



E6:9 Net Gain Delivery Plan: Planting Plan

Drury Quarry – Sutton Block



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For: Stevenson Aggregates Limited

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Document Guide

As part of the Sutton Block pit expansion, a full suite of ecology assessments, reports and plans have been developed. A summary of each document, including its objectives and key findings are provided in this section. This table is provided at the start of each ecology document with the relevant document highlighted to improve navigation. This document is 6 of a series of 9 ecology documents (E6:9).

Table 1. Documents prepared as part of this project

Document name (abbreviated name)	Aspects covered
E1:9 Ecology Documents Guide and Summary	Summary of the whole project and guidance for navigating documents.
Ecological Impact and Management	
E2:9 Ecological Impact Assessment (EcIA)	Assessment of ecological values and impacts of the proposed Sutton Block on terrestrial and freshwater ecosystems, including regenerating and mature forest fragments, water courses and wetlands. Fauna values include common native invertebrates and birds, At Risk pipit, copper skinks, longfin eel and (potentially) threatened long-tailed bats. Recommendations are provided for avoiding, managing, offsetting and compensating for significant residual adverse effects.
E3:9 Ecological Management Plan (EMP)	Management of ecological impacts in accordance with the effects management hierarchy, prior to and during and following construction. Specific impacts and values addressed in this Plan include: a) Management of Vegetation Removal b) Avifauna Management Plan c) Long-Tailed Bats Management Plan d) Native Lizard Management Plan e) Edge Effects Management Plan f) Native Freshwater Fauna Management Plan g) Sutton Block Riparian Planting Plan
Residual Effects Analysis Reports (REAR)	
E4:9 REAR: Terrestrial Ecology (REAR-TE)	Residual effects on terrestrial ecosystems and fauna
E5:9 REAR: Stream and Wetland Loss (REAR-SW)	Residual effects on freshwater ecosystems
Net Gain Delivery Plans (NGDP)	
E6:9 NGDP: Planting Plan (NGDP:PP)	Terrestrial offset planting
E7:9 NGDP: Pest and Weed Control (NGDP:PWC)	Terrestrial offset pest and weed control
E8:9 NGDP: Wetland Planting (NGDP:WP)	Freshwater offset planting of wetlands.
E9:9 NGDP: Riparian Planting (NGDP:RP)	Freshwater offset planting of streams.

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List of acronyms and abbreviations

Abbreviation/Acronym	Explanation
AEE	Assessment of Ecological Effects
AUP	Auckland Unitary Plan
BBOP	Business and Biodiversity Offsets Programme
BCM	Biodiversity Compensation Model
BOAM	Biodiversity Offset Accounting Model
ED	Ecological District
ha	Hectares
EclA	Ecological Impact Assessment
NGDP:PP	Net Gain Delivery Plan: Planting Plan
NGDP:PWC	Net Gain Delivery Plan: Pest and Weed Control
NVS	National Vegetation Survey
REAR-TE	Residual Effects Analysis Report – Terrestrial Ecology
REAR-SW	Residual Effects Analysis Report – Stream and Wetland Loss
SAL	Stevenson Aggregates Limited
SEA	Significant Ecological Area
Spp	Species
SPQZ	Special Purpose Quarry Zone
VS2	Kānuka scrub/forest ¹
WF7.2	Puriri forest on boulder substrate
WF9	Taraire, tawa, podocarp forest

¹ As described in Singers et al (2017).

EXECUTIVE SUMMARY

This Plan follows on from the Residual Effects Analysis Report – Terrestrial Ecology (REAR-TE)

The Sutton Pit Project will result in the loss of 16.65ha of native vegetation over the 50+ year life of the quarry pit. Native ecosystems to be lost include Taraire tawa podocarp forest (WF9), Rock Forest (a variant of WF7 Pūriri forest) and Kānuka scrub/forest (VS2). Biodiversity offset accounting modelling (BOAM) to counteract the loss of these native habitats is described in the BOCP and requires the replanting of equivalent (“like for like”) forest types.

The Net Gain Delivery Plan: Planting Plan (NGDP:PP) or “Sutton Block Planting Plan” sets out the rationale for the revegetation of 62.32ha of Taraire tawa podocarp forest (WF9), rock forest (WF7.2) and kānuka scrub/forest (VS2) as part of the proposed biodiversity offset for the Sutton Pit Project.

The proposed offset planting actions follow the accepted principles for biodiversity offsetting in New Zealand according to the published literature.

Offset planting will occur predominantly at the Stevenson Aggregates Ltd (SAL) Drury Quarry site in areas outside the Special Purpose Quarry Zone (SPQZ). The planting at the SAL site will connect to the culturally and ecologically significant Kaarearea Paa site and to another large area of SEA (SEA_T_5323).

The Sutton Block Planting Plan sets out the site-specific revegetation plans to achieve the quantum and type of planting required to provide the modelled biodiversity offset for loss of native vegetation within the Sutton Block project area.

The offset planting will deliver the modelled net gain through a two-phase planting programme that aims to establish areas of young forest with the key species composition and diversity found in the ecosystems being lost. Ongoing management and monitoring will occur over 20 – 30 years to ensure the projected biodiversity goals are achieved.

1. OVERVIEW

1.1 Project description

Stevenson Aggregates Limited (SAL) Drury Quarry is located in Drury, within the Auckland Region, and has been in operation for over 80 years. Drury Quarry is a greywacke hard rock quarry supplying concrete, asphalt and roading aggregate to the Auckland market. The Drury Quarry is located within the wider landholdings owned by SAL which encompasses an area of approximately 562ha. This landholding includes quarry activities, a clean fill, farmland and large swathes of native vegetation.

The Sutton Pit will generally be developed in the following five stages as shown in Figure 1. These are:

- Stage 1 – Infrastructure establishment (three-year plan)
- Stage 2 -Operating Quarry (15- year plan)
- Stage 3 – Operating Quarry (30-year plan)
- Stage 4– Operating Quarry (40-year plan)
- Stage 5- Life of Quarry Plan (50-year plan)

1.2 Purpose of this Plan

The Residual Effects Analysis Report – Terrestrial Ecology (REAR-TE) details the outcomes of biodiversity offset accounting models (BOAM) for loss of terrestrial native habitats within the footprint of the Sutton Pit Project.

The outputs of these models are designed to counterbalance the residual adverse effects that are anticipated as a result of the Project and are expected to result in an overall net gain in ecological values at the offset sites. The model outputs include both native restoration planting and enhancement of existing areas of degraded native forest.

The purpose of this NGDP:PP is to set out the site-specific revegetation plans to achieve the quantum and type of planting required to provide the modelled biodiversity offset for loss of native vegetation within the Sutton Block project area.

For completeness, it should be read in conjunction with the EclA, the REAR-TE and the Net Gain Delivery Plan: Pest and Weed Control (NGDP:PWC).

Freshwater and wetland management and offsetting is addressed in a separate report, the Residual Effects Analysis Report – Stream and Wetland Loss (Bioresearches 2025)

The offset planting will deliver the modelled net gain through a two-phase planting programme that aims to establish a young forest with the key species composition and diversity found in the ecosystems being lost. The plan includes methods for pest and weed control and long-term maintenance of the planting areas.

Ongoing management and monitoring will occur over 20 – 30 years to ensure the projected biodiversity goals are achieved.

Individual mature native trees that occur as isolated specimens or small groups across the site have also been accounted for as part of the BOAM. They will be offset through replacement planting at suitable sites as set out in this report.

1.3 Loss of terrestrial vegetation

In total, 16.78 ha of indigenous terrestrial vegetation and fauna habitat and 130 individual native trees would be removed to accommodate the new pit and associated infrastructure (Drury Quarry EclA, Bioresearches and JS Ecology 2025). Table 1 presents the ecological values and quantum of each vegetation type to be removed from the Sutton project area.

Table 1 Vegetation types to be lost from the Sutton Block project area and their assessed ecological values.

Habitat	Ecological value	Area of removal (ha)	Level of Effect	Conservation management action	Level of effect after management action
Rock forest (RF)	High	0.65	Very high	Biodiversity Offset	Net Gain
Taraire tawa podocarp forest (WF9)	Moderate	7.33	Moderate	Biodiversity Offset	Net Gain
Kānuka forest (VS2)	Moderate	8.67	Moderate	Biodiversity Offset	Net Gain
Relict native trees amongst pasture	Low	130 individual trees	Very Low	Replacement planting	Net gain
Exotic forest	Negligible	2.79	Very Low	Fauna Management	Very Low
Exotic scrub	Negligible	2.47	Very Low	Fauna Management	Very Low
Exotic grassland		83.5	Very Low	Fauna Management Plans	Very Low

1.4 Offset Modelling

1.4.1 Model outputs

Detailed investigations of the ecological values to be impacted in the Sutton Block Project area have been undertaken using a variety of accepted ecological assessment methods. Modelling of this data using the Biodiversity Offset Accounting Model (BOAM) (Maseyk et al 2016) showed that some 62.32ha of revegetation and 108.35ha of enhancement is required to offset the loss of these ecosystems and habitats (Table 2). Taraire tawa podocarp Forest 2, 3 & 4 will be planted at least 10 years in advance of vegetation loss and this has been accounted for in the model.

The model accounts for the time lag required to re-establish native vegetation of the same ecological value/maturity to that being lost by factoring in:

1. The amount of habitat being lost (ha) and
2. Its ecological values

Table 2 *Biodiversity Offset Accounting Model (BOAM outputs for required revegetation of each ecosystem type.*

Ecosystem type	Loss (ha)	Timing of removal	Revegetation	Time of offset Planting	
				Phase 1	Phase 2 enrichment
Rock Forest	0.65	0-5	8.32	Year 2 -3	Years 5 – 9
Broadleaved Podocarp Forest 1 (WF9 1 & 5)	1.98	0-5	12	Years 1-5	Years 4 - 8
Broadleaved Podocarp Forest 2, 3 & 4 (WF9 2, 3 & 4)	5.46	>30	20	Years –6-9	Years 9 - 13
Kānuka Forest (VS2)	8.79	>30	22	Years 10- 16	None
Relict native trees amongst pasture	130 individual native trees	1 - 50	887 young trees planted	Year 1 - 10,	none
Total	16.65		62.32	62.32	40.32

1.4.2 Description of revegetation actions

Figure 2 shows the location of all revegetation planting and forest enhancement actions for the Sutton Project and how these will connect to each other and to existing areas of indigenous vegetation (SEA_T_5349 Kaarearea Paa) and existing consented indigenous revegetation planting and covenants for other projects.

The proposed ecological restoration planting will provide enhanced ecological connectivity across the site. The very high value Ballard's Cone / Kaarearea Paa) Rock Forest will be connected with the 108 ha of enhancement forest to the east through the proposed restoration planting.

Biodiversity offset actions within land adjacent to Macwhinney Reserve on the slopes above Macwhinney Drive will remove a biodiversity threat posed by pest plants and fulfil community aspirations for the restoration of this area. It also connects to existing restoration planting and forest on the western side of the Sutton Pit, strengthening ecological connections to the south and to SEA_T_5323 on the northern side of the pit.

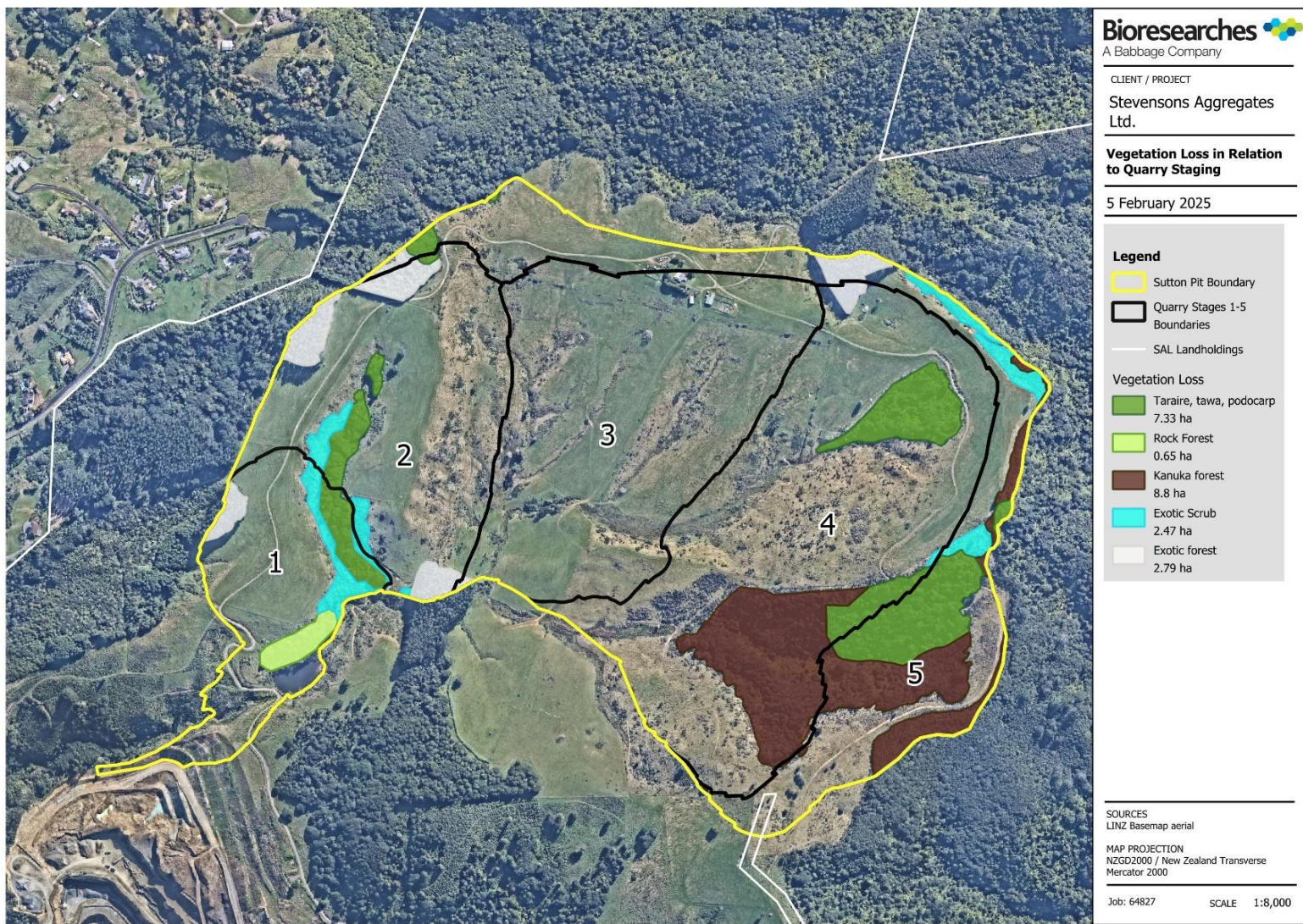


Figure 1 **Quarry staging and vegetation loss for the Sutton Pit Project**

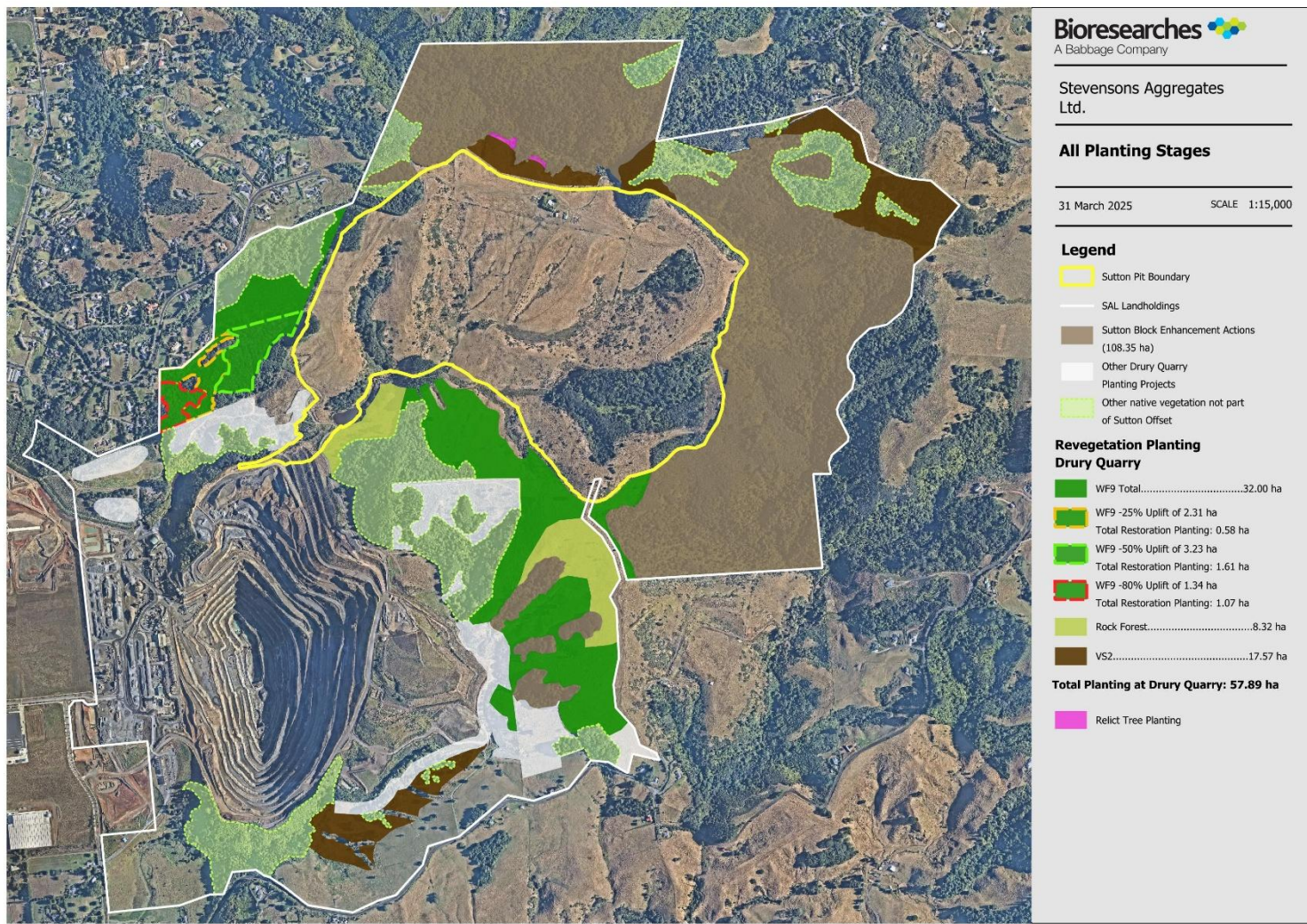


Figure 2 Restoration planting and enhancement plan for the Sutton Project within Drury Quarry, showing the ecological connectivity between areas.

2 ECOLOGICAL OFFSET PLANTING PLAN

2.2.1 Revegetation

Revegetation aims to replace what is lost. These values will, however, take decades to achieve similar maturity to those lost, and are therefore long-term benefits. The BOAM accounts for this lag, and therefore larger areas are planted and protected to achieve an overall modelled biodiversity Net Gain within a 30-year timeframe.

