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Paul Bushing
Development Control / Team Leader

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ASHFORD PARK REHABILITATION:

ECOLOGICAL ISLANDS PLAN

OCTOBER 2018

[THIS PLAN WAS DEVELOPED TO MEET THE REQUIREMENTS OF KCDC LAND USE CONSENT RM150184, CONDITIONS 51(A)-(F)]

ASHFORD PARK REHABILITATION:

ECOLOGICAL ISLANDS PLAN

PREPARED BY: SARAH KILLICK
BIORESEARCHES GROUP LTD
68 BEACH ROAD, AUCKLAND
SARAHKILLICK@BIORESEARCHES.CO.NZ

FOR: **GBC WINSTONE**

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P O Box 2828, Shortland Street, Auckland 1140. Telephone: (09) 379-9417 Facsimile (09) 307-6409
Website: www.bioresearches.co.nz

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Authors:	S. A. Killick MSc. (Hons). Ecologist
Reviewer:	T. J. Barnett, MSc. (Hons.) Senior Ecologist

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CONTENTS

Page

1 INTRODUCTION

Winstone Aggregates operate Ashford Park Quarry in rural Ōtaki, near the Kapiti Coast. Although this area would have historically held outer riparian forest for the adjacent Ōtaki River, agricultural modification and the construction of a stud farm has created and maintained paddocks of mainly low ecological value and function. The 45ha property is flat, low-lying, and within the Ōtaki floodplain. The underlying soils are characterised as Ōtaki Stony Loamy Sand Soils and Manawatu Loam over stony river deposits.

Ecological assessments undertaken by Wildlands (2015) and Bioresearches (2017) observed that within the paddocks, two native remnant forests have been retained. The remnants' canopies comprise mature tītoki (*Alectryon excelsus*), kohekohe (*Dysoxylum spectabile*) and tōtara (*Podocarpus totara* var. *totara*). This semi-coastal community composition is rare within the Kāpiti Coast area, therefore the relatively large Ashford Park remnants are considered ecologically significant (Wildlands 2015).

Consent to quarry Ashford Park was approved by the Kapiti Coast District Council on 24 March, 2016 (RM150184). The consent holder will extract gravel using a four-staged approach. Gravel extraction will result in exposure of the underlying water table, creating a large body of water. The two remnant forests will be retained and protected by riparian planting, forming "Ecological Islands" within the final formed lake.

Winstone Aggregates approached Bioresearches to request an Ecological Islands Plan in compliance with Consent Conditions 51 – 56. A planting plan specific to the Ecological Islands is required as islands can experience increased wind and light exposure and some change in ecological function due to isolation.

Figure 1: Overview of the Ashford Park Quarry site. Yellow dashed lines indicate stage zones, and the blue overlay indicates expected lake extent. Green area is the approximate riparian area, however the margins will differ from those shown. Map is north-facing.

1.1 METHODOLOGY

An assessment of the Ashford Park site was undertaken on August the 16th, 2017, to assess the ecological values on-site and compare to those described in an earlier report (Wildlands, 2015). The whole-site Rehabilitation plans (Boffa Miskell Limited, 2016; GBC Winstone, 2016a) and the riparian margin planting plan (GBC Winstone, 2016b) were also reviewed, in order to inform the Ecological Islands Plan

This Ecological Island Planting Plan considers the naturally-occurring ecosystems native to Ashford Park as well as the novel environmental conditions expected to result from the creation of the lake. The riparian areas, including the formation of the riparian slope, are designed to enhance the lake water quality as well as protect the interior Island vegetation. Greater Wellington Regional Council's guide "So you're thinking about a pond…" (2005) has been used to guide the riparian form design.

1.2 EXISTING VEGETATION

The remnant forests which will form the future Ecological Islands were dominated by tītoki, kohekohe, and tōtara trees in the canopy tier. The trees were generally healthy mature specimens with average tree heights ranging from 10m (karaka, western island) to 15.2m (tōtara, western island). In a functioning forest, the mid-tier would typically comprise saplings, large shrubs, and ferns; however, the mid-tier in both remnants was depauperate. This suggests that browsing has occurred here previously, during which time the forest was not self-sustaining.

Although the understory vegetation was similarly sparse in places, early regeneration was evident. Within the two future Islands karamū (*Coprosma robusta*), kawakawa (*Piper excelsum*), tarata (*Pittosporum eugenoides*), tītoki, and kohekohe were noted within the understory tier. Exotic taxa had also established, including a severe infestation of *Tradescantia flumensis*.

The lack of lower and mid-height vegetation, particularly around the outer remnant edges, allows increased wind movement and light penetration into the interior. This increased level of exposure can slow native regeneration and favour exotic invasive plant species.

1.3 REHABILITATION OBJECTIVES

The long term site rehabilitation vision is to "facilitate the successful rehabilitation of the site in a manner that will retain and enhance native species on islands and thriving native riparian vegetation along waterbody margins to maintain water quality and long term ecological health and successfully reintegrate quarried areas within the Ōtaki floodplain landscape" (GBC Winstone, 2016a).

The formation and enhancement of the two Ecological Islands will help to achieve these objectives by retaining the greatest ecological values on site and increasing their individual value through revegetation and legal protection. Furthermore, the riparian plantings around the islands will improve water quality and ecological functioning, increase habitat complexity, and assist in the natural management of flood events.

2 ISLAND FORMATION

2.1 EXTRACTION STAGING

The quarrying process has been divided into four discrete sequential stages. The underlying water table will be exposed at each stage, culminating in the final lake formation at the end of stage four. Although the creation of the Ecological Islands will not be complete until stage four completion, the eastern Island will be partially surrounded by lake water from the commencement of stage two (Figure 2).

