

ASSESSMENT OF ECOLOGICAL EFFECTS FOR PROPOSED EXPANSION OF THE KIWI POINT QUARRY, NGAURANGA GORGE, WELLINGTON



Māhoe forest on the shady side of the ridge, within the proposed quarry footprint.

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1. INTRODUCTION

Kiwi Point Quarry has been operating on Wellington City Council (WCC)-owned land in the Ngauranga Gorge since the 1920s. The current pit is about 40 metres deep and will be deepened by another 15 metres to reach the highest value rock. Only four to five years of rock remains within the current pit and WCC and the quarry operator hope to extend the life of the centrally-located quarry by extending mining southward. This would require an amendment to the current Open Space B zoning for some of the land required, through a plan change to the Business 2 Zone under the Wellington City District Plan.

The final landform of the proposed quarry would comprise a tall, steep, benched, northeast-facing slope above the excavated pit, which would have similarly-benched slopes rising a shorter distance on other aspects.

The proposed quarry expansion has the potential to affect ecological values, including vegetation that has been identified as being potentially ecologically significant as a Wellington City Council (WCC) EcoSite (Wildland Consultation 2016), and the Ngauranga Stream and Tyers Stream. WCC staff undertook a brief site survey to assess potential effects on ecological values and suggested that a more detailed assessment should be undertaken.

Potential quarry expansion boundaries have already been adjusted to avoid the most mature vegetation types (c.f. Park 1999), but an assessment of ecological effects is required to accompany documents to be submitted by early August 2017. As such, this report includes descriptions of the current vegetation and habitat types, fauna observations (or evaluation of the likelihood of occurrence), potential effects on vegetation (including adjacent to the site), terrestrial fauna, and stream habitat values, measures to avoid or minimise potential adverse effects, and potential mitigation opportunities based on best practice biodiversity offsetting. A subsequent report may be required to provide additional information on site values (for example information on lizards and invertebrates), and details of any mitigation opportunities identified.

2. METHODS

2.1 Review of information

Relevant information on the site and its context was reviewed, including information from databases such as eBird (www.ebird.org/content/newzealand/) and the Department of Conservation's Bioweb Herpetofauna database, the Freshwater Fish database maintained by NIWA, the threatened environment classification, and spatial layers showing land held by Wellington City Council, including existing reserve land.

2.2 Field survey

A five hour site visit was undertaken on 4 July 2017, during which representative areas of indigenous vegetation and habitats were traversed on foot. The weather during the site visit was fine and sunny with light winds. The scope of the site visit was to provide more comprehensive information on habitats, vegetation, and plant

species present. Areas of indigenous vegetation and habitat were mapped and described, and all vascular plant species observed during the site visit were recorded. Birds using the site were also recorded. However the brief period over which the survey was undertaken would only provide a snapshot of bird use of habitats at the site. The winter timeframe of this survey also means that summer-green plant species, such as most orchids, would not be detected, but may be present.

3. ECOLOGICAL CONTEXT

3.1 Site description

The landform on which the proposed quarry would operate, comprises a ridge extending northeast from Gurkha Crescent in the adjacent residential area (Figure 1). The portion of this ridge closest to State Highway 1 is zoned Business 2 (Figure 2) and has previously been subject to disturbance and development, including quarrying on both sides of the ridge at lower elevation, resulting in rocky, terraced hillsides. A bulldozed track also crosses the ridge in this part of the site, and areas of existing indigenous forest have been fragmented. The western part of the ridge, currently within the Open Space B zone (Figure 2), is covered by indigenous forest on the shady, southern side of the ridge, and mostly by exotic scrub and grassland on the northern, sunny side of the ridge.

In this report, ‘the site’ refers to the area currently zoned as Business 2 and the area zoned Open Space B that would require rezoning if the full quarry development goes ahead. The site ranges from 60-180 metres elevation above sea level, and covers 13.3 hectares.

3.2 Wellington Ecological District

The site is located within Wellington Ecological District. The Wellington Ecological District is differentiated from the adjacent Tararua Ecological District by virtue of its more fertile soils and relative scarcity of beech (*Fuscospora* spp.) forest (McEwen 1987). The prevailing winds are from the west and northwest, with high wind run and frequent gales, while warm summers, mild winters, and evenly-distributed annual rainfall of 900-1,400 mm also characterise the climate of Wellington Ecological District (McEwen 1987).

3.3 Land cover

Land cover types in Wellington Ecological District¹ are quite varied, and include a notable 11,340 hectares of built-up urban land, covering 22 percent of the Ecological District. Other extensive land cover types within the Wellington Ecological District include high producing exotic grassland (13,904 hectares; 27% cover), broadleaved indigenous hardwoods (8,036 hectares; 15% cover), and gorse and/or broom

¹ Defined by the Land Cover Database version 4.1.



Eagle Technology, LINZ

Figure 1: Location of the Kiwi Point site

Data Acknowledgment	
Imagery sourced from: Taranaki District Council. Imagery date: April 2016	
Report: 4378	
Client:	
Ref: 05 0290	
Path: E:\gis\Kiwi_Point_Quarry.mxd	
File: Kiwi_Point_QuarryLocation.mxd	

Wildlands	
www.wildlands.co.nz, 0 908 WILDNZ	
Scale:	1:15,000
Date:	7/07/2017
Cartographer:	KM
Format:	A4

(7,622 hectares; 15% cover). The indigenous forest cover type, which describes more mature indigenous forest, covers 998 hectares or just under two percent of Wellington Ecological District.

3.4 Protected areas

Very few areas of indigenous vegetation and habitat in the vicinity of the site are legally protected. Fort Street Conservation Area is located between Fort Street and State Highway 2 at the base of the Ngauranga Gorge. The next closest area of conservation land is the Otari Scenic Reserve some five kilometres to the southwest of the proposed quarry site.

There are no Queen Elizabeth the Second Open Space Covenants (QEII covenants) near the proposed quarry site, the nearest being some 3-5 kilometres to the southwest, northwest, and east.

However, Wellington City Council reserves are relatively plentiful in the local area and include the Tyers Stream Reserve adjacent to the southwestern boundary of the site, and the Imran Terrace/Maldives Street Reserve c.150 metres to the west of the site.

Potential significant natural areas (SNAs) are more extensive locally, and include all of the more extensive indigenous forest patches within the site, and other areas of indigenous forest on both sides of the Ngauranga Gorge.

