Pteris macilenta</i>	0.5 - 1	5%
Toropapa	<i>Alseuosmia macrophylla</i>	0.5 - 1	10%

Table 7: Planting Schedule for Cave Entrance Enhancement (25 m radius)

Common Name	Botanical Name	Spacing (m)	Proportion of area to be occupied
Akapuka, broadleaf	<i>Griselinea lucida</i>	1	10%
Gossamer grass	<i>Anemanthele lessoniana</i>	1	5%
Harakeke	<i>Phormium tenax</i>	1	10%
Kāmahi	<i>Pterophylla racemosa</i>	1	15%
Kamu, hook grass	<i>Carex uncinata</i>	1	5%
Karamū	<i>Coprosma robusta</i>	1	10%
Kawakawa	<i>Piper excelsa</i>	1	10%
Mānuka	<i>Leptospermum scoparium</i>	1	15%
Ongaonga	<i>Utica ferox</i>	1	5%
Rangiora	<i>Brachyglottis repanda</i>	1	5%
Ti kōuka	<i>Cordyline australis</i>	1	10%

5.2.2 Fencing

Fencing will be placed surrounding all cave entrance features to protect the planting restoration as well as preventing animals from accessing the cave features. It is estimated that revegetation should occur within a 10 m radius of each feature. Depending on the location of the cave (inside other betterment areas) or natural features, full fencing may not be required. As such, fencing requirements are calculated to be between 400 – 1,600 m.

Installation will occur prior to planting and will comprise a minimum 7-wire post and batten type, to effectively exclude both sheep and cattle with less maintenance requirements. Larger pest species such as wild goats and deer will also be excluded once the fence is in place.

5.2.3 Enhancement Process for Caves

The enhancement process for cave systems should be as follows:

1. Identify and scope for each of the 21 cave entrances – ensure they are associated with sufficient cave length and floor area (minimum 224 m² cumulative).

2. Establish by survey the condition of the 10 m radius of each entrance and highlight physical works required to remove infrastructure, weed species, or rubbish etc.
3. Identify planting conditions and opportunity to determine if the entire 10 m radius requires planting in full or in part. Determine what adjacent betterment programme is also in action and merge.
4. Map out the potential zones for the plant species mixes in the cave entrance radius (see plant species list in Table 6).
5. Identify vegetation within 25 m radius to determine if additional planting is required.
6. Survey (using GPS) of the probable fence line.
7. Having accepted each entrance and enhancement area, undertake all necessary works to prepare the 10 m radius of the mouth (weed control, soil preparation, rubbish removal, etc), fence prior to planting.
8. Undertake the planting during early autumn/winter.
9. Monitor plantings (to ensure establishment and healthy condition: see Section 8.0) and conduct pest management (weed and animal) in line with the Plant and Animal Pest Management Plan (PDP, 2025b).
10. Continue monitoring and management activities for 5 years.

6.0 Mangawhitikau Stream Catchment

6.1 Site Setting

The Mangawhitikau Stream catchment, which includes the catchment of the Upper Camelot Stream and Pōtea Spring covers approximately 32.8 km² in total. The Mangawhitikau Stream flows into the Mangapu River downstream of Pōtea Spring.

The total area proposed to be fenced is 10.4 ha, and within this, 9.3 ha will be planted (excluding existing areas of bush/vegetation). These areas have been selected to target steep land (greater than 20 degrees slope) which are predominantly farmed pasture. These locations, which are all situated on Graymont-owned land, are shown in Figure 6 with an overview provided in Figure 1.