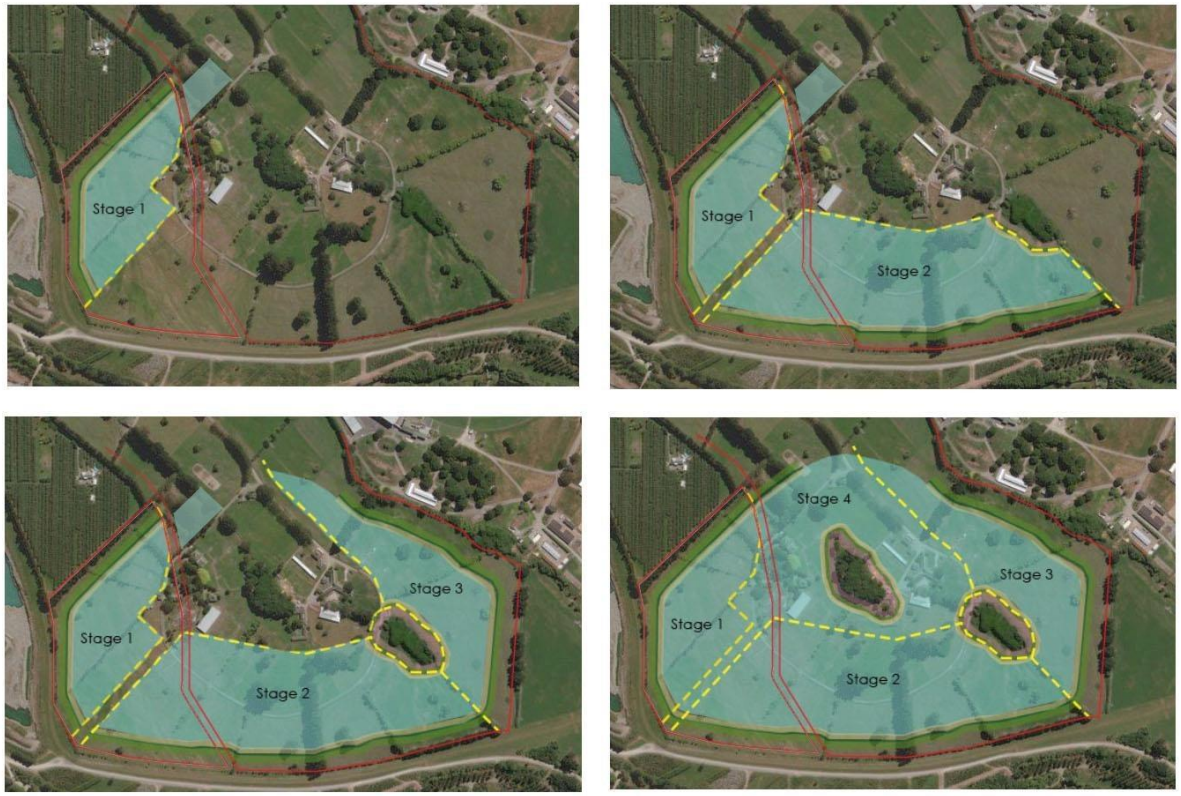

Figure 2: Project stages 1 (top left), 2 (top right), 3 (lower left) and 4 (lower right).

2.2 MARGIN SLOPE

Healthy New Zealand lakes are characterised by low nutrient content (oligotrophic), with cool clear water and the ability to support a diverse assemblage of native flora and fauna. Lakes that have high nutrient concentrations (eutrophic) are often warm and murky or cloudy, accumulate sulphur-smelling oxygen-poor sludge on the lake floor, and are associated with algal blooms. Eutrophic lakes are ecologically dysfunctional, aesthetically unpleasing, smell offensive, and are poor for recreational use. It is immensely difficult to return a eutrophic lake to a healthy oligotrophic state, and so every effort must be taken to create and maintain a lake that promotes an ongoing low-nutrient system.

The Ecological Islands will be formed by excavating the surrounding areas. The shape and slope of the margin leading into the water will affect the lake water quality. If the slope is too slight, the lake will be shallow and prone to warming. This will result in greater concentrations of macrophytes and algae, and may lead to eutrophication. Conversely, if the lake margin is too steep there will be insufficient

area to accommodate the riparian plants within the emergent and submerged zones, which are important for providing habitat, diversity, and for filtering runoff before it enters to water body.

The slope aspects proposed for the riparian area surrounding the lake's outer edges (Bioresearches 2017; GBC Winstone 2016) are also appropriate for both Ecological Islands. The underwater portion is steep (c. 30°) to rapidly increase depth, but the submerged and emergent wet vegetation zone is at a low angle (c. 7°) to increase habitat area. The upper dry-zone vegetation is raised (c. 18.5°) to protect the forest interior and encourage free-draining into the lake body (Figure 3). The edges should be scalloped unevenly to increase variation and availability in habitat for native flora and fauna.

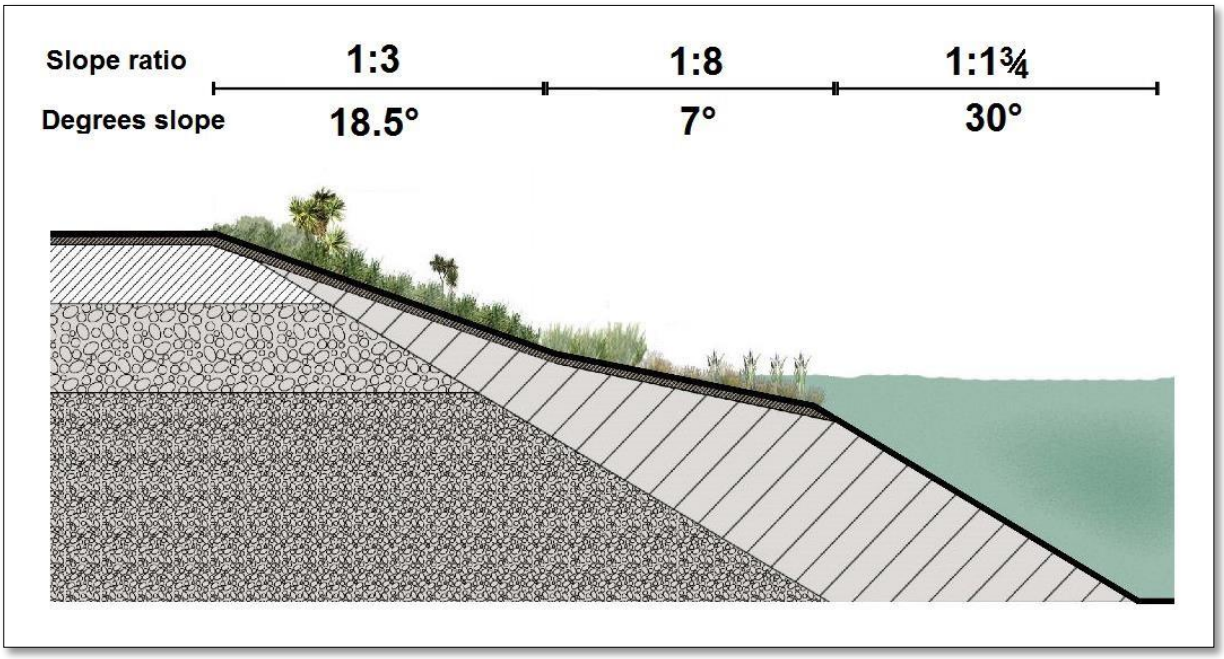

Figure 3: Lake margin slope aspects. Recreated from GBC Winstone (2016a).