4. VEGETATION AND HABITATS

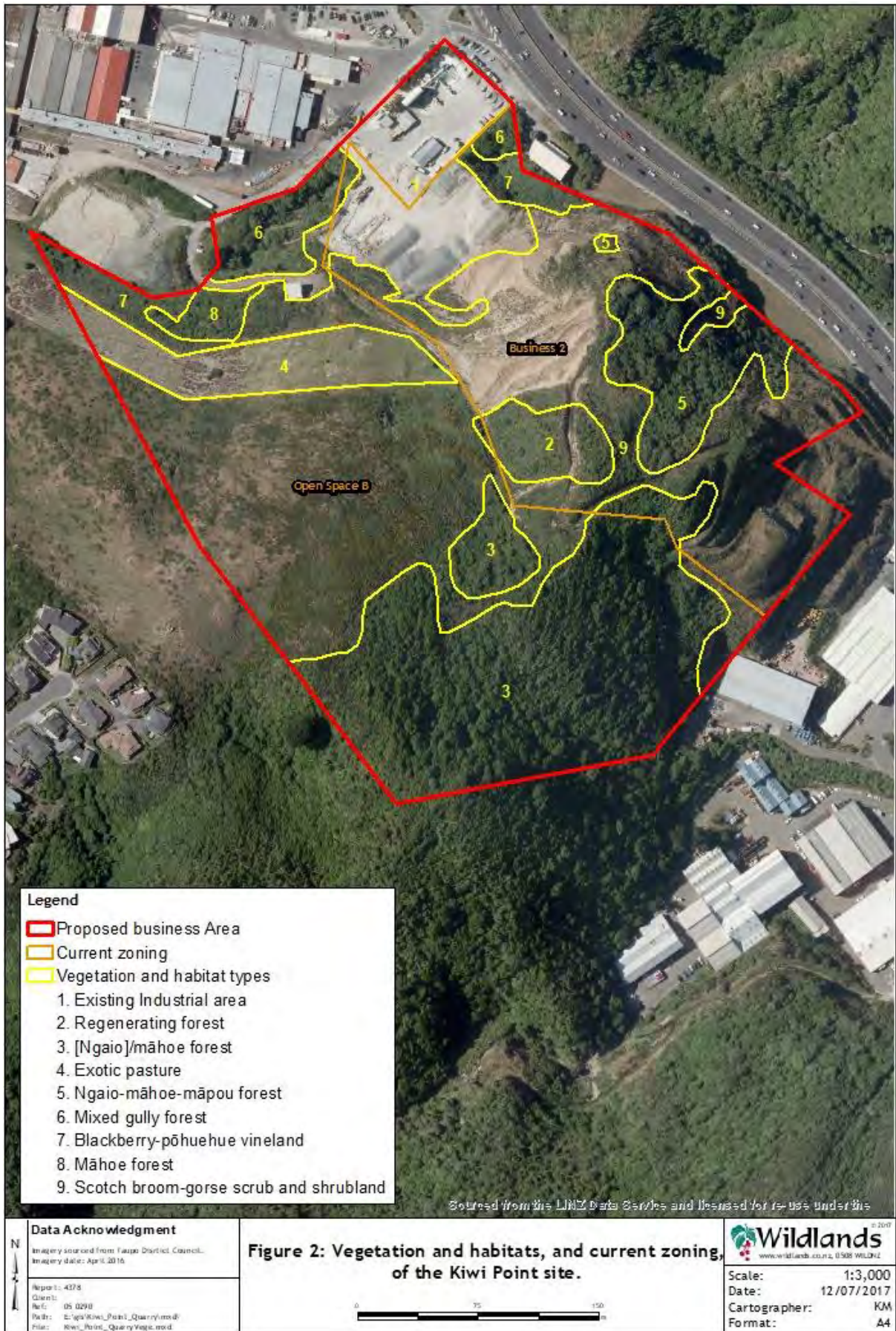
Eight different vegetation/habitat types were identified at the site:

- [Ngaio]/māhoe forest
- Ngaio-māhoe-māpou forest
- Māhoe forest
- Regenerating forest
- Mixed gully forest
- Scotch broom-gorse scrub and shrubland
- Blackberry-pōhuehue vineland
- Exotic pasture.

These habitat types are described in more detail below and mapped in Figure 2.

4.1 [Ngaio]/māhoe forest

Forest on the steep south-eastern faces of the ridge above Tyers Stream comprises low (3-4 metres tall) māhoe (*Melicytus ramiflorus*) forest (Plate 1), with scattered taller and larger ngaio (*Myoporum laetum*). Other canopy trees at lower abundance were mamaku (*Cyathea medullaris*), whauwhaupaku (*Pseudopanax arboreus*), māpou (*Myrsine australis*), and mānuka (*Leptospermum scoparium*). Lianes are abundant in



the forest canopy; these are mostly *Parsonsia heterophylla*, but there is also occasional pōhuehue (*Muehlenbeckia australis*) and rare clematis (*Clematis paniculata*). Kawakawa (*Macropiper excelsum*) is abundant in the understorey (Plate 1), with locally common rangiora (*Brachyglottis repanda*) and hangehange (*Geniostoma ligustrifolium*), occasional kanono (*Coprosma grandifolia*), and rare ponga (*Cyathea dealbata*). Shining spleenwort (*Asplenium oblongifolium*), hound's tongue fern (*Microsorium pustulatum*), and seedlings of *Parsonsia heterophylla* form the main ground covers, with scattered *Lastreopsis glabella*. Ground cover is sparse in the eastern part of this forest, but dense in the western part.



Plate 1: Interior of [Ngaio]/māhoe forest showing the relatively low canopy height and abundant kawakawa in the understorey.

This is a relatively young patch of secondary forest, which represents recent regeneration of māhoe and other broadleaved trees after historic disturbance that left only scattered ngaio trees standing. There is a gradient of disturbance across the slope, with western parts of the forest appearing older and more intact, compared with eastern parts. One patch of this forest type occurs on the northern slope of the ridge, separated from the larger patch on the southeastern slopes by a former bulldozed track that is now largely occupied by Scotch broom (*Cytisus scoparius*) and gorse (*Ulex europaeus*).

4.2 Ngaio-māhoe-māpou forest

On steep northeast facing slopes above State Highway 1, there are patches of forest of different composition. Scattered apparently older ngaio trees occur in a 4-5 m tall canopy dominated by māhoe, but patches of māpou dominance are also present. A

variety of other canopy trees occur in lower abundances, especially where the canopy is shorter (2-3 metres tall), including kowhai (*Sophora microphylla*; one individual), kānuka (*Kunzea robusta*), *Hebe parviflora*, karamū (*Coprosma robusta*), akiraho (*Olearia paniculata*), and poataniwha (*Melicope simplex*). The understorey is mostly sparse but has occasional dense patches dominated by kawakawa. Poataniwha, *Coprosma rhamnoides*, hangehange, and rangiora are occasionally present. Shining spleenwort, button fern (*Pellaea rotundifolia*), *Polystichum neozelandicum* subsp. *xerophyllum*, and occasional *Lastreopsis glabella* are occasional in the ground layer. Rocky areas support a relatively diverse assemblage of indigenous fern species, including those listed above as well as hound's tongue fern and jointed fern (*Arthropteris tenella*). Dense swards of veldt grass (*Ehrharta erecta*) and common blackberry (*Rubus fruticosus*) occur on forest margins.