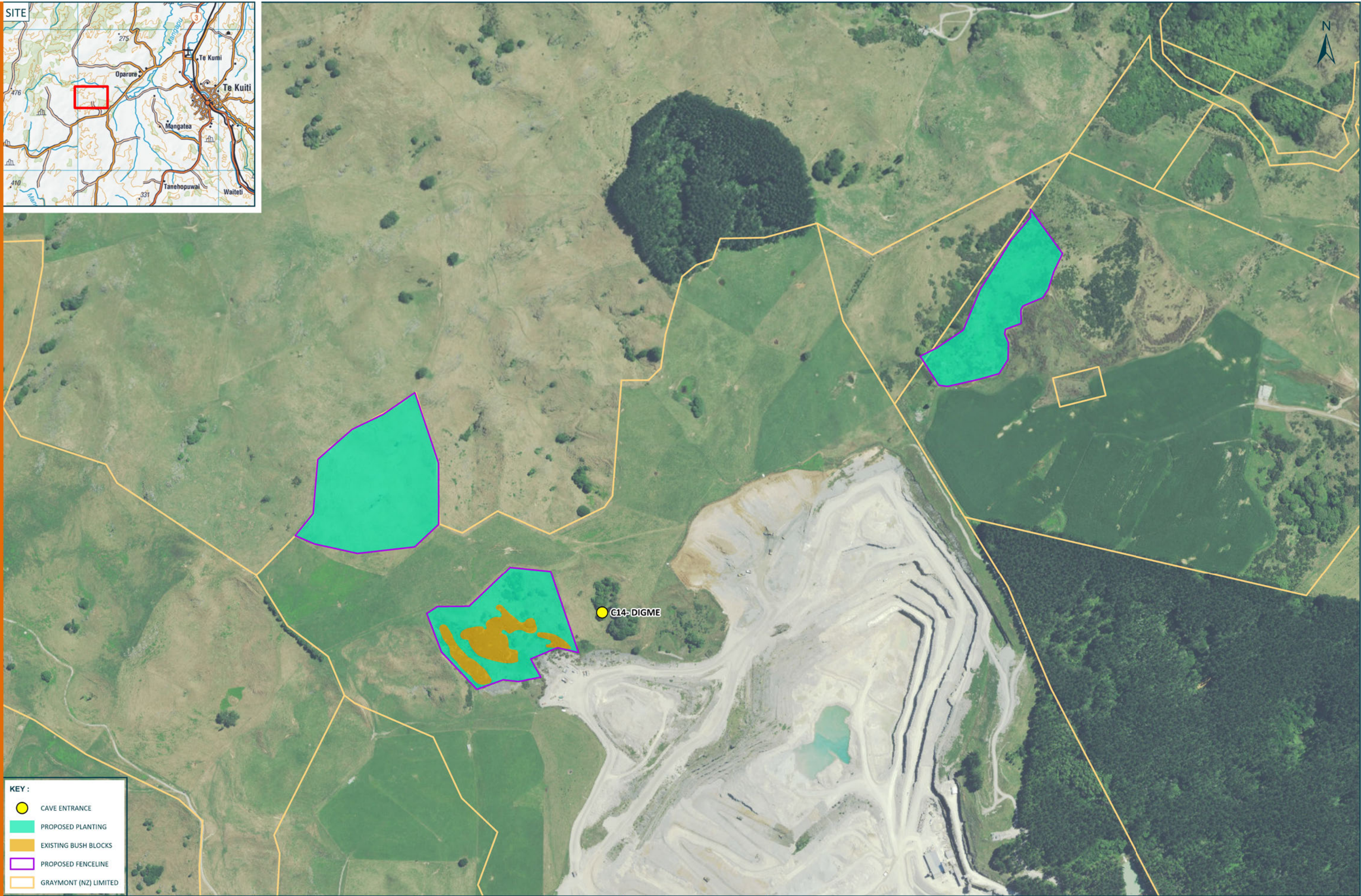
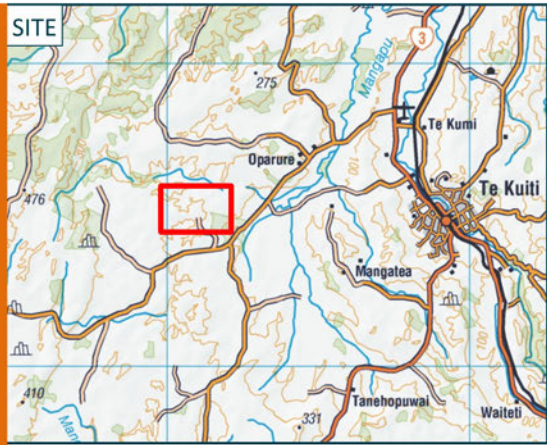
Current land use in steep areas of the Mangawhitikau Stream Catchment has resulted in high potential for sediment runoff during rainfall events, which will discharge to the Mangawhitikau Stream (and Mangapu River) predominantly via dolines and tomos and the subsurface karst system.

6.2 Ecological Management Actions

6.2.1 Sediment Reduction Planting

To reduce sediment mobilisation to the Mangawhitikau Stream during rainfall events, three areas will be fenced and planted with native species as shown in Figure 6.

The planting layout and species compositions shall be in accordance with those specified for the Upper Camelot Stream catchment restoration (southern area; see Section 2.0, Table 2). Details on planting strategies such as site preparation and required maintenance are provided in Sections 7.0 and 8.0.