The slope angles recommended are approximate; the creation of uneven scalloped edges will require some variation in slope construction. Machinery operators should be encouraged to be inexact, within reason, in order to create ecologically-beneficial natural variation. The scalloped edges (Figure 4) will allow for increased habitat and plant diversity.

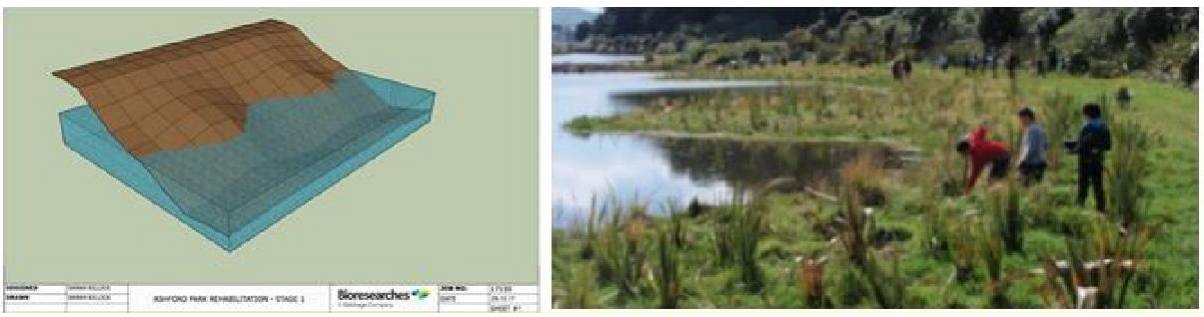

Figure 4: Scalloped margins, modelled left by Bioresearches. Photo on right from GBC Winstone (2016).

2.3 SITE PREPARATION

Top soil removed during the excavation process will be used to dress the surface following margin formation. Soil depth should be no less than 300 millimetres. Except as tablets or pellets placed within the holes prior to planting, application of fertilizer to the soils should be avoided as this will enter the lake and promote algal growth.

If soil is to be left for prolonged periods prior to planting, weedy taxa will likely establish. In this case, control weeds prior to the planting seasons. For the riparian (wet) areas, this will be over winter, to ensure readiness for summer planting, but for the dry areas within the Islands' interiors weeding should occur over summer, to allow for planting during autumn to winter.

3 PLANTING PLAN

3.1 PASSIVE REHABILITATION

The Ashford Park Gravel Extraction Rehabilitation Strategy (Boffa Miskell 2016) encourages the use of passive rehabilitation in conjunction with active (planting) rehabilitation for the riparian dry zones (Section 6.9.2). Native seed source is abundant on site and in the near vicinity, as evidenced by seedling establishment in fenced areas. These seed sources are ecologically preferable to seedlings sought from external areas as they are formed from local genetic lineages (ecosourced) and will only establish in optimum microsites where the conditions are favourable for germination and survival (ecosited).

Additional planting will still be required to ensure a vegetation density of 1.0 m centres in newly revegetated areas, and 3.0 m in established mature forest (Boffa Miskell 2016). Absolute plant numbers will need to be adjusted at the time of planting to reflect the area available for vegetation; to assist this, percent mix (%) has been provided for each species.

3.2 REVEGETATION APPROACH

Planting should occur in two stages: the 'wet zone' planting in summer, and the 'dry zone' planting over winter. The rationale for this is that during summer, the water level is likely to recede, allowing planting to occur in the emergent and submerged zones. Where inundation is unlikely, planting should occur over autumn to early winter to allow the establishment of root systems prior to the hotter summer months and increase plant survivorship.

Planting will use small grade plants (up to PB3 or 1L grade) planted to high density (0.7m centers) in the riparian zones to prevent weed colonization. Plant spacing must be adequate to allow the vegetation to present with a closed canopy within five years from planting, although it is expected than some spread of existing species (e.g. karamū) into the planted dry areas will occur. Appropriate spacing will provide protection to the interior plants from exposure; smaller plants, such as sedges, will require less space than large shrubs or trees. Initial weeding (as per Section 5) will need to be carried out prior to planting. Residual effects vary between herbicide products, therefore the timing of initial weed management will need to take into consideration the waiting period required prior to replanting.

3.3 RECOMMENDED METHODOLOGY

Water plants thoroughly and allow to drain out of direct sunlight. Set them out on site at the distances recommended in Table 3. Dig out a hole at least 1.5 – 2 times larger than the plant root ball. The application of mycorrhizal fungi to the soils during planting will allow strong root growth and increased nutrient uptake, and should be considered. This may be unnecessary if the topsoil has retained the mycorrhizal communities that were likely present prior to excavation. If unsure, trial plants with and without added mycorrhizae in the soil prior to the main planting event. Remove the plant carefully from the bag. If the plant is root bound, untangle the roots carefully to help them to grow. Do not do this with mānuka as the roots are very sensitive. Place a plastic cloche over the plant, secured with stakes, to protect the seedling from wind and pukeko browsing.

3.4 PLANTING ZONES

The recommended plants have been grouped by tolerance to freshwater immersion and wind tolerance. There are four planting units: Restoration Planting, Riparian Dry Zone, Riparian Wet Zone (Emergent), and Riparian Wet Zone (Submerged).

'Restoration Planting' will enhance canopy gaps in the retained vegetation and in the 8m around the outer edges. In addition to preventing weedy taxa from establishing in open areas, the restorative planting will provide a protective edge around each island and expedite the interior ground tier regeneration.