Plate 2: Frequent māpou trees can be seen in the canopy of ngaio-māhoe-mapou forest.

This forest type is reasonably representative of the original forest and scrub that would have naturally occurred on these steep and sometimes rocky, exposed, slopes. Thin soils in rocky areas would have allowed the shorter trees and shrubs to persist, while deeper soils would have supported taller trees such as māhoe, māpou, ngaio, and kowhai.

4.3 Māhoe forest

A small patch of māhoe-dominant forest occurs on the toeslope near the meat processing works (Plate 3). This vegetation was not inspected closely, but appears to be relatively young secondary forest.

4.4 Regenerating forest

A patch of strongly-modified vegetation at the end of the Gurkha Crescent ridge, incorporating bulldozed tracks and other disturbed areas, mostly comprises Scotch broom, gorse, and fennel (*Foeniculum vulgare*), but there are several small regenerating trees of māpou and māhoe. Shrubs of boneseed (*Chrysanthemoides monilifera*) and Darwin's barberry (*Berberis darwinii*) were also seen within this vegetation, and exotic grasses and herbs including browntop (*Agrostis capillaris*) and catsear (*Hypochaeris radicata*) are common.



Plate 3: Māhoe-dominant forest on the toeslope below exotic pasture and Scotch broom-gorse scrub. Blackberry-pohuehue vineland can be seen to the right of the māhoe forest.

In the absence of further disturbance, this vegetation would slowly become more dominated by indigenous trees, but Darwin's barberry would likely persist due to its tolerance of shade and ability to grow beneath a forest canopy.

4.5 Mixed gully forest

Gullies near the margin of the industrial land near the meat processing works contain a mix of indigenous and exotic trees and shrubs. Indigenous species in these gullies include mamaku, ngaio, karamū, taupata (*Coprosma repens*), koromiko (*Hebe stricta*), kawakawa, māhoe, and karaka (*Corynocarpus laevigatus*). Exotic species include radiata pine (*Pinus radiata*), buddleia (*Buddleja davidii*), blackberry, Scotch broom, brush wattle (*Paraserianthes lophantha*), pampas, tree lucerne (*Chamaecytisus palmensis*), willow (*Salix* sp.), and climbing dock (*Rumex sagittatus*).

4.6 Scotch broom- gorse shrubland

Scrub and shrubland dominated by Scotch broom and gorse occupy the northwest-facing slopes of the ridge that stretch down toward the meat processing works and other industrial land (Plates 3 and 4), the eastern corner of the site in the Tyers Creek catchment, and in other areas that have been more recently disturbed by bulldozing and tracking. Fennel, holly-leaved senecio (*Senecio glastifolius*), and exotic grasses are common species in these shrublands, while occasional blackberry, pampas

(*Cortaderia selloana*), climbing dock, vetch (*Vicia sativa*), karamū, māhoe and kānuka are also present. The indigenous shrub *Melicytus crassifolius* was reported in rocky habitat on the sunny faces within this vegetation by Wellington City Council staff.



Plate 4: Scotch broom-gorse scrub is dominant on the sunny slopes of the ridge. A strip of exotic pasture can be seen at lower left, below which is a small patch of māhoe forest.

4.7 Blackberry-pohuehue vineland

In one area on the northwestern toeslopes, and in a gully near State Highway 1, a dense vineland of blackberry and pōhuehue occurs. Occasional māhoe and ngaio trees emerge from this vineland, in which climbing dock is also frequent.

4.8 Exotic pasture

A horizontal strip of exotic pasture is located on the lower northwestern slopes (Plates 3 and 4). It was not assessed in detail but comprises exotic grasses and herbs.

5. FLORA

A total of 98 vascular plant species were observed during the site visit, of which 55 (56 percent) were indigenous species and 43 (44 percent) exotic. No nationally Threatened or At Risk plant species were recorded at the site, but kowhai, of which only one individual was seen, is uncommon in Wellington Ecological District.

6. BIRDS

A relatively low diversity of bird species was observed during the site visit, however road noise was significant and reduced detectability. Three exotic bird species and three indigenous bird species were observed using habitats at the site, and the indigenous karoro/black-backed gull (*Larus dominicanus*) was observed flying over the site (Table 1). Pipihi/silvereye (*Zosterops lateralis*) was the species observed most commonly in forest vegetation at the site.

Table 1: Bird species recorded at and flying over the Kiwi Point site.

Species	Common Name	Status
<i>Emberiza citrinella</i>	Yellowhammer	Introduced and Naturalised
<i>Fringilla coelebs</i>	Chaffinch	Introduced and Naturalised
<i>Turdus merula</i>	Blackbird	Introduced and Naturalised
<i>Rhipidura fuliginosa</i>	Piwaiwaka; Fantail	Endemic; Not Threatened
<i>Larus dominicanus</i>	Karoro; black-backed gull	Indigenous; Not Threatened
<i>Gerygone igata</i>	Riroriro; grey warbler	Endemic; Not Threatened
<i>Zosterops lateralis</i>	Pipihi; silvereye	Indigenous; Not Threatened

Additional bird species that are mostly likely to regularly use the proposed quarry were inferred using recent records from nearby forested sites where bird observations have been made on multiple occasions, including two sites in the adjacent Tyers Stream Reserve and one in coastal forest. The indigenous tūi/kōkō (*Prosthemadera novaeseelandiae*) and exotic starling (*Sturnus vulgaris*) are almost certainly regular seasonal users of habitats at the proposed quarry site, while house sparrow (*Passer domesticus*) and goldfinch (*Carduelis carduelis*) are also very likely to use these habitats (Table 2). Other indigenous species that are likely to be present at times are pīpīwharau/roa/shining cuckoo (*Chrysococcyx lucida*) and kererū (*Hemiphaga novaeseelandiae*), which have both been observed at lower frequency and abundance at two sites within the adjacent Tyers Stream Reserve (Table 2).

Table 2: Bird species recorded within one kilometre of the site at three sites where multiple observations have been submitted to the Ebird database (2011-2013 data).

