Te Ngahere
Native Forest Management

Oakley Creek Te Auaunga Ecological Restoration Plan

2015-2025

Ecological Restoration and Consultancy

Oakley Creek Te Auaunga Ecological Restoration Plan

2015-2025

July 2015 - Final

Prepared on behalf of: Auckland Council

Prepared by:
Michelle Dublon
Ecologist
Te Ngahere

PO Box 71109 Rosebank Post Centre, Auckland 1348
326 Rosebank Road, Avondale 1026
Ph 09 828 4035
www.te-ngahere.co.nz

Te Ngahere

Table of Contents

Table Index

Figure Index

1 Introduction

The Oakley Creek Te Auaunga Ecological Restoration Project is an excellent example of the local community, Auckland Council (formerly Auckland City Council) and various stakeholders working together to deliver long-lasting environmental benefits to an important urban stream corridor. The restoration programme covers the lower reaches of Oakley Creek from Great North Road to the southern extent of Harbutt Reserve.

Major ecological gains have been made along the Oakley Creek corridor over the last 10+ years, through reducing the presence of environmental weeds, restoring the vegetation cover to appropriate streamside native species, and decreasing the numbers and effects of animal pests. This has had wider benefits of creating habitat for native wildlife, increasing shade over the stream, helping to stabilise banks and reduce erosion, improving water quality and working towards reducing the effects of stormwater flows.

Ecological restoration along Oakley Creek has been guided by the original ecological restoration plan produced in 2005 by Te Ngahere, "*Environmental Weed Control and Native Revegetation Programme for Oakley (Te Auaunga) Creek*", which was revised and updated by Te Ngahere in 2009.

Initially, weed control and revegetation focused on the lower (northern) reaches of Oakley Creek (from Waterview Downs to Great North Road), but since 2010 restoration has progressed to Phyllis Reserve and Harbutt Reserves.

In 2011/2012 the Albert-Eden Local Board funded a report to assess the remnant mahoe rock forest areas along Oakley Creek Walkway (Te Ngahere Oct 2012, updated Aug 2013). This report identified management priorities and a programme of restoration work for remnant mahoe rock forest areas in management units 8, 9, 10 and 11.

As the original restoration plan for Oakley Creek has expired, a new ecological restoration programme covering the next 10 years, 2015-2025, is needed to guide ongoing management of the project. This new plan combines all management units (MU 1-11) and adds the esplanades reserves on the western side of the creek, into one plan for ease of understanding and management.

A restoration plan is necessary to provide coordinated ecological management of the site with a long-term vision, clear objectives and a proposed programme of work. Restoration along Oakley Creek needs to consider ecological, cultural, amenity and archaeological values of the site, as well as local community involvement.

1.1 Vision

A long-term (30 year plus) vision is essential for any ecological restoration project. The vision for Oakley Creek Te Auaunga is to see its environs restored and protected as a natural, native ecosystem, incorporating a range of wildlife habitats, indigenous species and recreational amenities for present and future generations.

1.2 Aim

To maintain a holistic approach to the restoration, enhancement and protection of the ecological health of Oakley Creek Te Auaunga, and its environs. The vegetation composition will consist of predominantly native species, with weed and animal pest species significantly reduced, and will provide important habitat and food sources for native fauna.

1.3 Goals

1) To establish Oakley Creek as a place of major ecological, social and cultural value.
2) To establish Oakley Creek as a natural waterway, which provides shelter and food for native wildlife.
3) To foster local community involvement in the restoration of Oakley Creek to create a sense of community ownership and pride.
4) To enhance the natural character of Oakley Creek by establishing native vegetation in the riparian area and the wider stream corridor.
5) To reduce the impacts of weed species and animal pests along Oakley Creek.
6) To protect the stream banks of Oakley Creek from erosion, through riparian planting and encouraging appropriate erosion mitigation.
7) To restore and enhance the water quality in Oakley Creek, through riparian planting and providing rough surfaces for stream life.
8) To establish Oakley Creek as a natural area of multiple environments, including native forest, stream habitat, wetland, open space and walkway.
9) For Oakley Creek to become a wildlife corridor and stepping stone in the urban landscape, linking to other areas of ecological importance in the surrounding area.

1.4 Restoration Programme Objectives

In the process of fulfilling the above vision, aim and goals for Oakley Creek, this restoration programme will achieve the following objectives:

1) Provide a long-term, step-by-step restoration programme that can be used by Auckland Council, local community groups (such as Friends of Oakley Creek) and other stakeholders.
2) Protect, restore and enhance the ecological, cultural and archaeological values of Oakley Creek.
3) Support the aspirations of the local community and maintain relationships between the various stakeholders through the provision of restoration guiding principles and a work plan.
4) Reduce the presence of environmental pest plants through a comprehensive programme of weed control, weed tree removal and planting maintenance.
5) Reduce the impacts of animal pests (including rodents, mustelids and possums) through a programme of trapping and baiting. This will increase the diversity, survival and breeding success of native fauna – including birds, lizards and invertebrates.
6) Carry out an appropriate programme of revegetation planting, using native species

appropriate to the habitat type, local soils/ geology and site conditions, which are eco-sourced from the Tamaki Ecological District.

7) Undertake ecological monitoring to establish effective progress and review approaches. This will include the monitoring of animal pests, birds, weta, water quality, fish, macroinvertebrates, vegetation plots and the use of photopoints .

In carrying out these objectives a wide range of issues will need to be taken into account such as cultural and archaeological sites, local landforms and geology, erosion issues, preserving views and maintaining recreational use of the area.

2 Site Overview

2.1 Site location and catchment character

Oakley Creek, also known as Te Auaunga, is located in Central West Auckland, starting in Keith Hay Park in Mt Roskill (Puketapapa Local Board), and flowing through Owairaka, Mt Albert, Avondale, Waterview (Albert-Eden and Whau Local Boards) and then to the sea. Oakley Creek is the longest stream in Auckland City, at approximately 15km in total length. The stream discharges through the Waterview inlet (just south of the Waterview/Point Chevalier interchange of the Northwestern Motorway SH 16 / SH 20 link) into the Motu Manawa – Pollen Island Marine Reserve in the Waitemata Harbour.

The Oakley Creek catchment varies from a relatively natural character in the lower reaches, with steep valley sides, a meandering stream and floodplain areas, plus a 6m-high waterfall (the only significant waterfall within Auckland City). Whilst in the upper reaches it is more modified, with straightened and channelised (or piped) stream sections with very limited native vegetation.

There are a variety of land uses along the Oakley Creek catchment. These include relatively low density residential areas, roads, commercial and industrial sites and open space (including parks, schools and playing fields). The upper catchment, in particular, has been modified to prevent flooding, by channelling stormwater to the Waitemata Harbour during storm events. As part of the Waterview Connection SH 20 works, the mid-reaches of Oakley Creek, in Alan Wood Reserve, have been re-aligned and naturalised through enhancement planting. As part of the proposed Te Auaunga Awa (Underwood / Walmsley Reserves) stormwater upgrade, approximately 1.3 kilometers of concrete lined channel will be renaturalised, with extensive planting being undertaken. Both these projects should bring downstream benefits to the creek.

2.2 Restoration work area

This Ecological Restoration Plan and programme of work covers the section of Oakley Creek in the lower reaches, where it flows along the Oakley Creek Walkway and through Phyllis and Harbutt Reserves. The project area is bordered by Great North Road in the north, Unitec Institute of Technology (Unitec) in the east and residential areas around to the west. The southern boundary is at the south-western end of Harbutt Reserve parallel with the western railway line. See Figure 1 for a location map.

This ecological restoration plan work area covers the land along the creek in Auckland Council ownership, which is mainly within the Albert-Eden Local Board. Council reserve land, in existing and potential esplanade reserves on the western side of the creek within the Whau Local Board, has also been included.

The restoration work area has been split into Management Units (MUs) in order to prioritise management and identify specific work areas. The original 'Oakley Creek Restoration Plan' (Te Ngahere 2005, revised 2009) only included MUs 1-9, while this 2015-2025 Restoration Plan has now been extended to include MUs 10 & 11 to the south-western extent of Harbutt Reserve and a new MU 12 for the western esplanades. Refer to Management Unit maps, showing the restoration work area boundaries (Figure 7 and Figure 8).

The active local community group 'Friends of Oakley Creek' is also engaged in working with adjacent landowners to carry out restoration tasks, such as Unitec, Ngati Whatua and local residents, who have properties backing on to the creek.

Figure 1. Site location map for the Oakley Creek restoration work area (Great North Road to end of Harbutt Reserve)

2.3 Site values and designations

2.3.1 Ecological importance and designations

The Oakley Creek restoration work area is designated as a Significant Ecological Area (SEA_T_6008) and zoned as Public Open Space – Conservation in the Proposed Auckland Unitary Plan (as notified 30th September 2013). It covers the vegetated extent of the stream corridor on both banks, from Great North Road to the southern extent of Harbutt Reserve, together with some bush islands in Waterview Glades and Harbutt Reserve. The waterfall is also identified as an Outstanding Natural Feature (ID 134, Oakley Creek waterfall) and is a unique feature in Auckland city. The adjacent sports fields and amenity grass areas (to the east) are classed as Public Open Space – Sport & Active Recreation and Public Open Space – Informal Recreation.

Oakley Creek is significant for a number of reasons. The lower reaches of Oakley Creek have high ecological value due to the range of habitats present (stream, wetland, regenerating forest, remnant mahoe rock forest) and diversity of in-stream aquatic species that it supports, such as a good range of native fish and macroinvertebrates.

It is one of the only waterways in Auckland that remains above ground for the majority of its path (apart from some culverts under roads). The lower reaches covered in the restoration work area provide a long stretch of relatively unmodified natural stream corridor, with permanent flows and a good diversity of in-stream features (deep pools, riffles, backwaters, rocky material and silty sediment). Water quality in the past has been poor, but with ongoing restoration is improving. Freshwater mussels and torrentfish have been observed, which both require good water quality and are uncommon in urban streams, especially in Auckland.

Oakley Creek is an important and extensive area of streamside and river slope vegetation within urban Auckland. It provides a valuable natural corridor and stepping stone between native bush remnants and other reserves in the surrounding area, thereby facilitating the movement of native fauna and flora. Further ecological restoration of the creek and its surrounds will help to sustain our urban biodiversity by providing essential habitat and food resources for native fauna. In addition the vegetated area acts as an important buffer between urban development and the creek, not only for aesthetic reasons, but also as a filter for pollutant and sediment laden runoff into the creek and eventually the sea.

Ongoing restoration efforts and revegetation of the stream banks and slopes has led to enhanced forest and riparian habitat for native birds, lizards and invertebrates, which will continue to increase in value as vegetation matures over time. A noticeable increase in the number and diversity of native birds has been observed along Oakley Creek since restoration began in 2004.

2.3.2 Archaeological and cultural significance

Oakley Creek is highly significant to local iwi for its environmental and cultural values. A number of cultural sites are known to be present from previous Māori occupation, including middens, pits and potential terraces.

Several other archaeological sites are situated along Oakley Creek including remnants from historic farming practices e.g. stone walls, stream crossings, a potential old mill, a tannery and several quarries.

All restoration activities should take these historically and culturally significant sites into consideration, and appropriate parties should be consulted, including archaeologists and local iwi.

In the Proposed Auckland Unitary Plan (as notified 30th September 2013), there are a number of Historic Heritage sites identified along Oakley Creek including:

- Sites and Places of Value to Mana Whenua – numerous sites (ID 2955, ID 2411, ID 860, ID 859, ID 858, ID 857, ID 856, ID 855, ID 3430, ID 2842)
- Historic Heritage Place (1583, Oakley Creek)
- Historic Heritage Extent of Place (1583, Oakley Creek) – covers the lower reaches from Great North Road to just north of Waterview Downs.

Druskovich (2009) has identified and documented archaeological sites within and in proximity to Oakley Creek, with regular update reports provided during restoration works from 2009-2015 (Druskovich, various). A further archaeological survey of the Oakley Creek restoration work area is being undertaken in winter 2015 (as part of applying for a new Heritage New Zealand 'Authority to Modify'), and the resulting recommendations will need to be followed and incorporated into this Ecological Restoration Plan.

There is a chance that further archaeological / cultural sites could be discovered in the future. Therefore, an Accidental Discovery Protocol needs to be adhered to during ecological restoration tasks, whereby, if any suspected archaeological material is discovered all work must stop immediately and the appropriate authorities and consultant archaeologist must be informed. In addition, if any koiwi (human remains) are uncovered, work should cease immediately and the tangata whenua and police should be contacted so that appropriate arrangements can be made.

2.3.3 Recreational and amenity value

Oakley Creek is an important publicly accessible greenspace and is well used for recreation by walkers, joggers, commuters, local residents and families, as well as for wildlife appreciation and environmental education. The stream corridor forms a large green network with the adjacent playing fields, amenity grass areas and the park-like grounds within Unitec. The popular Oakley Creek Walkway runs along the stream corridor from Harbutt Reserve to Great North Road, Waterview.

As part of the Waterview Connection / SH 20 mitigation works, a new 'shared path' will be constructed parallel with the walkway (on the upper plateau). This will create better linkages between Alan Wood Reserve and the SH 16 cycleway, with connections to the Oakley Creek walkway.

Oakley Creek is an important recreational resource and landscape feature, which the local community value. As plantings continue to mature and native fauna thrives, restoring the area will be an excellent advocacy tool to help promote the benefits of managing our natural environment, as well as providing social and health-related rewards.

2.4 Site threats

The creek holds historical and ecological value, however this is threatened by a number of factors. These threats include:

- Presence and ongoing re-invasion of environmental weeds (from upstream, spread by wind and from adjacent land).
- Urban intensification, such as subdivision and road development projects adjacent and upstream to the stream, which leads to:
    - Increased impervious surfaces, resulting in changes to ground water and increased overland flow and sediment entering the waterway. This will also result in an increase in the volume and velocity of water entering the stream.
    - Increased stormwater run off and high flows – which are often contaminated with heavy metals, oils and grease, hydrocarbons, nutrients and suspended solids. High flows lead to scouring and erosion hotspots along the creek and can cause bank instability. Direct impacts will be pollution / decreased water quality, loss of vegetation and negative effects on biodiversity within the stream, harbour and coastal waters downstream.
    - Increased pressure from predators (rats and domestic cats) on native wildlife.
    - Increase in garden exotics and weeds invading native vegetation along the stream.
- Unitec planned development proposals – could significantly affect the natural character and land use adjacent to Oakley Creek. This could result in increased housing density (and the resulting negative impacts mentioned above), loss of surrounding open space and increased use pressure.
- Climate Change – is likely to result in increased rainfall events and more unpredictable weather patterns, resulting in increased storm events, more high flows and potential stream erosion.
- Wastewater overflows can result during high storm flow events leading to contamination of streams and a decrease in water quality, as well as health hazards. The Central Interceptor Wastewater Projectis a long-term wastewater upgrade project which is expected to reduce existing wastewater overflows from the combined sewer-stormwater system into urban streams and the Waitemata Harbour.

One of the most serious threats to Auckland's natural environment is the establishment and spread of invasive weeds within remaining bush remnants and corridors. Environmental weeds replace native trees, prevent native regeneration and smother native plants. This is why it is essential to restore areas of native habitat to prevent the transformation of native forest/streams into exotic ecosystems. An ongoing comprehensive weed management and native revegetation programme is essential for restoring the creek's unique ecology and landscape.

2.5 Restoration benefits

Significant achievements have been made in restoring Oakley Creek over the last 10 years, including establishing native vegetation in the riparian area and stream corridor. Along with weed and animal pest control this revegetation continues to bring a range of environmental benefits to this important stream and the wider area.

These environmental benefits include:

- an enhanced natural character, better appreciated by the local community,
- increased amenity value and recreation resource,
- terrestrial and in-stream biodiversity benefits:
  - increased shelter and food sources for native wildlife;
  - reduced number of animal pests, therefore, less predation of native wildlife, less tree browse and increased natural regeneration (as less seeds consumed by rodents);
  - greater shading of the stream resulting in more stable water temperatures which are needed by in-stream fauna, and more shelter for fish and macroinvertebrates,
  - increased overall habitat diversity and structure;
  - ongoing decrease in invasion and abundance of weeds (due to reduced weed seed sources, more shading and less open areas).
- improved ecosystem services:
  - improved water quality;
  - reduced flows;
  - enhanced fish and wildlife habitat;
  - mitigation of pollution (through the filtering effect of vegetation);
  - less erosion and stream bank stability issues;
- enhanced ecological corridor providing wildlife linkage to other sites,
- benefits to habitats downstream, as area becomes a functioning ecosystem.