The 'Riparian Dry Zone' will perform similar edge buffer roles but will receive greater exposure to winds carried over the water and increased light and drying heat levels. For this reason, the Dry Zone vegetation must be tolerant and hardy.

The 'Riparian Wet Zone' has been separated into the 'Emergent' (above the water line) and 'Submerged' (below the water line) sub-categories.

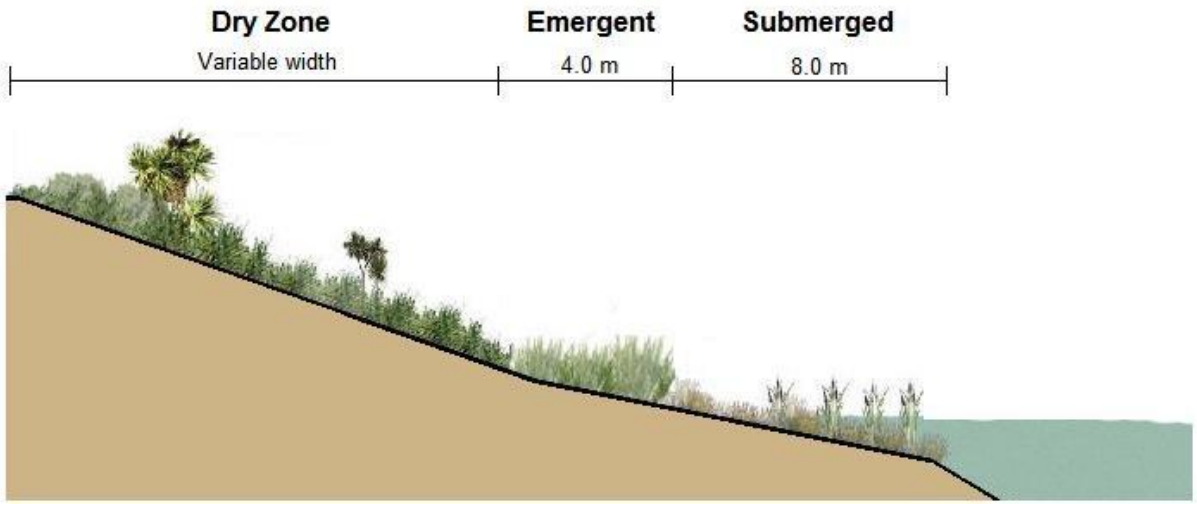

Figure 5: Planting zones from upper dry area (left) to lake margin (right). Image altered from GBC Winstone (2016a).

Vegetation will vary between zones, but some level of zone blending should occur to increase habitat complexity and provide a more natural look.

3.5 SPECIES SELECTION

The species selected for the rehabilitation of the newly formed riparian margin are required to be locally sourced native species that are suitable to the area and the specific conditions on site. To satisfy these conditions, the species lists are island and planting unit specific.

3.5.1 Western Island

Table 1: Western Island, Restoration Planting [4920m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Alectryon excelsus	titoki	5	3	30
Beilschmedia tawa	tawa	5	2	20
Brachyglottis repanda	rangiora	1.5	4	131
Coprosma areolata	thin-leaved Coprosma	1.2	2	82
Coprosma crassifolia		1.2	3	123
Coprosma rhamnoides	twiggy coprosma	1	1	49
Coprosma rotundifolia		1.2	2	82
Dicksonia squarrosa	Wheki	1.4	2	70
Dodonea viscosa	akeake	1.5	5	164
Dysoxylum spectabile	kohekohe	3	3	49
Elaeocarpus dentatus	hinau	2	3	74
Geniostoma ligustrifolium	hangehange	1	5	246
Hedycarya arborea	porokaiwhiri, pigeonwood	3	3	49
Knightia excelsa	rewarewa	4	3	37
Lophomyrtus bullata	ramarama	1.4	2	70
Lophomyrtus obcordata	rohutu	1.4	1	35
Melicope ternata	wharangi	1.4	3	105
Melicope simplex	poataniwha	1.4	2	70
Melicytus ramiflorus	mahoe	1.5	7	230
Microlaena stipoides	bush rice grass	1	4	197
Myoporum laetum	ngaio	2	3	74
Myrsine australis	mapou	1.2	4	164
Neomyrtys pedunculata	rohutu	1.5	3	98
Nestegis lanceolata	white maire	1.2	3	123
Nestegis montana	narrow leaved maire	1.2	2	30.0
Olearia rani var. *colorata*	heketara	1.3	2	76
Pennantia corymobosa	kaikomako	1.2	2	82
Piper excelsum	kawakawa	1.2	5	205
Pittosporum eugenoides	tarata	2	3	74
Pittosporum tenuifolium	kohuhu	2	2	49
Podocarpus totara var *totara*	totara	4	6	74
Pseudopanax crassifolius	horoeka	1	2	98
Strebulus heterophyllus	turepo	1	3	148
TOTAL			**100%**	**3208**

NOTE: Plant numbers are an approximate measure based on the current space available. A decrease is open area following passive regeneration will decrease this number, which can be estimated by: Plant number = ((Area/100) x % abundance) / spacing.

Table 2: Western Island, Riparian Dry Zone [5330m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Coprosma areolata	thin-leaved coprosma	1.0	3	160
Coprosma crassifolia		1.2	3	133
Coprosma repens	taupata	1.2	5	222
Coprosma rhamnoides	twiggy coprosma	1	5	267
Coprosma rotundifolia		1.2	5	222
Dodonea viscosa	akeake	1.2	2	89
Dysoxylum spectabile	kohekohe	5	3	32
Elaeocarpus dentatus	hinau	2	1	27
Geniostoma ligustrifolium	hangehange	1	5	267
Hedycarya arborea	pigeonwood	3	3	53
Knightia excelsa	rewarewa	5	2	21
Kunzea amathicola	rawiritoa	4	5	67
Lophomyrtus bullata	ramarama	1.5	2	71
Lophomyrtus obcordata	rohutu	1.5	1	36
Melicope ternata	wharangi	1.4	2	76
Melicope simplex	poataniwha	1.4	1	38
Melicytus ramiflorus	mahoe	1.2	3	133
Microlaena stipoides	bush rice grass	1	5	267
Myoporum laetum	ngaio	1.5	4	142
Myrsine australis	mapou	1.5	5	178
Neomyrtys pedunculata	rohutu	1	3	160
Nestegis lanceolata	white maire	2	3	80
Nestegis montana	narrow leaved maire	2	3	80
Olearia rani var. *colorata*	heketara	2	2	53
Pennantia corymobosa	kaikomako	1.5	3	107
Piper excelsum	kawakawa	1.2	4	178
Pittosporum eugenoides	tarata	2	2	53
Pittosporum tenuifolium	kohuhu	4	2	27
Podocarpus totara var. *totara*	totara	4	3	40
Pseudopanax crassifolius	horoeka	2	2	53
Sophora microphylla	kowhai	5	4	43
Strebulus banksii	turepo	1.5	2	71
Strebulus heterophyllus	turepo	1.5	2	71
TOTAL			**100%**	**3515**