Species	Common Name	Frequency (n=3)	Total Number Observed
<i>Carduelis carduelis</i>	Goldfinch	67	11
<i>Emberiza citrinella</i>	Yellowhammer	33	1
<i>Fringilla coelebs</i>	Chaffinch	100	26
<i>Carduelis chloris</i>	Greenfinch	67	5
<i>Passer domesticus</i>	House sparrow	67	22
<i>Prosthemadera novaeseelandiae</i>	Kōkō; tui	100	19
<i>Prunella modularis</i>	Dunnock	33	1
<i>Sturnus vulgaris</i>	Starling	100	12
<i>Turdus philomelos</i>	Song thrush	67	4
<i>Chrysococcyx lucida</i>	Shining cuckoo	33	1
<i>Callipepla californica</i>	Californian quail	33	1
<i>Hemiphaga novaeseelandiae</i>	Kererū	33	3
<i>Turdus merula</i>	Blackbird	100	30
<i>Rhipidura fuliginosa</i>	Piwaiwaka; Fantail	100	10
<i>Larus dominicanus</i>	Karoro; black-backed gull	100	8

Species	Common Name	Frequency (n=3)	Total Number Observed
<i>Gerygone igata</i>	Riroriro; grey warbler	100	27
<i>Zosterops lateralis</i>	Pipihi; silvereye	100	28

7. LIZARDS

A number of lizard observations have also been made within one kilometre of the proposed quarry site, though most of these relate to residential areas, and date from the 1990s. These observations cover seven indigenous lizard species, four of which have a current threat status of At Risk-Declining (Table 3). All of these lizard species are able to occupy forest, shrubland, and dense grassland habitats in the Wellington area (Adams 2009) and thus they all may be present within the site.

Table 3: Lizard records within one kilometre of the site (Department of Conservation Herpetofauna database).

Species	Common Name	Threat Status
<i>Mokopirirakau granulatus</i> ¹	Forest gecko	At Risk-Declining
<i>Nautilunus punctatus</i>	Barking gecko	At Risk-Declining
<i>Oligosoma aeneum</i>	Copper skink	Not Threatened
<i>Oligosoma ornatum</i>	Ornate skink	At Risk-Declining
<i>Oligosoma polychroma</i> Clade 1	Northern grass skink	Not Threatened
<i>Oligosoma zelandicum</i>	Glossy brown skink	At Risk-Declining
<i>Woodworthia maculata</i>	Raukawa gecko	Not Threatened

¹This record probably more accurately refers to the Ngahere gecko, *Mokopirirakau* “southern North Island”, which has the same threat status.

8. FISH

A tributary of Ngauranga Stream passes through the more modified part of the site adjacent to the meat processing works (Plate 5), and is partly confined to underground piped channels in this area. There are no records from this stream in the New Zealand Freshwater Fish database. Four freshwater fish lists dating from 2009 to 2016 have been compiled from sampling within Tyers Stream, within the Tyers Stream Reserve (Table 4).

Table 4: Freshwater fish records from Tyers Stream (from NIWA Freshwater Fish database).

Species	Common Name	Status
<i>Anguilla dieffenbachii</i>	Longfin eel	At Risk-Declining
<i>Anguilla australis</i>	Shortfin eel	Not Threatened
<i>Galaxias brevipinnis</i>	Koaro	At Risk-Declining
<i>Galaxias fasciatus</i>	Banded kokopu	Not Threatened



Plate 5: Ngauranga Stream tributary adjacent to the meat processing works.

9. ECOLOGICAL SIGNIFICANCE

Ecological significance of indigenous vegetation and habitats of indigenous fauna at the site has been determined below using the ecological significance criteria in the Greater Wellington Regional Policy Statement. The assessment has been undertaken at the scale of the Wellington Ecological District, where scale is relevant to a criterion.

(a) **Representativeness:** *the ecosystems or habitats that are typical and characteristic examples of the full range of the original or current natural diversity of ecosystem and habitat types in a district or in the region, and:*

- (i) *are no longer commonplace (less than about 30% remaining); or*
- (ii) *are poorly represented in existing protected areas (less than about 20% legally protected).*

Assessment

This criterion requires ecosystems or habitats to be not only typical and characteristic, but also to be significantly reduced and poorly represented in protected areas.

Of the two more intact areas of indigenous vegetation and habitat at the site, the ngaio-māhoe-māpou forest on sunny, exposed slopes is more representative of the original (pre-human) vegetation than the [ngaio]/māhoe forest on shady slopes. The [ngaio]/māhoe forest is a relatively young stand of secondary forest that has quite a

different structure and composition to the taller and more diverse podocarp/broadleaved forest that would have originally occupied this part of the site.

Secondary broadleaved forest dominated by māhoe is relatively widespread in Wellington Ecological District, while the more diverse ngaio-māhoe-māpou forest is more reduced. Nevertheless, as Wellington Ecological District would have been largely forest-covered, and the total current area of indigenous forest and broadleaved indigenous hardwoods only occupies 15 percent of Wellington Ecological District (see Section 3.3), both types can be regarded as no longer commonplace.

With respect to protection status, protected areas are small and scattered across Wellington Ecological District, thus both of the above habitat types will have much less than 20 percent of their area protected within Wellington Ecological District.

In summary, the ngaio-māhoe-māpou forest is representative, strongly reduced, and poorly protected, and thus meets the definition of representativeness. [Ngaio]/māhoe forest is not representative of the former vegetation, and therefore is not significant under this criterion, but is also strongly reduced and poorly-protected within Wellington Ecological District.

*(b) **Rarity:** the ecosystem or habitat has biological or physical features that are scarce or threatened in a local, regional or national context. This can include individual species, rare and distinctive biological communities and physical features that are unusual or rare.*

Assessment

As described above, both of the indigenous vegetation types present within the site are considerably reduced, and the ngaio-māhoe-māpou forest type is likely to be quite scarce in Wellington Ecological District. Kōwhai is an uncommon species in Wellington Ecological District. Indigenous lizards with At Risk-Declining status are likely to be present in habitats within the site, and the tributary of Ngauranga Stream that passes through the more modified part of the site may provide habitat for indigenous fish with At Risk-Declining status.