Table 3 Biodiversity attributes to be offset through revegetation

Biodiversity Component	Biodiversity attributes
Vegetation Structure	Indigenous Canopy % cover
	Indigenous Subcanopy % cover
	Indigenous Understorey % cover
	Indigenous Groundcover % cover
Vegetation diversity and volume	Total vascular species richness
	Groundcover species richness
	Canopy species basal area
	Mean canopy height
Fauna habitat resources	Log fall
	Leaf litter depth
	Winter fruit diversity (trees and shrubs)
	Winter nectar-bearing flower diversity (trees and shrubs)

Revegetation targets the immediate landscape where biodiversity benefits will include:

- Buffering and connection of isolated rock forest fragments and areas of taraire tawa podocarp forest;
- Restoration of weed dominant components of SAL land adjacent to MacWhinney Reserve;
- Conversion of a pine plantation on land adjacent to MacWhinney Reserve to native forest;
- Planting around Ballard's Cone / Kaarearea Paa to buffer and reconnect this high value tract of forest;
- Planting along the edge of SEA_T_5323 to the north of the Sutton Pit, which will provide additional buffering to the Waihoehoe Stream.

All areas of revegetation will also be subject to pest animal and weed control.

2.2.2 Location of revegetation planting

The offset planting locations (Figure 3) were selected according to the following considerations:

- Within the SAL site where possible.
- Suitable substrates and habitats (e.g. boulderfield);
- Where possible, adjacent to existing areas of the same vegetation type;
- Provision of enhanced ecological connectivity between areas of indigenous vegetation;
- Consideration of mana whenua and community aspirations;

- Native revegetation of degraded, weed-infested areas.

This framework helps to ensure the principles of biodiversity offsetting are adhered to and to assure a like-for-like offset design, that provides net biodiversity gains compared to the losses occurring at the project site. A full analysis of how the proposed biodiversity offset planting and enhancement complies with the principles of biodiversity offsetting is given in Section 1.4.2 of the BOCF.

Rock Forest: Restoration planting to offset loss of rock forest will occur on the northwestern side of Kaarearea Paa adjacent to existing protected rock forest and on the eastern side of the site adjacent to small, grazed remnants of rock forest. The substrate in both areas contain surface rocks and boulders, to which further boulders can be added as necessary to recreate the character of the rocky substrate being lost. These locations will buffer areas of existing rock forest and restore lost areas of rock forest resulting in improved ecological connectivity and increased extent of this endangered ecosystem type. A plant community that is characteristic of rock forest will be planted, including regionally threatened species such as mangeao (*Litsea calicaris*), poataniwha (*Melicope simplex*) and Kaikomako (*Pennantia corymbosa*).

Broadleaved podocarp forest (WF9): Restoration planting to offset the loss of broadleaved podocarp forest will be undertaken on land adjacent to Macwhinney Reserve on the western side of the Sutton Pit and on the eastern side of Kaarearea Paa, extending around the western edges of the rock forest fragments. These revegetation planting sites will improve ecological connectivity between the western and eastern sides of the site and also provide connectivity to an isolated forest fragment towards the southeastern corner of the site. Control of dense infestations of pest plants (privet and woolly nightshade) will remove a significant biodiversity threat to existing and proposed areas of restoration planting that surround Macwhinney Reserve.

Kānuka scrub/forest: Restoration planting to offset losses of kānuka forest will be undertaken around the edges of SEA_T_5323 and in the gully on the True Left of the Thorburn Stream where it will connect to SEA vegetation immediately south of the existing quarry pit and proposed riparian planting. 4.43 hectares of this vegetation type will also be planted on Drury Creek Islands Recreational Reserve (Ngā Motu a Hingaia) Island 2 to complete the revegetation of this island.

Relict tree replacement planting: Planting to offset for loss of mature individuals and small stands of relict native trees amongst pasture will be undertaken at three locations:

1. North of the Sutton Pit, on the southern edge of SEA_T_5323. This area lies adjacent to the Natural Stream Management Area (SMA) along the Waihoehoe Stream and will be planted in puriri and taraire during Stage 1.
2. Ngā Motu o Hingaia Island 2 in the Drury Estuary: Totara will be planted to provide seed islands² amongst pioneer kānuka scrub/forest.
3. Kahikatea, pukatea and rimu will be planted at the Tuakau site owned by Fulton Hogan, the parent company of SAL. The property is adjacent to the Waikato River and can provide suitable habitat for these species (628 trees) which the SAL site does not provide.

² A concept whereby canopy trees planted in small groups amongst pioneer vegetation provide roost sites that attract avian seed dispersers which bring in the seeds of other canopy species (Tanes Trees Trust 2024).

2.2.3 Site conditions

SAL site: Areas of offset planting at the SAL site lie within the Hunua Ecological District (E.D.). Climatic conditions for the Hunua E.D. include warm humid summers and mild winters (Mc Ewen 1987). Much of the site faces the southerly quarter, and more elevated parts would be exposed to prevailing south westerly winds. Soils are Mottled Yellow Ultic Soils (UYM) of the Whangaripo soil family (Smap Online). Soil fertility is moderate with low vulnerability to drought and annual rainfall is moderate at 1200 – 1300mm per annum. Land use Capability LUC) mapping (Auckland Council Geomaps) shows the site is mostly Class 6 which is non-arable land with slight to moderate limitations to pastoral use. Aside from the MacWhinney site, most offset planting areas are currently in managed pasture.

The growing conditions for restoration planting are well understood as extensive planting has been undertaken as part of earlier resource consent conditions.

Ngā Motu o Hingaia Island 2: This site lies some 6.5km to the west of the Sutton Block within a sheltered estuary.

Tuakau site: This site lies adjacent to the lower Waikato River near Tuakau. The site provides suitable habitat for a relatively large planting of 628 young kahikatea and pukatea trees (1.15ha), which will increase the extent of the kahikatea forest along the edge of the Waikato River.

2.2.4 Planting approach

For the mature forest types; rock forest and taraire tawa podocarp forest, the restoration planting approach is a two-phase process. Initial establishment of a pioneer plant community composed of manuka/kānuka, broadleaved shrubs and small trees is followed by a second phase of enrichment planting once the pioneer community is well established. Enrichment planting is undertaken to introduce appropriate future canopy species and understorey species. This approach hastens the process of natural succession and helps to ensure the appropriate tiered structure of the forest and species richness develops.

Kānuka scrub/forest is a simpler vegetation type and does not require a second phase of enrichment planting to develop into a similar plant community to that being lost.

Replacement planting of relict trees will require some initial planting of pioneer species to provide shelter for the young trees.

Biodiversity gains for revegetation have been modelled over 20 years for kānuka forest (VS2) and over 30 years for broadleaved podocarp and rock forest biodiversity types.

2.2.5 Mana Whenua values

SAL have undertaken consultation with Mana Whenua iwi in relation to the proposed pit development and management of natural resources. Ballard's Cone (Kaarearea Paa) is a site of high cultural value to Mana Whenua. Ngāti Te Ata Waiohua and Ngāti Tamaoho iwi have indicated a wish to revegetate the area around it. Restoration planting of rock forest and taraire tawa podocarp forest is planned in this area (Figure 8). Salvage of native seeds, cuttings and seedlings will preserve the

whakapapa of the mature forest species being lost in the Sutton Pit footprint. There will also be opportunity for salvage of native logs for cultural use at the time vegetation is removed.

Consultation also identified a Ngāti Te Ata Waiohua aspiration to see Ngā Motu o Hingaia fully restored to indigenous vegetation. In response SAL has agreed to locate 5ha of kānuka scrub/forest (VS2) on Island 2 where suitable terrestrial habitat exists. Replacement planting of totara will also be undertaken in groups to provide “seed islands” on Island 2.

3 SALVAGE OF FOREST RESOURCES

Areas of mature forest will be removed from the Sutton Project area. The salvage of forest resources prior to vegetation removal will be undertaken where possible. These will be used in restoration planting and by Mana Whenua where appropriate. Resources suitable for salvage include:

- Large basalt boulders for use within the rock forest restoration areas.
- Collection of seed, cuttings, and transplanting of young seedlings of native canopy and understorey species from areas of forest to be lost will be undertaken. These will be grown in the nursery and use as planting stock³.
- Propagation of several regionally threatened and at-risk rock forest species from the Kaarearea Paa rock forest for use in the rock forest restoration planting areas.
- Ponga logs carrying young epiphytes for managing in the nursery and introduction to planting areas as conditions become suitable for them.
- Surface humus and leaf litter (especially from within rock forest) for addition to planting areas where practicable.
- Mulched foliage and wood chips for use where practicable.

The use of these resources in biodiversity offset planting provides the opportunity to account for biodiversity attributes that are not specifically captured by the modelling. These include:

- Provision of suitable substrate for rock forest restoration planting.
- Genetic provenance of Drury Quarry flora species and genetic diversity.
- Epiphytes.
- Soil seedbank containing seeds and spores of a range of forest species that cannot be nursery grown and planted.
- Soil microbiome, including symbiotic mycorrhizal fungi and soil invertebrates.
- Nonvascular flora such as mosses, liverworts and lichens.

The use of these forest resources in planting areas (where appropriate) provides an opportunity to establish a presence for these biodiversity components that may otherwise take a very long time to establish naturally. Although the ultimate success of these efforts has not been quantified to date, it is expected that there will be at least modest success in introducing these components if carefully managed by knowledgeable practitioners. Salvage of forest resources should be overseen by the project ecologist.

Suitable locations have been selected for the offset actions (revegetation and enhancement) that meet the requirements for offsetting, as laid out in the Guidance on Good Practice Biodiversity Offsetting in New Zealand (New Zealand Government, 2014). This includes the requirement that any offset sites can achieve “comparable, additional, and lasting biodiversity gains”. A discussion of these principles and how they are met through the Net Gain Delivery Plan: Planting Plan (NGDP:PP) and Net Gain Delivery Plan: Pest and Weed Control (NGDP:PWC) for the Sutton Project is found in the REAR-TE Section 1.

³ Seedlings can be salvaged from within the Sutton Project area but not from land adjacent to Macwhinney reserve which has significant pest plant issues. Other forest areas will require electric fencing from livestock to allow seedlings to grow large enough to be transplanted.

4 PLANTING SCHEDULES

This section describes the indicative planting schedules to restore the required ecosystem types. The restoration planting seeks to replace over the long term the biodiversity values of forest habitats that will be lost at the impact site. Forest types found at the site are characteristic of taraire tawa podocarp forest (Taraire, tawa podocarp forest (WF9). Rock forest will be restored to puriri forest (WF7.2) which is the ecosystem type associated with volcanic boulder substrate in the Auckland Region. Planting schedules have been guided by Te Haumanu Taiao (Auckland Council 2023).

4.1 Restoration planting phases

Phase 1: The first stage of the restoration planting where pioneer species are planted is known as “Phase 1”. All planting areas will initially be planted with a suite of hardy native pioneer trees and shrubs that are appropriate to the ecosystem type. The pioneer planting will provide shelter and dappled shade for other, less hardy plants to establish. Three to five years from planting these species will have grown up sufficiently to provide suitable conditions to begin the introduction of young canopy trees.

Kānuka forest is a seral vegetation types that will be planted with appropriate pioneer species and will not require enrichment with canopy trees beyond a few hardy species that are included in small numbers in the pioneer planting. For replacement planting of relict trees, a simple palette of appropriate pioneer species will be planted. After 2 – 3 years these will form cover, sometimes known as a “nurse crop” that will provide dappled shade and shelter from drying winds for the young trees to be planted amongst.

Phase 2: The introduction of canopy species and other forest understorey species is known as “Phase 2”. Following the establishment of a good cover of Phase 1 pioneer plants, appropriate species of canopy trees and a small number of understorey plants can be planted amongst the pioneer vegetation, and these will eventually form the replacement forest types.

Planting will be undertaken during the winter months from May to September when temperatures are coolest, and rainfall is greatest. This allows the young plants to establish a good root system prior to the warmer temperatures and greater soil moisture deficits experienced over summer in the Auckland Region.

An annual programme of ongoing management will be required to ensure the successful establishment of the young plants. Management includes weed and pest control, frequently clearing tall grass from around the small plants and replacement of any that die. Management is most intensive in the first 3 years and becomes less so once a good canopy of native plants is established.

All planted areas will need to be securely fenced to exclude livestock, goats, deer and pigs.

4.2 Phase 1: pioneer planting

Planting schedules have been developed for two main plant habitats: hillslopes and gully bottoms as follows:

- Hillslopes. Can be a harsh environment if exposed to prevailing winds and summer-dryness. Aspect is an important factor with south-facing slopes generally being less dry. Hillslope planting utilises hardy species able to withstand wind and summer dry periods.
- Gully bottoms are more fertile and less exposed, often with some sheltered habitat. A range of plants can be planted in this environment with inclusion of some less hardy species. This

planting can grade into streamside planting as needed. The selected species will all grow well once established.

Manuka and kānuka are hardy pioneer species which generally make up the bulk of the pioneer planting (up to 50%). Amongst these, a range of broadleaved shrubs and small trees will be planted to provide diversity and early food resources for birds and invertebrates. Akeake is another hardy fast-growing pioneer species that provides rapid canopy cover but is often short-lived, making way for phase 2 plants as they grow. It is included to provide a tough species for exposed habitats. Gully habitats will support a wider range of broadleaved pioneer species than hillslopes. Totara, rewarewa and kahikatea are hardy canopy species that can be included in small numbers in appropriate habitats as part of Phase 1.

4.3 Phase 2: canopy species and enrichment planting

4.3.1 Forest types to receive Phase 2 planting

Plant schedules have been developed for Phase 2 planting to manage succession of the pioneer native vegetation towards two main forest types:

1. Taraire tawa podocarp forest (WF9)
2. Puriri, taraire forest on volcanic boulder field (WF7.2)

Relict tree replacement planting will also be undertaken into established pioneer vegetation.

Forest development

Over decades densely planted Phase 1 pioneer tree species (kānuka) compete with one another as they grow and gradually, over decades, these species reduce in number, while Phase 2 species increase in size and come to dominate the vegetation. Figure 3 shows a graphic representation of the process. Eventually the pioneer species are reduced to low numbers and the larger, long-lived tree species persist to form the forest canopy.

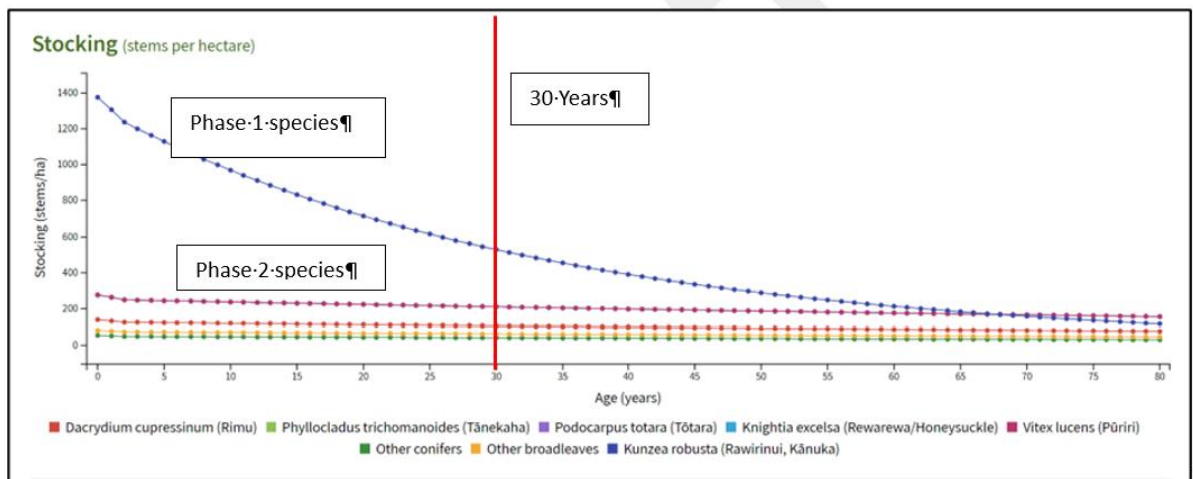


Figure 3 *Modelled forest composition with time (Source: Tanes Trees Trust growth and yield calculator).*

Similarly, by 30 years, much more of the forest biomass is made up of long-lived forest trees than by pioneer species. (Figure 4).

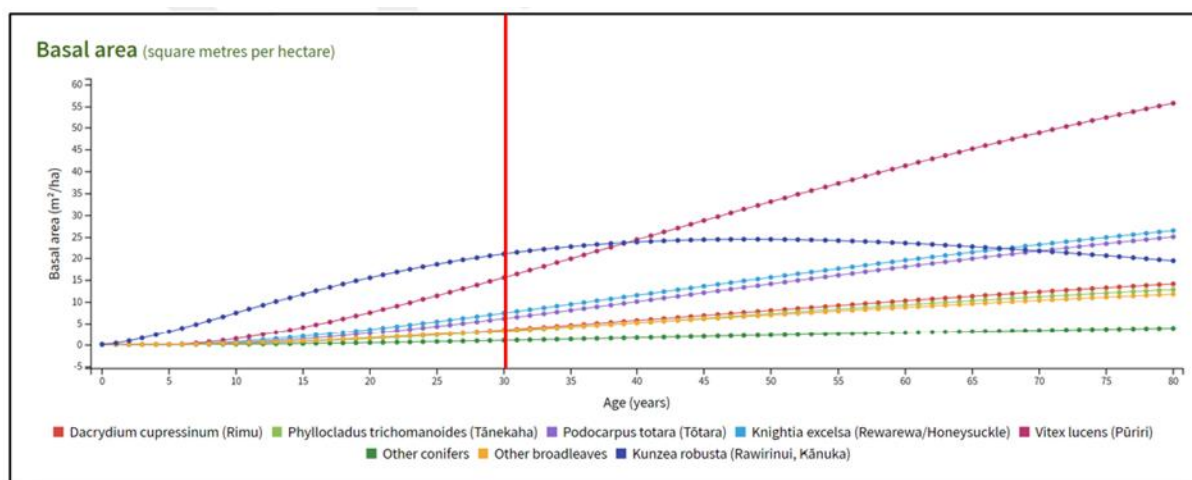


Figure 4 *Modelled forest biomass with time showing the gradual increase in forest biomass made up by long-lived canopy species (Source: Tanes Trees Trust growth and yield calculator).*

4.3.2 Canopy and understory enrichment

Canopy enrichment

Phase 2 canopy enrichment planting should begin once there is a good height (1.2 – 1.5m) and coverage of pioneer species. Phase 2 can begin at 3 years in sheltered areas but may not begin for until Year 4 or 5 years at more exposed sites.

Canopy trees will be planted in light gaps created where Phase 1 species may have died or are performing poorly. Losses of Phase 1 pioneer species are assumed to be 10% in the first 3 years.

Plant schedules have been developed for Phase 2 planting to manage succession of the pioneer native vegetation towards two main forest types:

1. Taraire tawa podocarp forest (WF9)
2. Rock forest (WF7.2)

Relict tree replacement planting to replace 130 individual puriri, taraire, totara, kahikatea, pukatea, and rimu trees will be undertaken. Ensure the correct spacings are kept between canopy species. Generally, kānuka forest will not receive Phase 2 enrichment planting unless it is identified that areas are lacking in species richness during the monitoring programme.