Ongoing restoration is required to further enhance and protect this sensitive stream environment and to continue to mitigate future impacts from land use changes, urban intensification and climate change.

3 Site Description

3.1 Vegetation

3.1.1 Historic vegetation

The original vegetation cover through this area was likely to have been predominantly Puriri forest (WF7) with small areas of Kauri, podocarp, broadleaved forest (WF11) (Draft Indigenous terrestrial and freshwater ecosystems of Auckland, Singers, N et al, 2014). Refer to the historical (potential) vegetation layer map in Figure 2 (provided by Auckland Council). These classifications are part of the terrestrial and freshwater ecosystems that have been identified by Auckland Council as occurring in the Auckland Region. Due to a history of modification the vegetation at Oakley Creek can no longer be classified as WF7 or WF11 forest types. A detailed map of the current vegetation (assessed as part of the Auckland Council ecosystem classification) illustrates the present day vegetation, see Figure 2).

The vegetation along Oakley Creek has been affected by human influences over a long period and is largely modified. Some vegetation would have been lost during Māori occupation through clearance and natural fires. European settlement would have further reduced the original vegetation through farming and urbanisation. Archaeological evidence includes stone walls and numerous midden sites. There are also the remains of old quarries in Phyllis and Harbutt Reserves, where basalt rock would have been extracted in the period from potentially late 1800s to early 1900s (exact dates unconfirmed, B. Druskovich pers. comm.). The surrounding vegetation near quarries could have been cleared for access or firewood.

Aerial photos from the 1940s show that the upper reaches were relatively open with scattered specimen trees along the banks and the surrounding land use as farming and some residential housing. The southern part of the creek was more densely vegetated. There are earthworks apparent at Phyllis Street Reserve and at the end of Harbutt Avenue in these images. These earthworks are the Phyllis Street Closed Landfill site, which has had remedial works carried out between 1999 and 2002, including clay capping and stormwater management improvements (Andrew Stewart, 2015). On the eastern slope of Management Unit 8 there is still evidence of a refuse tip, with old bottles and metal present (some of which was removed in 2014). The exact extent of landfill in Harbutt Reserve is unclear, but is from site observations suspected to be the upper flat areas and some of the regraded slopes in MU 9 and MU 10.

Early use of the land included the planting of a number of exotic tree species along Oakley Creek in the northern reaches of the project area, such as Tasmanian blackwood, white poplar, pedunculate oak, alder, pines, Yunnan poplar, bangalay (*Eucalyptus botryoides*) and flame tree. Tree privet, acmena and willows could have been planted and would have also spread naturally. The southern parts of the restoration work area contain areas of mature tree privet dominated forest. In the intervening period a wide range of environmental weed species invaded the length of the Oakley Creek stream corridor and there were serious weed infestations by 2004, when ecological restoration began in earnest.

Figure 2. Oakley Creek potential vegetation (hisoric) – provided by Auckland Council

3.1.2 Current vegetation

Weeds

Ecological restoration over the last 10 years has focused on reducing the presence and influence of environmental weed species and has involved staged control of weed trees. The majority of the willows along Oakley Creek have been controlled (apart from a few in MU 3 and MU 9-11) and selective flame trees have been removed. Tree privet continues to be controlled annually through selective weed canopy control (drilling and poisoning) or phased removal (mainly MU 1). Mature exotic trees in the lower reaches have not been targeted as a priority, apart from younger regrowth of hawthorn, alder and poplars. In 2015 a large number of mature pines were removed from the western banks of MU 6. The abundance of Chinese privet in the understorey has also been reduced in all areas.

Regular weed control carried out by contractors and volunteers has led to a significant reduction in the density of environmental weeds in the understorey and along the stream banks at Oakley Creek, yet ongoing weed regrowth and re-invasion continues to occur. Most of the Management Units in the restoration work area are in Seedbank Control, apart from some areas of MU 8 that are still in Initial Control and MU 10 is in Follow-up Control. For a list of weed and exotic species recorded along Oakley Creek, refer to Table 14 and Table 15 in the Appendix.

Native vegetation

The majority of native vegetation along Oakley Creek has been planted, apart from remnants of mahoe rock forest in the southern part of the restoration work area (described below). Few other mature native trees exist along the creek, with only the occasional mature karaka, puriri, kanuka and cabbage tree / ti kouka in the lower reaches.

In the last 10 years extensive native revegetation has been carried out with over 45,500 native plants planted, covering MUs 1-10. Some of the early plantings are now well established and nearly reaching canopy closure (such as MU1A, the southern end of MU 3 and top of the slope in MU 9). Planting has focused on enhancing riparian habitat, to create shade over the stream and help stabilise banks, as well as infill planting in open areas and in understorey planting to create suitable forest habitat. Some areas along paths or near the stream have been kept open for visual amenity or public access.

A mix of native colonising and diversity species have been planted, which are appropriate to Auckland Region broadleaf forest, mahoe rock forest, and wetland/ riparian habitat types, based on species lists in '*the Oakley Creek Restoration Plan'* (Te Ngahere, 2005 & revised 2009), *Assessment of Remnant Mahoe Rock Forest* (Te Ngahere, updated Aug 2013) and ecological guidance from Auckland Council.

Refer to the list of native species recorded for Oakley Creek in Table 16 in the Appendix. For further details regarding specific vegetation in management units refer to Section 5 .

Mahoe Rock Forest

An *Assessment of Remnant Mahoe Rock Forest* was undertaken in 2011-2012 (Te Ngahere, updated August 2013). This assessment survey identified six areas of remnant mahoe rock forest in the southern section of the Oakley Creek project area (Phyllis and Harbutt Reserves), covering a total area of 1.55 hectares, which all had significant weed issues in the understorey and groundcover layers. The forest vegetation in this southern section consists of distinct mahoe dominated areas (with some large mature multi-stemmed mahoe

specimens) and considerable tree privet dominated areas.

These rock forest remnants are all that is left of the original (historical) Puriri forest (WF7). The mahoe rock forest vegetation is still modified and, historically, mahoe would not have been the dominant canopy species. The original vegetation canopy of puriri, kohekohe, karaka, taraire and other broadleaf species is missing, probably due to logging and clearance. Mahoe would have, historically, been a dominate sub-canopy species in the rock forest areas and now fills the role of canopy tree along with exotic trees such as tree privet.

The six areas of mahoe rock forest at Oakley Creek vary in character, but mahoe forms a generally dominant or abundant canopy component with mature houhere, kanuka, puriri, karaka, mapou, ponga, lemonwood and cabbage tree also present in varying amounts in the canopy. The sub-canopy is generally relatively sparse with a mix of mapou, hangehange, karaka, lemonwood, mahoe, pigeonwood, karamu, houhere and ponga present. Native seedlings include karaka, mapou, mahoe, pigeonwood and karo.

The Oakley Creek mahoe rock forest is a form of lava flow rock forest, which is rare in the Auckland region and is only found at a few other small sites, mainly in Epsom and Mt Eden. Restoration work, over the past three years, has focused on restoring these remnant mahoe rock forest areas at Oakley Creek, and weed issues have been significantly reduced to small amounts of regrowth. There is generally a lack of structure to the understorey, due to the previous dominance of weeds (particularly dense climbing asparagus), so some native understorey planting has been undertaken in MU 8. Natural regeneration of native seedlings is beginning to occur and there is a good fern flora in some areas.

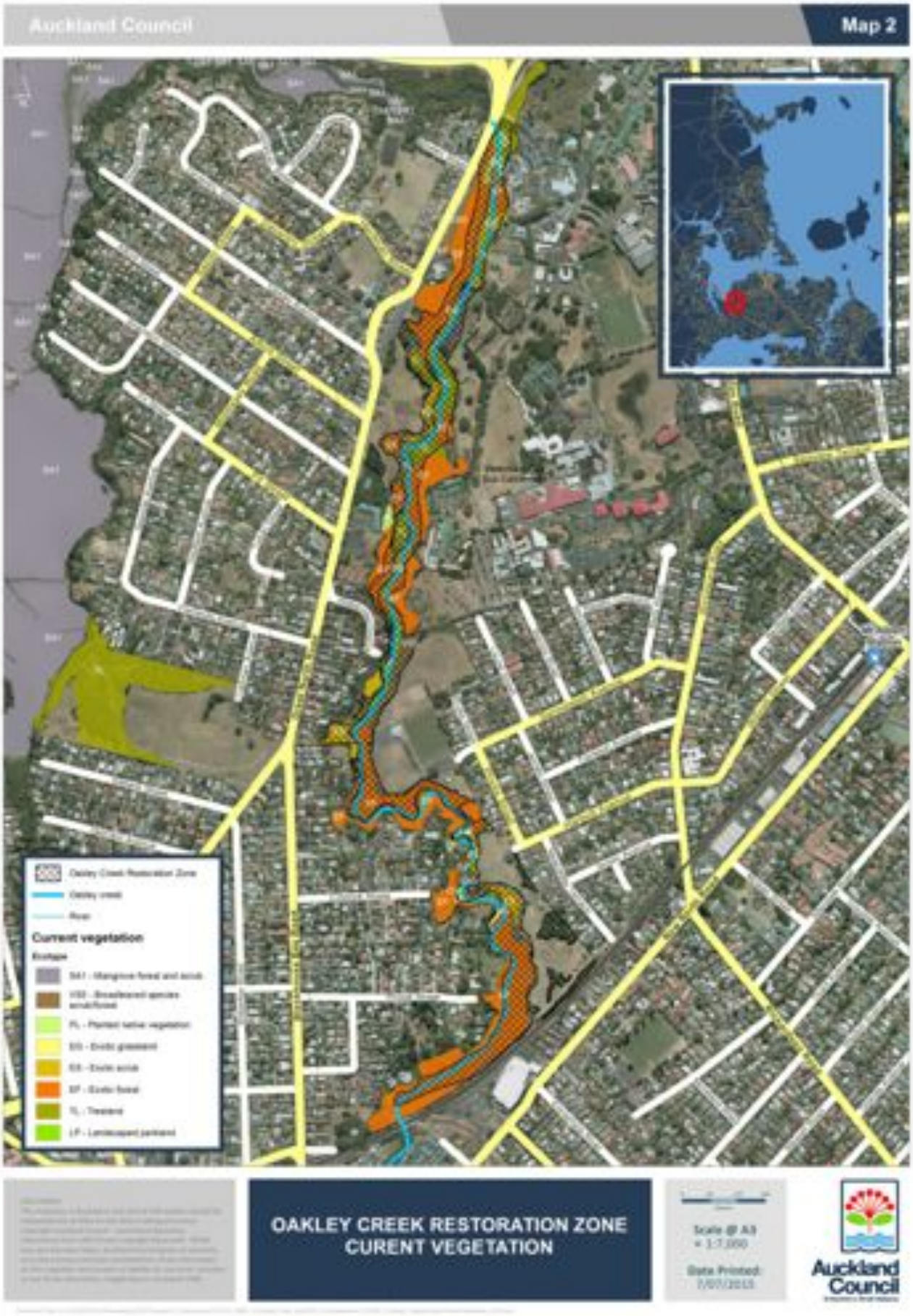

Figure 3. Oakley Creek current vegetation map – provided by Auckland Council

Rare plants

The following rare or threatened flora has been recorded at Oakley Creek (some records may be outside the restoration work area). The following list (Table 1) has been compiled from the Auckland Botanical Society Journal report for Oakley Creek (ABS Journal Volume 64 (2), December 2009), NZ Plant Conservation Network (NZPCN) and planting records.

Table 1. Summary of rare plants recorded at Oakley Creek

Latin name	Common name	Notes, Threat Classification	Origin
Blechnum zeelandicum (syn. Doodia squarrosa)		At Risk - Naturally Uncommon (de Lange et al. 2009). Found in lowland alluvial forest, river banks (often in the flood zone) and near waterfalls. Appears to show a strong preference for base-rich substrates, such as basalt.	Probably naturally occurring
Epilobium pedunculare		Regionally Uncommon (Stanley et al. 2005), with only two recent records (since 1959) from the Tamaki Ecological District.	Probably naturally occurring
Fissidens berteroi		Threatened - Nationally Vulnerable (de Lange et al. 2009) aquatic moss.	Probably naturally occurring
Fissidens rigidulus var. pseudostrictus		At Risk - Naturally Uncommon (de Lange et al. 2009) moss.	Probably naturally occurring
Geranium aff. retrorsum "Oakley Creek"		Only found so far around Oakley Creek, Auckland.	Probably naturally occurring
Triandrophyllum subtrifidum		Liverwort beneath waterfall. First record for the Auckland Ecological Region.	Probably naturally occurring
Streblus banksii	large-leaved milk tree	At Risk – Relict (de Lange et al. 2009). Mainly found on Hauraki Gulf Islands or more coastal sites in the Auckland region. Do not plant *Streblus heterophyllus* as potential to hybridise with *S. banksii*.	Planted
Arthropodium bifurcatum	rengarenga	At Risk - Relict. Not naturally occurring in Ecological District. If planting use *A. cirratum* (not listed in surveys of Oakley Creek).	Planted
Pellaea falcata	Sickle fern, Australian cliff brake	At Risk - Declining (de Lange et al. 2009). This species is found on northern offshore islands and inland on scoria and basalt rocks around Auckland city. There is potential for hybridisation with other *Pellaea* sp. on site. *Translocation record and source of those planted required by Auckland Council Biodiversity.*	Planted
Hebe speciosa	napuka, titirangi	Threatened - Nationally Vulnerable (de Lange et al. 2009). Known from west coast only in North Island (e.g. Muriwai). Not native to local Ecological District.	Planted
Libocedrus plumosa	kawaka	At Risk - Naturally Uncommon (de Lange et al. 2009).	Probably planted

Latin name	Common name	Notes, Threat Classification	Origin
Olearia traversiorum	Chatham Island tree daisy	Threatened - Nationally Vulnerable (de Lange et al. 2009). Out of natural range.	Planted
Piper excelsum subsp. peltatum	kawakawa	At Risk - Naturally Uncommon (de Lange et al. 2009). Only found on Hauraki Gulf Islands.	Planted
Planchonella costata,	tawapou	At Risk – Relict (de Lange et al. 2009). Found on Hauraki Gulf Islands.	Planted
Solanum aviculare var. aviculare	poroporo	At Risk – Declining (de Lange et al. 2009).	Probably planted

See Section 8.4 for discussion on appropriateness of use of threatened plants in restoration plantings at Oakley Creek.

3.2 Fauna

3.2.1 Birds

Friends of Oakley Creek has carried out annual bird monitoring since 2008, as part of the Landcare national garden bird survey, at ten sites along the creek. A wide range of exotic and native species have been recorded during the survey – a total of 34 species.

Tui, fantail and grey warbler are now frequently seen along Oakley Creek. Kereru records have increased overall since 2010 and are now not an uncommon sight. Welcome swallow, harrier hawk, shags, kingfisher and white-faced heron are all relatively regular visitors. Pukeko, paradise shellduck and silvereye are also present.

Shining cuckoo (which is a summer migrant) is heard regularly on the creek during the summer months, and morepork / ruru (nocturnal owl) is heard regularly, in the evenings. No bellbirds have been recorded, but it is hoped that they may in the future, visit urban areas of Auckland, such as Oakley Creek, from the Hauraki Gulf Islands.

A range of exotic bird species, associated with suburban gardens and parks, are seen along Oakley Creek, including blackbird, chaffinch, starling, house sparrow, common myna, song thrush, spotted dove, yellowhammer, greenfinch and goldfinch. Australian naturalised species include magpie and spur-winged plover, with the introduced eastern rosella also common.

3.2.2 Fish and aquatic invertebrates

Aquatic monitoring has shown a range of macroinvertebrates present in the creek, which are a typical mixture of taxa for a lowland stony/sandy/weedy Auckland stream. Species include backswimmers / boatmen, amphipods / isopods, water fleas, snails, damselflies, dragonflies, sandfly larva, midges, cranefly larva, horsehair worms, beetles, leeches, flatworms and oligochaete worms.

A few species, which are more indicative of better water quality/ habitat have been recorded, including caddisflies (woody-cased, smooth-cased and *Triplectides*), stoneflies (spotty and tail gill), freshwater shrimps (*Paratya*) and freshwater sponges. Freshwater mussels (*Hyridella)* were also recorded by Moore (2006) at sites below the waterfall, which is unusual for an urban stream, as this species requires good water quality.