Table 3: Western Island, Riparian Wet Zone (Emergent) [1980m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Austroderia toetoe	Toetoe	1	15	297
Carex buchanii	Buchanans sedge	0.5	6	238
Carex geminata	ruatahi	0.5	7	277
Carex maorica	Maori sedge	0.5	5	198
Carex secta	purei	0.5	10	277
Carex virgata	pukio	0.7	5	141
Juncus australis	wiwi, leafless rush	0.6	5	165
Juncus pallidus	giant rush	0.7	4	113
Juncus planifolus	grass leaved rush	0.7	5	141
Juncus sarophorus	fan-flowered rush	1	4	79
Luzula picta var. *picta*		0.5	4	158
Melicytus ramiflorus	mahoe	2	5	50
Ozothamnus laptophyllus	tauhinu	1	5	99
Phormium tenax	harakeke	1.5	15	198

Schoenus maschalinus	dwarf bog rush	0.5	5	198
TOTAL			**100%**	**2749**

Table 4: Western Island, Riparian Wet Zone (Submerged) [4260m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Carex maorica	maori sedge	0.50	8	682
Carex secta	purei	0.5	9	767
Carex virgata	pukio	0.5	10	852
Eleocharis acuta	sharp spike sedge	0.5	11	937
Eleocharis gracilis	slender spike sedge	0.3	5	710
Eleocharis sphacelata	kutakuta	0.6	12	852
Isolepis prolifera		0.5	10	852
Machaeina tenax		1	20	852
Schoenoplectus tabernaemontani	kuawa	0.5	5	426
Sparganium subglobosum	maru	0.5	5	426
Typha orientalis	raupo	1	5	213
TOTAL			**100%**	**7569**

3.5.2 Eastern Island

Table 5: Eastern Island, Restoration Planting [3040m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Alectryon excelsus	titoki	5	3	18
Beilschmedia tawa	tawa	5	2	12
Brachyglottis repanda	rangiora	1.5	4	81
Coprosma areolata	thin-leaved Coprosma	1.2	2	51
Coprosma crassifolia		1.2	3	76
Coprosma rhamnoides	twiggy coprosma	1	1	30
Coprosma rotundifolia		1.2	2	238
Dicksonia squarrosa	Wheki	1.4	2	43
Dodonea viscosa	akeake	1.5	5	101
Dysoxylum spectabile	kohekohe	3	3	30
Elaeocarpus dentatus	hinau	2	3	46
Geniostoma ligustrifolium	hangehange	1	5	152
Hedycarya arborea	porokaiwhiri, pigeonwood	3	3	30
Knightia excelsa	rewarewa	4	3	23
Lophomyrtus bullata	ramarama	1.4	2	43
Lophomyrtus obcordata	rohutu	1.4	1	22
Melicope ternata	wharangi	1.4	3	65
Melicope simplex	poataniwha	1.4	2	43
Melicytus ramiflorus	mahoe	1.5	7	142
Microlaena stipoides	bush rice grass	1	4	122
Myoporum laetum	ngaio	2	3	46
Myrsine australis	mapou	1.2	4	101
Neomyrtys pedunculata	rohutu	1.5	3	61
Nestegis lanceolata	white maire	1.2	3	76
Nestegis montana	narrow leaved maire	1.2	2	51
Olearia rani var. *colorata*	heketara	1.3	2	47
Pennantia corymobosa	kaikomako	1.2	2	51
Piper excelsum	kawakawa	1.2	5	127
Pittosporum eugenoides	tarata	2	3	46
Pittosporum tenuifolium	kohuhu	2	2	30

Podocarpus totara var *totara*	totara	4	6	46
Pseudopanax crassifolius	horoeka	1	2	61
Strebulus heterophyllus	turepo	1	3	91
TOTAL			**100%**	**2202**

Table 6: Eastern Island, Riparian Dry Zone [5230m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Coprosma areolata	thin-leaved coprosma	1.0	3	157
Coprosma crassifolia		1.2	3	131
Coprosma repens	taupata	1.2	5	218
Coprosma rhamnoides	twiggy coprosma	1	5	262
Coprosma rotundifolia		1.2	5	218
Dodonea viscosa	akeake	1.2	2	87
Dysoxylum spectabile	kohekohe	5	3	31
Elaeocarpus dentatus	hinau	2	1	26
Geniostoma ligustrifolium	hangehange	1	5	262
Hedycarya arborea	pigeonwood	3	3	52
Knightia excelsa	rewarewa	5	2	21
Kunzea amathicola	rawiritoa	4	5	65
Lophomyrtus bullata	ramarama	1.5	2	70
Lophomyrtus obcordata	rohutu	1.5	1	35
Melicope ternata	wharangi	1.4	2	75
Melicope simplex	poataniwha	1.4	1	37
Melicytus ramiflorus	mahoe	1.2	3	131
Microlaena stipoides	bush rice grass	1	5	262
Myoporum laetum	ngaio	1.5	4	139
Myrsine australis	mapou	1.5	5	174
Neomyrtys pedunculata	rohutu	1	3	157
Nestegis lanceolata	white maire	2	3	78
Nestegis montana	narrow leaved maire	2	3	78
Olearia rani var. *colorata*	heketara	2	2	52
Pennantia corymobosa	kaikomako	1.5	3	105
Piper excelsum	kawakawa	1.2	4	174
Pittosporum eugenoides	tarata	2	2	52
Pittosporum tenuifolium	kohuhu	4	2	26
Podocarpus totara var *totara*	totara	4	3	39
Pseudopanax crassifolius	horoeka	2	2	52
Sophora microphylla	kowhai	5	4	42
Strebulus banksii	turepo	1.5	2	70
Strebulus heterophyllus	turepo	1.5	2	70
TOTAL			**100%**	**3449**