To achieve modelled biomass of canopy trees by Year 30, 550 canopy trees per hectare at an average 4.25m spacing are required. It is very important not to plant canopy species too close together and to look for natural canopy gaps and spaces where the young trees will be sheltered but not shaded or overtopped by pioneer vegetation. Some effort is required to find suitable gaps amongst the pioneer canopy.

Understorey enrichment – WF9 and Rock forest planting

Phase 2 also involves the introduction of limited numbers of selected forest understorey trees and shrubs that do not thrive as pioneers and need the protection of the forest canopy (Tables 11 and 12). It is intended that the introduction of these species will hasten the succession process and the development of forest structural tiers. The addition of these species will increase the diversity of understorey shrubs and in turn create habitats for ground layer ferns and other plants to colonise throughout the area. These plants will be introduced as suitable habitats become available, likely to

be from Year 5 onwards. They can be planted sparingly beneath the pioneer canopy, although some do not like deep shade as indicated.

Relict tree replacement planting: During Stage 1, 146 puriri, taraire and rewarewa will be planted in sheltered gullies bordering the northern edge of SEA_T_5323. During Stage 2 113 tōtara will be planted on Hingaia Island 2 and at Stage 3 628 Kahikatea, pukatea and rimu will be planted in sheltered, moist habitats at the Tuakau site.

4.4 Taraire tawa podocarp forest (WF9) restoration planting

4.4.1 WF9 Phase 1

Table 4 sets out the indicative planting schedule for Phase 1 pioneer planting. Kānuka and Manuka should not exceed 50% combined (and can be less). The percentage of other species listed in Table 4 can be adjusted to suit the microhabitats present in each planting area, however the overall species diversity must be maintained. Gully habitats will support a wider range of broadleaved pioneer species than hillslopes. A more diverse palette of species will be planted in more sheltered gullies and around the edges of existing forest remnants. The planting contractor will need to assess each site to determine the amount of hillslope and gully habitat present at each and hence the number of each species required. Note that plant numbers given are per hectare. Any alterations to the percentages listed for each species, or substitutions with other species not listed in Table 3 must be approved by the project botanist in advance of planting to ensure any substitutions are suitable for the ecosystem type and location.

Table 4 WF9 indicative planting schedules for Phase 1 pioneer planting

Common name	Botanical name	Grade	Spacing/m	% of mix (Up to)	# of plants/ha
A: HILLSLOPES					
Akeake	<i>Dodonaea viscosa</i>	0.5L	1.4	10	510
Houhere	<i>Hoheria populnea</i>	0.5L	1.4	5	255
Kānuka*	<i>Kunzea robusta</i>	0.5L	1.4	30	1530
Karamuramu & Karamu	<i>Coprosma robusta/</i> <i>Coprosma lucida</i>	0.5L	1.4	10	510
Kohuhu	<i>Pittosporum tenuifolium</i>	0.5L	1.4	5	255
Koromiko	<i>Hebe stricta</i> var. <i>stricta</i>	0.5L	1.4	10	510
Mahoe	<i>Melicytus ramiflorus</i>	0.5L	1.4	5	255
Manuka*	<i>Leptospermum scoparium</i>	0.5L	1.4	20	1020
Mapou	<i>Myrsine australis</i>	0.5L	1.4	5	255
Rewarewa	<i>Knightia excelsa</i>	1L	5	0.5	26
Totara	<i>Podocarpus totara</i>	1L	5	0.5	26
Totals				100	5128
B: GULLIES					

Houhere	<i>Hoheria populnea</i>	0.5L	1.4	5	255
Kahikatea	<i>Dacrycarpus dacrydioides</i>	1L	1.4	2	102
Kānuka*	<i>Kunzea robusta</i>	0.5L	1.4	30	1530
Karamu	<i>Coprosma robusta</i>	0.5L	1.4	10	510
Kohuhu	<i>Pittosporum tenuifolium</i>	0.5L	1.4	10	510
Koromiko	<i>Hebe stricta</i> var. <i>stricta</i>	0.5L	1.4	5	255
Kowhai	<i>Sophora microphylla</i>	1L	2.4	2	102
Mahoe	<i>Melicytus ramiflorus</i>	0.5L	1.4	5	255
Makomako	<i>Aristotelia serrata</i>	0.5L	1.4	3	153
Manuka*	<i>Leptospermum scoparium</i>	0.5L	1.4	10	510
Porokaiwhiri	<i>Hedycarya arborea</i>	1L	1.4	2	102
Tī kōuka	<i>Cordyline australis</i>	0.5L	1.4	10	510
Totara	<i>Podocarpus totara</i>	1L	5	1	51
Whauwhaupaku	<i>Pseudopanax arboreus</i>	0.5L	1.4	5	255
Totals				100	5102

* Ensure planting stock is procured from a certified myrtle rust-free nursery.

4.4.2 WF9 Phase 2

Attention must be paid to the particular habitat requirements of each phase 2 species. Do not plant Phase 2 canopy or understorey species in deep shade or close to other plants as few plants will thrive under these conditions.

On ridges and hillslopes, contiguous with the gully planting areas, a hardier range of species will be planted to cope with the more exposed conditions (Table 5). Note that the vegetation types to be lost from within the Sutton Project footprint do not contain kauri. Due to the risk of the spread of kauri dieback disease kauri is not proposed for planting at Drury Quarry. Table 6 presents the plant schedule for WF9 understorey planting.

Table 5. Phase 2: WF9 forest enrichment indicative planting of forest canopy species

Common name	Botanical name	Situation/ cultural notes	Grade	% Of mix	Number of trees/ha
HILLSLOPES/RIDGES					
Mahoe	<i>Melicytus ramiflorus</i>	Requires some shelter to establish.	1L	10	55
Mamangi	<i>Coprosma arborea</i>	Hardy but can be slow to establish.	1L	5	28
Horoeka/lancewood	<i>Pseudopanax crassifolius</i>	Hardy once established	1L	10	55
Hinau	<i>Elaeocarpus dentatus</i>	Requires good drainage	1L	3	16
Miro	<i>Pectinopitys ferrugineus</i>	Requires shelter	1L	2	11
Rewarewa	<i>Knightia excelsa</i>	Early pioneer of scrub habitats	1L	20	110
Puriri	<i>Vitex lucens</i>	Reasonably hardy with some shelter	1L	15	83
Tanekaha	<i>Phyllocladus trichomanoides</i>	Light demanding.,	1L	15	83
Totara	<i>Podocarpus totara</i>	Hardy	1L	20	110
Totals				100	551
GULLIES (WF9)					
Hinau	<i>Elaeocarpus dentatus</i>	Requires good drainage	1L	1	5
Kahikatea	<i>Dacrycarpus dacrydioides</i>	Moist gullies and swampy areas. Light demanding. G, Riparian	1L	2	11
Karaka	<i>Corynocarpus laevigatus</i>	Reasonably hardy with some shelter	1L	5	28
Kohekohe	<i>Didymocheton spectabile</i>	Shade-tolerant. H,G	1L	10	55
Miro	<i>Pectinopitys ferrugineus</i>	R,H,G. Requires shelter	1L	5	28
Northern rata*	<i>Metrosideros robusta</i>	Reasonably hardy with some shelter	1L	1	5
Pukatea	<i>Laurelia novaezelandiae</i>	Riparian: permanently moist gullies & wetland	1L	1	5
Puriri	<i>Vitex lucens</i>	Reasonably hardy with some shelter	1L	20	110
Rewarewa	<i>Knightia excelsa</i>	Light demanding,	1L	10	55

Taraire	<i>Beilschmiedia tarairi</i>	Sheltered. Very drought-prone	1L	10 ⁴	55
Tawa	<i>Beilschmiedia tawa</i>	Sheltered.	1L	10	55
Titoki	<i>Alectryon excelsus</i>	Moist riparian	1L	5	28
Totara	<i>Podocarpus totara</i>	Hardy	1L	20	110
Totals				100	550

* Ensure planting stock is procured from a certified myrtle rust-free nursery.

⁴ Taraire will be planted in modest numbers because it is drought-prone and may be disproportionately affected by climate change effects.

Table 6: WF9 forest enrichment planting of understory species

Common name	Botanical name	Grade	Number/ha	Situation
HILLSLOPES/RIDGES				
Porokaiwhiri	<i>Hedycarya arborea</i>	1L	25	Plant throughout.
Scarlet rata	<i>Metrosideros fulgens</i>	1L	25	Sheltered, free draining site
Twiggy coprosma	<i>Coprosma rhamnoides</i>	1L	25	Does not like deep shade
Whauwhaupaku	<i>Pseudopanax arboreus</i>	1L	25	Does not like deep shade
Totals			100	
GULLIES				
Common name	Botanical name	Grade	Number/ha	Situation
Nikau	<i>Rhopalostylis sapida</i>	1L	25	Sheltered. Tolerates shade. Plant amongst established pioneer shrubs & young canopy trees.
Kawakawa	<i>Piper excelsum</i>	1L	25	Tolerates shade. Prefers shelter
Porokaiwhiri	<i>Hedycarya arborea</i>	1L	25	Plant throughout.
Kanono	<i>Coprosma autumnalis</i>	1L	25	Sheltered. Tolerates shade
Scarlet rātā	<i>Metrosideros fulgens</i>	1L	25	Plant where the liane can grow towards the light.
Toropapa	<i>Alseuosmia macrophylla</i>	1L	25	Tolerates shade. Requires shelter
Totals			100	

4.5 Rock Forest (WF7) restoration planting

4.5.1 WF7 Phase 1 planting

The rocky substrate necessary to re-establish rock forest can be dryer than surrounding areas due to greater drainage and the influence of the rocks in absorbing and retaining heat. A subset of the hillslope planting schedule containing a range of hardy, more drought-tolerant species will be used to establish early cover as set out in Table 7.

Table 7 Rock Forest indicative planting schedules for Phase 1 pioneer planting

Common name	Botanical name	Grade	Spacing/m	% of mix (Up to)	# of plants/ha
Akeake	<i>Dodonaea viscosa</i>	0.5L	1.4	10	510
Houhere	<i>Hoheria populnea</i>	0.5L	1.4	5	255
Kānuka*	<i>Kunzea robusta</i>	0.5L	1.4	30	1530
Karamu	<i>Coprosma robusta/</i>	0.5L	1.4	12	612
Koromiko	<i>Hebe stricta</i> var. <i>stricta</i>	0.5L	1.4	12	612
Manuka*	<i>Leptospermum scoparium</i>	0.5L	1.4	20	1020
Mapou	<i>Myrsine australis</i>	0.5L	1.4	5	255
Phormium cookianum subsp. hookeri	<i>Wharariki</i>	0.5L	1.4	5	255
Totara	<i>Podocarpus totara</i>	1L	5	1	51
Totals				100	5100

4.5.2 WF7 Phase 2

Puriri forest will be facilitated amongst identified and suitably prepared boulderfield substrate. Introduction of phase 2 species will occur as suitable habitats develop for them (Table 8) and may occur at a slower rate than for taraire tawa podocarp forest. It is expected that this process will be closely overseen by a skilled restoration ecologist due to the high value of the rock forest ecosystem type being offset for. The cultural requirements of each species must be considered and plants may require more care than usual to get them established.

Table 8. Phase 2: WF7 enrichment indicative planting of forest canopy species

Common name	Botanical name	Situation/ cultural notes	Grade	% Of mix	Number of trees/ha
Mahoe	<i>Melicytus ramiflorus</i>		1L	15	83
Karaka	<i>Corynocarpus laevigatus</i>		1L	10	55
Puriri	<i>Vitex lucens</i>		1L	20	110
Kohekohe	<i>Didymocheton spectabile</i>		1L	15	83
Kowhai	<i>Sophora microphylla</i>		1L	5	28

Mangeao	<i>Litsea calicaris</i>		1L	3	16
Porokaiwhiri	<i>Hedycarya arborea</i>		1L	12	65
Tarairi	<i>Beilschmiedia tarairi</i>		1L	10	55
Titoki	<i>Alectryon excelsus</i>		1L	5	28
Rewarewa	<i>Knightia excelsa</i>		1L	5	27
Totals				100	550

Understorey planting for rock forest (Table 9) includes a small number of kaikomako, poataniwha and carmine rata. These species are all considered threatened in the Auckland Region and are typically found amongst rock forest in the southern part of the Auckland Region. They should be planted in groups of 6 – 8 plants in accessible areas where they can be easily managed, taking particular note of their cultural requirements. **Note:** Planting stock will need to be ordered or sourced well ahead of time.

Table 9: Rock forest enrichment planting of understorey species

Common name	Botanical name	Grade	Number/ha	Situation
Nikau	<i>Rhopalostylis sapida</i>	1L	25	Sheltered. Tolerates shade.
Kawakawa	<i>Piper excelsum</i>	1L	25	Tolerates shade. Prefers shelter
Kaikomako	<i>Pennantia corybosa</i>	1L	25	Tolerates shade. Prefers shelter
Poataniwha	<i>Melicope simplex</i>	1L	25	Tolerates shade. Requires shelter
Scarlet rātā	<i>Metrosideros fulgens</i>	1L	25	Plant where the liane can grow towards the light.
Toropapa	<i>Alseuosmia macrophylla</i>	1L	25	Tolerates shade. Requires shelter
Totals			150	

4.6 Kānuka forest restoration planting

Kānuka scrub/forest revegetation will be planted with a range of species from Table 4 (Section 4.4.1) as appropriate to the site. Totara and kahikatea are appropriate to include in small numbers for this vegetation type as they are present within the area of VS2 to be removed. Rewarewa and kowhai are also commonly found amongst pioneer vegetation and can supply important food resources for native fauna.

4.7 Relict trees replanting

A total 887 trees will be planted at a rate of 550 trees/ha as set out in Table 10. The trees will be spaced 4.26m apart from one another on average with the remainder of the planting being made up of pioneer species (Table 11).

Replacement planting will occur at three sites:

- SAL north of the bund, on the edge of SEA_T_5323 (puriri, taraire, rewarewa: 0.265ha)
- SAL Tuakau site adjacent to existing protected kahikatea forest (kahikatea, pukatea, rimu: 1.14ha)
- Ngā Motu o Hingaia Islands 2: 7 groups of 11 trees and 3 groups of 12 trees (113 trees) to act as seed islands (3 – 5m spacing of trees within groups).

Table 10 Overall number of trees to be planted for relict tree replacement planting.

Species	Loss / count	Timing of removal / year	Replanting / count	Grade	Time of Planting	Location
Puriri	5	1 - 5	113	2L	Year 1 - 5	SAL Drury
Taraire	3	1 - 5	30	2L	Year 1 - 5	SAL Drury
Rewarewa	1	1	3	2L	Year 1 - 5	SAL Drury
Rimu	1	>30	5	2L	Year 20	Tuakau Site
Totara	14	>30	113	1L	Year 10 - 16	Hingaia Island 2
Kahikatea	94	>30	565	2L	Year 20	Tuakau Site
Pukatea	12	>30	58	2L	Year 20	Tuakau Site
Total	130		887			

4.7.1 Relict trees Phase 1

The spacing of the pioneer species for the Drury quarry and Tuakau site sites is greater than for that recommended for full revegetation planting. This will allow the replacement trees to establish and grow more quickly. Weed control and plant release will need to be assiduously done to ensure the plants establish and thrive in the early years. Totara planting on Ngā Motu o Hingaia Island 2 will occur amongst the earlier established kānuka scrub/forest pioneer planting.

Table 11 Phase 1 indicative planting for relict trees replacement planting

Common name	Botanical name	Grade	Spacing/m	% of mix (Up to)	# of plants
Puriri/taraire/rewarewa (0.265ha)					
Kānuka*	<i>Kunzea robusta</i>	0.5L	1.8	40	327
Karamu	<i>Coprosma robusta</i>	0.5L	1.8	10	82
Kohuhu	<i>Pittosporum tenuifolium</i>	0.5L	1.8	10	82
Mahoe	<i>Melicytus ramiflorus</i>	0.5L	1.8	10	82
Manuka*	<i>Leptospermum scoparium</i>	0.5L	1.8	30	245
Total					818
Kahikatea/pukatea/rimu (1.14ha)					
Harakeke	<i>Phormium tenax</i>	0.5L	1.8	30	1057
Mānatu/ribbonwood	<i>Plagianthus regius</i>		1.8	5	175

Mānuka	<i>Leptospermum scoparium</i>		1.8	30	1057
Putaputaweta	<i>Carpodetus serratus</i>	1L	1.8	5	175
Ti kōuka/cabbage tree	<i>Cordyline australis</i>		1.8	30	1057
Total				100	3521

4.7.2 Relict trees Phase 2

Phase 2 planting of relict trees is set out in Table 12. As with all canopy tree planting, care must be taken to plant the trees in suitable habitats, as set out in Table 4 in Section 4.4.2.

Table 12 *Phase 2: Indicative relict trees of forest canopy species*

Common name	Botanical name	Grade	Spacing/ m	# of plants
Puriri/taraire/rewarewa (0.265ha)				
Puriri	<i>Vitex lucens</i>	2L	4.26	113
Taraire	<i>Beilschmiedia tarairi</i>	2L	4.26	30
Rewarewa	<i>Knightia excelsa</i>	2L	4.26	3
Total				146
Kahikatea/pukatea/rimu (1.14ha)				
Kahikatea	<i>Dacrycarpus dacrydioides</i>	2L	4.26	565
Pukatea	<i>Laurelia novae-zelandiae</i>	2L	4.26	58
Rimu	<i>Dacrydium cupressinum</i>	2L	4.26	5
Total				628
Totara				
Totara	<i>Podocarpus totara</i>	1L	3 - 5	113

4.4 Plant sourcing and biosecurity

Plants should be sourced from the Hunua Ecological District. Ideally the majority of seed should be collected from the Drury Quarry landholdings.

Great care will need to be taken when propagating plants in the nursery to prevent infection with myrtle rust (manuka, kānuka and all species of *Metrosideros*). The nursery will need to have robust phytosanitary procedures in place and provide certification to prove that all planting stock is disease-free before leaving the nursery.

Due to the risk of the spread of kauri dieback disease kauri is not proposed for planting at Drury Quarry.

4.5 Planting Implementation

4.5.1 Site preparation

Control of environmental weeds and animal pests will need to take place prior to planting and be ongoing. Weed and pest control methods are contained in the Weed and Pest Management Plans in Sections 5 and 7. Complete any fencing that is required as set out in Section 6.

Where planting will occur into existing pasture, a 30 – 50cm circle will need to be sprayed with glyphosate herbicide at least 4 weeks prior to planting. Alternatively, the area can be manually cleared of pasture weeds at the time of planting.

If planting into kikuyu a selective herbicide for grasses (e.g. Haloxypop) should be used to clear the planting areas of this aggressive grass. Ensure spraying is done well before planting and follow up with further spot spraying 4 weeks later if necessary.

4.5.2 Planting technique

Correct planting technique is crucial to the successful establishment and growth of plants. A hole twice as wide and deep as the root ball of the plant should be dug. Loose soil should be placed in the bottom of the hole, a fertiliser tab added and the whole gently firmed down. All container grown stock must have the bag, canes and ties removed.