Monitoring by Wai Care and other stream surveys have found a good range of native fish in the Oakley Creek restoration area. There is quality fish habitat present, including deep pools, riffles and rocky material, which provide shelter and feeding opportunities. Native fish recorded include inanga, banded kokopu, shortfin eel, longfin eel, redfin bullies and common smelt.

An interesting discovery was the presence of torrentfish (*Cheimarrichthys fosteri*) below the waterfall. Torrentfish have quite particular habitat requirements, preferring swift flowing rocky riffles and are generally found in less-impacted waterways. Not much is known about these fish as they are quite secretive, but they are likely to eat midges, beetles and caddisflies (Morphum, 2011). Common bullies (*Gobiomorphus cotidianus)* and triplefin /cockabully (*Grahamina nigripenne)* have also been recorded (Moore, 2006).

Exotic fish have been sighted further upstream in Oakley Creek, including gambusia and koi carp, which have the potential to outcompete and feed on native organisms within the stream.

3.2.3 Lizards

Native copper skinks and the exotic rainbow skink are found along Oakley Creek. Ornate skinks may also be present but have not been recorded yet. Copper skinks were translocated into MU 3a as part of the Waterview Connection works, with enhancement planting and animal pest control being undertaken to increase their survival success.

3.2.4 Animal pests

Rats, possums, mice, hedgehogs and rabbits are the most common mammalian pests inhabiting the Oakley Creek area. Animal pest control has been undertaken since 2009 (for (rats, possums, hedgehogs and mustelids) and their impact has been significantly reduced, yet reinvasion is constantly occurring from surrounding areas. No mustelids have been caught in traps or observed during pest monitoring, yet stoats are caught occasionally on nearby Traherne Island. Mice tracking in monitoring tunnels has increased recently following the reduction in rat abundance, which is a typical trend. Domestic cats will also have some potentially negative impact on populations of native fauna in the area.

3.3 Geology

The geology of Oakley Creek consists of two main distinct geological types, as can be seen in the map below sourced from GNS Science (Figure 4):

1. Neogene sedimentary rocks (turbidite) with sandstone mudstone grit from the East Coast Bays Formation of Warkworth Subgroup (Waitemata Group), shown as yellow in the map. This geology is described as alternating sandstone and mudstone with variable volcanic content and interbedded volcaniclastic grits.

This covers part of the western banks and the northern section of Oakley Creek stream corridor (adjacent to Unitec campus).

2. Late Pleistocene - Holocene igneous rocks (basalt) with basanite from the Auckland Basalts Lava (Kerikeri Volcanic Group) of Auckland Volcanic Field, shown as red on the map. This geology is described as grey to very dark grey, dense, fine grained olivine basalt or basanite lava flows.

This geology follows the path of the Mt Albert lava flow, which is represented in the lower reaches of the restoration area from Phyllis to Harbutt Reserves, influencing both sides of the creek and extending up the steep eastern banks. Remnants of mahoe rock forest, a type of lava flow forest, exist along the steep eastern banks of this creek (between MU 8-11) and large volcanic basalt rocks are visible on these slopes.

The light pink geology shown on the map, which covers the Unitec campus and extends to the east of the Oakley Creek corridor, is also of volcanic origin and is called Auckland Basalts tuff (Kerikeri Volcanic Group) of Auckland Volcanic Field.

Mt Albert / Owairaka (shown as lighter red) is classified as Auckland Basalts Scoria (Kerikeri Volcanic Group) of Auckland Volcanic Field, scoria with basanite.

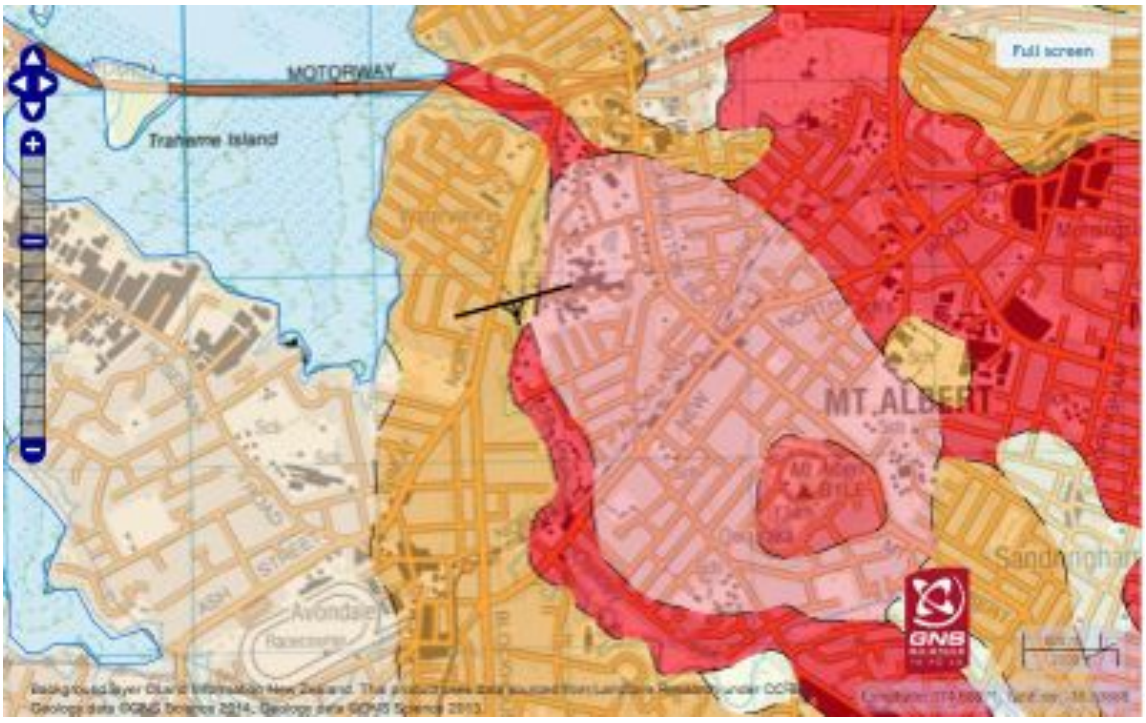

Figure 4. Map showing the main geological types in the Mt Albert area (source GNS science)

Note the two main types of geology found along Oakley Creek (red and yellow).

4 Current Restoration Efforts

A variety of groups, contributors and stakeholders have been involved in the restoration of Oakley Creek since the project commenced in 2004, and several of these continue to be involved in restoration tasks and projects. The various projects / groups are described below. For detailed descriptions of stakeholders and their project involvement see the *Review of Oakley Creek Restoration Plan (2005-2015*), (Te Ngahere, June 2015).

Refer to Figure 5 and Figure 6 for maps showing locations of some of the specific project areas.

4.1 Community Involvement

4.1.1 Friends of Oakley Creek Te Auaunga (FOOC)

FOOC was set up in 2004, and the original Oakley Creek management plan was produced in 2005 to facilitate a planned approach to the restoration of the creek. FOOC shares the vision of this restoration programme; to see "Oakley Creek Te Auaunga and its environs restored and protected as a natural ecosystem, incorporating a range of wildlife habitats, indigenous species and recreational amenities, for present and future generations."

FOOC works closely with the Auckland Council Local & Sports Parks and Biodiversity teams to co-ordinate and encourage activities and community involvement on the creek. FOOC also engages with the adjacent neighbours and landowners (such as Unitec, Ngati Whatua, private residents and Sustainable Neighbourhood groups) to encourage weed control and restoration planting on areas adjacent to Oakley Creek.

FOOC is involved in the co-ordination of and / or the liaison with the key contacts for all restoration efforts on the Oakley Creek Walkway. Some key community groups with a history of involvement with FOOC and Oakley Creek restoration are listed below:

- Buchanan Rehabilitation Centre
- St Judes Scouts Venturers
- Haven / Kodesh Christian Community
- A Rocha
- Collectively Kids Early Childhood Education Centre
- Gladstone Primary School

FOOC coordinates a wide range of restoration activities for the project including native plant propagation, planting, weed control, water quality monitoring and rubbish clean-ups. Volunteers have been undertaking monitoring and pest control since 2008. This includes animal pest monitoring and control of rodents, possums, hedgehogs and mustelids. Biodiversity monitoring tasks include annual bird counts, weta monitoring, vegetation plot and photo comparison monitoring.

4.1.2 Sustainable Neighbourhoods Groups

There are two Sustainable Neighbourhoods Groups along the western banks of Oakley Creek, one at the end of Powell Street and one at the end of Cradock Street (which includes the Haven / Kodesh Community). There activities are coordinated by FOOC, and are

resourced by the Auckland Council's Sustainable Neighbourhoods programme through the Whau River Trust. The groups carry out restoration tasks on their properties and the adjacent esplanade reserve land on Oakley Creek, including weed control and planting.

4.2 Te Ngahere

Te Ngahere, an ecological restoration contractor and consultancy, has been involved with restoration along Oakley Creek since at least 2001. Te Ngahere have developed an in-depth knowledge of the weed issues and restoration history of the reserve, as well as created close working relationships with FOOC, Council parks staff and other stakeholders.

Te Ngahere have undertaken the three restoration contracts along Oakley Creek for Auckland City Council / Auckland Council which began in 2002, which is currently continuing as the Ecological Restoration Contract (ERC). Initially the work area covered MU 1 – 6/7. MU 5a was added in December 2012. In 2014 the ERC work area was further extended to include the southern part of MU 9 (from end of MRF Area D), plus MU 10 and MU 11. The work area of these restoration contracts is restricted to the Council owned land.

These restoration contracts have ensured regular weed control visits are carried out and weed issues are followed up, thus reducing the prevalence and diversity of weeds along the stream corridor. This has supported the efforts of volunteers and allowed restoration to progress at a faster and more sustained rate. In addition, Weed Canopy Control work has been undertaken by Te Ngahere as required. This is where selected environmental weed trees are drilled and poisoned, where an existing understorey exists. Specific areas along the creek have been planted annually as part of the restoration contracts.

Te Ngahere have also been involved in other restoration projects along Oakley Creek, including SLIPs projects, AELB-funded works, WCA lizard and restoration works and requests from FOOC.

4.3 Auckland Council

4.3.1 Local Parks

Auckland Council's Local and Sports Parks Central team are responsible for park maintenance, community group liaison and management of the Ecological Restoration Contract (ERC) for the Oakley Creek Walkway. Local Parks staff work closely with FOOC, Te Ngahere, the consultant archaeologist, Stormwater team, Biodiversity team and other stakeholders to ensure restoration along the creek is carried out in a joint-up approach.

4.3.2 Wai Care

Wai Care is a programme for community and school groups that involves monitoring and education about water quality within the Auckland Council region. This programme is run by Wai Care coordinators in collaboration with FOOC and the local community. Currently there are three Wai Care monitoring sites within the Oakley Creek restoration work area, that are being monitored regularly by volunteers. Refer to Section 3.2.2 for details of aquatic fish and macroinvertebrates observed.

4.3.3 Sustainable Catchments Programme

The Sustainable Catchments Team at Auckland Council has produced an "Urban 10 Year Implementation Plan - South Waitemata (Sept 2014)" which covers the whole Oakley Creek catchment. It is a strategic document that sets out 'on-the-ground' catchment intervention options which link to Restoration Opportunities (ROs) identified in the *Watercourse Management Plan for Oakley Creek* (Morphum, Oct 2010).

Restoration work has been undertaken in RO 7 in 2013/2014 on the weed dominated slope and floodplain between Mahoe Rock Forest Areas A & B in MU 8. Extensive weed control has been undertaken, and planting was carried out by contractors and volunteers in the winter of 2014. Infill planting is planned in this area and maintenance will continue until 2016.

4.3.4 Biosecurity programme – Chinese Knotweed

Chinese knotweed (*Persicaria chinensis*), an MPI 'unwanted organism', was discovered along Oakley Creek in MU 8 (on east bank south of the Phyllis Reserve Bridge) by Te Ngahere. The site is checked, regularly, by a contractor and if required re-sprayed.

4.3.5 Stormwater

The Stormwater team at Auckland Council is responsible for ensuring that Oakley Creek stays clear of blockages that could result during flood periods. Stormwater contractors are also responsible for managing the weeds and clearing debris along the 1.5m riparian edge of the stream. Current contract holders are Downer.

The team is also responsible for implementing the recommendations in the *Oakley Creek Watercourse Management Plan* (WMP) (Morphum 2010), which covers engineering assets, erosion management, fish passage and enhancement opportunities.

The Stormwater team is looking to undertake some major erosion control works along several sections of Oakley Creek. These works were identified as issues in the Oakley Creek WMP and in the *Lower Oakley Creek Erosion Assessment* (Morphum 2012). These works are currently on hold until upstream re-alignment works are completed. New erosion 'hotspots' have also been identified and priorities will be adjusted accordingly.

Refer to the Appendix (Figure 17 and Figure 18) for maps showing stormwater planning / mitigation sites along Oakley Creek (fish barriers, Restoration Opportunities and erosion areas).

4.4 Local Board funded projects

4.4.1 Albert-Eden Local Board Small Local Improvement Projects (SLIPs)

The main focus areas for SLIPs work have been in MU1-MU7 and part of MU 8, covering work which has fallen outside the scope of ecological restoration contracts. Work has included planting site preparation, weed tree removal (such as privets and willows), planting maintenance of previously planted areas, plant supply and additional weed control, carried out or managed by Te Ngahere, with close liaison with Local Parks and FOOC. This has supported FOOC to carry out volunteer planting days and plan future planting.

4.4.2 Mahoe Rock Forest Restoration (MRF)

The Albert-Eden Local Board funded an assessment of remnant mahoe rock forest covering MU 8-11 in 2011/2012 (*Assessment of Mahoe Rock Forest* - Te Ngahere, updated Aug 2013). Further funding was allocated under the Auckland Council Long-term Plan (LTP) for a special project to restore remnant mahoe rock forest habitat along Oakley Creek.

Restoration works started with weed control in 2012. Weed control has continued annually (undertaken by Te Ngahere) with planting carried out by volunteers in 2013 and 2014. Weeds in MRF Areas A-F have been significantly reduced and all areas are now in seedbank control. This project was initially managed by the Council's SLIPs team, but in 2014/2015 it was included in the Local Board work programme for the ERC contract.

4.4.3 Albert-Eden Local Board Stream Restoration

This Local Board discretionary fund for community projects (managed by the Auckland Council Biodiversity Team) has contributed to streamside restoration in MU 9 Restoration Opportunity (RO) Areas 8, 9 and 11 (refer to the *Oakley Creek Watercourse Management Plan,* Morphum 2010) in 2012-2015. It has included site preparation, follow up plant maintenance, weed control and plant supply, with planting being carried out by FOOC.

4.4.4 CVNZ visits

The Local Board has funded Conservation Volunteers New Zealand (CVNZ) team visits approximately every 5 weeks to Oakley Creek and this work programme is coordinated by the Auckland Council Volunteer and Biodiversity Coordinator. This volunteer work has involved weed control tasks, planting, plant maintenance and rubbish removal.

4.4.5 Western Banks – Whau Local Board area

Restoration work has been undertaken, since 2013, in the Whau Local Board area along Oakley Creek by way of a partnership between Friends of Oakley Creek and Auckland Council Local and Sports Parks West. The areas focused on have included the pedestrian access way from Cradock Street down to the creek, and the esplanade reserve land downstream from the bridge. Contractors have undertaken site preparation and weed control, and planting on a steep scarp above the access way. Planting, plant releasing and weed control have been undertaken by volunteers from the Haven / A Rocha / Powell Street Sustainable Neighbourhood community.

4.5 Well-Connected Alliance (WCA)

The Well-Connected Alliance is the consortium undertaking the construction of the Waterview Connection / SH20 motorway. The project traverses through the northern part of the Oakley Creek catchment, completing the Western Ring Route between the southern portion of SH 20 and SH 16. It also includes a 2.4 km tunnel under Oakley Creek.

4.5.1 Lizard Enhancement Area

As part of the Waterview Connection works lizard capture and relocation was required, prior to commencement of construction of the motorway. The WCA relocated native copper skinks to suitable habitat in MU 3a in 2012 (referred to as the Lizard Management Area - LMA). The LMA is approximately 6000 m^2 and lies adjacent to Oakley Creek. This open area was enhanced, with the support from the WCA, with the placement of large logs and planting of native plants. Some areas have been kept open, with low-growing species / open grassland. Lizard monitoring and rodent monitoring were undertaken for three years, and rodent control is ongoing.