Table 7: Eastern Island Riparian Wet Zone (Emergent) [1720m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Austroderia toetoe	Toetoe	1	15	297
Carex buchanii	Buchanans sedge	0.5	6	238
Carex geminata	ruatahi	0.5	7	277
Carex maorica	Maori sedge	0.5	5	198
Carex secta	purei	0.5	10	277
Carex virgata	pukio	0.7	5	141
Juncus australis	wiwi, leafless rush	0.6	5	165
Juncus pallidus	giant rush	0.7	4	113

Juncus planifolus	grass leaved rush	0.7	5	141
Juncus sarophorus	fan-flowered rush	1	4	79
Luzula picta var. *picta*		0.5	4	158
Melicytus ramiflorus	mahoe	2	5	50
Ozothamnus laptophyllus	tauhinu	1	5	99
Phormium tenax	harakeke	1.5	15	198
Schoenus maschalinus	dwarf bog rush	0.5	5	198
TOTAL			**100%**	**2749**

Table 8: Eastern Island Riparian Wet Zone (Submerged) [3770m^2]

Species	Common name(s)	Spacing (m)	% abundance	Approx. No.
Carex maorica	maori sedge	0.50	8	682
Carex secta	purei	0.5	9	767
Carex virgata	pukio	0.5	10	852
Eleocharis acuta	sharp spike sedge	0.5	11	937
Eleocharis gracilis	slender spike sedge	0.3	5	710
Eleocharis sphacelata	kutakuta	0.6	12	852
Isolepis prolifera		0.5	10	852
Machaeina tenax		1	20	852
Schoenoplectus tabernaemontani	kuawa	0.5	5	426
Sparganium subglobosum	maru	0.5	5	426
Typha orientalis	raupo	1	5	213
TOTAL			**100%**	**7569**

3.6 ECOSOURCING

The sourcing of seed and/or plant propagative material in the local area (i.e. 'ecosourcing') is common conservation practice in New Zealand (Stevens *et al*., 2015). Although there are some concerns regarding the maintenance of natural levels of genetic variation, ecosourcing ensures that the plants grown are as similar as possible to the naturally occurring flora in the region and are adapted to local conditions. In accordance with Section 50 of the Conditions of Consent (RM150184), all native plants must be ecosourced from indigenous species from the Wellington Ecological District. The Ōtaki ecodistrict follows the west coast from just south of Turakina on the north, down to Paekakariki in the south (Figure 6).

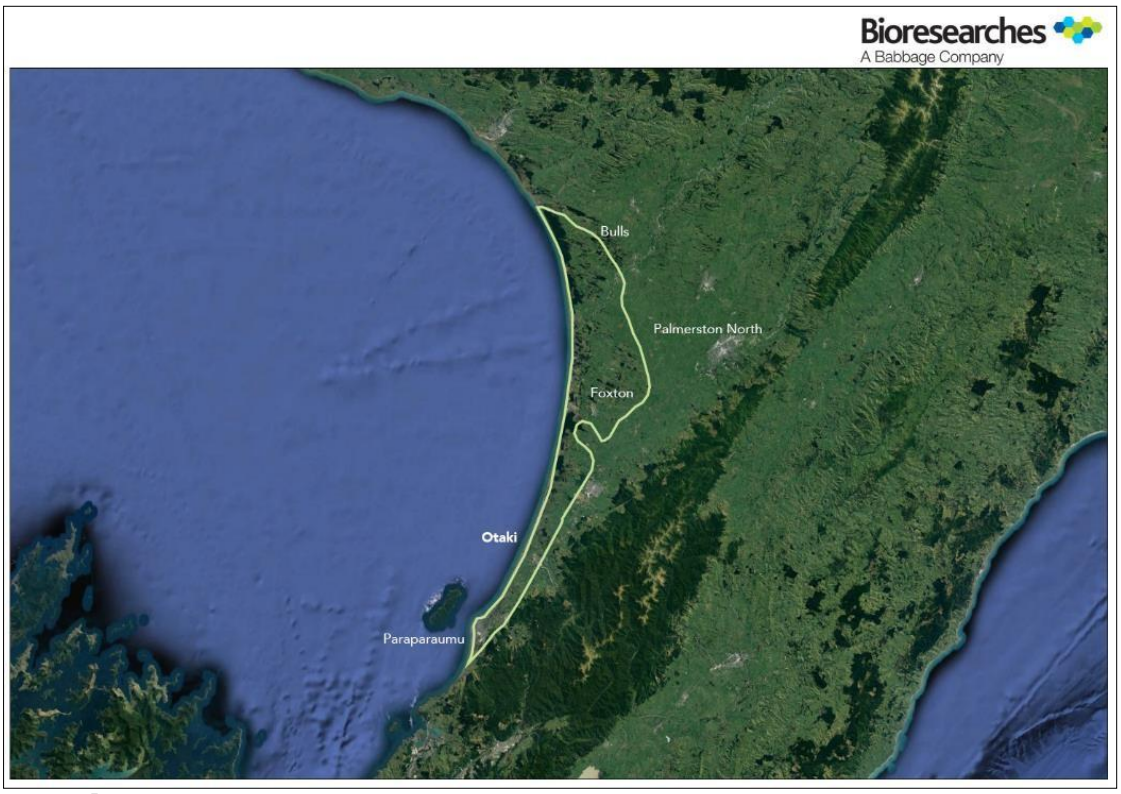

Figure 6: Ōtaki ecodistrict boundaries, based on the Department of Conservation map viewer (maps.doc.govt.nz), accessed 26th September, 2017. Seeds may be sourced from anywhere within the light green boundary.

To best preserve the regional flora, the following guidelines should be followed:

- Collect seed rather than plant cuttings wherever practicable, as this maintains genetic diversity.
- Maternal plants should be uncultivated (wild-sourced) wherever possible.
- Collect no greater than 10% of plants' seeds, and avoid utilizing the same plant multiple times.
- Select seed from multiple plants across different sites. Plants situated closely next to each other are likely to be closely related.
- Always obtain permission from the landowner before collecting seed or other plant material
- Maintain thorough records of seed species collected, source locations, collection dates, and habitat characteristics from the maternal plant site.