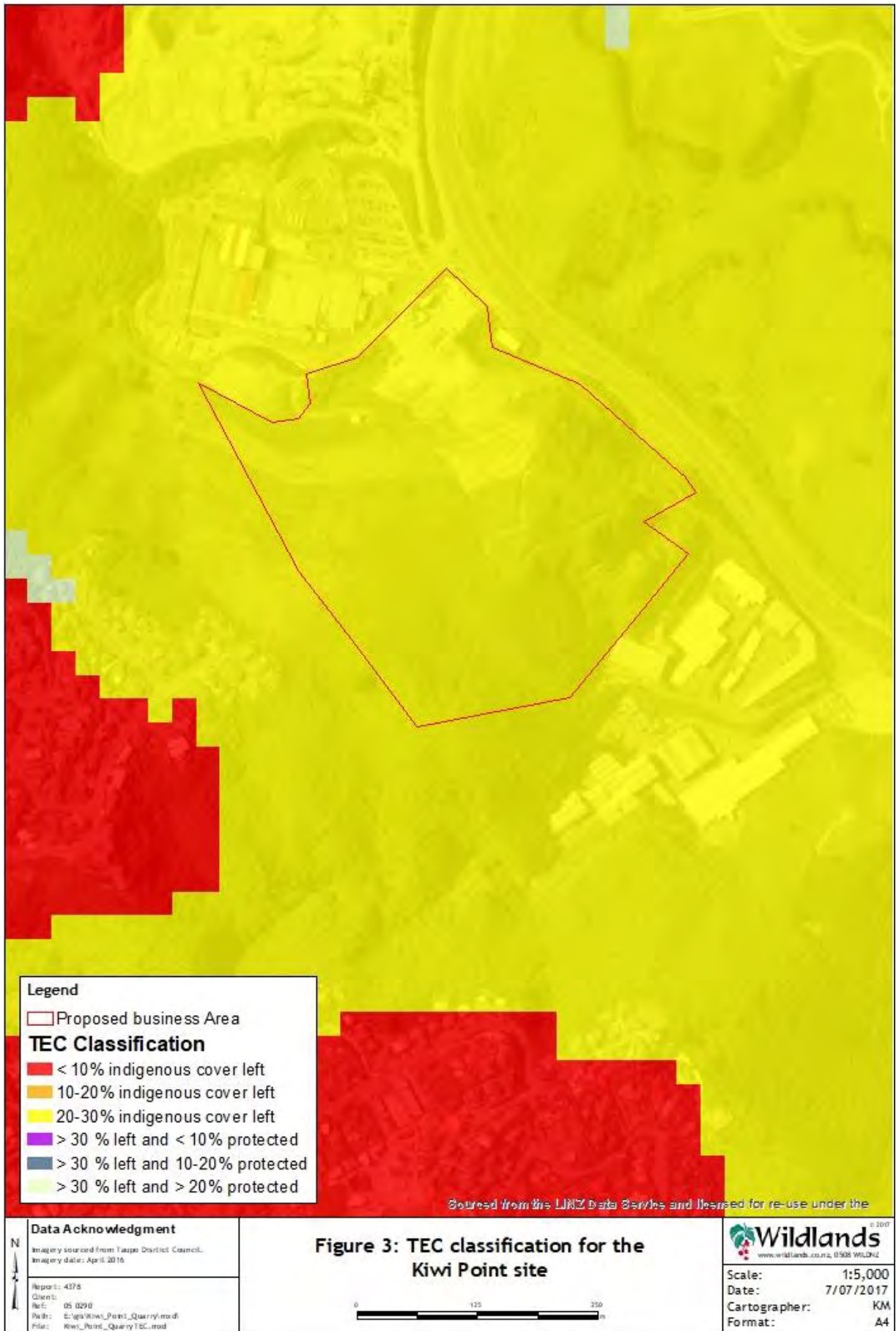
National priorities for the protection of rare and threatened indigenous biodiversity on private land (MfE and DOC 2007) are listed below and site values have been assessed in relation to each one:

1. *Indigenous vegetation on land environments that have less than 20% of their indigenous cover remaining.*

The site is located within At Risk land environments that have 20-30% of their indigenous cover remaining (Figure 3).

2. *Indigenous vegetation associated with sand dunes and wetlands.*

No sand dune or wetland habitats are present within the site.



3. *Indigenous vegetation associated with originally rare ecosystems.*

No originally rare ecosystems were recorded at the site.

4. *Habitats of acutely and chronically threatened species.*

The ‘acutely threatened’ and ‘chronically threatened’ categories have been superseded by a more recent threat classification system (Townsend *et al.* 2008), and now correspond to the Threatened and At Risk-Declining categories of Townsend *et al.* (2008). As described above, indigenous lizards, and potentially fish, with At Risk-Declining status are likely to be present within the site.

On the basis of the above, the ngaio-māhoe-māpou forest meets this criterion, as does kōwhai. Parts of the site that provide habitat for At Risk lizards or fish may also be significant.

(c) **Diversity:** *the ecosystem or habitat has a natural diversity of ecological units, ecosystems, species and physical features within an area.*

Assessment

The site has remnants of its natural diversity, as represented by different forest types on landforms with different aspects, but overall has a relatively low diversity of indigenous plant species. The most diverse plant habitat within the site is the ngaio-māhoe-māpou forest above State Highway 1. The diversity of indigenous lizards, birds, and fish is not known. A preliminary assessment based on indigenous habitats and plant species is that the site overall is not significant according to this criterion, but the ngaio-māhoe-māpou forest is significant.

(d) **Ecological context of an area:** *the ecosystem or habitat:*

- (i) *enhances connectivity or otherwise buffers representative, rare or diverse indigenous ecosystems and habitats; or*
- (ii) *provides seasonal or core habitat for protected or threatened indigenous species.*

Assessment

Indigenous forest at the site mostly comprises fleshy-fruited trees that would provide an important seasonal food source for frugivorous birds such as kererū, kōkō/tūī, and pipihi/silvereye. The mixed gully forest at the site also contains several fleshy-fruited trees which would provide food sources for these birds. In addition, tree lucerne (*Chamaecytisus palmensis*) foliage in these gully forests would provide a useful winter food source for kererū. When in flower, Scotch broom also provides a seasonal food source for kererū.

The site is connected to and helps to buffer the Tyers Stream Reserve, which contains representative lowland forest. Overall, the Tyers Stream Reserve and the indigenous forest at the proposed quarry site provide a large area of seasonal habitat for indigenous frugivores and permanent habitat for other indigenous bird species. Loss of the indigenous forest within the site could result in reductions in

the local population sizes of these species, because a large amount of habitat would be removed.

- (e) **Tangata whenua values:** the ecosystem or habitat contains characteristics of special spiritual, historical or cultural significance to tangata whenua, identified in accordance with tikanga Māori.

Assessment

This is not an ecological criterion, though can be informed by the ecological information in this report, for example by providing a list of plant species that may be taonga species for local tangata whenua. This criterion has not been assessed.