4.5.2 WCA Riparian Restoration Projects

Initially, the WCA proposed works included a construction yard in Waterview Glades (including part of MU 5), which required extensive riparian planting along the west side of the creek at the bottom of Waterview Glades, as part of the mitigation. The construction yard is no longer required, but the WCA have agreed to carry out the planting in partnership with Auckland Council and FOOC.

The restoration area covers a 20 metre riparian strip from MU 5, below the Unitec Bridge, down to the northern end of MU 4a. Restoration work will include weed control, weed tree removal and planting, with the works being undertaken in 2015-2016.

Additional restoration works will also be undertaken by the WCA (mitigation for a pollution incident in Alan Wood Reserve), including the control of weeds and weed trees trees, and planting along the stream edge and floodplain north of MU 4a (on both sides of the stream). This work will be undertaken in collaboration with FOOC in 2015 and 2016.

4.6 NZ Transport Agency (NZTA)/WCA/Auckland Transport Shared Path

As part of the Waterview Connection project a walking and cycling (shared) path will be constructed in the near future. This will run along the top of the valley, parallel to Oakley Creek, from the Alan Wood Reserve through to Great North Road, Waterview, and connect up with the SH 16 cycleway. The works will include a new raised boardwalk between Harbutt and Phyllis Reserves and an at-grade bridge crossing the stream close to the boundary of MU 3b and MU 5. Some positive outcomes from the project will be an expanded esplanade reserve between Harbutt and Phyllis Reserves, and more planting under the new Alford Street Bridge in MU 3b.

4.7 Unitec

Unitec have been working in collaboration with Friends of Oakley Creek to restore the Wairaka Stream where it runs through the Unitec grounds. A working group has been set-up and a *Unitec Biodiversity Strategy for Wairaka Stream Sub-precinct E* (undated, Unitec/ Morphum) has been developed. This strategy sets out planting lists and management units for the Wairaka Stream, which flows into Oakley Creek. The *Wairaka Stream Restoration Plan Discussion Document* (Morphum 2012) provides a framework for the restoration work.

Unitec students and staff have undertaken research and monitoring projects along Oakley Creek in the past, and use the site as a restoration case study.

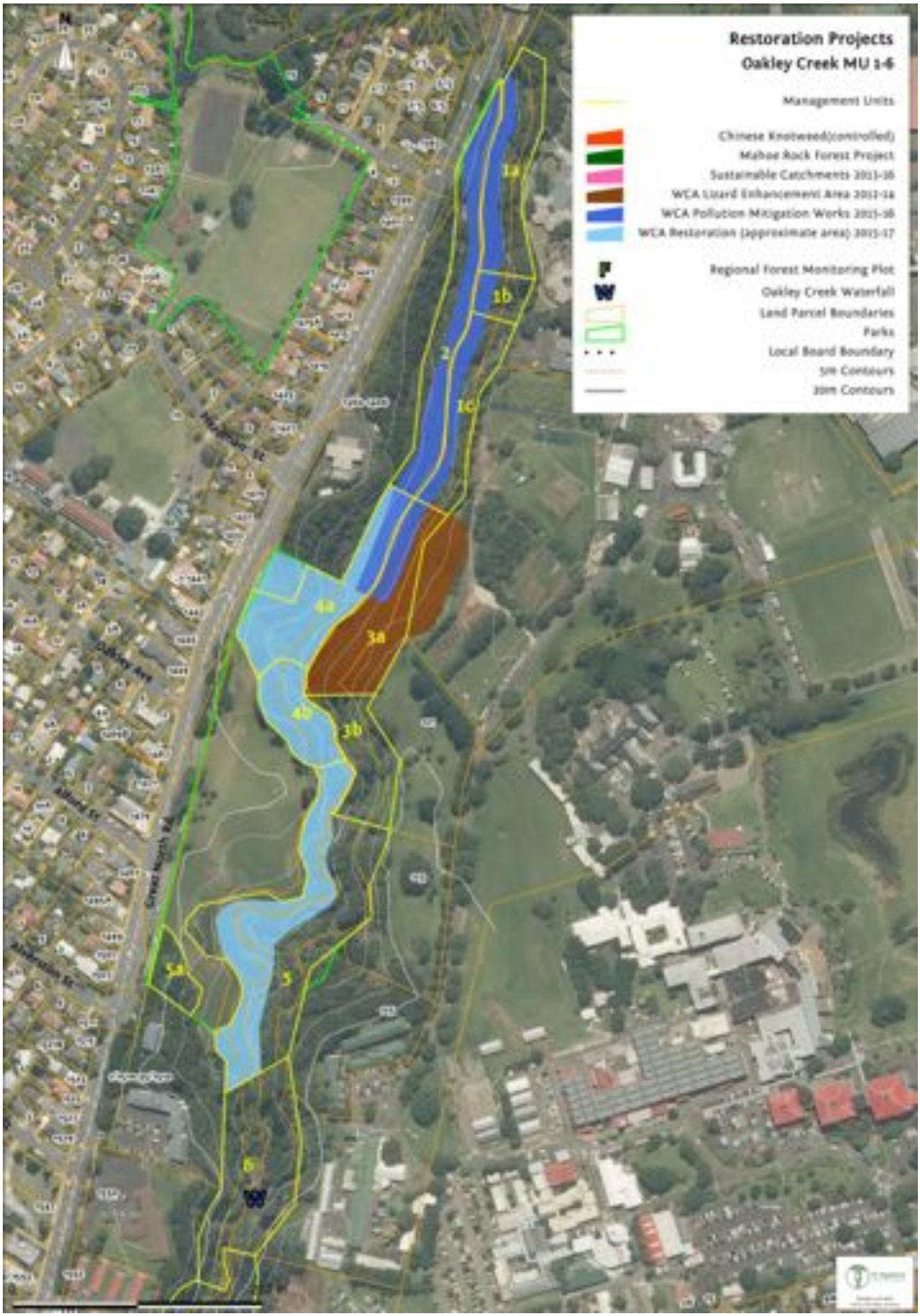

Figure 5. Oakley Creek Restoration Project locations MU 1-6

Figure 6. Oakley Creek Restoration Project locations MU 7-11

5 Management Unit Descriptions

Areas undergoing ecological restoration are often divided into management units to aid prioritisation of tasks. This also enables clear identification of particular locations and can accommodate varying requirements for different areas within the restoration site.

In the case of Oakley Creek the area is divided into management units depending on different land marks, the vegetation present, and previous restoration work undertaken in the area. It is important to keep units to a relatively small size so that they are more manageable and specific priorities can be targeted. In future, as weed densities become low and areas become fully revegetated, boundaries between sections (e.g. MU 1a and MU 1b) can dissolve in order to manage the entire management unit as a whole.

Management Units for Oakley Creek are depicted in Figure 7 and Figure 8. When planning restoration tasks archaeological sites identified by Druskovich (various reports, and to be updated in winter 2015 survey) need to be taken into account.

For details of restoration priorities, refer to the weed control priorities by Management Unit (in Section 6.5) and future planting sites identified in Section 8.6 .

5.1 Management Unit One

Management Unit One is divided into three different units MU 1a, MU 1b and MU 1c. MUs 1a-1c have been planted, with some infill planting areas remaining. They are bordered by the creek on the west and the Mason Clinic and Unitec on the east. MU 1a is at the northern end of the restoration work area. MU 1b covers the floodplain and adjacent slope, while MU 1c covers the area under tree privet canopy. There are some mature trees including pedunculate (English) oak, plane trees and karaka.

Weed issues have been significantly reduced in MU 1, with tradescantia continuing to reappear along the stream edges, and a few known 'hotspots' for Madeira vine. Environmental weed trees include tree privet (which has been progressively thinned in MU 1b and 1c) and mature flame trees. Some mature pines and a row of macrocarpa (in MU 1c on the boundary with Unitec, behind the tree privet) are present.

5.2 Management Unit Two

Management Unit Two covers the western side of the creek, from the northern extent of the project area through to the level of the privet canopy in MU 1c. Large exotic trees (6m+), such as silver poplar, alder, and Yunnan poplar are scattered across the floodplain and lower slope. There is some privet and mature acmena remaining at the northern end of MU 2 by Great North Road. Large willows by the stream were drilled in the past and are decomposing.

Above the informal track there are some areas of shrubby Chinese privet and hawthorn. Native plantings have established next to the track, especially to the north. The floodplain has been planted in many parts of the unit, but there are still open areas with annual weeds.

5.3 Management Unit Three

Management Unit Three is divided into two sections, MU 3a and MU 3b. The northern and southern ends of this unit are bordered by tree privet and oak canopy respectively, while the stream borders the western boundary, with Unitec grounds to the east. The large open area to the north has been revegetated in the last few years as part of the lizard habitat enhancement works (associated with the Waterview Connection Project). NB: Part of this open area in MU 3a is Auckland Council land, with the remainder owned by Unitec.

In MU 3a two large willows remain by the stream. The adjacent area is being kept open as an amenity area, providing access to stream, and to protect an archaeological site. Early plantings at the southern end of MU 3a are maturing well.

Bamboo covers a very large area at the northern end of MU 3b (eastern side of the creek). A long-term management approach is needed for this bamboo as it will be complex to remove, management of regrowth will be needed and there is probable presence of archaeology underneath. Also there is a large flame tree next to the bamboo.

The steep slopes and floodplain in MU 3b are covered in ground cover weeds. Due to potential presence of archaeology, including a possible old mill site, this unit has had limited weed control - mainly the removal of woody weed saplings. This area needs an archaeological assessment to establish future management.

A new at-grade bridge will be built across the valley between MU 3b and MU 5 (Waterview Glades), just downstream from the 'Troll Bridge', as part of the Waterview Connection shared path.

5.4 Management Unit Four

Management Unit Four is also divided into two sections. MU 4a runs from the southern end of MU 2 south to MU4B, and is bordered on the east by the creek and the west by Great North Rd (excluding the petrol station land). It has some exotic mature trees, with hawthorn and Chinese privet in the understorey. The floodplain areas and some of the lower slopes have been planted.

MU 4b covers the steep slope and ridge, which is currently a predominantly pine canopy. Part of the steep slope has been planted.

5.5 Management Unit Five

Management Unit Five encompasses both the west and eastern sides of the creek, from the Troll Bridge at the northern end of the oak canopy, through to the bridge that connects Unitec with the student accommodation, on the west side of the creek.

There are established native plantings on the south east of the unit along the walkway, and the slope under the oak canopy has been planted. The 'Cabbage Tree Swamp' area has been extensively restored with wetland species. The plan is to keep some of this area relatively open, as it provides amenity value.

There is a combination of natural regeneration and planted natives on the western side of

the creek, adjacent to Waterview Glades. There are still a number of weed tree species present in this area (particularly by the stream bend) including hawthorn, willow and Chinese privet.

MU 5a, which is a small pocket of bush, at the top of the slope, adjacent to Great North Road, was added to the work area in 2012. It has some native canopy and a range of weed species.

5.6 Management Unit Six

Management Unit Six runs along both sides of the creek from the main bridge between Unitec and the student accommodation, up to the Fern Glade Bridge above the waterfall. It is bordered on the east side by Unitec and on the west by private land, including an area of covenanted native bush. It encompasses the waterfall and surrounds, and has some steep slopes, as well as floodplains.

On the east side of MU 6 there are a number of exotic and weed canopy trees, incluidng pine and flame trees. MU 6 is otherwise dominated by regenerating and mature native shrubland, with some open areas at the top of the waterfall.

Pine tree felling / de-limbing has recently occurred on the western banks (above the waterfall) and on adjacent private land, with native replanting having been undertaken on the Council owned slope in winter 2014 and 2015. There is a bracken / gorse dominated area on the slope to the north of the pines and west of the path.

5.7 Management Unit Seven

Management Unit Seven is the narrowest portion of the site. Following south from management unit six it extends through to the Phyllis Reserve Bridge. It encompasses both sides of the creek, including the area surrounding the Waterview Downs Bridge and the walkway leading to Great North Road.

The east side of MU 7 includes the native planting on the slope above the gabion retaining wall (the Phyllis Reserve landfill site), which is establishing well and has had some understorey planting. Planting has been undertaken along much of the stream and on some open slopes.There are also areas of mature bush along the stream side, including puriri, mahoe and houhere.

The land in front of the houses at Waterview Downs has been kept open, with only sparse plantings, to maintain access and views of the creek.

Two areas of arundo have been controlled. Weed issues still remain on the steep western side from Phyllis Reserve Bridge to Waterview Downs, such as regrowth of vines and Chinese privet.

5.8 Management Unit Eight

Management Unit Eight follows the eastern side of the creek, from the Phyllis Reserve Bridge through to the southern end of Phyllis Reserve. The northern section, below the path up to the large willow, has been planted. To the south of here there is an area of initial control with a range of weeds on the steep slope and floodplain. This is one of the last areas of initial control remaining on the creek. Chinese knotweed (*Persicaria chinensis*), was found on the floodplain near here but has now been controlled, with no apparent regrowth.

To the south of this initial control area is a steep bank with serious historic rubbish dumping issues including extensive amounts of old bottles and metal. In 2014 contractors removed many truck loads of surface rubbish, but it is unknown how deep this rubbish persists for in the soil. It is suspected that the slope may be unstable. No weed control has occurred in this area and volunteer activity should be avoided here, until direction is provided on future remediation. The *Soil Handling Plan* for *Oakley Creek* (Andrew Stewart, March 2015) should also be referred to.

Mahoe Rock Forest (MRF) Areas A, B and C are in MU 8, which have a mahoe dominated to mahoe abundant canopy, with varying amounts of kanuka, houhere, lemonwood, puriri, mapou, karaka, cabbage tree and ponga in the canopy. Occasional mature weed trees including tree privet, wattle sp. and woolly nightshade, have been progressively controlled. The sub-canopy is sparse with mapou, mahoe, houhere, ponga, karaka, lemonwood and hangehange present. Weeds initially dominated the understorey but have been reduced to small amounts of regrowth. Understorey planting has been undertaken in MRF Area C on the slopes and floodplain.

Between MRF Areas A and B there was a weed infested steep slope, which is being restored. Weed control and planting have been undertaken in 2014-2015. A further weed infested open slope remains between MRF Areas B and C, with hemlock and vines dominating. This is the other area of remaining initial control along the creek.

5.9 Management Unit Nine

Management Unit Nine covers the area from the north end of Harbutt Reserve to the southern end of the walkway path, opposite the large bush island.

At the northern end of MU 9 there is an open peninsula which has had some specimen trees planted, including kahikatea. The adjacent wet area and riparian edge below the path (RO8), have also been planted. Above the path there is a steep slope, with some rubbish and a rock drainage area, that was dominated by vines and bamboo. These weeds have now been controlled and the site will be planted in future, following an archaeological assessment. Weed control and planting has been undertaken on the steep slope between the tortured willow and MRF Area D.

Post construction of the Waterview Connection / SH20 proposed shared path, land behind numbers 6, 8 and 10 Phyllis Street will pass into the management of Auckland Council Parks, following handover maintenance conditions. This area is currently weed dominated. The benefits for the creek will be a wider section of stream corridor and buffering to the adjacent MRF Area C to the north.

The eastern stream bank below the steep slope (downstream of the Cradock Street Bridge), is open apart from a few large cut willows. This area will be kept relatively open for amenity

purposes and access to the creek. Some planting is planned along the stream edge, both upstream and downstream of the bridge, once stream bank erosion remediation works have been undertaken by the Auckland Council Stormwater team (which are currently on hold until upstream works in Alan Wood Reserve are completed). To the south of the Cradock Street Street Bridge kahikatea specimen trees have been planted on the eastern stream bank.

As part of the *Assessment of Remnant Mahoe Rock Forest (*Te Ngahere, updated Aug 2013*)*, two MRF Areas have been identified in MU 9 – MRF Areas D and E (some of the latter extends into MU 10). In MRF Area D adjacent to the steps, the canopy consists of semi-mature mahoe, with five-finger, kohekohe and wharangi previously planted in the understorey. At the top of the bank there are established native plantings dating from 2004/2005. Further south in MRF Area D, the canopy is mahoe dominated with a mix of other natives present, including karamu, ponga and cabbage tree. Planting has been carried out in the understorey and weeds have been reduced.

In MRF Area E the canopy is mahoe dominated, with frequent ponga and occasional lemonwood. Sub-canopy species include karo, mapou, karamu, cabbage tree, five-finger, pigeonwood, hangehange and bracken. There were a number of weed trees present and extensive areas of climbing asparagus. Following weed control parts of this area are now quite open. Understorey planting will be carried out at the southern end in 2015. There are a few medium-sized large-leaved milk tree (*Streblus banksii*) trees located on the northern edge of MRF Area E that were planted.