3.7 MYRTLE RUST

Some of the plants recommended in this plan (mānuka, ramarama, and rātā) are susceptible to myrtle rust. Myrtle rust is a serious fungal disease that is expected to affect all plants within the myrtle family (Myrtaceae), including mānuka, kānuka, pōhutukawa, rātā, ramarama, feijoa, and eucalyptus. Spores are microscopic and windborne. It generally attacks soft, new growth, including leaves, shoots, buds, flowers, and fruit. This can cause yellow powdery eruptions on the leaves, which may turn into brown or grey pustules in older infections. It may also look like a grey 'fuzzy' growth on the undersides of leaves. If you suspect the presence of myrtle rust, try to take a photo without touching the plant. Touching the plant may release spores into the environment. Then, call MPI immediately on 0800 80 99 66.

4 PROTECTIVE MEASURES

4.1 PHYSICAL PROTECTION

A protective fence must be constructed surrounding all retained vegetation to prevent accidental removal or damage to the trees or root systems. The fence should be no closer to the trees than the drip line, and should preferably offer an additional 2m of protection beyond the drip line. The fences should be clearly visible and strong enough to protect the vegetation behind them.

No vehicle access or storage should be permitted behind the fences within the future Ecological Islands. No herbicide, fuels, or other phytotoxic substances should be mixed or stored within the fenced areas.

The eastern Island must be fenced prior to works commencing in Stage 2, and the western island must be fully fenced prior to Stage 4 commencement. The fences may be removed by section when the adjacent stage is complete and the riparian margin is ready to be shaped and planted.

4.2 LEGAL PROTECTION

In accordance with Consent Condition 53, the two ecological islands must be protected in perpetuity by way of QEII covenant or similar legal mechanism within 12 months of planting completion.

5 MAINTENANCE AND PEST MANAGEMENT PLAN

5.1 INITIAL WEED MANAGEMENT

Any weeds capable of smothering young plants should be managed prior to planting. Seed matter within the stored topsoil may have remained viable, therefore weeds currently not present may establish following riparian formation.

If kikuyu grass establishes, this should be managed thoroughly. *Tradescantia* within the forest interior should also be managed to encourage native dominance. Weed-specific methodology has been provided in Section 5.3.

5.2 REVEGETATION MAINTENANCE

Ongoing maintenance is important to ensure plant survivorship and native plant dominance and density. Plants will need to be released from weeds, and any that have died will need to be replaced. If weed release is undertaken using herbicide, extreme care is required to prevent spray drift from reaching the native plants. Only herbicides which explicitly state they are safe for use near waterbodies shall be used. No herbicides should be stored or mixed on site. Maintenance should last for at least five years from planting date for each area, and may decrease in frequency with time.

Year:	**1**	**2**	**3**	**4**	**5**
Number of maintenance visits:	**3**	**3**	**3**	**1**	**1**

However, the maintenance of the revegetation will remain the responsibility of GBC Winstone for the remainder of the 20 year project timeframe. It is likely that, over the course of this period, reinvasion will occur. Although smaller annual weeds are less likely to become problematic once canopy coverage has been established, vines (such as Japanese honeysuckle (*Lonicera japonica*), jasmine (*Jasminum polyanthum*), and moth plant (*Araujia hortorum*)) or woody weeds such as Chinese privet (*Ligustrum sinense*) or woolly nightshade (*Solanum mauritianum*) endanger native vegetation at all life stages and must be managed until five years after the project completion.

5.3 PLANT PEST CONTROL

Because the planting site will be sculpted post-excavation, there will be no weedy taxa present in the initial stages. However, there is a well-documented association between weedy species and disturbance, providing a strong likelihood of future invasive. The Greater Wellington Regional Council has assessed weedy taxa of a particular threat to the region, which are discussed within the Wellington Regional Pest Management Strategy (RPMSP) (2009). All species mentioned within the Wellington RPMS should be controlled, however species listed as 'Total Control' or 'Containment' species must be controlled immediately – even if the observation occurs outside of the schedules monitoring and management period. A species-specific weed management methodology has been provided (Table 9); further weed management options can be found at Weed Busters (www.weedbusters.org.nz).

Table 9: Weed Management Recommendations

Weed species	Common name	Action required
Aristea ecklonii	aristea	Spray with 3g metsulfuron-methyl 600g/kg +150 ml glyphosate + 10ml penetrant / 10L
Asparagus scandens	climbing asparagus	Dig out tubers. Spray with glyphosate (20ml/L).
Cortaderia selloana	pampas	Weed wipe (all year round): glyphosate (200ml/L + penetrant).
Lonicera japonica	Japanese honeysuckle	Spray (summer-autumn): glyphosate (10ml/L) or metsulfuron-methyl 600g/kg (5g/10L + penetrant) or clopyralid (50ml/10L) or Tordon Brushkiller (60ml/10L).
Selaginella kraussiana	African clubmoss	Spray with 100ml glyphosate + 2g metsulfuron-methyl 600g/kg + 10 ml penetrant / 10L.
Solanum mauritianum	woolly nightshade	Cut and paste stumps with Tordon Brushkiller or Yates Woody Weedkiller. Pull up smaller plants, and leave on site to rot down.
Tradescantia flumensis	Tradescantia	Rake and roll up, avoid dropping any fragments. Spray with triclopyr 600 EC (6ml/L + penetrant).
Ulex europaeus	gorse	Spray (spring-summer): triclopyr 600 EC (20ml/10L) or triclopyr 300 EC (40ml/10L).
Zantedeschia aethiopica	arum lily	Cut down and paint stump with 1g metsulfuron-methyl 600g/kg + 100ml glyphosate + 10 ml penetrant / L water.

The utmost care must be taken to ensure that only herbicides appropriate for use near waterways is used. Only some foliar herbicides are suitable for use next to waterways, including Diquat and glyphosate products Roundup®, Trounce®, and Zero®. Other herbicides, such as metsulfuron and Tordon® Brushkiller can be applied directly to cut stumps. Herbicide pouring and dilution must not be carried out within 20 m of the lake or the Ōtaki River, and no herbicides may be used over water unless explicitly recommended on the manufacturer's label. At no point may herbicides be used in any manner which may result in contamination of waterways.