The plant should be carefully removed from its container and placed in the hole so that collar (base of the stem) is slightly above the ground level for moist/ boggy sites and at or slightly below ground level on drier sites. Holding the plant firmly, gradually place soil all around the root ball making sure there are no air gaps, and finally gently firm down the whole area around the plant (Figure 5).

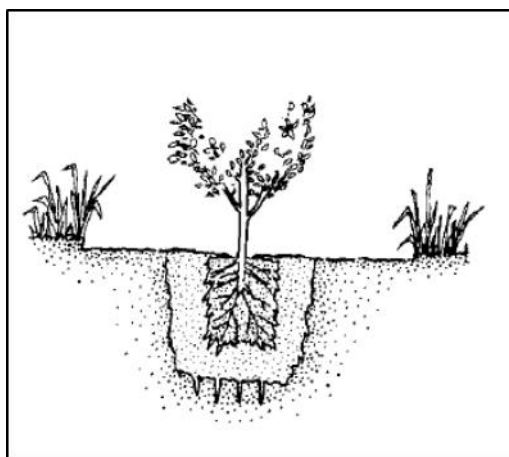


Figure 5 Correct planting technique (Picture sourced from Auckland Council Riparian Facts publication)

When planted correctly all plants should be firmly anchored in the ground. Larger Phase 2 canopy trees that are planted as 2L grade should be staked to ensure the roots remain firm in the ground and they can be easily located.

4.5.3 General programme for planting implementation

Tables 13 and 14 outline a programme⁵ for implementation of Phase 1 and Phase 2 planting.

It is not proposed to replace any Phase 1 plants that die unless losses are > 13% of the original planting density in any one year. Otherwise, the gaps left by any dead plants will be infilled with Phase 2 canopy and understorey plants during Phase 2 planting as set out in Section 4.3. If plant losses are >13% or there are bare patches in the first three years, replacement planting should be undertaken to ensure overall plant survival is 85 – 90%. After 5 years, at the completion of Phase 2 enrichment planting at least 80% average canopy cover of pioneer planting should be achieved. However, the contribution of the developing forest tiers to overall cover will change as the vegetation structure develops over the long term.

⁵ Note that year numbers refer to the age of the planting and not quarry stages.

Table 13 **Year 1-3: Phase 1 implementation programme**

Annual Tasks	Timing
Initial weed control	October/November of year prior to planting – March of following year
Follow-up weed control & pre-planting site preparation	April/May
Fencing to exclude livestock	By April/May
Phase 1 planting. Project botanist to check and certify plant size and quality on delivery to site.	May - September
Weed control	October /November
Annual report by Ecologist and certification that Phase 1 planting is complete for that stage.	1 November
Order Phase 2 plants for Year 3 onwards according to habitats available in the area	November
Weed control and plant release	December/January or 6 weekly if necessary over the summer

Table 14 **Years 3 – 5 Phase 2 implementation**

Annual Tasks	Timing
Site walkover by project ecologist and planting contractor to map Phase 2 planting sites by species	March/April
Pre-planting site preparation as necessary for Phase 2 plants	April/May
Phase 2 planting. Project botanist to check and certify plant size and quality on delivery to site.	May - September
Weed control and plant release	As per the maintenance programme
Annual report by Ecologist Certification that Phase 2 planting is complete (expected to be Year 5).	1 November

4.5.4 Utilisation of forest resources, rocks and mulch salvaged from Sutton Block footprint.

1. Mana whenua who have expressed an interest in obtaining native timber or other culturally valued forest resources from areas of native forest to be cleared should be notified well ahead of vegetation removal occurring.

2. Young seedlings of canopy and understorey species should be salvaged where possible from the parts of the Sutton Project footprint which will be cleared first (rock forest and gully forest in BP02). These can be potted up and grown on in the nursery. Six to nine months prior to salvage commencing, grazed areas will require temporary electric fencing to exclude livestock and allow seedlings to reach transplantable size. Knowledgeable staff from the planting contractor will identify and uplift suitable seedlings in the appropriate seasons (late autumn – early spring). The practice should continue as successive areas are scheduled for clearance, keeping in mind that plants will take up to 3 years to be ready for planting out. Once they are of suitable size, these plants will be utilised in Phase 2 planting of rock forest and taraire tawa podocarp restoration areas.
3. Seed and cuttings can also be collected from the wider SAL site for plant propagation.
4. Where possible, ponga logs carrying young epiphytes should be salvaged prior to, or at the time of vegetation clearance. They can be stored in a shade house with a misting system or automatic watering to keep them moist, until such time as the pioneer canopy develops. They can then be placed under the developing canopy at the same time Phase 2 is implemented once shade and shelter are provided by the pioneer plants. The logs will encourage the establishment of epiphyte species within the restoration planting, particularly rock forest and taraire tawa podocarp restoration areas. A suitably qualified botanist and Drury Quarry's planting contractors should oversee this work. Species supported by ponga logs may include:
 - Epiphytic ferns: *Asplenium faccidum*, *A. oblongifolium*, *Zealandia pustulatum*, *Dendroconche scandens*, *Icarus filiforme*, *Pyrrhosia elaeagnifolia*, *Tmesipteris* spp.
 - Epiphytic orchids: *Earina* spp.
 - Climbing rata: *Metrosideros perforata*, *M. diffusa*, *M. fulgens*
 - Nonvascular species: mosses, liverworts
 - Micro flora and micro fauna
5. Mulched foliage and woodchips can be used as mulch in areas that are of reasonably gentle contour and may be useful in rock forest restoration areas amongst the rocks. Mulch should not be used on steep areas where it could wash into watercourses. The material can also be stored and used in any of the restoration planting areas around the Drury Quarry site. Selection of appropriate forest material for mulching should be done in consultation with the project ecologist. Timing and placement of the material within planting areas will be agreed between the project ecologist and Drury Quarry's planting contractors.
6. Surface humus and leaf litter can be used amongst the boulders in the rock forest (and flatter areas of other sites) to introduce soil microbes, native seeds and invertebrates. If practicable, it should also be added to the propagation mix for the raising of the planting stock for the restoration planting areas. This material should be carefully salvaged by machine under the oversight of the project ecologist and stored appropriately until required. It should not be permitted to dry out or become anaerobic during storage.
7. Basalt boulders where possible should be salvaged from the area of rock forest that is to be removed. Care should be taken to ensure that boulders carrying rupestral (epiphytic) plants are

picked up and deposited in their original orientation so that the plants are retained. They should be placed in their new position under the direction of the project botanist.

4.5.6 Natural colonisation

Many fern species will naturally self-introduce as favourable habitats become available for them. Expected colonisers include tree ferns (*Cyathea dealbata*, *C. medullaris*, *Dicksonia squarrosa*), epiphytic ferns (*Asplenium flaccidum*, *A. oblongifolium*, *A. polyodon*, *Icarus filiformis* etc.) and ground ferns (*A. bulbiferum*.) and numerous others. All of these species prefer shaded moist conditions for establishment.

Use of salvaged ponga logs, humus and leaf litter and mulch in restoration planting areas, where possible will help epiphytic species and non-vascular flora species to establish.

4.6 Legal agreements and covenants

All areas of offset planting set out in this report will be legally protected in perpetuity via appropriate legal mechanisms such as covenants.

5 PEST PLANT MANAGEMENT

5.1 Objectives

The key objectives of pest plant control are as follows:

Objective 1: To eradicate all pest plant species in restoration planting areas prior to planting with native species; and

Objective 2: To implement an annual monitoring and control programme to remove and prevent the re-establishment of weed species within the restoration planting.

5.2 Weed control methods

Specific control methods for pest plants found at various locations within the planting areas are given in Appendix 1.

Herbicides should not be sprayed into or over any waterways. Weed control methods should minimise the use of herbicides, through the use of hand control methods such as “cut and paste”.

When using any herbicide read the label thoroughly to ensure that all instructions and safety requirements are followed. It is recommended that a Certified Handler or Experienced agrichemical user carry out pest plant control.

Existing native plants should be identified and retained within the restoration planting areas as far as practicable. Care should be taken not to damage these or existing adjacent native vegetation during the weed control phase of the project. Native plants are very sensitive to herbicides, and it is important to ensure that spray drift does not occur when spraying pest plants nearby. Hand control methods should be used where necessary.

5.2 Pre-planting weed control

Each of the planting sites should be surveyed in early spring prior to the winter planting season in which Phase 1 planting will be initiated. Weed control should be implemented for all pest plant species listed in the Auckland Regional Pest Management Strategy (ARPS) over the spring and summer months (Table 13).

Follow-up weed control should take place in late summer to early autumn to ensure all weeds are eradicated from the planting site. Any other weedy species that may prove troublesome should also be eradicated. Kikuyu grass can negatively impact young native plants by smothering them and this aggressive grass should be fully controlled prior to planting. Similarly, any exotic tree species can negatively affect native planting and should be removed prior to planting.

Pest plant control methods are listed in Appendix 1. All pest plant management methods have been sourced from Tiaki Tamaki Makaurau Ngā kīrearea ki Tāmaki Makaurau pest control guidelines: <https://www.tiakitamakimakaurau.nz/protect-and-restore-our-environment/pests-in-auckland/>.

A Weed Management Plan for each offset planting site should be prepared by a suitably qualified plant ecologist in consultation with the SAL maintenance contractor. The plan should contain detailed methods to be used for controlling any problem weeds that are present and setting out a programme for long-term weed monitoring and control.

Weed control on land adjacent to Macwhinney Reserve will need to be intensive in the first few years to ensure good control and removal of invasive pest plants, particularly privet (*Ligustrum lucidum* & *L. sinense*). It may take several years of weed control before some of these areas are ready to plant.

5.3 Weed monitoring and maintenance of planting areas.

The restoration plantings should be checked for regrowth of pest plants at least at three monthly intervals and at six weekly intervals over the summer months for the first two years after planting. Monitoring should occur at 3 monthly intervals for Years 3 - 5. This will involve walking through all parts of each area and noting any areas where weed species are present or returning.

From Year 6 until full canopy closure occurs weed monitoring needs to occur at least 6 monthly to ensure there are no new weed infestations. Monitoring should be done in spring and autumn to coincide with main growth periods. Ongoing monitoring needs to continue at least on an annual basis thereafter.

Maintenance of the restoration planting is required for the life of the project and must continue after implementation is complete (including Phase 2) in each area or until canopy closure is complete and weed infestation is no longer a threat to the native planting. Weed surveillance must continue on an annual basis in all areas and any new weed infestations must be eradicated as soon as possible following detection.

Maintenance also involves the replacement of any dead or poorly performing plants (both Phase 1 and Phase 2 species) but keeping in mind that gaps left by Phase 1 plants can be infilled with Phase 2 plants from Year 3 onwards. Additional fertiliser may be necessary to ensure good plant growth if plants appear slow to establish. Replacement of any Phase 1 or Phase 2 plants must be of the same species as those lost unless an alternate species is approved by the project ecologist. Note that the maintenance plan begins in Year 2 following implementation in Year 1 (see Table 13).

Table 15 Maintenance programme

Task	Timing
Year 2	
Walk through of planting areas to assess plant losses and determine whether any replacement plants are required. Order replacement plants if necessary. Ensure Phase 2 plants have been ordered for Year 3 – 4 onwards	March/April
Replacement of any plant losses >13%. Slow-release fertiliser if required.	May – September
Weed monitoring and control	December/January March/April June/July October/November
Year 3	
Annual walk through to identify the need for any replacement plants and identify developing habitats for Phase 2 plants.	March/April

Replacement of any dead/ poorly performing plants as required. Plant selected hardy Phase 2 plants. Slow release fertiliser as required.	May – September
Weed monitoring and control	December/January March/April June/July October/November
Year 4	
Walk through to identify habitats for Phase 2 plants. Order Phase 2 plants.	March/April
Replacement of any dead/ poorly performing plants as required. Continue planting Phase 2 plants. Slow release fertiliser as required.	May – September
Weed monitoring and control	December/January March/April June/July October/November
Year 5	
Annual walk through to identify any Phase 2 plant losses. Order replacements.	March/April
Replacement of any dead/ poorly performing plants as required. Continue planting Phase 2 plants. Slow release fertiliser as required.	May – September
Weed monitoring and control	December/January March/April June/July October/November

Research indicates that the most common reason that plants fail to thrive or die in native restoration planting areas is that they become overtopped by rank grass and weeds. It is therefore extremely important to maintain good weed control. Pest plants should be removed promptly once noted and competing tall grasses or other vegetation should be cleared from around the young plants as a regular part of the weed monitoring programme.

6 FENCING

Where grazing livestock are present secure stock proof fencing will need to be erected around the restoration planting areas. This needs to comprise a 7 wire post and batten fence as set out in Schedule 2 of the Fencing Act 1978 for rural fencing, preferably with a barbed wire as the top and middle strand to deter animals from leaning over or through the fence. Fencing should be erected prior to planting being undertaken. Any gates that are required to allow for maintenance to occur must be securely locked at all times to prevent accidental access by livestock.

7 PEST CONTROL

7.1 Browsers

If feral animals such as goats, pigs and deer are present these will need to be fenced out of planting areas or an effective shooting programme implemented prior to planting. Similarly, rabbits and hares can cause significant damage to native restoration planting, particularly in the first two years when plants are small. The pests tend to target broadleaved species, particularly in late winter when other food sources may be scarce. An effective control programme needs to be implemented prior to planting and continued until plants are no longer vulnerable to damage.

7.2 Predators

A programme for control of predators such as possums, rats and mustelids should be implemented to protect native fauna. Methods should follow best practice as set out in the Auckland Council Pest Control Guidelines, utilising innovations and improvements in pest control technology and methods as they become available. Generally, possums require a minimum of 1 trap or bait station /hectare and rats 2 traps or bait stations /hectare. A minimum of one DOC 200 trap/3ha should provide sufficient coverage.

At this stage, toxic baits are generally the most cost-effective method of targeting rats and possums. Mustelids are generally targeted using DOC 200 kill traps. Successfully trapping mustelids requires a good understanding of pest behaviour and care with the setting up and placement the trap. Pest control contractors who are experienced in conservation work should be employed to set up and maintain the pest control programme at each offset planting site.

With all pest control it is crucial to use the right materials and follow best practice for the placement and maintenance of the trap/bait station network. [Appendix 2](#) sets out recommended control methods for mammalian predators. A network of traps and bait stations covering each planting site needs to be set out. This is generally a series of traplines $\leq 100\text{m}$ apart with possum traps/bait stations placed 100m apart (1/ha) and rat traps/bat stations 50m apart (2/ha).

Pulsing pest control

Pest control should be “pulsed” four times a year in January, April, August and November as follows (Figure 7):

- Fill the bait station on day one, and refill as necessary on day 5 and day 14.
- Remove the bait at the end of week four to end the pulse.
- Mustelid traps should be maintained and reset at the beginning of each pulse and checked and reset again at the end of the pulse.

When ending the pulse remove all bait from stations and dispose of it correctly. Degraded bait can make animals bait shy as it is not as effective and may only make the animal feel sick without killing it.



Figure 7 Toxin pulse programme (Auckland Council pest control guidelines)

To ensure the safety of humans and non-target animals, care should be taken to follow all safety instructions found on the labelling of the poison bait products.

Automatically resetting traps are increasingly being developed and refined to target introduced mammalian predators. For difficult-to-reach sites these may be a good option as they require far less labour to maintain than bait stations. Current examples are the AT220 trap by NZ Autotraps and the Goodnature A24 rat trap.

8 SITE SPECIFIC RESTORATION PLANTING PLANS FOR DRURY QUARRY SITE

The following sections of the planting report provide detailed plans for reforestation for each planting stage at each of the offset sites described above. Section 2 of the REAR-TE provides detail on the landscape context and rationale for the offset planting and its staging. The specific planting plans in this report describe:

- The location, current management and landscape context of the planting site
- A site description of existing environmental conditions and ecological values
- A map of proposed planting areas and plant habitats
- Other biodiversity conservation actions to be undertaken and their staging.
- Expected biodiversity outcomes for the site.

Table 18 sets out the overall proposed schedule for restoration planting by year and biodiversity type. The schedule allows for the first year to be used for the preparation of the rock forest planting areas including placement of rocks that are removed from the rock forest impact area.

Rock forest and taraire, tawa podocarp forest will be planted first, to ensure adequate time for enrichment planting and monitoring. After Year 1, planting of these biodiversity types will occur at a rate of 5ha per year until completed. Green cells in Table 18 indicate years when Phase 2 enrichment planting will occur for each biodiversity type.

Kānuka scrub/forest will be planted later because this will achieve its endpoint within 20 years and doesn't require Phase 2 enrichment planting. Planting will be at a rate of 3 – 4ha per year until finished.

Table 16: Proposed planting schedule by year

Planting Plans						
Year	WF9 (Stages 1 and 2)	WF9 (Stages 4 and 5)	RF1 (Stage 1)	VS2 (stages 4 and 5)	Total/year	Running Total
1	3				3	3
2	2		3		5	8
3			5.32		5.32	13.32
4	5				5	18.32
5	2				2	20.32
6		5			5	25.32
7		5			5	30.32
8		5			5	35.32
9		5			5	40.32
10				4	4	44.32

11				3	3	47.32
12				3	3	50.32
13				3	3	53.32
14				3	3	56.32
15				3	3	59.32
16				3	3	62.32
Total	12	20	8.32	22	62.32	

- Green cells indicate years when Phase 2 enrichment planting will occur for planting of each biodiversity type

8.1 Stage 1: Years 0 -3

During this period, the rock forest (RF1) and part of BLP2 will be removed.

Planting in Years 0 -3 will centre around the biodiversity offset planting for rock forest and the first stage of taraire, tawa podocarp forest (WF9) planting (Figure 8).

The entire forest enhancement programme (Figure 8) will also be established and implemented during Stage 1. This programme is set out in Section 10 and will be ongoing for a period of 25 years.

8.1.1 The planting sites

- Rock forest planting will occur on the northwestern edge of Kaarearea PaaPā (Ballard's Cone) and to the southeast of the Pā site above small remnant pockets of rock forest in three gullies. (8.32ha).
- Broadleaved podocarp forest planting (5ha) will occur adjacent to the rock forest planting between the remnant pockets of rock forest.
- Replacement planting for relict puriri and taraire trees along the edge of SEA_T_5323 (146 trees within 0.265ha)

8.1.2 Landscape context

The Kaarearea Paa site is part of SEA_T_5349. It contains protected areas of rock forest and broadleaved podocarp forest on the steep sides of an extinct volcanic cone. Its position between the existing quarry pit and the proposed Sutton pit means that it will benefit from additional indigenous planting around the edges to provide a buffer between the highly valued cultural site and adjacent quarry activities. The northwestern side contains boulders amongst pasture which is suitable substrate for rock forest restoration.

To the southeast of SEA_T_5349 lie four small pockets (5.35ha) of remnant rock forest in gullies. The land above these contains natural boulders on the surface, suitable for rock forest restoration. Broadleaved podocarp forest planting will occur below the rock forest planting, connecting and buffering the rock forest remnants.