Initial control began in 2013 on the slope above the path towards the south end of MU 9, below the mature willows, wattles and MRF Area E, where there were large infestations of ginger. Some planting has been undertaken in this area in 2014. Weed regrowth is still an issue here.

Since 2013 plantings have taken place in Restoration Opportunity (RO11) along the streamside adjacent to and north of MRF Area E, which are starting to establish well. Large specimen trees have previously been planted on this floodplain, such as kahikatea and swamp maire.

5.10 Management Unit Ten

The original Oakley Creek Restoration Plan area only extended to MU 9, so did not include the southern part of Harbutt Reserve. MU 10 continues on from the southern end of MU 9, and finishes at the large bamboo patch along the railway line. Part of MRF Area E extends into the northern edge of MU 10, but is described above.

The canopy of MU 10 is tree privet dominated, with mature Chinese privet, woolly nightshade and wattle in the canopy. There are some large willows near the stream. At the top of the eastern bank there are two large macrocarpa trees. The canopy contains a few occasional natives: mamaku, ponga and mahoe. The sub-canopy contained a range of weeds before control began in 2013. Natives found in the sub-canopy include pigeonwood, ponga, karamu, karaka, mapou, hangehange and rarely mahoe. There is potential for understorey regeneration in this unit as weed issues continue to decrease.

There is an open gully before the railway line towards the south of MU 10, which extends to more open slopes to the north and south. This area had serious weed infestations and vigorous weed regrowth is still an issue. Planting was carried out in this area in 2014.

The canopy to the south of the weed gully is predominantly tree privet, and this is being selectively drilled annually as a staged process, to ensure that large light wells are not created. There are a few mature mahoe at the southern end of MU 10 on the lower slopes. Emergence of weed seedlings in the understorey in MU 10 continues to be an issue but this will be reduced over time.

A large stand of bamboo exists on the southern boundary of MU 10, which spreads from the top of the slope down towards the creek.

5.11 Management Unit Eleven

The original Oakley Creek Restoration Plan area only extended to MU 9, so did not include the southern part of Harbutt Reserve. MU 11 starts to the south of the large area of bamboo, which has not been targeted yet, and extends through to southern extent of the reserve, where the creek emerges from under the western railway line.

Initially the canopy consists of tree privet, mahoe and ponga (but is not mahoe dominated). There are occasional larger mahoe nearer to the stream and towards the top of the bank. There are also large wattles and willow on the upper slope. The sub-canopy contains the following natives: - hangehange, mahoe, karaka, cabbage tree and pigeonwood, with tree privet and Chinese privet also present. This area is considered a buffer zone to the adjacent mahoe dominated canopy to the southwest (MRF Area E) and has considerable restoration potential with the reduction of weeds.

The area between marker 2.50 and 2.55 is identified as MRF Area F, with mature mahoe being dominant, with several multi-stemmed specimens with 35-40cm DBH (diameter at breast height). The area of exclusive mahoe canopy was approximately 30 metres wide (in a southeast – southwest direction) and extended from the top of the slope to the stream. Further to the southwest large mahoe trees were more occasional. The sub-canopy consisted of ponga, hangehange, pigeonwood, mahoe and some tree privet. The ground cover was relatively bare with some mahoe, pigeonwood and karo seedlings. There was a wide range of weeds, which have now been reduced significantly to small amounts of regrowth. This is the best example of mature remnant mahoe rock forest along Oakley Creek due to the number and size of mahoe trees present, and it has very good potential for restoration. The focus should be on weed control and allowing natural regeneration (rather than extensive planting).

Southwest of MRF Area F, the canopy is tree privet dominated with only occasional tall mahoe. There is a mix of native and exotic species in the sub-canopy including karamu, mahoe, ponga, karaka, Chinese privet, Taiwan cherry, acmena, cabbage tree and pigeonwood. Climbing asparagus was dense throughout the understorey when initial control started in MU 11, and there was a wide range of other weeds. Weed issues are now less serious with ongoing regrowth. There are some willows along the stream banks.

5.12 Management Unit Twelve

Management Unit Twelve has been added as part of this new restoration plan and encompasses the esplanade reserves on the western banks (owned by Auckland Council). These esplanade reserves have been divided into MU 12 a, b, c and d, as can be seen in Figure 8. Areas that have been vested to Auckland Council are shown in blue. Potential esplanade reserves, shown in light green, are expected to be transferred to Auckland Council in due course through consenting processes or change of ownership (for example due to subdivision, shared path works). MU 12 b-d are within the Whau Local Board area, whilst MU 12 a is in the Albert-Eden Local Board area.

The western esplanades in MU 12 are generally narrow, steep strips of land. They border on to the creek and contain a mix of native and exotic vegetation, with a diverse range of weeds. In MU 12 d subdivision is happening on parts of the adjacent land and some vegetation clearance has happened (such as large pines) with replanting being carried out. The Powell St Sustainable Neighbourhoods Group is active in the northern part of MU 12 d, including the esplanade strips at 57 and 63 Powell Street.

MU 12 c starts from the end of Craddock St heading north, to the northern end of the bend below 36 Craddock St (which is a potential esplanade reserve).Vegetation is varied and includes a mixed canopy (such as oak, cherry, mahoe, Chinese privet, lemonwood and kanuka). At the southern end of MU 12 c the Craddock St Sustainable Neighbourhoods Group is involved in restoration tasks along the esplanade reserves and private land at 31 and 46 Craddock Street.

In MU 12 b, vegetation ranges from: kanuka and ponga dominated with a bare understorey, to tree privet dominated. At the northern end (south of the Phyllis St Bridge), there are open floodplain and slope areas, that have been planted.

MU 12 a includes three small areas of esplanade reserve below properties at 1604A, 1602 and 1/1600A Great North Road. 1/1600A was covered in dense arundo, that has been controlled, and this slope was planted in 2015.

Figure 7. Oakley Creek restoration work area MU 1-6

Figure 8. Oakley Creek restoration work area MU 7-12

6 Weed Control

6.1 Environmental weed control approach

An ongoing programme of weed control is needed at Oakley Creek to:

- tackle weed regrowth (from on-site seed sources and existing weed populations),
- target weed re-invasion (from neighbouring land, upstream, and dispersal by birds and wind),
- protect establishing plantings and existing native habitat,
- prevent spread of weeds to adjoining sites or the surrounding area.

It is recommended that the 'Forest Restoration Framework', which was developed by Te Ngahere, is used to address a site-led weed control approach at Oakley Creek. This framework is necessary to achieve a targeted approach that focuses efforts in an effective and efficient manner, and can be applied to wetland and riparian habitats, as well as forests. The framework aims to restore native habitats by controlling invasive weeds in a manner which minimises the use of herbicides and ultimately creates an ecologically viable and self sustaining system.

The programme works from Initial weed control, to Follow Up maintenance and progresses to the seedbank being monitored, and then onto Forest Protection phase to limit re-invasion of weeds from neighbouring seed sources. Major weed sources, such as near fruiting weed trees, path edges, stream edges and site boundaries need to be checked regularly as part of this weed approach.

Supplementary phases are needed for Tradescantia Control and where gradual removal of weeds is required (Long-term Control), for example if there is an erosion risk. The table below summarises the main phases of the 'Forest Restoration Framework' (Table 2).

In addition, Weed Canopy Control (part of Long-term Control) needs to be undertaken. This is where selected environmental weed trees are drilled and poisoned, where an existing understorey exists and there are no safety issues to park users.

This restoration approach has been used very effectively by Te Ngahere at Oakley Creek since 2002, through the ecological restoration contracts. This has allowed phased progression from Initial Control to Follow Up Control, now with the majority of the management units being in Seedbank Control, with some Long-term Control in specific areas.

Table 2. Description of Restoration Framework Phases

Framework Phase	***Description***
Initial Control	Initial control targets all plants and aims to eliminate plant pest reproduction within the site. This is achieved by cut stump application and following with an initial foliar spray application.
Follow Up Control	Follow up control targets all plants that were missed or failed to die due to numerous factors. If this phase is implemented in spring and autumn, usually only one calendar year is required to achieve this objective.
Seedbank Control	The seedbank control phase begins when all existing plants have been eliminated. Seedbank control targets the remaining seed in the soil layer. This phase needs implementation once a year in mid-summer to be effective. Implementation at this time allows for spring germination and enough biomass production for effective control. The duration of this phase is dependent on the seed viability of the targeted plant. It is commonly 2-4 years, depending on site situations and amount of cover.
Forest (Wetland/Stream) Protection	The protection phase is achieved when all seeds and seed sources are eliminated from the area. This phase is focussed on the prevention of plants establishing from incoming seed from adjacent areas. This is required to prevent a site from slipping back to the start of the process.
Long-term Control	The planned gradual removal of pest plants where complete removal would promote adverse environmental conditions e.g. erosion, removal of all structural habitat. This will involve cut stump or foliar spray of selected plant pests in selected areas over time. This is a long-term process.
Tradescantia Control	Control of *Tradescantia fluminensis* within a designated area, hence requires a unique methodology. Foliar spray application of tradescantia three times a year, until fewer applications are necessary. Vigilance is required to reduce tradescantia to low levels and re-invasion may occur from infestations adjacent or upstream from the site.

Oakley Creek will require an ongoing weed control programme to ensure weeds do not re-establish or re-invade. Weed control efforts will be required annually to control the extensive seed bank that will be present in the soil for a number of years. Plantings will also require regular maintenance until a canopy and substantial native ground cover is achieved. Once plantings have reached an age where the risk of being smothered by weeds is reduced, shade tolerant weeds are then likely to be the only threat in these planted areas.

If restoration efforts are coordinated to allow for long-term weed maintenance, the cost, labour and herbicide requirements for Oakley Creek will steadily decrease over time and should eventually be reduced to a minimum level as depicted in the graph below (Figure 9).

Regular reviews of the outcomes and methods implemented will help to determine the success of restoration efforts. This will also provide a means of identifying areas that may require further control or alternative applications / methods as a consequence of previous control efforts.

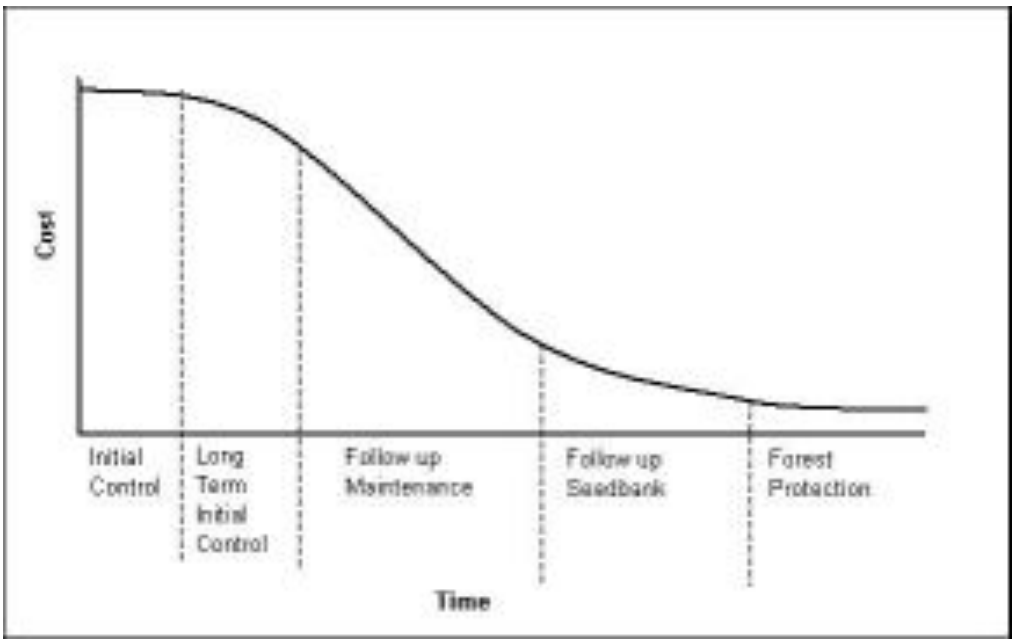

Figure 9. Theoretical representation of cost of weed control (i.e. amount of weed control required) over time, as a site moves through different weed control phases

6.1.1 Timing

Weed control visits should be undertaken 2-3 times per year (depending on species and restoration phase), targeting environmental weeds through appropriate hand pulling, cut stump or foliar spray methods, following a lowest toxicity herbicide policy. Weed control is usually targeted during times of active growth for a number of species, when herbicide will be most effective.

6.2 Environmental weed tree control

Environmental weed trees are those that:

- are listed in the Auckland Regional Pest Management strategy 2007-2012 (currently being updated), and/or
- are known to be invasive and impact significantly on the integrity of remnant native ecosystems by altering plant community structure and habitat, and by displacing native plant and animal populations.

The presence of individual mature environmental weed trees is undesirable as they provide weed seed sources that are spread into the surrounding areas of native vegetation, which are being restored. This exacerbates the efforts of weed control (and restoration) and leads to weed seed sources being present on site for longer.

In the short term certain weed trees do provide habitat and some food sources (such as berries or nectar) for native birds, such as tui and kereru. As restoration has progressed significantly over the last 10 years with plantings becoming established, there should be sufficient habitat and native food sources along Oakley Creek and in the surrounding area. Tree privet dominated canopy will be removed in a phased approach, so this will remain as a food source in the medium term.

It is strongly recommended that the remaining individual environmental weed trees are controlled and or removed along Oakley Creek, using professional contractors or arborists. Priority environmental weed tree species to be removed / poisoned include willow sp., wattle sp., acmena, flame / coral tree and phoenix palm.

Other mature exotic trees that are present along Oakley Creek, such as pine sp., pedunculate oak, poplar sp. (silver, lombardy and Yunnan), alder and liquidambar are less of a priority as they do not appear to be spreading significantly. They can be seen as part of the historic management of the site. As resources allow, pines and silver poplar trees could be removed progressively (unless they become a safety issue or are diseased), after the environmental weed trees have been controlled. In the interim exotic trees are providing some canopy and shade for plantings to establish. Exotic tree seedlings, saplings and spreading suckers should continue to be hand pulled / controlled as part of weed maintenance visits.

There are some small areas of bamboo that need follow-up control, but just three extensive areas of bamboo remain along Oakley Creek (large stand MU 3b, small patch MU 10 by railway line and large area on MU 10/11 boundary). The control of the larger stands is more complex and will need considerable funds and ongoing resources to follow-up regrowth. These areas should be considered for control in future. The smaller patch in MU 10 by the railway line will be easier to control and should be included in the ecological restoration contract as an additional requested task.

6.2.1 Phased control of tree privet canopy in MU 1b and 1c

Much of the tree privet canopy in MU 1 is concentrated next to the walkway, therefore poisoning and leaving trees in-situ is not an appropriate control method, as this will cause serious safety issues as trees collapse and drop limbs. Phased removal of tree privet in this area should be continued in order to replace the canopy steadily. Phased control should remove 1 in 5 mature tree privets per year in MU 1b and MU 1c, and this should be carried out over a 5-10 year period. Arborists will need to climb and section tree privets, carefully lowering sections to the ground whilst causing minimal disturbance to surrounding native vegetation. The adjacent row of macrocarpa trees should also be felled as they are becoming hazardous. Underplanting under the privet canopy as it is thinned should be continued, to provide replacement native vegetation, and some diversity / canopy species should be included along with colonising species.

6.2.2 Phased control of tree privet canopy in MU 10 and MU 11

Long-term weed canopy control is needed of tree privet in MU 10 and MU 11 in order to restore this area to a native mahoe dominated rock forest, over time. This process needs to be undertaken over a 20 year period to ensure that these areas are not opened up to light too quickly, which will result in re-invasion of weeds. For MU 10 and MU 11 phased control needs to involve drilling and poisoning a maximum of 1 in 10 privet trees per year in areas where there is an understorey starting to develop. This approach will allow for natural regeneration of native seedlings. In some areas it may be necessary to carry out supplementary understorey planting with appropriate mahoe rock forest plants.

6.3 Weed control considerations

6.3.1 Use of suitably qualified ecological restoration contractors

It is recommended that the majority of weed control is undertaken by qualified contractors due to the variety and extent of weed issues that exist across the site, which require spraying or cut-stump control using specific chemicals, to be tackled effectively. All contractor field staff need to hold the Introductory Growsafe Certificate and EPA Approved Handlers test certificates, and be trained in chemical application for weed control. Agrichemical management and application must adhere to NZS 8409:2004 "Management of Agrichemicals" and policies in the Auckland Regional Air, Land and Water Plan.