Summary of Significance Assessment

In summary, forest vegetation at the site is significant because it provides locally important seasonal habitat for indigenous forest birds. The ngaio-māhoe-māpou forest is also significant because it better represents the likely pre-human vegetation of its site, has moderately high plant species diversity, and provides habitat for a locally uncommon plant species. Other habitats may be significant depending on their significance for indigenous lizards and fish.

10. POTENTIAL ADVERSE EFFECTS

The main potential adverse effects of quarry development would be clearance of a relatively large area - approximately 3.5 hectares - of indigenous forest vegetation and habitat that is locally important for indigenous forest birds, and probably also indigenous lizards. Some lizards would probably be killed during quarry excavation. Small amounts of indigenous forest would be left on quarry margins, but these would be exposed to edge effects, which for the forest remnants above State Highway 1, would be very significant. The adjacent Tyers Stream Reserve would have reduced buffering from the effects of wind and spread of ecological weeds.

These effects would be significant, and if quarry development cannot avoid these effects, it will require substantive mitigation and/or remediation.

11. MITIGATION OF CLEARANCE OF VEGETATION AND HABITATS

The following mitigation options are suggested based on a scenario of full quarry development. In principle, mitigation should be in kind (like for like), on a site with similar environmental gradients, close to the affected area, and with the potential for additional conservation actions over a larger area (ideally at least three times larger) than the affected area.

Key habitats that would be affected by the quarrying are the [ngaio]/māhoe forest on shady slopes, and the ngaio-māhoe-māpou forest on the steep, more sunny and exposed faces above State Highway 1. Thus a mitigation site would need to incorporate both sunny and shady aspects and gradients of exposure.

Three nearby sites have been identified (Figure 4) that could potentially be legally protected and/or rehabilitated and/or enhanced, and thus would help to mitigate the adverse effects of vegetation and habitat clearance:

- a) A package of sites close to the proposed quarry site. These include three distinct areas:
 - Part of the ridge and upper hill slopes immediately west of the proposed quarry site - adjacent to the suburb of Rangoon Heights - currently supports 2.7 ha of scattered tī kouka/cabbage tree (*Cordyline australis*) within Scotch broom-gorse shrubland, and approximately 0.8 ha of advanced growth regenerating māhoe forest. These areas could be legally protected and restoration actions undertaken to more quickly return these areas to indigenous forest. This site would represent only sunny and exposed aspects, and would be at higher elevation to most of the affected areas of indigenous vegetation and habitat. A key advantage of this component of mitigation would be to provide a forested connection between the Tyers Stream Reserve and other areas of indigenous forest.
 - Forest below the water tanks and their Maldive Street access. Approximately 2.5 ha of māhoe-dominant forest is present within this area, and there is also an area with scattered trees in a vineland matrix that could potentially be enhanced through active restoration. These areas include some lower elevation land. Legally protecting these areas would help to slow the rate of future loss of māhoe forest.
 - A 1.62 ha triangle of low elevation māhoe-dominant forest between the potentially affected [ngaio]-māhoe forest and the Tyers Stream Reserve, which could be legally protected to prevent future development activities. The benefits of this would be to slow the rate of future loss of this forest type.
- b) A ridge extending from the suburb of Cashmere, immediately down-valley of the site to be affected, currently supports indigenous forest remnants and Scotch broom/ gorse scrub on its sunny and exposed side, and exotic plantation forest on its shady side. This ridge has similar topography and aspect and exposure differences to the site to be affected, but is slightly lower. It has an area of 13.6 hectares, and is therefore very similar to the overall size of the subject site, and approximately 3.5 times the size of the areas of indigenous forest to be affected. This site could also potentially be legally protected and rehabilitated to indigenous forest. An electricity transmission line crosses the ridge, but would pose few constraints to ecological restoration.
- c) An area of northwest-facing upper slopes on the northern side of Ngauranga Gorge comprises Wellington City Council reserve land and is currently covered by regenerating indigenous broadleaved forest and Scotch broom-gorse scrub.

This area is relatively higher (140-200 metres above sea level) than the affected areas, and its predominant aspect is also different to aspects of the indigenous vegetation and habitat to be affected. It is approximately 9.8 hectares, and thus about 2.5 times the size of the affected areas of indigenous forest.

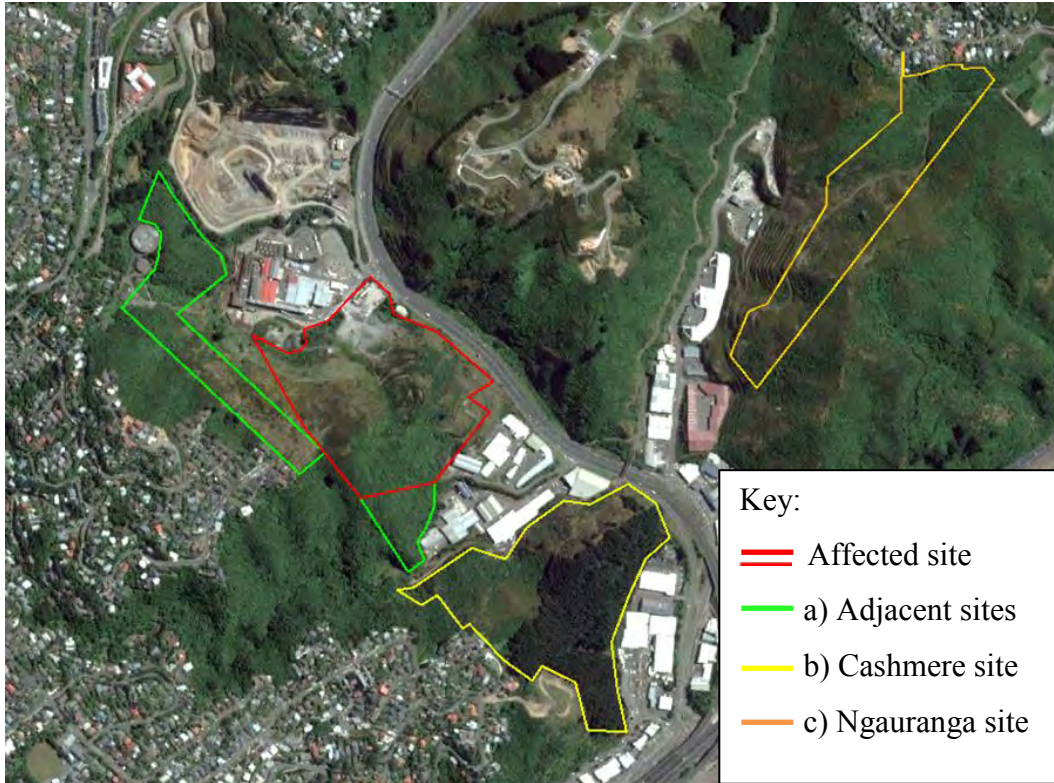


Figure 4: Potential local sites for which mitigation options could be considered.