8.1.3 Rock Forest planting site descriptions and plant habitats

The land adjacent to Kaarearea Paa site lies at an altitude of 160 – 190m a.s.l⁶. on moderately steep slopes with a northwestern aspect. The majority of the site is covered in improved pasture, although gorse (*Ulex europaeus*) is a pasture weed. Parts of the site have surface boulders and rocks (Figures 9 - 11); additional rocks can be salvaged from the Sutton Pit Project area to augment these. Boulders and rocks also occur just below the soil surface.

Isolated mature specimens of taraire, rimu and totara are found scattered amongst the pasture. These individual mature native trees and adjacent rock forest at the Karearea Pā site provide a seed source to aid forest regeneration. A watercourse which will receive riparian planting (see separate riparian planting plan) flows around the northwestern edge of the area. The site is relatively sheltered from prevailing winds.

Land to the southeast amongst existing rock forest fragments is covered in grazed pasture, which is largely free of weeds, although gorse is present outside the planting site. Surface rocks and boulders are scattered about the area (Figure 11) and further rock material will be added from existing piles of natural rock on site or from the Sutton Pp project area. The land is rolling to steep with a west to south westerly aspect, exposing the site to prevailing south-westerly winds.

⁶ Above sea level

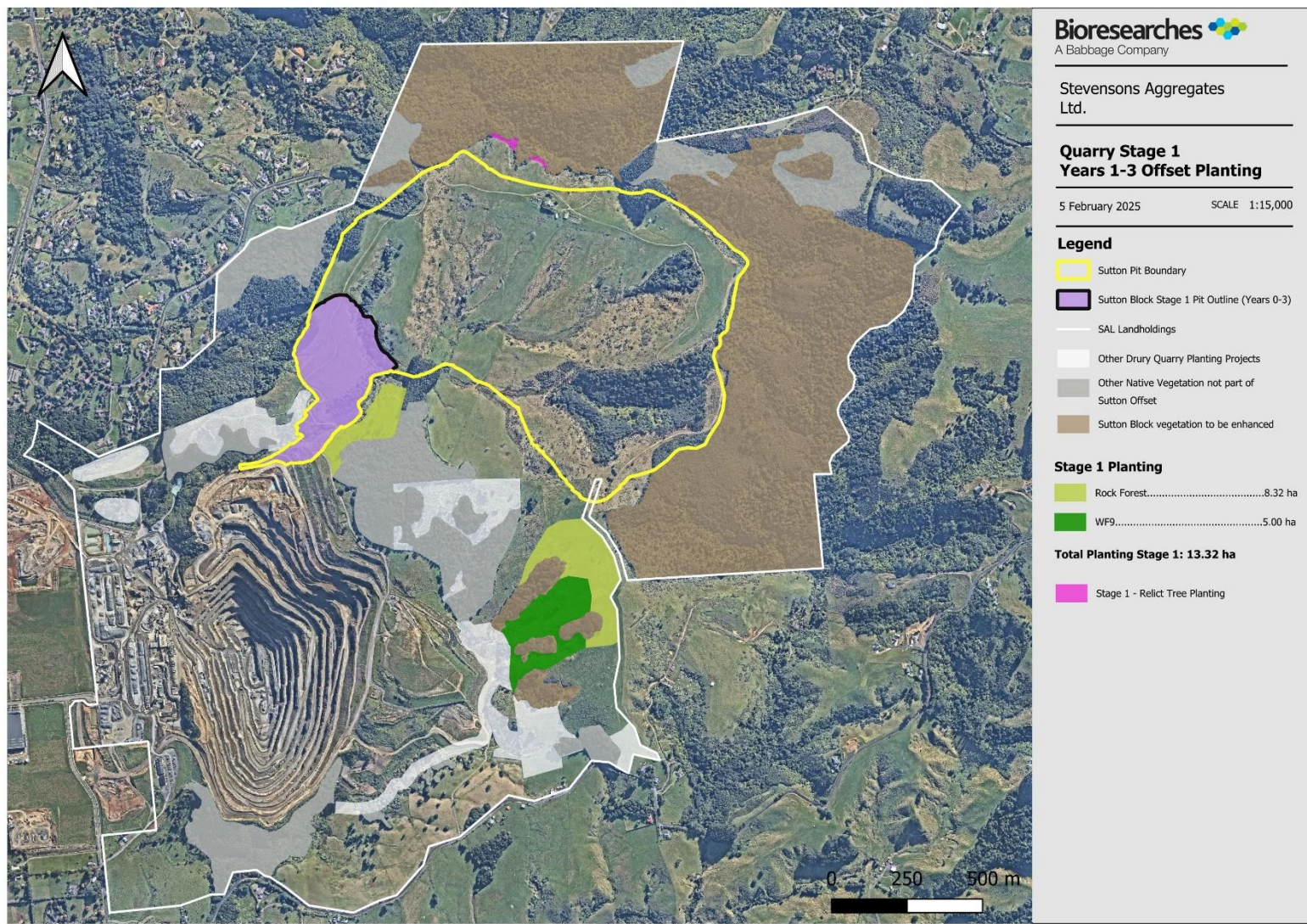


Figure 8 Restoration planting and enhancement for Stage 1: Years 0 – 3



Figure 9 (left): Boulderfield habitat within the Sutton Project area.

Figure 10 (below): Boulderfield under rock forest within the Sutton Project area.

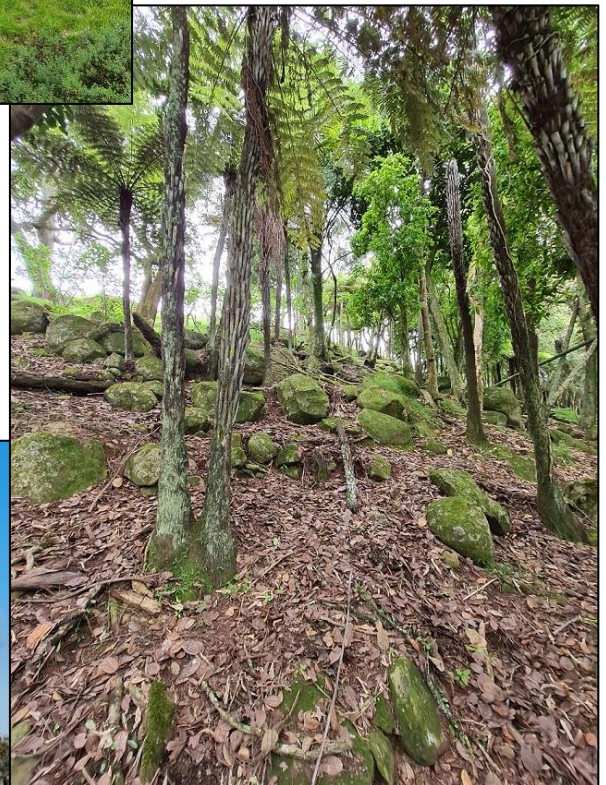


Figure 11 (above): Boulderfield in the rock forest planting area outside the Sutton Project area southeast of Kaarearea PaaPā . The broadleaved podocarp forest planting area lies downslope (right).

8.1.4 Broadleaved podocarp forest planting site descriptions and plant habitats

The planting area for broadleaved podocarp forest planting (5ha) comprises steep westerly facing ridges and hillslopes that will be exposed to prevailing south westerly winds (Figure 11). Soils are of moderate fertility with low vulnerability to drought, however, and growing conditions should still be suitable for the range of species proposed.

8.1.5 Relict trees replacement planting

Replacement planting of individual relict puriri, taraire and rewarewa trees that will be lost during Stage 1 and 2 will be undertaken in Years 1 – 3. The planting will extend the edge of the SEA_T_5323 into lower hillslope and gully habitats with a northerly aspect (Figure 12). These are generally sheltered, warm, moist habitats where the proposed plantation of trees should thrive. The planting is adjacent to the Waihoehoe Stream NSMA and will provide additional buffering to the stream and tie into edge effects management to the west.



Figure 12 Replacement tree planting Year 1 - 3

8.1.5 Planting implementation for Years 1 -3

Rock Forest

- Areas of existing boulderfield will be enhanced with the addition of boulders salvaged from within the Sutton Project area (and elsewhere within the Drury Quarry site as necessary) to create suitable rock forest habitat. Salvage, placement and grouping of boulders requires consultation between Drury Quarry management and the project botanist to achieve the desired outcomes. The process needs to be planned well in advance and some further detailed work needs to be undertaken to plan how boulders and rocks will be distributed to provide the required three-dimensional substrate.
- Salvaged topsoil and humus should be placed between rocks to encourage establishment of the rock forest microbiome and nonvascular flora.

- Salvaged ponga logs can be placed occasionally in the rock forest planting area to encourage the establishment of epiphytes and rupestral species typical of rock forest.
- Pioneer planting will occur in Years 2 & 3 as set out in Table 17 with enrichment planting to occur between Years 5 and 9. See Section 4.5: Tables 7 -9 for plant schedules.

Broadleaved podocarp forest

Pioneer planting will occur in Years 1 and 2 as set out in Table 17, with enrichment planting to occur between Years 4 and 9. See Section 4.4: Tables 4 - 6 for plant schedules.

Relict tree replacement planting

A total 146 replacement trees will be planted at SAL to replace the lost biomass (refer Section 4.7: Tables 11 & 12).

8.1.6 Expected biodiversity outcomes for the site

- Implementation of rock forest offset planting will occur as early as possible to coincide with the loss of the high value rock forest fragment. This will allow maximum time for establishment, management and monitoring to occur over the ensuing decades. Close management of the rock forest offset planting areas by skilled personnel will be needed to ensure successful establishment of rock forest on boulder field habitat at Drury Quarry. The large area proposed for revegetation in rock forest will be an important contribution to the maintenance of this critically endangered ecosystem type in the local landscape. This is of particular importance given the gradual loss of rock forest along the Drury scarp due to land use intensification.
- The Year 1 - 3 planting will provide additional ecological connectivity and buffering to remnant rock forest patches.

Table 17 Planting implementation programme year Stage 1

Year	Rock Forest	Podocarp Forest
1	• Salvage of rocks and forest resources from rock forest to be lost from RF1. • Salvage of forest resources from BLP2 prior to its removal. • Detailed planning and preparation of rock forest planting areas using salvaged rocks as necessary.	• Fencing as necessary to exclude livestock. • Phase 1 pioneer PBF planting amongst eastern rock forest fragments (3ha)
2	• Fencing as necessary to exclude livestock. • Planting of Phase 1 (5.32ha). • Regular plant release (4 X annually) • Weed and pest control	• Salvage of forest resources • Regular plant release (4 X annually) • Weed and pest control.
3	• Continued planting of Phase 1 as necessary to complete planting in all rock forest areas (3ha) • Weed and pest control, • Regular plant release (4 X annually) • Replacement of any dead plants	• Planting of Phase 1 (2ha) • Weed and pest control • Regular plant release (4 X annually) • Replacement of any dead plants

4 - 9	- Implement Phase 2 enrichment planting as the pioneer planting matures - Weed and pest control, - Regular plant release - Replacement of any dead plants.	- Implement Phase 2 enrichment planting as the pioneer planting matures - Weed and pest control, - Regular plant release - Replacement of any dead plants
1 - 30	Monitoring, management, reporting as per Section 8	Monitoring, management, reporting as per Section 8

8.2 Year 4 -15

During this period the rest of BLP2 and part of BLP5 will be removed. Offset planting for the loss of this vegetation will already have been initiated during Stage 1. Planting during Stage 2 will be 10 -20 years in advance of the loss of the vegetation on the eastern side of the pit that it will offset. The vegetation needs to be planted ahead of the loss to allow for the required monitoring, maintenance and reporting to occur prior to the end of the 35-year resource consent period.

8.2.1 The planting sites

Planting in Years 4 -15 will see the rest of the offset planting completed apart from 3ha of VS2 (Figures 12 & 13). This comprises:

1. Taraire tawa podocarp forest (23.74ha) planted on the northeastern and eastern side of Kaarearea Paa and to the south of the Stage 1 offset planting.
2. Taraire tawa podocarp forest (net 3.26ha) planted on the slopes above Macwhinney Drive.
3. Kānuka scrub/forest (4.43ha) planted on Hingaia Island 2 (see separate section 9)
4. Kānuka scrub/forest (14.57ha) planted on the edges of SEA_T_5323 and to the south of the Thorburn Stream at the SAL site.

Taraire tawa podocarp forest will be planted before kānuka scrub/forest as set out in Table 15, however the exact order in which the different areas will be planted has yet to be fully determined.

Land on the northeastern and eastern edge of Kaarearea Paa to be planted in WF9 is mostly grazed pasture with a small area of early-mature plantation pines on the northern end.

The land on the slopes above Mawhinney Drive adjacent to Mawhinney Reserve contain an area of early-mature plantation pine (c. 25 years old), with an understorey of pest plants and occasional native shrubs which will be removed and replaced with native planting. A plantation of manuka (c. 16 years old) is infested with large woolly nightshade trees and gorse. There is no understorey other than rank grass.

The remainder of the land adjacent to Mawhinney Reserve appears from historical aerial photographs, to have been fenced off for at least 30 years. Within the fenced area is a very small fragment of WF9 (0.7ha) with a broken canopy, which is surrounded by privet- infested vegetation that is a mixture of pest plants and native mapou (*Myrsine australis*) and mahoe (*Melicytus ramiflorus*) of some 2.5 – 3m in height. The southern half of this area is almost pure privet, while the northern half is a mixture of privet (*Ligustrum lucidum* & *L. sinense*) and native shrubs. The historical aerals indicate the privet infestation has expanded over the past decades. There is little evidence that the native vegetation has the ability to develop into an ecologically diverse plant community since the seedling layer is almost entirely composed of privet seedlings.

Kānuka planting sites at the SAL site are on moderate to steep slopes with a variety of aspects. They are mainly open pasture with a small component of plantation forest (to be removed) and gorse-infested areas.

8.2.2 Landscape context

Land adjacent to Macwhinney Reserve slopes generally to southwest with moderate to steep topography. A small area of covenanted WF9 lies on the northern side of the planting areas (Figure 16). Areas of revegetation planting lie on its southeastern edge at Drury Quarry and to the southwest lies a small area of WF9, also on quarry land and recent revegetation planting within the Drury South development. Planted and natural indigenous vegetation connects it to SEA_T_5323 to the northeast.

Planting to the east of Kaarearea Paa will connect this high value site to the rock forest and WF9 planting and enhancement established during Stage 1. The eastern planting slopes steeply away to the southwest. The northeastern planting adjacent to the Pā site will provide a substantial buffer between the quarry pit edge and the Pā site. It slopes to the north on a moderate contour.

The WF9 planting to the south of the Stage 1 offset planting slopes steeply to the south and west. It will connect and buffer isolated remnants of rock forest in the southeastern corner of the SAL site.

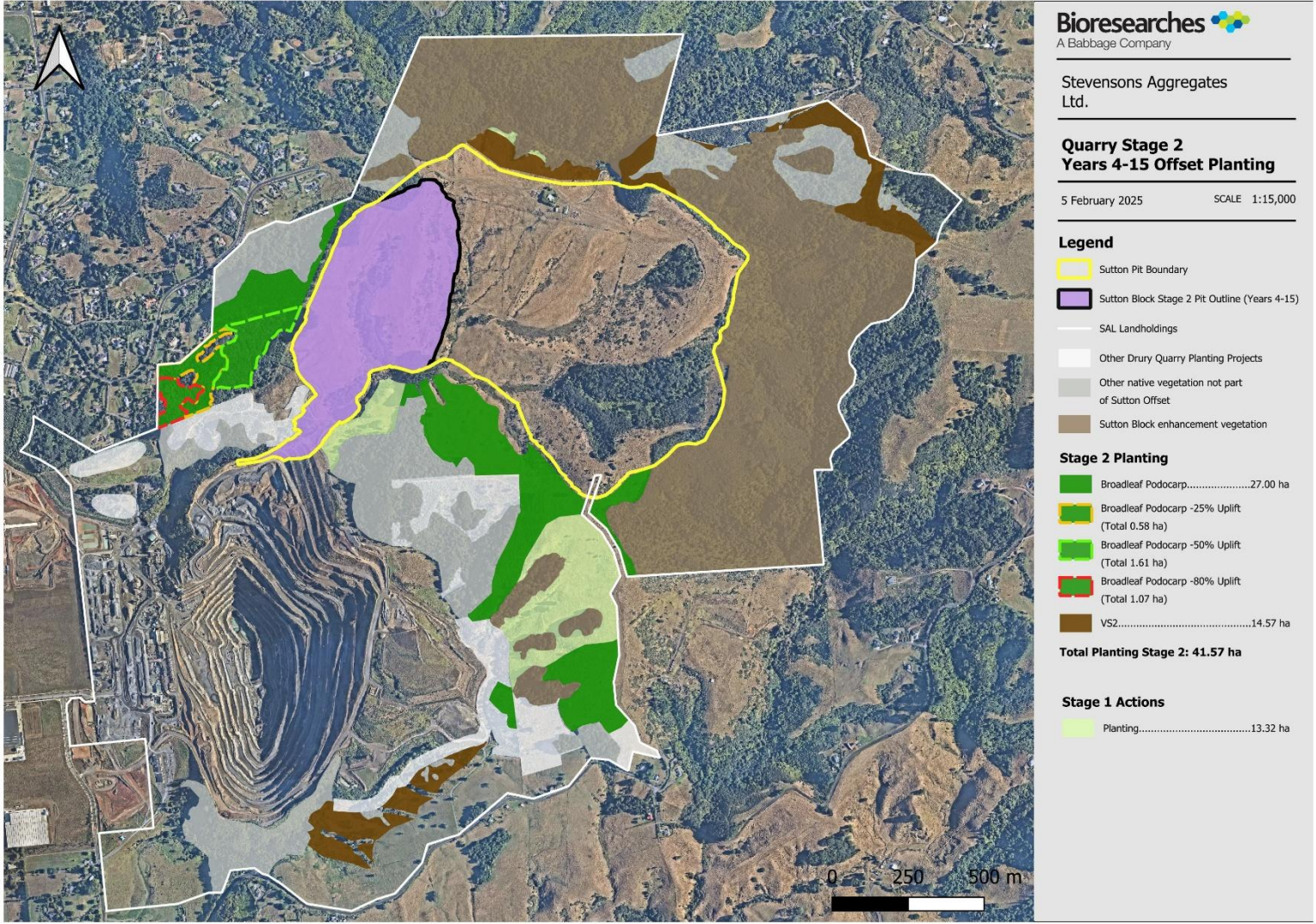


Figure 13 Planting proposed for Years 4 – 15 at the SAL site

8.2.3 Plant habitats

Planting areas at the SAL site for Years 4 – 15 comprise ridges and hillslopes with a variety of aspects and moderate soil fertility. Growing conditions should generally be good, although some sites may be exposed to south-westerly winds.

8.2.4 Planting implementation Years 4 – 15

The quantum and type of planting undertaken each year will follow that set out in Table 18. The slopes above Macwhinney Drive may require several years lead-in to allow for felling and clearance of the plantation pines and control of invasive pest plants, which could be initiated during Stage 1.

Western area above Macwhinney Drive: taraire tawa podocarp forest planting

WF9 restoration planting areas on the western side of the Sutton Project area have various types of pre-existing vegetation (Figures 14 & 15) and will be treated slightly differently in terms of site preparation and planting (Table 18 & Figure 15). When calculating the area available for planting in this area allowance has been made for existing components of native vegetation (Figure 12) which will be retained wherever possible.