A Lowest Toxicity Policy should be used which aims to minimise risk to users and the environment, by using herbicide with the lowest toxicity that is effective for the weed species being targeted. Extra caution is required with use of agrichemicals in wetlands and near waterways and only appropriate herbicides approved for use over the water must be used.

6.3.2 Public safety

Throughout all stages of weed control it is important to consider public safety. Oakley Creek is frequented by a number of people on a daily basis, therefore the appropriate signage and precautions will be necessary. This may include temporary closure of some sections of the walkway during the felling of large trees.

It should be noted that there are areas of rubbish that may become further exposed through weed control, such as in MU 8. There are also areas of landfill in Phyllis and Harbutt Reserves. Refer to the *Soil Handling Plan* for recommended site management procedures when working in these areas (see Appendix 8).

6.3.3 Volunteer weed control

Volunteers managed by Friends of Oakley Creek (FOOC), regularly carry out weed control using manual and cut and paste methods. FOOC also carry out planting maintenance, which focuses on manual methods and hand clearance. FOOC works closely with adjacent neighbours and landowners and they also manage other groups carrying out weed control tasks at Oakley Creek (e.g. CVNZ, corporate groups). It is important that volunteers are briefed at the start of tasks about any site hazards and that health and safety considerations are discussed. Tasks need to be suited to the age, fitness and ability of volunteers (as well as weather and site conditions) and volunteer groups should be supervised by an experienced volunteer supervisor. Suitable community tasks are discussed further in Section 9

6.3.4 Neighbouring properties

Oakley Creek is surrounded by a number of private properties that contain environmental weed species and invasive garden plants. These adjacent properties provide significant seed source threats for areas of restored habitat along Oakley. Neighbours should be encouraged to carry out weed control through support from FOOC and Auckland Council, to prevent continual reinvasion of weeds.

6.3.5 Stream bank stability

It is important to acknowledge that the removal of vegetation along streams can increase the potential for stream bank erosion and subsidence. The control of exotic grass and herbaceous weeds should be avoided where possible, and stream banks should be revegetated as soon as environmental weeds have been controlled to a low level. Low priority herbaceous weeds and grass will be shaded out once a ground cover is achieved. If areas do become clear due to weed removal, then 'living mulch', a rye-clover seed mix, can be spread to establish a quick and effective ground cover until planting is possible.

6.3.6 Steep slope stability

Caution should be undertaken when controlling mature trees or dense vegetation on steep slopes, as removal can lead to erosion. Each situation should be assessed and options such as phased removal, leaving tree stump or cutting higher to create a totem trunk, should be considered ,where appropriate. If near a walking track or public area then safety will take priority.

6.3.7 Sites of archaeological and cultural significance

It is highly recommended that interest groups (e.g. local iwi and archaeologists) be consulted prior to any weed control in areas of archaeological and / or cultural significance, such as the large bamboo stand in MU 3b. Archaeological sites have been identified with appropriate management recommendations made in Druskovich (2009) and will be included in the updated archaeological survey (to be completed by Brent Druskovich in winter 2015).

6.4 Environmental weed species control list

A site-led weed control approach should be followed at Oakley Creek, yet the following weed list (shown in Table 3) provides guidance for volunteers and contractors when considering which environmental weeds should be controlled as part of the weed control programme. The priority ranking relates to the impact of the weed on the site e.g. for high - it is a very invasive weed, or there is only a small amount of this weed species present, therefore it is a priority to eradicate it. Other environmental weeds may be found along Oakley Creek in future and this list should be updated and reviewed as weed control progresses.

Table 3. List of environmental weeds to be controlled at Oakley Creek

Common name	**Latin name**	**Auckland RPMS ***	**Priority**	**Notes**
Chinese knotweed	*Persicaria chinensis*		Controlled	Controlled. Biosecurity Team, Auckland Council carry out follow-up checks.
acmena, monkey apple	*Syzygium smithii*	Surveillance	High	Environmental Weed Tree
agapanthus	*Agapanthus orientalis*	Surveillance	High	
alligator weed	*Alternanthera philoxeroides*	Surveillance	High	
bears breeches	*Acanthus mollis*	Research	High	
aristea	*Aristea ecklonii*	Surveillance	High	Only small amounts remaining.
blue morning glory	*Ipomoea indica*	Surveillance	High	
castor oil plant	*Ricinus communis*	Surveillance	High	
Chinese privet	*Ligustrum sinense*	Surveillance	High	Environmental Weed Tree
climbing asparagus	*Asparagus scandens*	Surveillance	High	
coral tree, flame tree	*Erythrina x sykesii*		High	Environmental Weed Tree
eleagnus	*Eleagnus x reflexa*	Surveillance	High	
elephants ear	*Alocasia brisbanensis*	Surveillance	High	
German ivy	*Delairea odorata*	Surveillance	High	
giant reed	*Arundo donax*	Surveillance	High	Main patches now controlled.
ginger, kahili	*Hedychium gardenerium*	Surveillance	High	
Italian evergreen buckthorn	*Rhamnus alaternus*	Surveillance	High	
Japanese honeysuckle	*Lonicera japonica*	Surveillance	High	
Japanese spindle tree	*Euonymus japonicus*	Surveillance	High	Mainly regrowth.

Common name	Latin name	Auckland RPMS *	Priority	Notes
jasmine	*Jasminum polyanthum*	Surveillance	High	
madeira vine	*Anredera cordifolia*	Surveillance	High	
mist flower	*Ageratina riparia*	Surveillance	High	
moth plant	*Araujia sericifera*	Surveillance	High	
palm grass	*Setaria palmifolia*	Surveillance	High	
pampas	*Cortadeira selloana, C. jubata*	Surveillance	High	
tradescantia	*Tradescantia fluminensis*	Surveillance	High	Re-invades from upstream.
tree privet	*Ligustrum lucidum*	Surveillance	High	Environmental Weed Tree
wattle, brush	*Paraserianthes lophantha*	Surveillance	High	Environmental Weed Tree
willow, crack	*Salix fragilis*	Surveillance	High	Environmental Weed Tree
woolly nightshade	*Solanum mauritianum*	Containment	High	
African club moss	*Selaginella krausiana*	Surveillance	Medium	
African love grass	*Eragrostis curvula*	Surveillance	Medium	Number of sites, e.g. MU1b, MU 9
arum lily	*Zantedeschia aethiopica*	Surveillance	Medium	
bamboo	*Bambusa sp., Phyllostachys sp.*		Medium	3 main patches exist.
bangalow palm	*Archontophoenix cunninghamiana*	Research	Medium	
bartlettina	*Bartlettina sordida*	Surveillance	Medium	
blackberry	*Rubus fruticosus agg.*	Surveillance	Medium	
brush cherry	*Syzygium australe*		Medium	
buddleia	*Buddleja davidii*	Surveillance	Medium	
canna lily	*Canna indica*		Medium	
cape honeysuckle	*Tecomaria capensis*		Medium	
climbing dock	*Rumex sagittatus*	Surveillance	Medium	
cotoneaster	*Cotoneaster glaucophyllus*	Surveillance	Medium	Environmental Weed Tree
cretan brake fern	*Pteris cretica*	Research	Medium	
English ivy	*Hedera helix*	Surveillance	Medium	
ginger, yellow	*Hedychium flavescens*	Surveillance	Medium	
gorse	*Ulex europaeus*	Surveillance	Medium	
grey sedge	*Carex divulsa*	Surveillance	Medium	
hawthorn	*Crataegus monogyna*	Surveillance	Medium	
Himalayan honeysuckle	*Leycestreria formosa*	Surveillance	Medium	
montbretia	*Crocosmia x crocosmiiflora*	Surveillance	Medium	
nasturtium	*Tropaeolum majus*		Medium	
periwinkle	*Vinca major*	Surveillance	Medium	

Common name	Latin name	Auckland RPMS *	Priority	Notes
phoenix palm	*Phoenix canariensis*	Surveillance	Medium	Environmental Weed Tree
plectranthus	*Plectranthus ciliatus*	Surveillance	Medium	
Queensland poplar	*Homalanthus populifolius*	Surveillance	Medium	
silver poplar, white poplar	*Populus alba*		Medium	Control suckers and saplings.
smilax	*Asparagus asparagoides*	Surveillance	Medium	
Sydney golden wattle	*Acacia longifolia*	Research	Medium	Environmental Weed Tree
Taiwan cherry	*Prunus campanulata*	Research	Medium	
Tasmanian blackwood	*Acacia melanoxylon*		Medium	
three-cornered garlic, onion weed	*Allium triquetrum*		Medium	
tuber ladder fern	*Nephrolepis cordifolia*	Surveillance	Medium	
tutsan	*Hypericum androsaemum*	Surveillance	Medium	
umbrella sedge	*Cyperus eragrostis*		Medium	Can be an issue in riparian revegetated areas.
wattle, black	*Acacia mearnsii*		Medium	Environmental Weed Tree
bindweed sp. (exotic or hybrids)	*Calystegia sp.*		Low-Med	Can be an issue in revegetated areas.
convolvulus	*Convolvulus arvensis*		Low-Med	Can be an issue in revegetated areas.
eucalyptus	*Eucalyptus sp.*		Low	Control seedlings.
liquidambar	*Liquidambar sp.*		Low	Control seedlings.
oak	*Quercus sp.*		Low	Control seedlings.
pines	*Pinus sp.*		Low	Remove trees steadily as die/become unsafe. Control seedlings.
sycamore	*Acer pseudoplatanus*		Low	Control seedlings.
willow weed	*Polygonum persicaria*		Low	Do not confuse with native species.

* Auckland RPMS – Auckland Regional Pest Management Strategy 2007-2012, currently being updated

6.5 Weed control management priorities

Table 4. Current restoration phases and ongoing weed control priorities by management unit

Management Unit	Restoration Phase (as at June 2015)	Ongoing Weed Control Priorities for 2015-2025
1a, 1b, 1c	Seedbank Control, Long-term Control – Tree privet	Ongoing weed maintenance visits. Check Madeira vine sites. Control environmental weed trees such as flame tree. Continue phased removal of tree privet in 1b and 1c (by arborists).
2	Seedbank Control	Ongoing weed maintenance visits. Control any remaining tree privet and acmena. Control seedlings/ regrowth of exotic trees.
3a	Seedbank Control	Ongoing weed maintenance visits. Control large willows by stream.
3b	Seedbank Control, Long-term control – Bamboo, Old mill site	Ongoing weed maintenance visits. Long-term control of large Bamboo stand – complex issues (large area, regrowth management, potential archaeological issues). Immediate priority to push back bamboo encroaching on stream. Control flame tree by bamboo. Establish control methodology for open slope old mill site – needs archaeological assessment.
4a	Seedbank Control	Ongoing weed maintenance visits. Thin hawthorn and Chinese privet. Control regrowth / suckers of poplar and alder.
4b	Seedbank Control, Long-term Control - Pines	Ongoing weed maintenance visits. Remove large pines as die / become unsafe.
5	Seedbank Control	Ongoing weed maintenance visits. Control hawthorn, willow and Chinese privet on western bank.
6	Seedbank Control	Ongoing weed maintenance visits. Control weeds in bracken / gorse area. Check for bamboo regrowth above waterfall. Control flame trees.
7	Seedbank Control	Ongoing weed maintenance visits. Focus on steep western slopes. Check two Arundo areas for regrowth. Control and remove Phoenix Palm.

Management Unit	Restoration Phase (as at June 2015)	Ongoing Weed Control Priorities for 2015-2025
8	Seedbank Control, Initial Control – two areas	Ongoing weed maintenance visits. Continue weed control in Mahoe Rock Forest Areas (MRF) A, B and C. Target two areas of initial control – south of large willow and open slope between MRF B and C. Identify approach for slope with rubbish dumping in MU 8. Auckland Council Biosecurity team to continue to monitor Chinese knotweed site.
9	Seedbank Control	Ongoing weed maintenance visits. Focus on regrowth on slope to south of MRF D. Continue weed control in Mahoe Rock Forest Areas (MRF) D and E. Continue maintenance of open planted areas. Control row of willows along stream in future (previously cut low). Staged control of willow and wattle on slope above MRF E and path.
10	Follow-up Control, Long-term control – Tree privet	Ongoing weed maintenance visits. Focus on regrowth along floodplain, on slopes and open gully. Continue phased Weed Canopy Control of tree privet (drill & poison), ensuring no large light gaps are created. Control small patch of bamboo on railway boundary. Staged control of willow on floodplain.
11	Seedbank Control, Long-term control – Bamboo, Tree privet	Ongoing weed maintenance visits. In future target large patch of bamboo, as budget allows. Continue phased Weed Canopy Control of tree privet (drill & poison), ensuring no large light gaps are created. Continue weed control in Mahoe Rock Forest Area (MRF) F and adjacent buffer area. Control willows along stream.
All MUs	Tradescantia Control	Ongoing tradescantia control is required along the stream and for known sites to reduce to low levels, as constant re-invasion will occur from upstream.
All MUs	Planting Maintenance	Planting maintenance is needed of younger and establishing plantings to ensure weeds do not invade and plants establish and survive successfully. This should be carried out as a combination of volunteer and/or contractor effort depending on the location.
Western Esplanades (MU 12)	Initial Control mainly	Assess weed control requirements in different areas. Carry out initial control to reduce the presence of vines and understorey weeds. Control smaller weed trees and target ground cover weeds, where no risk of slope erosion.

7 Animal Pest Control

Animal pest control has been undertaken in the lower part of Oakley Creek from MU 1 to MU 6 (referred to as the 'pest control area') since 2009 and is managed by Friends of Oakley Creek. For locations of existing bait stations and traps in the 'pest control area' at Oakley Creek, refer to the map in Figure 10. This does not show the traps set-up by the Roskill Rovers in Harbutt Reserve.

Purpose: The purpose of pest control along Oakley Creek is to increase the abundance of native wildlife living there, to ensure native plants survive and reproduce, and generally to create a create a healthy and functioning native ecosystem (FOOC, 2010a).

7.1.1 Rodent control

Rodent bait stations have been installed on both the east (27 stations) and west banks (24 stations) of Oakley Creek from MU 1-6, at 50 m spacings – a total of 51 stations. Rats are the main target, but mice will also take bait.

An additional 12 bait stations were installed in the Lizard Management Area (LMA) in MU 3a in July 2012 at a spacing of approximately 25m x 25m, to try to reduce predation on relocated lizards. Refer to Figure 11 showing bait stations in the LMA in MU 3a.

Rodent baiting is carried out 4 times per year (approximately February, May, August, November). Ditrac (active ingredient Diphacinone), a first generation anti-coagulant bait has been mainly used for rodent control. It is also important to use an aFrom 2012 an annual pulse of a 2nd generation bait, such as Contrac (active ingredient Bromadiolone) to prevent 'shyness' to a particular type of bait. In August and November 2014 Ratabate (active ingredient Diphacinone) and Ratabate/Ditrac were used. The amount of bait placed in stations needs to be carefully recorded. At the end of the baiting period the amount remaining is recorded (any remaining bait is removed), then the amount of bait consumed is calculated.

Recommendation: It is recommended that rodent baiting is continued in the 'pest control area', with 4 visits being carried out per year between August and November to reduce rodent levels.

As restoration work has expanded to Phyllis and Harbutt Reserves, it would be beneficial to set-up rodent bait stations in this southern half of the restoration work area, if volunteer capacity and resources are available.

7.1.1 Possum control

Friends of Oakley Creek volunteers began trapping possums in late 2009 on the east side of the creek, and in April 2010 on the west side of the creek. Possum numbers have been significantly reduced, yet will continue to arrive from surrounding areas.

There are 11 Timms traps (at 100m spacings) on the east side of the creek, which are checked and re-baited weekly by FOOC volunteers. The St Judes Venturer Scouts have been checking the 11 Timms traps on the western side of Oakley Creek since 2010.

The Roskill Rovers have setup a line of traps on the east side of Oakley Creek in Harbutt Reserve, from marker 1.70 by Mahoe Rock Forest Area C up to marker 2.65. This includes

10 DOC 200 traps and 10 Timms traps, which are checked weekly. The Sustainable Neighbourhood Group at Powell Street have recently installed 3 Goodnature self re-setting possum traps in their project area on the western side of the creek.

Recommendation: It is recommended that possum trapping is continued in the 'pest control area'. As possum numbers continue to be reduced in this area, trap check visits could be reduced to every two weeks or monthly in future. Yet, possum traps checks could be undertaken weekly in autumn months when young male possums tend to be dispersing to establish new territories.