Advantages and disadvantages of these three sites for mitigation of the adverse effects of clearance are summarised in Table 5.

Table 5: Attributes of the suggested mitigation sites in relation to the areas to be affected.

Factors Compared to Areas to be Affected	Potential Mitigation Sites		
	a) Adjacent Sites	b) Cashmere (b)	c) Ngauranga
Size	Twice as large	3.5 times larger	2.5 times larger
WCC owned?	Yes	No	Yes
Similar landform?	Partly	Yes	No
Similar aspects?	Partly	Fully	Partly
Indigenous forest cover?	c.50% of area	c.10% of area	c.50% of area
Similar vegetation?	Partly	Partly	Partly
Similar elevation?	More at higher elevation, less at lower elevation.	More at lower elevation, less at higher elevation.	Mostly higher elevation.
Other factors			

Factors Compared to Areas to be Affected	Potential Mitigation Sites		
	a) Adjacent Sites	b) Cashmere (b)	c) Ngauranga
Opportunity for landscape mitigation?	Moderate, local mitigation	Significant if pines replaced with indigenous forest.	Limited as mostly on a successional trajectory to full indigenous dominance.
Additionality	Moderate	Strong if pines are replaced.	Limited as mostly on a successional trajectory to full indigenous dominance.

Overall, the Cashmere site stands out as being a similar landform of significant size with strong potential for ecological restoration and also has potential to remove the landscape effects of pine forest. It also represents a slightly lower elevation site, which would better help to mitigate the more extensive loss of indigenous vegetation in lowland environments. The main constraint with this site is that it is not owned by Wellington City Council. Nevertheless, this increases the additionality of conservation actions for the site, such as legal protection.

The package of adjacent sites incorporating legal protection and ecological restoration has the advantages of being closest to the affected site and through ecological restoration, better-connecting existing areas of indigenous forest. This would be sufficient to mitigate adverse effects of quarry development on māhoe-dominant forest, but would not mitigate the effects of clearance of the representative ngaio-mahoe-mapou forest.

The Ngauranga site lacks close similarity with the site to be affected, and ecological restoration at this site would not be fully additional given that the existing vegetation is currently on a successional trajectory to greater cover of indigenous forest.

Other sites owned by Wellington City Council may be available for mitigation in the wider area, and in particular, a site where restoration actions to mitigate the loss of ngaio-mahoe-mapou forest should be sought. Any such sites should also be assessed for environmental similarity and scope to undertake additional conservation activities that would not otherwise occur. However, it would be preferable to undertake mitigation activities close to the site to be affected, where possible.

12. REMEDIATION

12.1 Vegetation

The final quarry pit slopes will be have a range of landforms and aspects and should provide areas of sheltered habitat. Wind modelling of the final pit landform should be undertaken, to identify potentially sheltered areas. When quarrying ceases these should be a focus for active rehabilitation of indigenous vegetation and habitat. This will require topsoil to be stockpiled for use in any planting sites on quarry benches.

12.2 Lizard habitat

More exposed benches could be rehabilitated to promote lizard habitat. This should include provision of rock jumbles and/or artificial lizard habitat on benches, together with planting of potential food and habitat resources, such as *Melicytus crassifolius*.

13. CONCLUSIONS

The proposed quarry site contains two types of indigenous forest that represent the main vegetation values of the site. Forest patches above State Highway 1 are a more representative, diverse, and reduced type of forest than the more extensive, secondary broadleaved forest on shady slopes adjacent to the Tyers Stream Reserve. Both forest types provide locally important, seasonal habitat for indigenous forest birds, and are ecologically significant according to the significance criteria in the Greater Wellington Regional Policy Statement. There is a reasonable likelihood that additional indigenous lizard and freshwater fish values are present in habitats within the site, and surveys for these fauna should be undertaken.

Adverse effects of clearance of these habitats for quarry development would be significant, and would require mitigation and remediation. Ideally, mitigation should occur on a nearby site that has features similar to the areas to be affected and where conservation actions would be strongly additional. There is good potential for mitigation on the neighbouring ridge down-valley, which is similar to the areas to be affected, but as this site is private land it would need to be purchased by Wellington City Council for this potential to be realised. Sites adjacent to the proposed quarry have potential for mitigation for adverse effects on māhoe-dominant forest, but an alternative site should be chosen to address mitigation for loss of ngaio-mahoe-mapou forest.

In addition to mitigation, there is potential for remediation of some adverse effects once the quarry operation has ceased. However, this would only take place in the future, and would be significantly constrained by quarrying. As such, it should be seen as a retrospective action which will address some effects, but only after the quarry operation has ceased. It will also take some time to achieve significant ecological (and landscape) effects. Overall, site remediation is important but should be considered to be complementary to mitigation.