Table 18 Site preparation and planting for western slopes above Macwhinney Drive.

Area/ha	Treatment	Effective planting area/ha
Plantation pines: 5.0ha	Clear felling: could be undertaken during Stage 1. Revegetation with WF9 Phases 1 & 2	4.41ha allowing 15m wide strip for visual screening planting along western pit edge.
Manuka planting: 3.23ha	Weed removal. Phase 2 planting.	1.61ha: 50% of total
Privet-dominant vegetation: 1.34ha.	Weed removal, Phase 1 & 2 planting	1.07: 80% of total
Mixed native shrubs and exotic pest plants: 2.31ha	Weed removal, Phase 1 dense planting & Phase 2 enrichment	0.58: 20% of total.
Total WF9 forest planting		7.67

1. Pine plantation will be clear-felled, and the area planted in Phase 1 & Phase 2 pioneer vegetation (Tables 4-6).
2. A monoculture of planted manuka 2.5 -3m tall and planted 2 -3m apart: Large woolly nightshade, gorse and other pest plants will be removed. Phase 2 forest canopy and understorey species will be added to the established pioneer vegetation (Tables 5 & 6). Some Phase 1 species may also be used where appropriate.
3. Privet-dominant vegetation: Privet and other weeds will be removed and the area planted in indigenous vegetation (Tables 4 - 6).
4. Mixed native broadleaved scrub and invasive privet with a dense, privet-dominant seedling layer: Privet and other pest plants will be removed and native shrubs retained where possible. This will be planted in native pioneer vegetation to suppress pest plants (Table 4) and later Phase 2 canopy species (Table 5). An area of some 7.67ha will be reforested in native vegetation at the western site, making allowance for existing native vegetation.

Most plant habitats in the western area will be sheltered to some degree by existing vegetation. A Mexican cypress plantation on the southeastern edge of the area will remain as visual screening, providing some shelter. A 15m wide visual screen of fast- growing exotic trees will be planted on the northeastern edge which will also provide shelter and buffering from quarry activities.

All areas to be planted require good control of pest plants prior to restoration planting. Weed monitoring and weed removal will need to be intensive in the first few years, to rid the area of pest plants. Full removal of pest plants will require several years to achieve and should follow a logical plan working from the top of the ridge towards the southwestern boundary.



Figure 14 *Landscape view from the southern end of Drury Hills Rd showing recent Drury South Development planting in the foreground and proposed western planting area in the background with the pine plantation partially visible top left (yellow outline). Remnant native vegetation occupies the gully between.*



Figure 15: Western planting areas showing manuka area (left) with very low plant diversity, and dense carpet of Chinese privet seedlings amongst native and exotic shrub area (below).



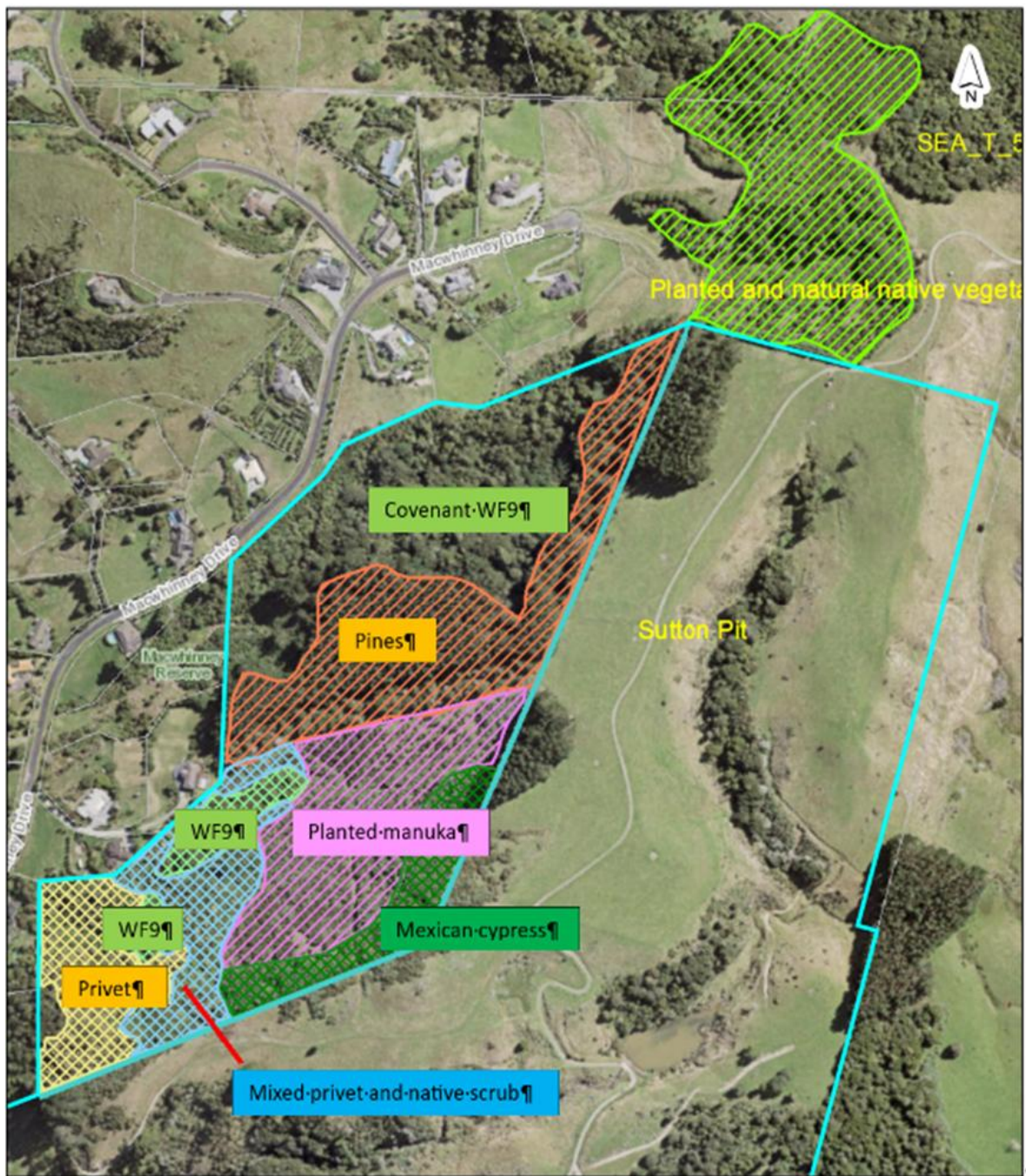


Figure 16 Outline map of the western planting area showing planting areas discussed in the text above. Mexican cypress will remain as visual screening.

Taraire tawa podocarp forest planting: rest of SAL site

Kaarearea Paa northeastern edge

Planting along the northeastern side of the existing native vegetation at Kaarearea Paa will be sheltered to some extent by the landform (Figure 17). The northeasterly aspect should provide good growing conditions. This is a large area comprising c. 13ha which will be planted over several years (Table 19).

Felling of a stand of plantation pines on the northern side of the SEA will also occur, which will allow replacement planting with broadleaved podocarp offset planting to connect through to the rock forest planting (Stage 1) to the northwest of Karearea Pā.

Table 19: Planting implementation programme years Stage 2

Year	Podocarp Forest (WF9)	Kānuka Scrub/ Forest (VS2)
4 - 9	- Salvage of forest resources from BLP2 and BLP5 prior to their removal. - Felling of pine trees in western planting area. - Pest plant removal and planting of manuka area - Pest plant removal from mixed native/exotic and privet areas - Fencing as necessary to exclude livestock. - Planting of Phase 1 (Table 4) - Regular plant release (4 X annually) - Weed and pest control - Replacement of any dead plants.	
10 - 15	- Implement Phase 2 enrichment planting as the pioneer planting matures (Tables 5 & 6) - Weed and pest control, - Regular plant release - Replacement of any dead plants.	- Preparation of planting sites on Hingaia Island 2 - Phase 1 planting on Hingaia Island 2 - Preparation and planting of other VS2 offset sites at SAL - Regular plant release (4 X annually) - Weed and pest control. - Replacement of any dead plants - Planting of replacement totara trees on Hingaia Is 2.
4 – 35	Monitoring, management, reporting as per Section 8	Monitoring, management, reporting as per Section 8

8.2.5 Expected Biodiversity outcomes:

The western planting area will build on existing native forest patches and see exotic pine plantation and weed-infested areas converted to a contiguous area of native vegetation.

Adjacent patches of forest will provide a source of colonising native ferns, epiphytes and non-vascular flora as well as seed for vascular species.

The actual loss of the vegetation is projected to be at least 10- 20 years after the offset planting begins. The offset planting should be well established prior to actual loss of the vegetation reducing the time lag between the loss of ecological values and their replacement by the offset planting. Advance planting helps to maintain ecological values in the landscape and provide assurance that the offset will succeed and provide the modelled biodiversity benefits.

8.3 Years 16 -30

All except 3ha of kānuka offset planting will have been completed by Year 15.

8.3.1 The planting site

The last 3ha of VS2 will be planted in Year 16 in the far northeast corner of the SAL site adjacent to SEA_T_5323 (Figure 17). It is a steep gully head with a small stream at the bottom. It currently supports some 3ha of plantation pine forestry on the upper slopes with regenerating native broadleaved scrub and native tree ferns surrounding the watercourse (1.1ha). The pines will be cleared and the gully fully restored to native vegetation.

Relict tree replacement planting

Replacement planting for relict trees will be undertaken in Year 16 - 18 at the Fulton Hogan Tuakau sand works site. A total of 628 young trees (kahikatea, pukatea, rimu: 1.14ha) will be planted adjacent to existing protected kahikatea forest. Pioneer vegetation as set out in Table 7 will be established prior to planting the trees.

8.3.2 Expected biodiversity outcomes

Biodiversity offset planting for loss of 8.8ha of VS2 Kānuka forest/scrub and replacement planting for the loss of 130 relict trees will be completed by Year 16. This will see the biodiversity offset implemented prior to the loss of the VS2 kānuka and most of the trees on the eastern edge of the Sutton Pit since this vegetation lies in an area proposed to be mined between Year 30 and Year 50. The offset planting may therefore have at least 10 and 20 years to establish prior to vegetation loss, allowing the replacement of some biodiversity attributes ahead of their loss within the Project area.

As shown in Figure 3 the EOPP and the EOEMP for the Sutton Block, once fully implemented, and combined with earlier offset planting and proposed offsetting for freshwater effects, will see the majority of the land outside of the quarry footprint revegetated or maintained in native vegetation. This will be protected and managed for biodiversity conservation purposes over an extended period (20 – 30 years). Plantations of exotic pines will be removed from several parts of the site and replanted in native vegetation.

Community and mana whenua aspirations have been included in the design of the offset and these actions will provide important social and cultural benefits to surrounding communities.

Overall, the integrated biodiversity offset package for the Sutton Block will provide a connected and cohesive landscape of existing and regenerating native vegetation, containing a full range of terrestrial habitats.

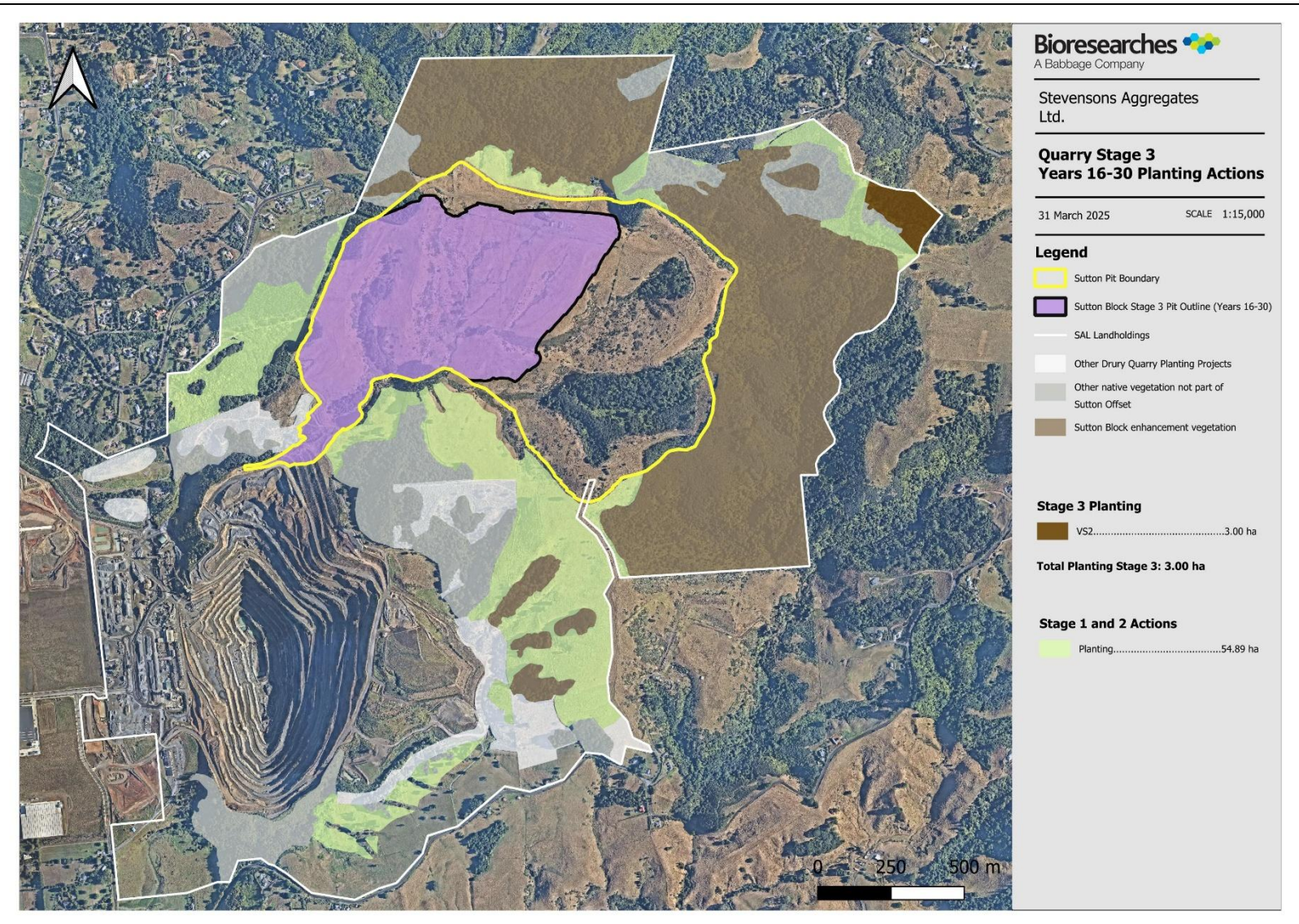


Figure 17 Area of VS2 kākūka scrub/forest to be planted from Year 16.

9 NGA MOTU O HINGAIA ISLAND 2 PLANTING PLAN

9.1 Purpose of the planting

A total 5ha of revegetation planting will be implemented on Hingaia Island 2. The planting has three purposes:

1. To partially offset the loss of Kānuka scrub/forest in the footprint of the Sutton Pit
2. To align with mana whenua aspirations for Ngā Motu o Hingaia to be fully restored to appropriate native vegetation and habitats.
3. To plant groups of totara trees amongst the pioneer planting to replace 14 individual totara trees to be lost in the footprint of the Sutton Pit in Stages 4 & 5.

The proposed restoration planting is designed to provide a “like for like” offset that is appropriate to the site conditions. Kānuka scrub/forest is a widespread and common vegetation type in Aotearoa/NZ and the species composition varies according to local conditions. As a seral ecosystem type kānuka scrub/forest is generally succeeded by climax forest types in the absence of disturbance such as grazing. The proposed planting schedules reflect both the vegetation composition within the Sutton pit and the climatic conditions that exist on Hingaia Island 2.

9.2 Location of planting

Ngā Motu o Hingaia lie at the confluence of the Whangapouri, Ngakaroa and Hingaia Streams as they flow into the upper reaches of the Manukau Harbour at Drury.

Low lying parts of the island have already been restored as saline wetland and coastal scrub as part of biodiversity offsetting for the adjacent Auranga precinct development in Drury.

SAL offset planting will occur on higher parts of the island, generally 5 -10m a.s.l.⁷ where hill-slope shrubland and forest environments occur.

Completion of the indigenous terrestrial planting on the island is an aspiration of Ngāti te Ata Waiohū for Ngā Motu a Hingaia.

9.3 Plant habitats

Ngā Motu o Hingaia Island 2 has a generally benign environment with mild climatic conditions. Existing restoration planting has established well.

The proposed planting areas were formerly grazed by cattle and supported pasture and a number of exotic trees that have since been removed. The land is currently rank pasture grasses with a few small wilding pines and gorse bushes. The soil is mapped as Manuherikia sandy loam which is generally well-drained with good soil moisture retention and low susceptibility to nitrogen leaching (Landcare Research Smap Online). It is located within the western extent of the Manukau Ecological District and experiences a mild climate with some coastal influence. Review of previous monitoring reports for existing planting on the island (RMA Ecology December 2023) has highlighted a potential need for good control of rabbits and hares prior to planting and good weed control; particularly of

⁷ Above Sea Level

gorse (*Ulex europaeus*), privet (*Ligustrum lucidum*), woolly nightshade (*Solanum mauritianum*) and wilding pines (*Pinus radiata*).

9.4 Planting implementation

Drury Island 2 will be planted in Stage 2 between Years 10 and 15 of LOQ for the Sutton Pit. This will result in the group of three small islands in the Hingaia estuary being fully restored to native vegetation. The coastal influence on climatic conditions requires the establishment of a suite of hardy pioneer species followed by the introduction of less hardy species to provide diversity and future canopy species.

Phase 1: Following site preparation, including weed control and any rabbit/hare control that may be necessary the main planting of hardy pioneer species will be undertaken (Table 20), followed by the introduction of enrichment species in Years 3 – 5 (Table YY).

Relict trees replacement planting: Amongst the pioneer vegetation it is proposed to plant ten groups of larger grade totara trees: seven groups of 11 trees and three groups of 12 trees (113 trees) to replace mature totara trees that will be lost to the Sutton Pit project. The trees will be spaced 3 – 5m apart within groups and are intended to act as “seed islands”⁸, growing up quickly and attracting native birds, bringing the seed of other native plants to the islands. Grouping the trees in easily accessed locations allows them to be specifically managed and nurtured.

Phase 2 planting: will introduce greater diversity to the restoration planting. Later introductions of enrichment species such as porokaiwhiri, rewarewa, tanekaha and whauwhaupaku can be added to the groups of totara trees as appropriate, where they will benefit from the established shelter. These species are natural associates of tōtara.

It is appropriate to include a good number of tōtara in the planting mix since the VS2 vegetation being lost at the Sutton pit contains a significant component of tōtara.

Planting of archaeological sites

Three archaeological sites have been identified on Hingaia Island 2, one on the northern side and two on the southwestern side (Figure 18). These sites are all shell middens on the eroding coastal edges of the island, and all have been damaged by past land use practices and bank erosion (Cruikshank 2017). A 50m planting buffer zone around the sites has been proposed (RMA Ecology 2025).