As restoration work has expanded to Phyllis and Harbutt Reserves, it would be beneficial to set-up possum traps in this southern half of the restoration work area, if volunteer capacity and resources are available.

7.1.1 Hedgehogs and mustelids

Friends of Oakley Creek have set out 9 DOC 200 traps on the west side of the creek and 11 DOC 200s on the east side. They are baited with an egg or rabbit lure for control of hedgehogs and mustelids (ferrets, weasels and stoats) and are generally checked/cleared weekly, at the same time as the Timms traps, apart from a few weeks over the summer months.

No mustelids have been caught (pers comm. FOOC) since trapping began, while hedgehogs are caught occasionally.

Recommendation: It is recommended that mustelid and hedgehog trapping is continued in the 'pest control area'. Mustelids have large home ranges so may pass through Oakley Creek occasionally (NB: mustelids, particularly stoats, are caught sproradically in DOC 200 traps on Traherne Island). As hedgehog trapping incidences are relatively low (with occasional by-catch of rats), trap checks could be reduced to every two weeks or monthly.

As restoration work has expanded to Phyllis and Harbutt Reserves, it would be beneficial to set-up further DOC traps in this southern half of the restoration work area (taking into account the location of DOC 200 traps set-up by the Roskill Rovers), if volunteer capacity and resources are available.

7.1.2 Health and Safety

All volunteers involved in animal pest control and monitoring should attend animal pest control training run by a suitably experienced person, so that they are aware of health and safety requirements.

Hazardous Substances and New Organisms (HSNO) Act 1996 regulations require warning signs to be placed at all major public entrances to the site. These will state the type of toxin and trap, emergency phone numbers, the dates bait is to be present / trapping period, and contact names and phone numbers. Auckland Council Local Parks team have designed appropriate pest control hazard signs which need to be installed and maintained. It is important to ensure that signs are up-to-date (i.e. show current period of baiting and trapping) and have not been removed or defaced.

It is a legal requirement to carry Safety Data Sheets (SDSs) for baits being used at the time whilst refilling bait stations. Members of the public may ask to view these if they have concerns.

Baits need to be secured in bait stations. Protecta Sidekick tamperproof bait station are used at Oakley Creek, which are placed on the ground and secured to trees. This reduces the chance of tampering by pets or children. Traps should be placed away from immediate path edges and labelled as dangerous.

Precautions should be taken when handling bait and dead animals. Plastic gloves must be worn and hands washed thoroughly before eating, drinking, smoking or going to the toilet.

It is a legal requirement to store bait in a secure (i.e. locked) location. This should be well ventilated and dry, out of reach of children, and not accessible to pets. Do not store bait near any food, drink and animal foodstuffs. Bait must be stored in its original container with the correct label.

For further guidelines on carrying out animal pest control and associated hazard mitigation, refer to the *Animal Pest Control Volunteer Handbook* (Te Ngahere, January 2014), which was developed for Auckland Council Local Parks volunteers.

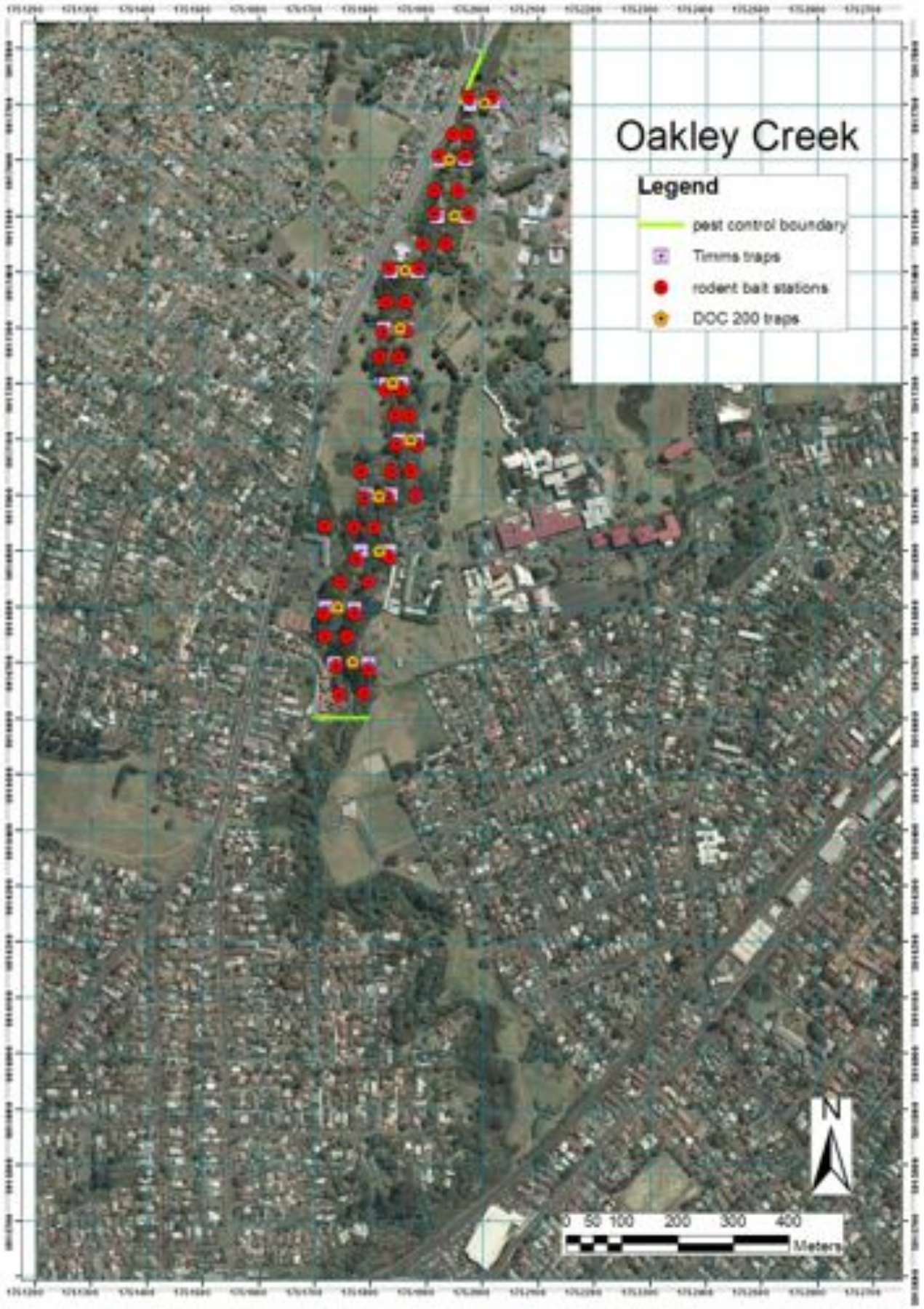

Figure 10. Location of bait stations and traps in the 'pest control area' at Oakley Creek (FOOC)

Figure 11. Location of additional rodent bait stations in Oakley Creek Lizard Management Area in MU 3a (map created in December 2012 by Te Ngahere)

Note: Orange / Green indicates existing rodent bait station set-up by Friends of Oakley Creek. Blue (S60 - S71) refers to additional bait stations installed for lizard enhancement works.

8 Revegetation

8.1 Revegetation introduction

Revegetation planting is a core component of the restoration programme at Oakley Creek. The first community planting at Oakley Creek was carried out by FOOC in 2004, with over 45,500 native plants have been planted since then.

Initial planting was mainly focused on the northern half of the Oakley Creek walkway, and since 2009 the number of plantings undertaken in MU 7-9 has increased. In 2014, the first plantings were carried out in MU 10 by Te Ngahere. No planting has been undertaken in MU 11 as restoration was only recently begun in this unit, and the focus in Mahoe Rock Forest Area F will be on natural regeneration. An updated archaeological assessment is also being undertaken for the whole Oakley Creek restoration area.

The majority of plantings have been carried out by the community (involving various local community groups, educational institutes, volunteer organizations) and a few business / corporate groups, and have been coordinated by FOOC. Annual planting at a selected site(s) has also been carried out by Te Ngahere since 2006, as part of the restoration contracts.

8.2 Revegetation aims

Revegetation planting brings a number of positive outcomes for biodiversity, ecosystem function and amenity.

The aims of revegetation / restoration planting at Oakley Creek are to:

- Assist and promote natural ecological processes.
- Provide buffering to wetland and riparian areas, which will help to filter out sediment and pollutants from runoff, therefore improving water quality.
- Restore the habitat structure and diversity of the existing vegetation which will provide more valuable food and habitat resources for native birds, reptiles and invertebrates, therefore attracting them into the area and maintaining their populations.
- Enhance the quality of habitat used by fauna within the stream and wetland areas (particularly macro-invertebrates and fish), including providing shading to help stabilise stream water temperatures.
- Augment natural regeneration, and act as a nurse crop to provide shelter for diversity and canopy species.
- Prevent the establishment of weeds, including those that have been washed down from upper reaches of the stream.
- Help stabilise banks which will reduce erosion of the stream edge and decrease undercut banks from collapsing.
- Allow for unimpeded movement of flood waters by plants lying flat while flood water

moves over them, which can help to reduce flows and mitigate high flow erosion.

- Protect the soil surface and enhance soil stability, decreasing sediment inputs into the stream.
- Link areas of existing riparian vegetation and regenerating forest habitats, to improve site connectivity and create continuous habitat.
- Create ecological connectivity to external sites through an enhanced wildlife corridor.
- Provide opportunities to engage the local community in restoration.
- Aesthetically enhance the area, thereby increasing the social and amenity value of the site and providing for recreational use of the stream corridor.
- Enhance the integrity of the creeks landscape and landforms.

Revegetation will take into account the need to maintain open areas for significant views of the landscape, recreation and public safety concerns. Archaeological sites will be protected and only appropriate species will be planted on these sites, under the direction of the consultant archaeologist.

8.3 Revegetation principles

Revegetation should follow best practice ecological restoration planting principles, as outlined below:

8.3.1 Ensure plants are appropriate for the site and location

In order to thrive and carry out their function, riparian plants need to be placed in the appropriate substrate and correct zone of a stream, whether it is directly on the stream banks, within the flood plain or further back up the slope. With the appropriate planting assemblage, a stream is more likely to perform its various functions in a similar manner to that of a stream with remnant 'natural' vegetation.

It is also important to take into account site conditions such as open areas, dry sites or steep slopes and to select appropriate plants. Some plants will need shade to establish while others require wetter conditions. At Oakley Creek there are two main geology types, alluvial and volcanic, and plants need to be chosen that are suited to these soil conditions (refer to geology map in Figure 4).

8.3.2 Use predominantly pioneer/ colonising species to achieve canopy closure and sufficient ground cover

Pioneer species specialise in growing in exposed open sites that are drier and hotter than sites shaded by trees or shrubs. The natural function of these species is to act as a nurse crop that provides sheltered conditions in which other species will establish naturally or be planted at a later stage. If the nurse crop is established from well-selected, rapid growing and closely planted native plants, it is also likely that weed seed germination will be reduced significantly on the establishment of canopy closure, or soil coverage in the case of sedges and grasses. This should occur ideally within 3-5 years after planting depending on site conditions.

8.3.3 Use a small percentage of diversity species for later phase plantings

It is important to use colonising species when re-establishing or enhancing riparian and forest habitats, to ensure structure and shade are created initially. Some early diversity species and hardy species could be used early on to supplement colonising species in some situations.

Once weeds are controlled and understorey structure / vegetation cover is developed then the appropriateness of introducing diversity species should be carefully considered. Natural regeneration and succession should be encouraged, yet these are relatively slow processes, so patience is required. Ecological restoration should not be rushed and diversity or canopy species planting may not be required in all situations. As the restoration programme at Oakley Creek has progressed over the last 10 years there may be some situations where canopy and diversity/ understorey species could be added. This should focus on diversity trees in preference to low growing species, such as ferns, or more uncommon species.

The following should be taken into account when considering diversity planting:

- Within the Oakley Creek catchment and the greater Tamaki Ecological District there are plenty of natural seed and spore sources.
- Natural establishment has a more natural distribution, plants find their natural niches and survival is more likely.
- Ferns are particularly good at establishing naturally, but may take a while to arrive.
- There is an increase cost for using diversity plants due to the labour to collect, propagate and raise these more specialist species. Some plants are hard to germinate and source.
- Consider what site specific management is needed, such as further weed control in certain locations, in order for species to naturally establish.
- Establishment success rates for some sedges, gahnia and ferns can be difficult or limited when there is strong regrowth of weeds or annuals, so requires high maintenance which is not always possible to achieve.

Diversity planting needs to be appropriate to the distinct vegetation type / ecosystem that is appropriate for the section of Oakley Creek, so that homogenous or generic vegetation types are not created.

These vegetation types include:

- Lowland Broadleaf Forest in the lower reaches of the creek on the slopes.
- Riparian vegetation and wetland vegetation along the stream banks and wetter areas.
- Alluvial Forest along the floodplain and lower slopes, where alluvial soils exist.
- Mahoe Rock Forest (a form of lava flow forest) in the southern part of the restoration area, where there are volcanic soils.

It should be noted that Coastal Forest is not an appropriate vegetation type for Oakley Creek, so strictly coastal species should not be planted (such as karo, houpara and wharangi).

It has been agreed that the establishment of Kauri Forest or planting of kauri is not a reasonable outcome for Oakley Creek, given the size, urban nature of the site, predominantly lowland broadleaf vegetation present and risk of kauri dieback disease.

Refer to specific planting lists for vegetation types and riparian zones in Section 8.5 , which highlight suitable diversity species. In Appendix 4, Table 17, there is a summary of these recommended diversity plants (combined list of diversity plants mentioned in the restoration plan habitat/slope planting lists).

Appendix 5 (Table 18) contains a list of non-recommended diversity species for reference, which are generally not suitable for planting at Oakley Creek (with reasons explained). When considering what diversity species to plant this list should be referred to and discussions should be had with the Auckland Council Biodiversity Team regarding suitability of species.

8.3.4 Eco-sourcing

Ensure all planting material is eco-sourced from naturally occurring indigenous stock growing within the Tamaki Ecological District.

Eco-sourcing is a principle fundamental to the long-term success of a revegetation programme.
The benefits of eco-sourcing include:

- the maintenance of local biodiversity,
- plants are adapted to growing in local conditions,
- plants are more resilient to threat of disease and changes in the local environment, and
- genetic variability is maintained across New Zealand.

Best practice eco-sourcing principles should be followed:

- Seed collection should be mainly from outside Oakley Creek (with limited onsite collection) to improve genetic diversity.
- Encourage that the majority of collection is done from within the Tamaki Ecological District, with some suitable sites on the border of the Tamaki / Waitakere Ecological District used if necessary. Suggested plant sourcing locations are referred to for some species in recommended diversity planting list in the Appendix.
- Discuss eco-sourcing requirements with local native plant nurseries to ensure they are aware of requirements and are able to source appropriately. Avoid using nurseries that buy-in plants from different regions or are unable to provide verifiable details of where plants have been sourced from.
- Plan for sufficient lead-in times for nurseries or volunteers to carry out seed collection from sites in advance.

It should be noted that the majority of vegetation along Oakley Creek has been planted (apart from mahoe rock forest remnants), therefore what is currently on site (or recorded by botanical surveys) is not a good reference for what vegetation was naturally occurring. Thus, we need to be sure of the origin of parent plants before collecting seeds and before assuming that a species is locally occurring.

8.3.5 Natural regeneration

Natural regeneration of native seedlings should be encouraged wherever possible, especially as weed issues are reduced. Natural regeneration is particularly appropriate in mahoe rock forest areas, where there are native canopy species present.

8.3.6 Plant size selection

The selection of the plant grade or size in which revegetation plants are to be supplied, is an important consideration in ensuring the success of revegetation plantings. Plant size should be appropriate to location. 1 L and 1.5L (PB3 equivalent) are recommended for revegetation projects. These sizes have been selected for most species to allow for the quickest establishment rates, which will in turn minimise the need for ongoing follow-up maintenance. 0.5 L size may be appropriate for very rocky slopes.

8.3.7 Plant spacing

It is important to recognise the influence plant density has on the revegetation process. Plant layout should be carried out carefully to maintain appropriate plant spacings. A planting density of 1m centres on slopes and forest areas is ideal for achieving rapid establishment of native vegetation cover, which in turn reduces competition from weed species. Along the stream bank, flood plain, and in the back wetland, plantings are best carried out at 0.5m to 0.75m spacings. Certain plants should be planted in groups (such as cabbage trees and sedges), to increase the benefit to feeding birds and other native fauna. This also creates a more natural vegetation cover.