Great care shall be taken to protect all retained vegetation from contact with herbicide. The persons undertaking weed management should be suitably qualified, and be mindful of retained vegetation, potential contamination of waterways and the health of humans and wildlife when using herbicides.

Table 10: Wellington RPMS species

Species	Common name	Wellington RPMS level
Akebia quinata	Chocolate vine	Surveillance species
Alternanthera philoxeroides	Alligator weed	Surveillance species
Bomarea caldassi	Bomarea	Surveillance species
Bomarea multiflora	Bomarea	Surveillance species
Carex longebrachiata	Australian sedge	Surveillance species
Gymnocoronis spilanthoides	Senegal tea	Surveillance species
Houttuynia cordata	Houttuynia	Surveillance species
Lythrum salicaria	Purple loosestrife	Surveillance species
Nassella neesiana	Chilean needlegrass	Surveillance species
Nassella trichotoma	Nassella tussock	Surveillance species
Pennisetum alopecuroides	Chinese pennisetum	Surveillance species
Pennisetum setaceum	African fountain grass	Surveillance species
Polypodium vulgare	polypodium	Surveillance species
Reynoutria japonica	Asiatic knotweed	Surveillance species
Reynoutria sachalinensis	Giant knotweed	Surveillance species
Sagittaria montevidensis	Californian arrowhead	Surveillance species
Sagittaria platyphylla	Delta arrowhead	Surveillance species
Sagittaria sagittifolia	Hawaiian arrowhead	Surveillance species
Schoenoplectus californicus	Californian bulrush	Surveillance species
Solanum linnaeanum	Apple of Sodom	Surveillance species
Solanum marginatum	white-edged nightshade	Surveillance species
Spartina spp.	Spartina	Surveillance species
Tropaeolum speciosum	Chilean flame creeper	Surveillance species
Xanthium occidentale	Noogoora bur	Surveillance species
Anredera cordifolia	madeira vine	Total Control species
Araujia hortorum	moth plant	Total Control species
Carthamus lanatus	saffron thistle	Total Control species
Celastrus orbiculatus	Climbing spindleberry	Total Control species
Passiflora caerulea	Blue passionflower	Total Control species
Pennisetum macrourum	African feather grass	Total Control species
Solanum mauritianum	woolly nightshade	Total Control species
Urtica dioca	perrenial nettle	Total Control species
Vallisneria gigantea	eelgrass	Total Control species
Vallisneria spiralis	eelgrass	Total Control species
Xanthium spinosum	Bathurst bur	Total Control species
Zizania latifolia	Manchurian wold rice	Total Control species
Ceratophyllum demersum	Hornwort	Containment species
Chrysanthemoides monilifera	boneseed	Containment species
Polygala myrtifolia	sweet pea shrub	Containment species
Rhamnus alaternus	evergreen buckthorn	Containment species

5.4 ANIMAL PEST CONTROL

Rabbits, the greatest pest concern for plantings around the outer lake edges, will be unable to access the Ecological Islands when they become surrounded by the newly formed lake. Any rabbits on the island should be managed until a zero density is achieved.

Possums, rodents, and mustelids must be managed on an on-going basis. Possums selectively browse young shoots, reducing plant reproductive ability. Rodents destroy seed matter, preventing regeneration, and all three pest groups predate upon birds, eggs, and herpetofauna.

Although native, pukeko are occasionally considered to be pests, as they will pull-up and eat newly planted vegetation. Plastic tube cloches around young plants have been used successfully as pukeko deterrents and are strongly recommended here. If cloches are not implemented, or in areas close to the lake edge where plastic is inappropriate, ensure plants are firmly planted and are not easy to pull out.

Table 11: Pest Management Recommendations

Pest	Management options	Ideal timing	Density
Rodents	Victor snapback rat traps or DOC200 traps, or Ratabate poison in bait stations.	Bait stations or traps should be placed for two weeks prior to filling / setting.	2 bait stations or traps per island. If using DOC200 for rats as well as stoats, use 2 double-ended traps per island.
Mustelids	DOC200 traps baited with meat or eggs,	Check fortnightly in summer and monthly in winter.	
Possums	Use cyanide for the initial 'knock down' and then maintain low densities with Sentinel traps.	Knock down is best timed before and during bird breeding season (August – January).	Two stations of western island and one station on the eastern island.
Rabbits	Use Pindone pellets in a multi-feeder bait station until zero-density has been achieved. Re-invasion is unlikely once islands are isolated by water.	Begin before their main breeding season (late winter to early summer) during a dry period. Refill 10 days after initial fill. Repeat treatment prior to each planting day.	One station per island.

Management of all mammalian pests should occur for at least five years post-completion of the islands' revegetation to allow native fauna to establish robust populations.

6 SUMMARY AND RECOMMENDATIONS

The quarrying of Ashford Park, Ōtaki, will result in the formation of a large lake. Two tītoki-kohekohe- tōtara remnants within the project site were determined to be ecologically significant due to their relative size and rarity. These remnants will be retained within the formed lake, resulting in two Ecological Islands.

The edges of the islands will be sloped and scalloped to increase habitat availability and assist in the creation and maintenance of a healthy lake ecosystem.

Planting of the wet riparian edges around the outer islands will assist in bank stability, water quality management, and habitat provision. The dry riparian areas will be planted with larger-growing plants that are capable of surviving the increased wind and light exposure from the lake. The riparian vegetation will protect the Ecological Islands' interiors and encourage regeneration. Open areas within and surrounding the existing forest will also be planted to expedite the rehabilitation process.

The Ecological Islands will be protected by fences to protect the vegetation during quarrying; these fences may only be removed at project completion. Within 12 months of project completion, the Islands must be protected in perpetuity by way of QEII Covenant or similar legal mechanism.

To encourage successful rehabilitation of the Ecological Islands, the following recommendations have been made:

- Ongoing weed management and additional infill planting will be required. Management shall meet the requirements of the Greater Wellington Pest Management Strategy, and supress invasive species to less than 5% relative abundance.

- All plants used should be suitable for the site, and their positioning in the planting. Plants must be native and ecosourced from the Ōtaki ecological region.

- Bare ground exposed by site works alongside the lake should be stabilised and replanted with appropriate vegetation as soon as possible.

7 REFERENCES

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