The Department of Conservation (DOC) recommend the use of shallow-rooted plants where planting is proposed around or within archaeological sites (Jones 2007). The list of suggested species in the DOC publication includes a number of plant species that are specified in Table 20 of this report. Plant species suitable for planting adjacent to the archaeological sites are kānuka, manuka, koromiko, and mingimingi *Coprosma propinqua*.

No planting will be undertaken within listed archaeological sites, as per DOC policy for not planting on such sites.

⁸ See Tane’s Trees Trust 2024 Waikereru Ecosanctuary Seed Island Project.

Threatened and At-Risk species

There is some scope to include small numbers of threatened and at-risk species of plants where appropriate, and where habitats are available. Possible candidates would be tawapou (*Planchonella costata*), purple hebe (*Veronica speciosa*) and mangeao (*Litsea calicaris*), all of which are found in coastal habitats. Further consultation with DOC and iwi would be required and sources of planting stock found before deciding on which species could be planted as part of the biodiversity offset.

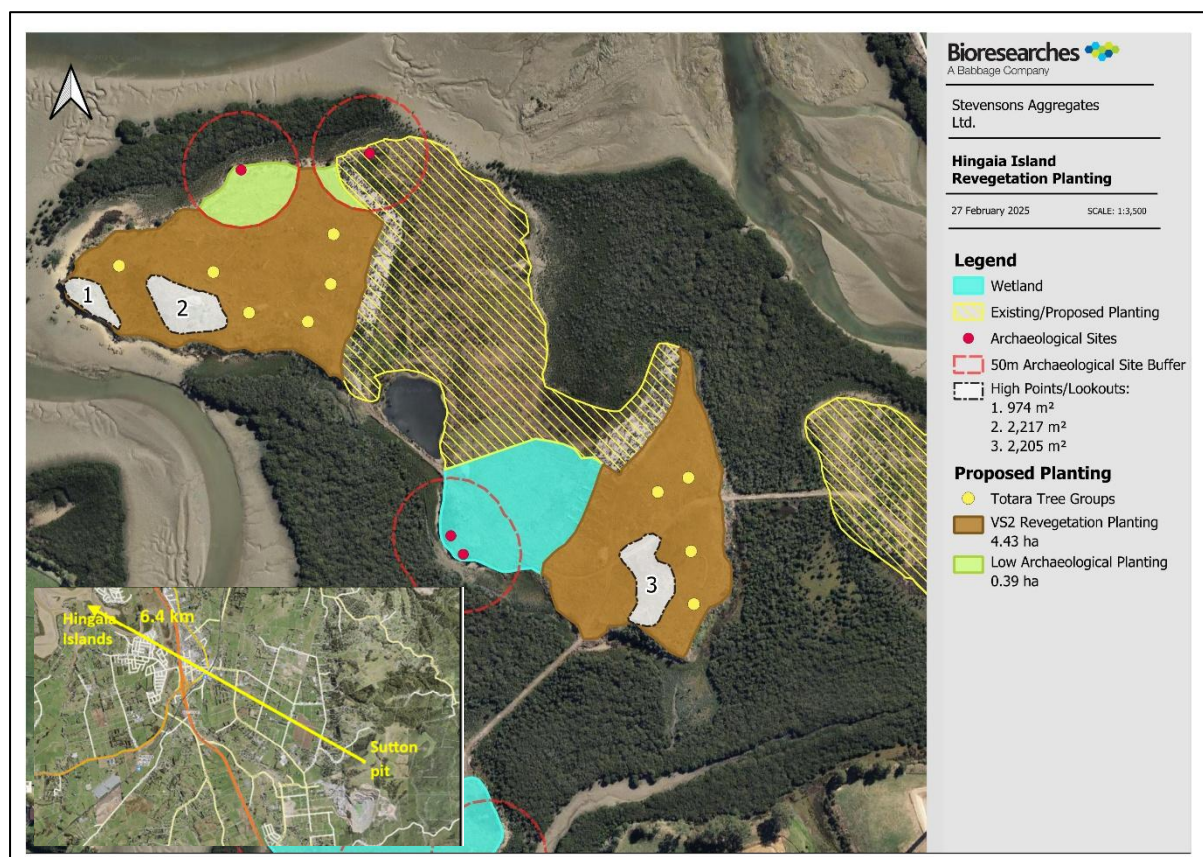


Figure 18 Terrestrial planting proposed for Hingaia Island 2 Yellow dots show positions for totara tree replacement planting groups (seed islands).

9.5 Ngā Motu o Hingaia Island 2 Planting schedule

Pioneer species must be hardy to exposure, wind and summer dry periods (Table 20). All plants must be well grown for their pot size and fully hardened off outside the nursery prior to planting.

Schedule A lists suitable species, grades, spacing and % of the mix. Schedule B includes enrichment species and some further canopy species to be planted amongst the developing pioneer canopy after 3 – 5 years.

Table 20: Indicative Pioneer and Enrichment plant schedules for Ngā Motu o Hingaia Island 2

Common name	Botanical name	Grade	Spacing /m	% of mix (Up to)	# of plants/ha
A:PHASE 1					
Akeake	<i>Dodonaea viscosa</i>	0.5L	1.4	10	510

Harakeke	<i>Phormium tenax</i>	0.5L	1.4	5	255
Houpara/ Coastal five finger	<i>Pseudopanax lessonii</i>	0.5L	1.4	5	255
Kānuka*	<i>Kunzea robusta</i>	0.5L	1.4	30	1530
Karamuramu & Karamu	<i>Coprosma macrocarpa</i> <i>subsp. minor</i> <i>Coprosma robusta</i> / <i>Coprosma lucida</i>	0.5L	1.4	10	510
Karo	<i>Pittosporum crassifolium</i>	0.5L	1.4	5	255
Koromiko	<i>Hebe stricta</i> var. <i>stricta</i>	0.5L	1.4	10	510
Mānuka*	<i>Leptospermum scoparium</i>	0.5L	1.4	20	1020
Mingimingi	<i>Coprosma propinqua</i>	0.5L	1.4	5	255
Totals				100	5100
B: PHASE 2 enrichment species					
Horoeka/Lancewood	<i>Pseudopanax crassifolium</i>	1L	1.4	10	40
Houhere	<i>Hoheria populnea</i>	0.5L	1.4	10	40
Kohuhu	<i>Pittosporum tenuifolium</i>	0.5L	1.4	10	40
Mahoe	<i>Melicytus ramiflorus</i>	0.5L	1.4	15	60
Porokaiwhiri*	<i>Hedycarya arborea</i>	1L	1.4	5	20
Rewarewa*	<i>Knightia excelsa</i>	1L	3	10	40
Tanekaha*	<i>Phyllocladus</i> <i>trichomanoides</i>	1L	5	5	20
Totara*	<i>Podocarpus totara</i>	2L	3 – 5	10	40
Whau	<i>Entelea arborescens</i>	0.5	1.4	10	40
Whauwhaupaku	<i>Pseudopanax arboreus</i>	0.5L	1.4	15	60
Totals				100	400

* Species to form seed islands

9.6 Pest and weed control

Pest and weed control will generally follow the methods set out in Sections 4 and 6 of this report. The final configuration and implementation of the pest and weed control programme will be agreed between the stakeholders including Ngāti te Ata Waiohua. There will be no requirement for stock-proof fencing as there will be no livestock present.

9.7 Expected biodiversity outcomes

Completion of the indigenous terrestrial planting on the island is an aspiration of Ngāti te Ata Waiohū for the Hingaia Islands. The islands lie in Manukau the lowlands, south of the Manukau Harbour where historic land clearance for agriculture has left the landscape depauperate of native vegetation. The local Drury/Karaka area is undergoing rapid urbanisation and native habitats of all types are under pressure. The proposed planting offers an opportunity to restore local habitats and especially an ecotone from estuarine mangrove forest through saltmarsh and coastal scrub to terrestrial kānuka scrub/forest.

9.8 Monitoring and Reporting

Monitoring and reporting for all planting sites is set out in Section 11 of this report. Data collection sites for Ngā Motu o Hingaia Island 2 are as follows:

- 2 plots in Kānuka Scrub/Forest (VS2), one in each of the eastern and western planting areas.
- Measure dbh and height of 50% of replacement totara trees and calculate total basal area and mean tree height.

10 TUAKAU SITE RELICT TREE REPLACEMENT PLANTING PLAN

10.1 Purpose of the planting

The purpose of the planting is to replace 107 individual kahikatea, pukatea and rimu trees to be lost from the footprint of the Sutton Pit, in Stages 3 and 4.

10.2 Location of planting

The replacement trees will be planted at the Tuakau Sand works adjacent to the Waikato River. The property is owned by Fulton Hogan, the parent company of SAL and can provide suitable habitat for these species which the SAL site does not provide. The proposed planting area is adjacent to existing kahikatea forest and close to proposed offset planting for loss of wetlands for the Sutton pit (Figure 19).

10.3 Plant habitats

This site lies adjacent to the lower Waikato River near Tuakau. It currently supports areas of remnant Kahikatea Forest and open pasture. The soils are mapped as Typic Orthic Gley Soils formed in alluvial sand silt or gravel deposited by running water, from rhyolite parent material. These soils are poorly drained and may become seasonally waterlogged. The site provides suitable habitat for the establishment of kahikatea, pukatea swamp forest vegetation (Singers et al 2017).

10.4 Plant schedule

Pioneer species (Table 7) will be planted first, followed by 565 young kahikatea, 58 pukatea and 5 rimu after 2 – 3 years. All replacement trees will be 2L grade.

Table 21: Indicative Pioneer and Enrichment plant schedules for Kahikatea/pukatea/rimu relict tree replacement planting(1.14ha)

Common name	Botanical name	Grade	Spacing/m	% of mix	# of plants
A:Phase 1 planting					
Harakeke	<i>Phormium tenax</i>	0.5L	1.8	30	1057
Mānātu/ribbonwood	<i>Plagianthus regius</i>		1.8	5	175
Mānuka	<i>Leptospermum scoparium</i>		1.8	30	1057
Putaputaweta	<i>Carpodetus serratus</i>	1L	1.8	5	175
Tī kōuka/cabbage tree	<i>Cordyline australis</i>		1.8	30	1057
Total				100	3521
B:Phase 2 planting					
Kahikatea	<i>Dacrycarpus dacrydioides</i>	2L	4.26	90	565
Pukatea	<i>Laurelia novae-zelandiae</i>	2L	4.26	9	58
Rimu	<i>Dacrydium cupressinum</i>	2L	4.26	1	5
Total					628

10.5 Planting implementation

Replacement planting for relict trees will be undertaken in Year 16 - 18 at the Fulton Hogan Tuakau sand works site. A total of 628 young trees (kahikatea, pukatea, rimu: 1.14ha) will be planted

adjacent to existing protected kahikatea forest. Pioneer vegetation as set out in Table 7 will be established prior to planting the trees.

The trees will be spaced 4.26m apart from one another on average with the remainder of the planting being made up of pioneer species (Table 7) at an average spacing of 1.8m between them. The spacing of the pioneer species is greater than for that recommended for full revegetation planting. This will allow the replacement trees to establish and grow more quickly. Weed control and plant release will need to be assiduously done to ensure the plants establish and thrive in the early years.

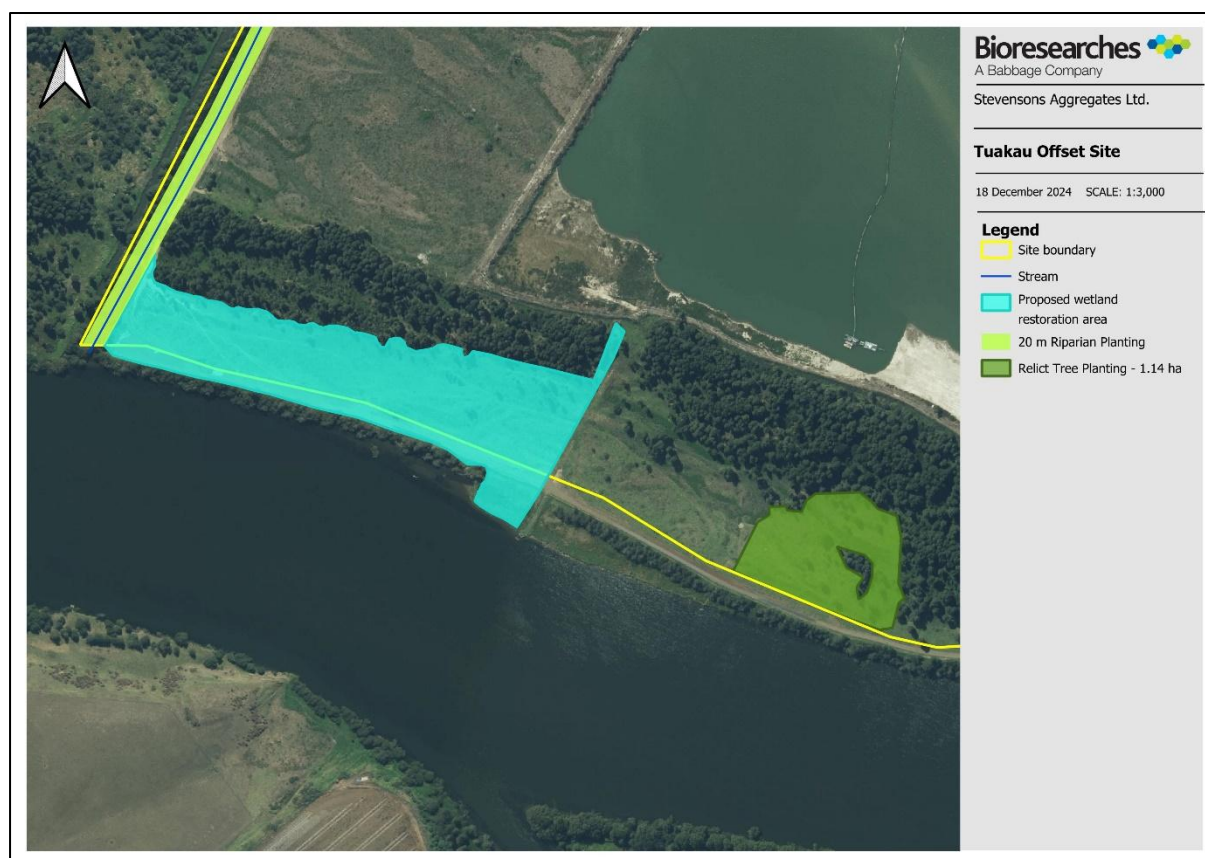


Figure 19 Location of relict tree offset planting at the Tuakau site.

10.6 Expected biodiversity outcomes

The proposed replacement planting at Tuakau sand works will restore kahikatea forest to an area of river floodplain that is currently pasture. Combined with the proposed wetland offset planting it will buffer and expand existing kahikatea forest that is being managed for biodiversity conservation purposes. Kahikatea forest was originally very common and widespread along the lower reaches of the Waikato River but has been extensively replaced by pasture and exotic willows (*Salix* spp.) due to historic land clearance and modification.

10.7 Monitoring and reporting

Monitoring and reporting for all planting sites is set out in Section 11 of this report. Data collection sites for the Tuakau site tree replacement planting are as follows:

- Measure the dbh and height of 10% of each tree species within the planting area and calculate total basal area and mean tree height.

11 MONITORING AND REPORTING FOR ALL PLANTING SITES

Monitoring will be undertaken annually for the first five years, followed by long term monitoring thereafter in Years 7, 10, 15, 20 and 30, at which time a detailed report will be prepared assessing the progress of the revegetation planting against the biodiversity offset targets and BOAMs contained in Table 19 to Table 23 of the REAR-TE. These reports must identify any major contingencies that need to be implemented such as remodelling of any biodiversity attributes in response to actual results or adjustment of timescales and adaptive management.

11.1 Record keeping

Detailed records must be kept by planting contractors, weed and pest control contractors, including the following:

Planting: species, numbers, grade & spacing. Photographs of planting stock.

Weed control programme: Species controlled, dates undertaken and location map, methods of control, herbicides used & effectiveness of control methods. A summary of weed control outcomes for the year to be forwarded to Drury Quarry Environmental Manager in November each year.

Pest control: Target species, dates undertaken and location map of traps/bait stations and areas of shooting, kill tallies and bait uptake. A summary of pest control outcomes for the year to be forwarded to Drury Quarry Environmental Manager in November each year.

These records form part of the monitoring and reporting programme.

11.2 Monitoring of establishment phase: Years 1 - 5.

11.2.1 Planting completion

At the completion of the pioneer planting in each identified planting area a planting completion report should be prepared by a suitably qualified person verifying that planting has been completed in accordance with the detailed restoration planting plan for the area. This completion report will form part of annual monitoring.

11.2.2 Annual monitoring

Annual monitoring in the first 5 years for each planting area should include the following information and assessment parameters at a minimum:

- Description of planting (species, numbers, grade & spacing), pest and weed management undertaken in the preceding 12 months;
- Plant survival and growth;
- Note any species or specific areas that are performing poorly;
- Weed presence and effectiveness of pest plant control;
- Effectiveness of pest control;
- Plant species density and diversity;
- Canopy closure and mean height.
- Identification of any replacement planting or additional planting required.
- Identification of any additional weed or pest management required.
- Recommendations on any changes required to the NGDP:PP

Monitoring reports should identify any adaptive management required in the coming year to ensure each planting area develops in line with the BOAM and the detailed restoration planting plan for that biodiversity type. Any alterations to the percentages listed for each species or substitutions

with other species not listed in the plant schedules for each biodiversity type must be approved by the project botanist in advance of any infill/ replacement planting. This report is to be provided to Council within three months of the annual audit being undertaken.

11.2.3 Planting Establishment Report:

Within 12 months of the completion of five years annual monitoring of the planting in each identified planting area, a planting establishment report is to be prepared by the project ecologist verifying that planting has been completed in accordance with the approved detailed restoration planting plan for the area and all relevant resource consent conditions.

A series of permanently marked Recce plots and photo points are to be established within each planting area to collect quantitative data on the following biodiversity attributes for comparison with modelled targets as follows:

- a) Indigenous Canopy cover (%)
- b) Indigenous ground cover (%)
- c) Total native vascular plant species richness
- d) Native ground cover species richness
- e) Mean canopy height
- f) Leaf litter depth (mm)
- g) Photo points taken from each corner of the plot facing into the centre.

The Planting Establishment Report must set out the results of the plot measurements at year 5 and provide an assessment against the modelled 5-year monitoring targets for the relevant vegetation type contained in the REAR-TE Section 3 (Tables 41 – 51).

The assessment must consider whether the revegetation area has the appropriate species diversity and structural characteristics to enable it to meet the modelled targets and adhere to the detailed restoration planting plan. Any major adaptive management actions, contingencies or adjustments to the model should be identified at this time and appropriate action taken.