KEY :	
	CAVE ENTRANCE
	PROPOSED PLANTING
	EXISTING BUSH BLOCKS
	PROPOSED FENCELINE
	GRAYMONT (NZ) LIMITED



0 100 200
METRES
SCALE : 1:6,000 (A3)

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FIGURE
FIGURE 6: MANGAWHITIKAU STREAM CATCHMENT PLANTING

PROJECT
KARST AND RIPARIAN MANAGEMENT PLAN

7.0 Restoration Area Preparation and Planting Strategies

The following sections outline the key principles for planting the betterment areas associated with the upper Camelot Stream catchment, Pōtea Spring, the SNA areas and interlinking parcel, and the cave entrances. These guidelines support the successful establishment and long-term sustainability of restored habitats, promoting biodiversity, soil health, and resilience in the landscape.

7.1 Site Preparation

Site preparation for native planting requires areas to be cleared of all pest plants (weeds and shrubs). Allow mature exotic trees (e.g., poplar, alder, willow, holly, pine, cherry, macrocarpa) to remain for two years after planting to avoid erosion and to provide interim protection to establishing native species. These will be poisoned once plants establish. A list of pest plant species (not exhaustive) and the control methods are provided in the Plant and Animal Pest Management Plan (PDP, 2025b).

Areas adjacent to water sources (springs or streams) should be hand cleared unless assessed and undertaken by a suitably qualified ecological restoration contractor.

If the pasture has been ungrazed for a long period, spot-spray with herbicide to make space for planting within long grass. Non-invasive grasses can be left to provide a living mulch that protects new plants from drought, frost, and wind.

Ensure the gap between weed clearance and planting is less than a month to prevent weeds to re-establishing.

Place salvaged logs, branches, and boulders throughout the planting area to enhance texture and physical diversity, which supports native fauna and the recruitment of native flora species from the surrounding landscape.

7.2 Plant Sourcing

Eco-sourced plants will be sourced primarily from local contractors and nurseries within the Otorohanga/Waitomo Ecological District. These plants are better suited to local conditions, which improves their survival and helps protect the region's genetic diversity.

Eco-sourced plants are crucial for ensuring that the vegetation is well-adapted to local conditions. This promotes successful establishment and helps maintain a representative ecosystem. Only pure stock will be used, with no hybrids permitted.

The procurement process requires at least 18 months of lead time for seed sourcing and plant propagation. While some nurseries may already have stock available, not all species or necessary quantities may be in stock, so planning ahead is essential.

For Myrtaceae species, nurseries must provide a signed Myrtle Rust Nursery Management Declaration, confirming compliance with the New Zealand Plant Producers Incorporated Myrtle Rust Protocol, before the plants can be delivered.

7.3 Plant Condition and Size

All plant material must be healthy, vigorous, and free from pests and diseases. Plants will be hardened off and acclimatised to the site before delivery, and they must meet the specified size and container requirements.

Upon delivery, plants will be inspected for quality, including visual checks of foliage and roots. At least 10 plants will be lifted by the stem to ensure their root systems are well-developed and properly supported.

Trees and shrubs are to be supplied in 1 L to 1.5 L containers (Planting Bag [PB] 3 or larger). This is to ensure plants have a large root to shoot ratio, allowing them to establish quickly, increase survival rates (when combined with appropriate planting techniques), and minimise maintenance requirements. Plants of this size will also be more resilient to adverse conditions. Plant sizes will vary with plant form however, and grasses/sedges and ferns can be planted at smaller grades (e.g., 0.5 – 1 L containers).

7.4 Plant Layout and Spacing

The layouts for each restoration area are provided in the relevant chapters above which suggested planting proportions and spacing densities for each species. The goal is to achieve an 80% canopy cover quickly, a standard for successful revegetation, as it indicates the plants are self-sustaining and resistant to weed invasions. Achieving this cover depends on initial planting density, species selection, and post-planting maintenance. A denser planting (e.g., 1 plant per square meter) can reach 80% cover in 3-4 years with proper care will be used for the enhancement sites.

To promote plant survival and establishment, plants should be grouped in clusters of one or more species, avoiding large areas of open ground. Clusters mimic natural seed dispersal and prevent large monocultures or unnatural separation of species. The overall plant layout should appear random, reflecting natural regeneration rather than organised grids or rows.

7.5 Planting Techniques

Planting will be carried out or supervised by a qualified ecological restoration contractor. The contractor will assess the required quantity of plants against the planting area and make necessary adjustments to ensure proper placement and number of species in suitable locations.