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VASCULAR PLANT SPECIES RECORDED AT THE SITE

*Denotes exotic species. Abundance is expressed across the whole site

Species	Common Name	Plant Type	Abundance
<i>Acaena anserinifolia</i>	Bidibidi	Dicot herb	Rare
<i>Agapanthus orientalis</i> *	Agapanthus	Dicot herb	Rare
<i>Agrostis capillaris</i> *	Browntop	Grass	Occasional
<i>Anagallis arvensis</i> *	Scarlet pimpernel	Dicot herb	Rare
<i>Apium graveolens</i> *	Wild parsley	Dicot herb	Occasional
<i>Arthropteris tenella</i>		Fern	Rare
<i>Asplenium appendiculatum</i>	Ground spleenwort	Fern	Rare
<i>Asplenium bulbiferum</i>	Hen and chicken fern	Fern	Rare
<i>Asplenium flabellifolium</i>	Necklace fern	Fern	Rare
<i>Asplenium hookerianum</i>	Hooker's spleenwort	Fern	Rare
<i>Asplenium oblongifolium</i>	Shining spleenwort	Fern	Frequent
<i>Beilschmiedia tawa</i>	Tawa	Tree	Rare
<i>Berberis darwinii</i> *	Darwin's barberry	Shrub	Occasional
<i>Brachyglottis repanda</i>	Rangiora	Tree	Occasional
<i>Brassica napus</i> *		Dicot herb	Occasional
<i>Buddleja davidii</i> *	Buddleia	Shrub	Occasional
<i>Centaurium erythraea</i> *	Centaury	Dicot herb	Rare
<i>Centranthus ruber</i> *	Spur valerian	Dicot herb	Occasional
<i>Cerastium fontanum</i> *	Mouse-ear chickweed	Dicot herb	Rare
<i>Chamaecytisus palmensis</i> *	Tree lucerne	Tree	Occasional
<i>Chrysanthemoides monilifera</i> *	Boneseed	Shrub	Rare
<i>Clematis paniculata</i>	Puawananga	Vine	Occasional
<i>Coprosma grandifolia</i>	Kanono	Tree	Occasional
<i>Coprosma</i> hybrid	<i>Coprosma</i> hybrid	Shrub	Rare
<i>Coprosma propinqua</i>	Mingimingi	Shrub	Occasional
<i>Coprosma repens</i>	Taupata	Shrub	Rare
<i>Coprosma rhamnoides</i>		Shrub	Occasional
<i>Coprosma robusta</i>	Karamu	Tree	Occasional
<i>Cordyline australis</i>	Cabbage tree / ti kouka	Tree	Rare
<i>Cortaderia selloana</i>	Pampas	Grass	Occasional
<i>Corynocarpus laevigatus</i>	Karaka	Tree	Occasional
<i>Cyathea dealbata</i>	Ponga	Fern	Occasional
<i>Cyathea medullaris</i>	Mamaku	Fern	Occasional
<i>Cytisus scoparius</i> *	Scotch broom	Shrub	Abundant
<i>Dactylis glomerata</i> *	Cocksfoot	Grass	Occasional
<i>Digitalis purpurea</i> *	Foxglove	Dicot herb	Rare
<i>Ehrharta erecta</i> *	Veldt grass	Grass	Frequent
<i>Erigeron canadensis</i> *	Canadian fleabane	Dicot herb	Occasional
<i>Euchiton audax</i>	Native cudweed	Dicot herb	Rare
<i>Foeniculum vulgare</i> *	Fennel	Dicot herb	Frequent
<i>Fumaria muralis</i> *	Scrambling fumitory	Dicot herb	Rare
<i>Geniostoma ligustrifolium</i>	Hangehange	Tree	Frequent
<i>Hebe parviflora</i>		Shrub	Rare
<i>Hebe stricta</i>	Koromiko	Shrub	Occasional
<i>Hedycarya arborea</i>	Pigeonwood / porokaiwhiri	Tree	Rare
<i>Hypochaeris radicata</i> *	Catsear	Dicot herb	Occasional
<i>Hypolepis ambigua</i>		Fern	Rare
<i>Kunzea robusta</i>	Kanuka	Tree	Occasional

Species	Common Name	Plant Type	Abundance
<i>Lastreopsis glabella</i>	Smooth shield fern	Fern	Occasional
<i>Lathyrus latifolius</i> *	Everlasting pea	Dicot herb	Rare
<i>Leptospermum scoparium</i>	Manuka	Tree	Frequent
<i>Linaria purpurea</i> *	Purple linaria	Dicot herb	Occasional
<i>Macropiper excelsum</i>	Kawakawa	Tree	Abundant
<i>Melicope simplex</i>	Poataniwha	Tree	Rare
<i>Melicytus ramiflorus</i>	Māhoe	Tree	Occasional
<i>Metrosideros diffusa</i>	White climbing rata	Vine	Rare
<i>Metrosideros excelsa</i>	Pohutukawa	Tree	Occasional
<i>Microsorium pustulatum</i>	Hound's tongue fern	Fern	Frequent
<i>Muehlenbeckia australis</i>	Pōhuehue	Vine	Frequent
<i>Myoporum laetum</i>	Ngaio	Tree	Frequent
<i>Myrsine australis</i>	Mapou	Tree	Occasional
<i>Myrsine divaricata</i>	Weeping matipo	Tree	Rare
<i>Olearia paniculata</i>	Akiraho	Tree	Rare
<i>Oxalis incarnata</i> *	Lilac oxalis	Dicot herb	Rare
<i>Ozothamnus leptophyllus</i>	Tauhinu	Shrub	Rare
<i>Paraserianthes lophantha</i> *	Brush wattle	Tree	Occasional
<i>Parsonsia heterophylla</i>	Native jasmine	Vine	Abundant
<i>Pellaea rotundifolia</i>	Button fern	Fern	Occasional
<i>Pennantia corymbosa</i>	Kaikomako	Tree	Rare
<i>Phytolacca octandra</i> *	Inkweed	Dicot herb	Occasional
<i>Pinus radiata</i> *	Radiata pine	Tree	Rare
<i>Pittosporum crassifolium</i>	Karo	Tree	Occasional
<i>Plantago lanceolata</i> *	Narrow-leaved plantain	Dicot herb	Occasional
<i>Poa anceps</i>		Grass	Rare
<i>Polystichum neozelandicum</i>	Shield fern	Fern	Occasional
<i>Prunus sp.</i> *	Wild plum	Tree	Rare
<i>Pseudopanax arboreus</i>	Five-finger, whauwhaupaku	Tree	Occasional
<i>Pseudopanax crassifolius</i>	Lancewood / horoeka	Tree	Rare
<i>Pteridium esculentum</i>	Bracken	Fern	Occasional
<i>Pyrrosia eleagnifolia</i>	Leatherleaf fern	Fern	Occasional
<i>Rubus cissoides</i>	Lawyer	Vine	Rare
<i>Rubus fruticosus</i> *	Blackberry	Shrub	Frequent
<i>Rumex sagittatus</i> *	Climbing dock	Dicot herb	Occasional
<i>Rytidosperma racemosum</i> *	Danthonia	Grass	Occasional
<i>Salix sp.</i> *	Willow	Tree	Rare
<i>Senecio glastifolius</i> *	Holly-leaved senecio	Dicot herb	Frequent
<i>Senecio skirrhodon</i> *	Gravel groundsel	Dicot herb	Rare
<i>Solanum chenopodioides</i> *	Velvety nightshade	Dicot herb	Frequent
<i>Solanum laciniatum</i>	Poroporo	Shrub	Rare
<i>Sonchus oleraceus</i> *	Puha / sow thistle	Dicot herb	Rare
<i>Sophora microphylla</i>	Kowhai	Tree	Rare
<i>Stellaria media</i> *	Chickweed	Dicot herb	Occasional
<i>Stellaria parviflora</i>	Native chickweed	Dicot herb	Rare
<i>Tradescantia fluminensis</i> *	Tradescantia	Dicot herb	Occasional
<i>Trifolium hybridum</i> *	Alsike clover	Dicot herb	Rare
<i>Trifolium repens</i> *	White clover	Dicot herb	Occasional
<i>Ulex europaeus</i> *	Gorse	Shrub	Frequent
<i>Vicia sativa</i> *	Vetch	Dicot herb	Occasional



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