11.2.4 Data collection sites

- Plot locations should be representative of the average condition of the total area of revegetation and should aim to provide wide spatial coverage where offset monitoring requires multiple plots.
- Four 10 x 10 m Recce plot should be used in place of one 20 x 20 Recce plot if better representation is achieved. This may be a useful approach on the western slopes above Macwhinney Drive where there are several different planting areas.
- Plot locations should be permanently marked, and data collection repeated at the same locations in every monitoring year.
- Rock forest will have a greater density of monitoring plots due to its higher value and greater contingency risks.
- Monitoring data will be collected from WF9, rock forest and kānuka revegetation areas within fourteen standard 20 x 20 Recce plots as follows:
 - Drury Quarry
 - 2 plots in Rock Forest (1 plot/4ha)
 - 7 plots (1 per 4.5ha) in Taraire, Tawa Podocarp Forest (WF9)
 - 3 plots (1 per 5.6ha) in Kānuka Scrub/Forest (VS2)

- Ngā Motu o Hingaia Island 2:
 - 2 plot in Kānuka Scrub/Forest (VS2)
 - Measure dbh⁹ of 50% of replacement totara trees
- Relict tree offset planting at Drury Quarry, Ngā Motu a Hingaia, Tuakau
 - Measure dbh of 10% of each species across each site and calculate total basal area.

11.3 Long Term monitoring Years 7 – 30.

11.3.1 Progress monitoring Years 7, 10, 15, 20 & 30

Following the issue of the Planting Establishment Report, progress monitoring will be undertaken by a suitably qualified and experienced person (SQEP). All parts of the offset planting areas will be walked through, and the following qualitative information recorded:

Description of the survival and growth rate of planted specimens, average canopy closure, average height and plant diversity:

- Evidence of natural regeneration and colonisation by native flora and fauna species;
- Evidence of development of forest community structure.
- Fauna habitat values and native bird abundance.
- Description of pest and weed management undertaken and its effectiveness.
- Description of any replacement planting, or other remedial actions or adaptive management undertaken since the last monitoring report.
- Identification of any replacement planting or adaptive management or other remedial actions required before the next monitoring report.
- Identification of any additional weed or pest management required.
- Recommendations on any changes required to the NGDP:PP

The purpose of the progress report is to identify actions that need to be taken in the coming years to ensure each planting area develops in line with the modelled targets and the detailed restoration planting plan for that biodiversity type (contained in this report, the EOCPP).

This report is to accompany the long-term monitoring review, undertaken 7, 10, 15, 20 & 30 so that both qualitative and quantitative data is collected.

11.3.2 Long term monitoring review Years 7, 10, 15, 20 & 30

A full review of for each planting area shall be conducted by a SQEP at Years 7, 10, 15, 20 and 30 following completion of the implementation of planting.

The purpose of each review is to gather quantitative data to determine whether the biodiversity offset strategies used to address the ecological effects of the project are achieving the modelled 10-, 20- and 30-year monitoring targets contained in the REAR-TE and associated management plans for each area.

Permanently marked Recce plots and photo points (as established at Year 5) are to be used within each biodiversity planting type (VS2, WF9 & RF) to collect data on the following biodiversity attributes for comparison with modelled targets as follows (Table 22):

⁹ Diameter at breast height

Table 22 **Measurement of biodiversity attributes for revegetation areas: WF9, WF7.2, & VS2 Years 5 – 30.**

Biodiversity attribute	Plot Collection method
Indigenous Canopy cover (%)	Standard Recce method
Indigenous subcanopy cover (%)	Standard Recce method
Indigenous understorey cover (%)	Standard Recce method
Indigenous ground cover (%)	Standard Recce method
Total native vascular plant species richness	Standard Recce method
Native ground cover species richness	Standard Recce method
Basal area (m ² /ha)	Measurement of canopy species only
Mean canopy height/m	Standard Recce method
Log fall (m ³ / ha)	Within each plot, measure diameter x length of all woody objects >2cm diameter. Calculate total volume and convert to m ³ / ha. Monitoring value is mean of all plots for that biodiversity component.
Leaf litter depth (mm)	Within each plot, take five measurements of leaf litter depth: four corners and one in plot centre. Monitoring value is mean of all plots for that biodiversity component.
Native winter fruit diversity (count)	Monitoring value is total species richness recorded from all plots for that biodiversity component.
Native winter flower diversity (count)	Monitoring value is total species richness recorded from all plots for that biodiversity component.

Relict tree replacement planting monitoring

This revegetation area is being managed to replace individual relict trees within the Sutton Pit footprint. Key attributes to be replaced are canopy height and basal area. These are the main attributes to be monitored (Table 23).

Table 23 **Measurement of biodiversity attributes for revegetation areas: Relict tree replacement planting (WF8) Years 5 – 30.**

Biodiversity attribute	Plot Collection method
Indigenous Canopy cover (%)	Standard Recce method
Basal area (m ² /ha)	Measurement of canopy species only
Mean canopy tree height/m	Measurement of canopy species only

An Offset Planting Progress Report must be prepared for submission to council within 12 months of each planting area having reached the 7, 10, 15, 20 and 30 year anniversaries since planting.

The report must compare measured data with modelled monitoring targets and consider whether the progress of the planting to date is likely to result in the achievement of the modelled endpoint target for each biodiversity type. Any major adaptive management actions, contingencies or adjustments to the model should be identified at this time and appropriate action taken.

If there is risk of not achieving modelled targets, contingency actions as set out in the REAR-TE, or other actions deemed necessary by the project ecologist must be identified and agreed with SAL management. Implementation should occur within 2 years of the issue of the report.

11.4 Risks and contingencies

Risks and contingencies must be considered as part of the planting plan. Key risks include:

- Fire
- Drought
- Extreme weather events
- Pests and diseases

Fire

Fire is a significant risk as climate change increasingly results in hotter, drier summers and periods of drought. Fire risk needs to be considered when selecting plant species for restoration planting and determining the placement of more flammable species such as kānuka and manuka within the planting area. Generally, more flammable species should not be grouped together or planted too densely. Some species such as mahoe produce a flammable litter and placement of these species also needs to consider fire risk.

A challenge with the restoration planting is that manuka and kānuka are typical first colonisers of vacant habitat as part of natural regeneration and these two species provide ideal protection for young canopy trees to establish. Manuka and kānuka should not comprise more than 50% of the overall species mix and interspersed with broadleaved species to keep them at a lower density within the planting.

Prior to large scale planting being established a well- conceived risk and contingency plan will need to be implemented to ensure any fires can be quickly put out without threat of catastrophic loss of native vegetation. Such a plan will need to consider water sources, volume available and access to the planted areas for firefighting machinery.

Drought

In addition to planting during cooler wetter times of the year, careful consideration should be given to plant microhabitats to ensure that hardy, drought resistant species are planted in dryer, more drought- prone habitats such as exposed ridges. Watering of plants may need to be considered if there is a high risk of large plant losses to drought.

Extreme weather events

Extreme weather events are a risk to restoration planting, particularly flooding and high winds. Little can be done to mitigate the risk except to be aware that any affected areas of planting will need remediation.

Pests and diseases

Key concerns are myrtle rust and kauri dieback disease. It is imperative that seed and propagation material for all myrtaceous species are sourced from disease-free locations and grown in nurseries with the appropriate phytosanitary certification processes. It is not planned to plant kauri as part of offset planting at Drury Quarry since the species does not occur within areas of vegetation to be lost.

11.5 Adaptive Management

11.5.1 Remodelling for planting in advance of loss

All offset planting for rock forest (WF7.2) and WF9 will have been implemented by the beginning of Year 10, a total of 40.32ha. If net present biodiversity component values have been met or exceeded at this stage, the remaining obligation to plant a further 22ha of VS2 can be remodelled based on the updated data and any further benefits that can be expected from advance planting of this vegetation. For VS2, advance planting has not been modelled yet because the exact timing for its loss at Stages 4 & 5 cannot be accurately determined so far into the future. It is possible that a lesser amount of planting for VS2 may be sufficient to provide a net gain in biodiversity values based on planting in advance of loss.

11.5.2 Remodelling if biodiversity goals are not met.

Based on the complexities of this ecological offset, a two-tier system will be provided based on remodelling of attribute values as necessary:

1. If net present biodiversity component values at Years 5, 10, 15, 20 and 30 are below the modelled values for these years for any biodiversity type, but within 10 % of the targets, then only notification is required at time of reporting. Adaptive management and remediation should be proposed to address the shortfall and ensure the restoration remains on track to meet the 30 year targets.
2. If net present biodiversity component values are below modelled values, and are greater than 10 %, below targets, then additional modelled actions must be presented for certification. Any requirement to increase the area of planting or other offset actions such as alterations to the percentages listed for each species or substitutions with other species must be informed by expert opinion and consultation between stakeholders.

Monitoring targets are provided in Table 19 to Table 23 of the REAR-TE. These are based on the modelled outcomes. While ultimate success will be determined at 30 years, the targets provide an indication of expected values for attributes at each 5-yearly interval with the gradual development and maturation of the offset vegetation. Failure to meet biodiversity attribute targets prior to 30 years may not necessarily result in failure of the offset, however monitoring outcomes that result in values that are short of the targets would inform adaptive management actions, such as additional planting, watering, provision of fertilisers, or wind protection.

11 SUMMARY OF BIODIVERSITY OUTCOMES

Proposed revegetation planting at Drury Quarry will result in the revegetation of 40.48 ha of reforestation of rock forest, broadleaved podocarp forest and kānuka scrub/forest over a period of 20 – 25 years as the Sutton Pit Project progresses over the next 40 – 45 years.

Over half (56%) of the revegetation planting will occur at least 10 years in advance of the loss of vegetation, providing very important biodiversity gains ahead of vegetation loss and addressing time lags inherent in loss of vegetation. Advance planting allows for long-term monitoring of up to 30 years for slow-maturing forest types such as rock forest and taraire forest and up to 20 years for seral kānuka forest, ensuring all planting is self-sustaining by the time monitoring finishes.

The reforestation at Drury Quarry, will protect important habitats for native fauna and establish a large area of new native vegetation encircling the southern side of the proposed Sutton Pit Project.

The proposed biodiversity offset actions will connect isolated patches of remnant rock forest, restore degraded habitats and provide a contiguous tract of forest between the highly valued Kaarearea Paa rock forest and the large area of SEA_T_5323 that extends northward across the Drury Hills towards the Hunua Ranges. It represents a significant improvement in the extent, quality and connectivity of local indigenous biodiversity and habitats.

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Disclaimer and restrictions of intended purpose

This report has been prepared solely for the benefit of Stevenson Aggregates Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

JS Ecology has performed the services for this project in accordance with the standard agreement for consulting services and current professional standards for environmental site assessment. No guarantees are either expressed or implied.

Recommendations and opinions in this report are based on discrete sampling data. The nature and continuity of matrix sampled away from the sampling points are inferred and it must be appreciated that actual conditions could vary from the assumed model.

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Appendix 1 Control methods for pest plants found within offset planting areas for Sutton Pit Project

Common name	Scientific name	Control method(s)	Herbicides and application rate	Time of application	comments
Barberry	<i>Berberis glaucocarpa</i>	(i) Hand pull seedlings & small plants (ii) Cut and paint stump with herbicide	(ii)metsulfuron-methyl 600g/kg (5g/L).	(i)All year round: (ii) All year round	Cut stumps resprout quickly, can be hard to kill. Follow up 6-monthly
Blackberry	<i>Rubus fruticosus</i>	(i)Dig out or cut and paint stumps. (ii)Foliar spray with Metsulfuron	(i) metsulfuron gel. (ii) 5 g Metsulfuron + 10 ml Penetrant/10 litres water	(i) November to April (ii)Apply Metsulfuron November to April	Plant material should be burned or disposed of at a refuse centre. Only mulch dead plant material.
Eleagnus	<i>Eleagnus reflexa</i> x	(i)Dig out with machinery if possible. (ii). Cut at ground level & stump paint. Follow up likewise on suckers. (iii). Bore & fill large stems at ground level (iv) Spray small plants and regrowth.	(ii) Glyphosate (250ml/L) or a product containing 100g picloram+300g triclopyr/L (undiluted) or picloram gel. (iii) 20 ml undiluted Tordon BK per hole. (iv) (5g metsulfuron /10L)	 (iii) Best done in autumn.	(i) & (ii) Do not mulch. Remove cut material from site (iii) Inferior to stump painting but eliminates need to dispose of stems, which can be cut & removed once dead.
Gorse	<i>Ulex europaeus</i>	(i)Dig out or rotary slash. (ii) cut and paint stumps with herbicide (iii) Foliar spray	(ii) Paint stumps with 2g metsulfuron per 1 L of water. (iii). Foliar spray with 5g metsulfuron-methyl per 10L of water and 20ml penetrant or	(i)All year round (ii) All year round (i)November - February	(i) Do not burn as this triggers seed germination (ii)Ensure stumps are painted with herbicide within <u>5 minutes</u> of felling.

			foliar spray with 60ml triclopyr per 10 Litres of water and 20ml penetrant.		
Hawthorn	<i>Crataegus monogyna</i>	(i) Hand pull seedlings & small plants (ii) Cut and paint stump with herbicide	(ii)metsulfuron-methyl 600g/kg (5g/L)).	(i)All year round: (ii) All year round	Cut stumps resprout quickly, can be hard to kill. Follow up 6-monthly.
Kikuyu	<i>Cenchrus clandestinus</i>	(i)Spray with herbicide	(i) Foliar spray with 100ml glyphosate green per 10L of water and 20ml penetrant or 150ml haloxyfop-P-methyl per 10L of water.	(i) October-April	2-3 treatments required. Spray during drought or other stress if using near watercourses.
Moth plant	<i>Araujia sericifera</i>	(i) Destroy ripe pods (ii) Pull/dig out seedlings where feasible. (iii) Foliar spray where host plants will not be affected (iv) Cut stems low down and paint stumps where growing on desirable host plants. Paint 20cm of the stem below the cut as well.	(iii)5 g Metsulfuron /10 litres water and 20ml penetran (iv) 1g metsulfuron-methyl per 1 L of water or metsulfuron gel.	(i) March - May (ii) Year round (iii) October - March (iv) October - March	(i) pick pods off plants and dispose of to deep landfill (ii) & (iii) leave uprooted or sprayed plants to compost (iv) Leave cut vegetation to die on host plant.
Pampas (common and purple)	<i>Cortaderia selloana</i> , <i>C. jubata</i>	(i)Hand dig small plants or use a digger to remove large clumps or (ii) Foliar spray larger plants & clumps	(ii) Foliar spray with 200ml glyphosate green per 10L of water and 20ml penetrant or 150ml haloxyfop-P-methyl per 10L of water.	(i) All year round (ii)October-March for best results	Burn or mulch cut vegetation or send to landfill. (ii)Thoroughly cover all foliage with spray. 2-3 treatments required.
Poplars	<i>Populus deltoides</i>	(i)Cut and squirt large plants make 1 cut every 100mm around the trunk	(i) 10g metsulfuron-methyl per 1L of water	(i)all year round:	

		and fill or saturate each cut with herbicide (ii) Cut trunk and paint stump with herbicide	(ii) metsulfuron gel.	(ii) all year round	(ii) Cut trunk near to the ground, and swab freshly cut stump
Privet (Chinese & tree)	<i>Ligustrum sinense</i> <i>Ligustrum lucidum</i>	(i) Pull/ dig out seedlings where feasible or (ii) foliar spray (iii) cut and treat stump for larger plants or (iv) Drill trunk and inject. Drill 18mm holes every 150 mm around the trunk and saturate each hole with herbicide	(ii) 5 g Metsulfuron /10 litres water (iii) 10g metsulfuron-methyl per 1L of water (iv) 10g metsulfuron-methyl per 1L of water.	(i) All year round (ii) October-April (iii) October-April	(i), (ii) & (iii) Compost, burn or mulch cut vegetation. (iii) Ensure stumps are painted with herbicide within <u>5 minutes</u> of felling. (iv) leave to die standing
Wild ginger		(i) Cut stems and dig out rhizomes of small plants (ii) Cut down and paint stump: cut above pink 'collar' at base and apply herbicide.	(ii) 1g metsulfuron-methyl per 1 L of water	(i) All year round (ii) All year round	<u>(i) Do not leave tubers on site – dispose of to landfill.</u> (ii) Leave stems and leaves on site to rot down. Reduce rates to 0.5g metsulfuron-methyl per 1 L of water if working under native forest.
willow	<i>Salix fragilis</i> <i>Salix cinerea</i>	(i) Cut and squirt: Make 1 cut every 150mm around the trunk and saturate with herbicide. (ii) Bore and fill (summer-autumn): Drill 18mm holes every 150 mm around the trunk and saturate each hole with herbicide (iii) Frilling: use a sharp chisel to make a continuous series of cuts around the trunk near ground level. Fill each cut with herbicide.	(i) 500ml glyphosate per 1L of water (ii) 500ml glyphosate per 1L of water (iii) 500ml glyphosate per 1L of water	(i) October-April (ii) October-April (iii) October-April	Begin control at top of catchment, treat every stem. (i), (ii) & (iii) Apply herbicide within 5 minutes of making cuts or holes in the trunk. Under planting with natives can follow as soon as the trees defoliate. Remove any cut material from site.

Woolly nightshade	<i>Solanum mauritianum</i>	(i) Seedlings – hand pull (ii) Cut and paint stumps of larger trees (iii) Frill stem and paste fresh cuts (iii) Trees – drill and inject	(ii) Double strength glyphosate or picloram gel (iii) Double strength glyphosate or picloram gel (iii) Metsulfuron 20g/litre water, plus 2ml surfactant	(i) All year round (ii) All year round (iii) All year round	(i) leave plant material on site to rot or mulch (ii) Ensure stumps are painted with herbicide within <u>5 minutes</u> of felling. (iii) Leave to die standing Avoid using picloram near streams and wetlands.
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Appendix 2 Pest Control methods

Common name	Scientific name	Recommended control method/s	Timing/ density of traps or bait stations	Comments
Possum	<i>Trichosurus vulpecula</i>	(i) Trapping: Timms or Trapinator trap or similar OR (ii) Automatic trap e.g. AT220 (iii) Brodifacoum or Double Tap pellets in bait stations. One bait station/hectare	(i) & (ii) 1 trap per hectare (ii) Place Philproof bait stations 100m apart	(i) Check all traps frequently at first to ensure they are catching pests. Continue to check Timms/Trapinator traps frequently to re-bait and reset (ii) Replace lures and batteries/CO ₂ cylinders as necessary (ii) Check baits frequently at first and replenish as required. Pulse four times annually
Rat: ship rat Norwegian rat	<i>Rattus rattus</i> <i>Rattus norvegicus</i>	(i) Automatic trap e.g. Goodnature A24 or AT220 (ii) Brodifacoum or Double Tap pellets as for possums in bait stations (2/ha).	(i) 2 traps/ha Bait stations can be placed up to 50m apart.	(i) Check all traps frequently at first to ensure they are catching pests. Replace lures and batteries/CO ₂ cylinders as necessary. Check baits frequently at first and replenish as required. Pulse four times annually
Mustelids: ferret Stoat weasel	<i>Mustela furo</i> , <i>Mustela erminea</i> <i>Mustela nivalis vulgar</i>	DOC 200 kill trap baited with a hen's egg or fresh rabbit meat.	1 trap per 3 hectares or every 200m along the riparian corridor.	Check monthly, re-baiting and resetting as necessary. Keep the mechanism in good order using vegetable oil to lubricate.