Planting techniques to increase success of restoration efforts include:

- ✧ Plants should be placed with their main stems vertical and at a depth such that, when the soil is firmed down, it aligns with the earth marks on the stem from the container's soil level.
- ✧ Any loose roots must be spread out naturally, with soil carefully placed underneath and among them to fill voids and firmed in.
- ✧ Holes should be dug to a minimum of twice the size of the plant container, with the soil in the base of the hole loosened with the tines of a garden fork or a similar tool to allow for better root penetration and drainage. The sides of the hole should also be roughened to remove any surface glazing.
- ✧ If post hole borers or other motorised equipment is used to dig holes, the walls and base of each hole need to be roughened/loosened as above.
- ✧ Container-grown plants must not have their containers removed until immediately before planting. The roots at the base of the root mass should be slightly loosened to encourage outward growth once planted, rather than remaining in a tight ball. Any major roots that are accidentally broken or frayed should be cleanly cut.
- ✧ Plants must be pressed or heeled in firmly to minimise air pockets around the root system.
- ✧ Water in new plantings on dry sites and stake to locate them more easily during release maintenance and inspections.

All woody species shall be planted with a combi-guard cell. Combi-guards allow smaller grades to be planted with a higher survival rate. Thus, allowing a dense canopy to form quickly, suppressing weed species. Establishment and survival rates are increased by using combi-guards by acting as a mulch mat preventing browse from rabbits and hares, preventing spray damage, frost damage, and the sleeve which the plant sits within also creates a humid environment conducive to plant growth.

7.6 Timing of Planting

Planting of drier areas (e.g., Upper Camelot, SNA area, and cave entrances) will occur in autumn and winter (May to September) to take advantage of rainfall, which helps root establishment. Planting of Pōtea Spring can occur in summer months during low flows, to allow plants to establish before experiencing water level fluctuations or flooding during winter months. Riparian areas are best planted between late October and early November, allowing plants to receive adequate water while avoiding frosts and becoming established before dry summers and autumn storms. If any areas are damaged by unexpected weather events soon after planting, they will need to be replanted.

Initial planting can be completed in Year 1, as no intensive pre-planting weed control is required. A post-planting weed maintenance plan will follow to ensure successful establishment, with infill planting in subsequent years to replace any plants that did not survive. By Year 3, enrichment planting will be undertaken to enhance biodiversity and improve ecological function (see the restoration timeline in Appendix A).

Infill planting to replace any lost vegetation should be carried out in Years 2 and 3 to maintain continuous canopy coverage (see Section 8.1). Species should be replaced on a one-to-one basis.

8.0 Post Planting Maintenance and Monitoring

Post-planting maintenance is essential for ensuring the successful establishment and growth of restored areas. It involves ongoing care to support plant health, address challenges like pests and weeds, and promote long-term ecological integrity. Proper maintenance supports the sustainability of the restoration effort.

The following sections describe the required maintenance. A schedule of maintenance is provided in Appendix A.

8.1 Plant Survival

Plant survival is essential for restoration, as it helps re-establish ecosystem functions and biodiversity. Thriving plants stabilise soil, enhance water retention, and support wildlife. Monitoring plant survival allows for the replacement of unsuccessful species and provides insights into which species may be struggling due to environmental factors or competition. This information enables adjustments to planting strategies and site conditions, ensuring the restoration project remains on track and adaptable to changing ecological needs. Appendix D provides a template of the form that is to be filled out to check survival rates. This should be completed once a year prior to infill or enhancement planting.

An annual report will be prepared by a qualified ecological restoration contractor which outlines the monitoring conducted (as per Appendix C) and Plant survival as per Appendix D with recommendations. The reports shall be provided to Waikato Regional Council, Waikato District Council, and Tāngata Whenua.

This plan shall be reviewed every two years to allow for improvements in enhancement and management of challenges encountered.

8.2 Drought Conditions

Should drought conditions occur during any of the first three summers following planting (depending on the planting area), elevated plant mortality is likely.

Plant health should be assessed using the Plant Survival Monitoring document provided in Appendix D.

To minimise plant losses and reduce the need for larger scale infill planting in subsequent years, a watering plan will be developed to support plant establishment over summer for a minimum of 3 years. Given that many planting areas are in hilly, rural terrain, existing stock water supply infrastructure may be able to provide a practical water source for this purpose. If this is not possible, an alternative solution will be sought that is both practical and cost-effective.

8.3 Weed Control

A five-year weed control programme will be undertaken at the planting sites to allow for successful establishment of native plants. Weed inspections and monitoring will be undertaken once every three months in Years 1 and 2, with a focus before and after Christmas as weeds grow faster over the summer months. Weed control will be initiated if weeds are identified.

Quarterly weed inspections and monitoring will be required for the first three years to prevent weed species and long exotic grasses from smothering new plantings. After year three, the weed monitoring can be reduced to twice a year unless there has been a pattern of high plant failure due to weed incursion and/or weeds look to be out competing plantings. Weed monitoring will be continued up to 5 years to allow native plants to establish.

8.4 Animal Pest Management

A five-year animal pest management plan will be undertaken across the entire site. Refer to the Plant and Animal Pest Management Plan (PDP, 2025b) for further information regarding the methodology around animal pest management. The PMP provides the required animal pest management to support the establishment of new plantings and areas requiring protection.

9.0 Conclusion

The enhancement and protection of ecological features through thoughtful planting are key to restoring and maintaining healthy ecosystems. This plan outlines strategies to for site preparation, planting, monitoring, and maintenance of enhancement areas. These efforts not only improve the quality of the landscape but also support and promote the long-term sustainability of vital ecosystems for future generations.

10.0 References

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Table A-1: Restoration Timeline and Monitoring Schedule												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Year 0										Pest Management installation	Pre works: Lizard, avifauna and bat management if applicable	
Year 1		Initial weed Control						Weed Control			Weed Control	
		Site Preparation			Initial Planting							
	Fence Construction										Check Fences	
Year 2					Infill Planting							
		Weed Control			Weed Control			Weed Control			Weed Control	
											Check Fences	
Year 3					Infill Planting							
		Weed Control			Weed Control			Weed Control			Weed Control	
											Check Fences	
Year 4		Weed Control									Weed Control	
											Check Fences	
Year 5		Weed Control									Weed Control	
											Check Fences	

Appendix B: Planting Preparation Checklist

Table B-1: Summary of key planting preparation actions	
Action Requirements	Notes
☐ Clear Pest Plants Refer to the Pest Management Plan for specific pest plant species and control methods. Ensure all weeds and shrubs are removed from the planting areas.	
☐ Leave Mature Exotic Trees for 2 Years - Retain mature exotic trees (e.g., poplar, alder, willow) for two years after planting to provide interim protection. - After 2 years, these trees should be poisoned to prevent erosion.	
☐ Spot-Spray Ungrazed Pasture (If Applicable) - If the pasture has been ungrazed for a long period, use herbicide to clear long grass in preparation for planting. - Non-invasive grasses can remain as a living mulch to protect new plants from drought, frost, and wind.	
☐ Loosen Compacted Soil In areas compacted by livestock or vehicles, loosen the soil (e.g., by ripping) to improve water retention and nutrient exchange, which is especially important for deep-rooted species.	
☐ Leave Soil Surface Rough After loosening, avoid grading the soil surface. Leave it rough to create microclimates that support diverse plant growth.	
☐ Add Physical Texture Place salvaged logs, branches, and rocks throughout the site to enhance texture and create habitat diversity.	
☐ Do Not Use Fertilizer Avoid adding fertilizer or topsoil, as the existing soil already contains sufficient nutrients.	
☐ Apply Mulch (at Least 20cm Deep) Apply a thick layer of mulch (minimum 20cm) where the slope allows. This will help retain moisture, reduce weed growth, and provide organic material for soil microbes.	
☐ Use Matting on Steep or Un-Stabilised Areas For steep gradients or un-stabilised areas, use matting (e.g., coconut matting) to prevent soil erosion and provide stabilization.	
☐ Check Plant Quality and Size - Ensure plants are in good condition before planting. - Tree and shrub plant sizes should be 1 – 2L, while sedges, grasses, and ferns should be 0.5 – 1L in size.	

Table C-1: Monitoring Checklist				
Item	Action Requirements	Checked?	Follow Up Required	Notes
Fence Condition	1. Conduct perimeter fence walk. 2. If fence is unsound, organise repair.	☐ ☐	☐	
Weed presence	1. Conduct full site walk over. 2. Identify and record any new weeds and the species name (if known). Photos can be taken to record these. 3. Manually remove new weed incursions. 4. If long grasses are smothering new plants, hand release a 30 cm circle around the plant. 5. If weed cannot be removed manually consider herbicides follow best practice methods. 6. Dispose any weed waste in situ.	☐ ☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐ ☐	
Plant Survival	1. Conduct full site walk over. 2. Record species and number plant mortalities, these will need to be replaced the following planting season. Photos can be taken to provide record. 3. Take notes if any areas or species have higher failure rates.	☐ ☐ ☐	☐ ☐ ☐	

[illegible]