8.3.8 Planting timing

Planting should take place during the months of May to August, as long as soil conditions are suitable (e.g. not too dry). Planting can occasionally be extended into April or September, depending on soil moisture levels, but plants may not establish as well.

8.3.9 Planting maintenance

Planting maintenance is an important restoration task, to ensure the survival success and establishment of native plantings. Planting maintenance should be carried out for a minimum of two years, and ideally for longer. Regular visits are required to prevent annual plants and weeds suppressing the establishment and growth of plantings.

8.3.10 Stream bank erosion/stability

Stream bank erosion and subsidence is visible throughout Oakley Creek and is occurring at a faster rate than would generally be expected within unmodified riparian ecosystems. The two main causes for this are likely to be: i) the lack of stream bank vegetation and ii) the rate at which the water flows through the stream. To reduce the occurrence of such erosion, banks should be revegetated with the appropriate plants. Appropriate plants need to be selected that will establish quickly and not get washed away or swamped by annual plants

or weed regrowth. It has been found in recent years that larger sedges (*Carex lessoniana*), *Cyperus ustulatus* and toetoe are particularly effective at creating dense cover along stream edges at Oakley Creek, and some tree species, planted in the early stages are also good for bank stability/shade, including manuka and mahoe.

8.3.11 Stormwater restoration opportunities

In the WMP, specific restoration opportunities (ROs 1-12) have been identified along Oakley Creek to improve amenity, for erosion control/ bank stability, to enable fish passage, to allow stormwater conveyance and for ecological enhancement. These ROs need to be taken into consideration when planning planting, in order to meet multiple objectives and consider future erosion control works. Stormwater planning maps (showing fish barriers, erosion control areas and Restoration Opportunities) are shown in the Appendix, Figure 17 and Figure 18. Discussions should be had between Auckland Council Stormwater team and relevant stakeholders to consider RO objectives and future opportunities for stream enhancement.

8.3.12 Open spaces

Oakley Creek holds significant recreational and amenity value within the community. By maintaining open areas adjacent to boardwalks and paths, it is anticipated the site could continue to be utilised for a variety of recreational activities such as picnicking and exercise. This also addresses public safety issues that would arise if the entire area were to be revegetated. To ensure open spaces remain, where large grassed areas presently exist, plants need to be placed in isolated groups.

8.3.13 View shafts

The management of view shafts is another consideration that needs to be incorporated into this revegetation programme. It is important that revegetating Oakley Creek does not compromise views of the creek or any other landmarks. It is unlikely that views from the boardwalks and various pathways within Oakley Creek will be obscured, as most revegetation along these areas will be small, low growing plant species.

8.3.14 Landscape integrity

In a similar manner to the view shafts, it is also important to plant in a way that is in line with the natural contours of the land and the flow of the creek. Species chosen for streamside plantings are naturally found in the riparian zone, which will not only help restore the biodiversity, but also improve the aesthetics and natural character of the local area.

8.3.15 Archaeological site revegetation

To assist in the preservation of the archaeological sites within Oakley Creek, it is important to utilise plant species as specified by Jones (2007) that have suitable root structure and form, provided they are also suitable for the area / specific planting site, and to follow the recommendations of Druskovich (2009 – to be updated in winter 2015) for the revegetation of archaeological sites.

8.3.16 Living mulch

To assist in the regeneration of native vegetation, and to prevent the reinfestation of environmental weeds, rye-clover grass seed (known as living mulch) can be spread through the planted area, e.g. where there is bare soil, as this has been found to be very effective at other sites. It is likely that grass will gradually colonise bare ground naturally, however, spreading seed through areas prone to reinvasion and regrowth of weeds will speed up this process and reduce plant maintenance requirements.

8.3.17 Specimen tree planting

In recent years planting of specimen trees in open areas, such as along floodplains or unvegetated slopes, has been trialled at Oakley Creek. On floodplains the aim is to establish some shade in the interim so that lower growing species can establish underneath and the stream will be shaded quicker. On slopes the principle is to create accelerated establishment of tree cover by using slightly larger plant grades, so that further infill planting can happen. This approach has had varying success. Some specimen trees have established along the floodplain (such as kahikatea in MU 9) whilst others have been slow to grow due to open conditions. On the slopes (such as Harbutt steep slope) planting establishment has been slow and plants have become overgrown by weeds or long grass, with high maintenance required.

In general, denser plantings of colonising species seem to be more successful on open slopes, whilst on floodplains mass planting of larger sedge-like plants and colonising species create more rapid cover. Some planting of specimen trees on floodplains can help to create shade to reduce competition from weeds and annuals. The planting of specimen trees should be limited to situations where amenity values / requirements are equal to ecological requirements. Otherwise, planting principles of dense coloniser plantings should be followed to achieve the ecological restoration goals of the project.

8.4 Introduction of threatened or rare plants

The introduction of threatened or rare plants is not a high priority as part of restoration efforts along Oakley Creek. It is more important to establish representative natural habitat types and ensure that these develop structural diversity over the next 10 years.

The decision to introduce threatened or rare plants should be carefully considered and the reasons for doing so be documented. There should be clear thinking around why each species is being used, whether it is locally known and how and where it will be planted. Site suitability and site threats need to be considered carefully, as well as whether a viable population can be established. Any maintenance and site management requirements should be considered before a decision is made to introduce threatened plants.

Sourcing of threatened and rare plants will need special collection and propagation requirements and may need permissions / approvals, depending on where they are sourced from. Any threatened plants proposed for introduction need to be discussed with the Auckland Council Regional Biodiversity Advisor (Flora), before any steps are planned. A 'Threatened Plant Translocation Planning Template' form (see Appendix) needs to filled out and submitted to the Regional Biodiversity Advisor (Flora) and then this will be discussed, and threatened plant translocation/ introduction approved with appropriate conditions or rejected.

Careful record keeping is needed to record where the rare plant is sourced from, and where and when it was planted. Monitoring of the threatened plant will be required and threatened plant survey sheets will need to be returned to the Auckland Council Regional Biodiversity Advisor (Flora) regularly. Records of existing threatened plants that have already been planted at Oakley Creek need to be collated and passed on to the Biodiversity team.

8.5 Specific planting lists by habitat / soil type

With the above revegetation principles in mind the following riparian planting units are proposed. These units are based around a typical stream profile **(see Figure xxx)**, of regions starting from the stream edge, through to the slope above the floodplain. Within each management unit this stream-planting template can be used as the overall guideline for each area.

Original vegetation cover is likely to have been lowland broadleaf forest in the lower reaches with some lava flow forest to the south. Species chosen to revegetate a site are not necessarily those that would be found in these areas 'naturally'. For example a stream bank would naturally be occupied by a number of plant species that prefer damp conditions. It is often the case however, that stream banks are hot and dry and, therefore, need to be initially planted with species that can tolerate these conditions. A number of species have been shown to establish well within modified stream banks and it is from these that the revegetation list has been predominantly chosen.

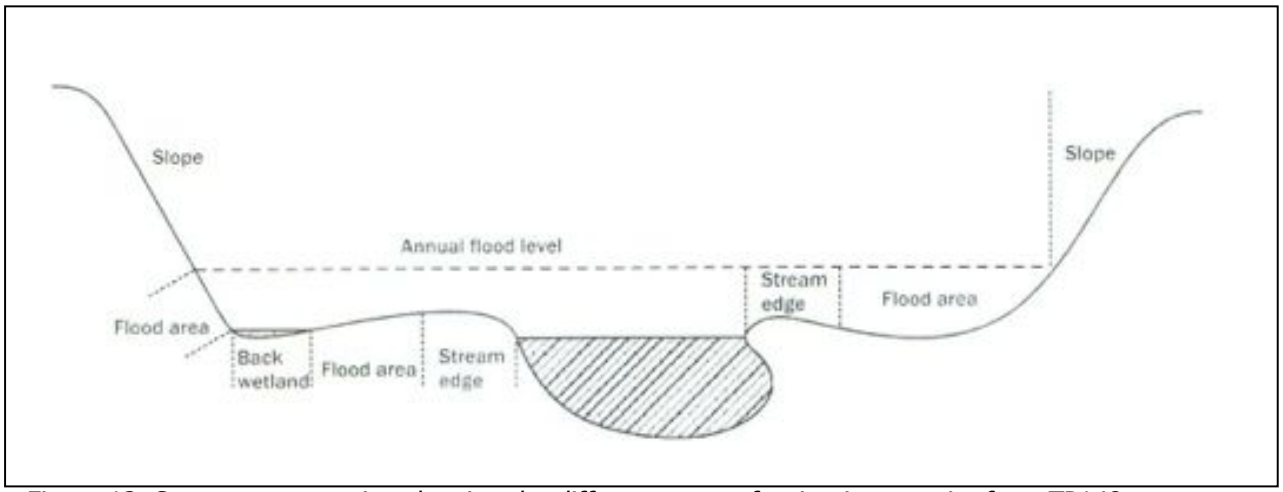

Figure 12. Stream cross section showing the different areas of a riparian margin, from TP148 Auckland Regional Council, June 2001.

8.5.1 Stream edge

The stream edge is the most important area to revegetate to reduce stream bank erosion and subsidence. The stream bank should be a priority when revegetating all management units.

A stream edge is:

- The first 2-3m from the stream, including the lip of the bank.
- Frequently damp, but can be hot and dry during summer months.
- Water is likely to reach upper levels of the bank.
- Erosive forces are considerable.

Plants within the stream bank unit perform a number of important functions; therefore it is essential species chosen are appropriate to this area (seeTable 5) for recommended species).

Vegetation such as sedges and grasses in particular will:

- Prevent the establishment of some weeds that have been washed down from upper reaches of the stream.
- Stabilise banks i.e. reduce erosion of the stream edge and undercut banks from collapsing.
- Enhance the quality of habitat used by fauna within the stream.
- Filter out sediment and pollutants from runoff.
- Allow for unimpeded movement of flood waters by plants lying flat while flood water moves over them.
- Provide ground cover to provide adequate habitat for native invertebrates and reptiles.

Stream edge habitat exists in all MUs (MUs 1-12) where the banks are low enough to the watercourse. The stream edge varies in width and some areas can be periodically inundated.

Table 5. Appropriate stream edge planting species

Common name	Species	Composition in planting	Planting notes
Coloniser species			
giant umbrella sedge	*Cyperus ustulatus*	Common	Plant in groups.
rautahi	*Carex lessoniana**	Abundant	Plant in groups. Prefers wetter conditions.
small swamp sedge	*Carex virgata*	Common	Plant in groups. Can cope with wet or dryer conditions. Can be outcompeted by annuals.
toe toe	*Austroderia fulvida*	Common	Plant in groups
Diversity species			
flat-leaved sedge	*Carex dissita*	Common	This sedge is easily smothered by weeds therefore is ideal as an infill species once the majority of weeds have been controlled and shaded out.
putaputaweta	*Carpodetus serratus*	Sparingly	Tolerates sun and semi-shade. Prefers wetter conditions.
kiokio	*Blechnum novae-zelandiae*	Sparingly	Plant in shade where possible. May be difficult to source.
toe toe	*Austroderia fulvida*	Common	Plant in groups.
mahoe	*Melicytus ramiflorus*	Sparingly	Plant to provide some shade.
manuka	*Leptospermum scoparium*	Sparingly	Plant to provide some shade.
mapou	*Myrsine australis*	Sparingly	Plant to provide some shade.
karamu	*Coprosma robusta*	Sparingly	Plant to provide some shade.
Silver fern, ponga	*Cyathea dealbata*	Sparingly	Plant in appropriate locations to create some shade.
mamaku	*Cyathea medularis*	Sparingly	Plant in appropriate locations to create some shade.

Note: *Carex secta* is commonly suggested as an appropriate plant for revegetating riparian areas. However, it is naturally only found in areas of standing water and not in flowing water (McKain, 2004), therefore, it is inappropriate for the riparian margins of Oakley Creek.

* There is some discussion amongst botanists regarding the hybridisation/ difference between *Carex lessoniana* and *Carex geminata*. There is some argument that *C. geminata* is more of a West Coast species in the Auckland Region whilst *C.lessoniana* is found more often in Auckland central areas. Others refer to *C.geminata agg.* as these two species are known to hybridise and are difficult to differentiate. For simplicity *C. lessoniana* is used throughout this restoration plan.

8.5.2 Flood area / floodplain

The flood area / floodplain is:

- Stream flat and toe of adjacent slope.
- The stream flat that is frequently subject to flooding.
- Generally high fertility and moisture levels.
- Low erosion forces.

Plants within the floodplain carry out important functions such as protecting the soil surface and enhancing the stability of the area. As with the stream bank, plants should have low resistance to flood waters which, in turn, reduces the potential for erosion. It should be noted that plants such as flax, that have a high resistance to flood waters should not be planted in the flood plain zone. A small number of trees can be planted sparingly to add diversity, create shade and attract native fauna to the area. Table 6 below shows details of appropriate species to plant within floodplain areas.

Floodplain and flood areas exist in all MUs (MUs 1-12) where there is a wider flat area. In some parts of MUs the banks are too steep and high, and so do not contain a floodplain.

Table 6. Appropriate flood area / floodplain planting species

Common name	Species	Composition in planting	Planting notes
Coloniser species			
giant umbrella sedge	*Cyperus ustulatus*	Common	Plant within the floodplain, close to the stream bank region.
mahoe	*Melicytus ramiflorus*	Sparingly	
rautahi	*Carex lessoniana*	Common	Plant in groups along the stream flat. Prefers wetter conditions.
small swamp sedge	*Carex virgata*	Common	Plant in groups. Can cope with wet or dryer conditions. Can be outcompeted by annuals.
ti kouka, cabbage tree	*Cordyline australis*	Sparingly	Plant in clumps of 3-4 plants.
toetoe	*Austroderia fulvida*	Abundant	Plant along the toe of the slope and on the floodplain.
Diversity species			
flat-leaved sedge	*Carex dissita*	Common	This sedge is easily smothered by weeds therefore is ideal as an infill species once the majority of weeds have been controlled and shaded out.
kahikatea	*Dacrycarpus dacrydioides*	Sparingly	Plant on the toe of the slope and in floodplain.

Common name	Species	Composition in planting	Planting notes
pukatea	*Laurelia novae-zelandiae*	Sparingly	Characteristic of wet sites, the trunk offers low resistance to flood waters.
putaputaweta	*Carpodetus serratus*	Sparingly	Plant along the toe of the slope and sparingly on floodplain.
mahoe	*Melicytus ramiflorus*	Sparingly	Plant along the toe of the slope and sparingly on floodplain.
manuka	*Leptospermum scoparium*	Sparingly	Plant along the toe of the slope and sparingly on floodplain.
Silver fern, ponga	*Cyathea dealbata*	Sparingly	Plant in appropriate locations to create some shade.
mamaku	*Cyathea medularis*	Sparingly	Plant in appropriate locations to create some shade.

8.5.3 Back wetland or spring and seasonally wet areas

The back wetland or spring is:

- Wet for most of the year.
- Arises when a stream changes course, springs emerge or stream banks have accreted.
- Little or no erosion.

Plants in this region of the riparian margin need to be tolerant of permanently wet conditions (or in some cases seasonally wet conditions) as described in Table 7**.**

Wetland or seasonally wet areas exist at Oakley Creek near pipe outfalls/channels, in lower lying areas and in the Wairaka Wetland.

Table 7. Appropriate back wetland / spring or seasonally wet planting species

Common name	Species	Composition in planting	Planting notes
Coloniser species			
giant umbrella sedge	*Cyperus ustulatus*	Common	Plant on margin of wetland.
manuka	*Leptospermum scoparium*	Sparingly	Plant on margin of wetland.
rautahi	*Carex lessoniana*	Common	Plant in groups.
small swamp sedge	*Carex virgata*	Common	Plant in groups. Can be outcompeted by annuals.

Common name	Species	Composition in planting	Planting notes
ti kouka, cabbage tree	*Cordyline australis*	Common	Plant in groups of 3-4 plants.
flax / harakeke	*Phormium tenax*	Common	Do not plant near stream edge.
Diversity species			
kahikatea	*Dacrycarpus dacrydioides*	Sparingly	Canopy. Plant on margin of wetland.
pukatea	*Laurelia novae-zelandiae*	Sparingly	Canopy. Characteristic of wet sites, the trunk offers low resistance to flood waters.
kiokio	*Blechnum novae-zelandiae*	Sparingly	Plant on margin of wetland.
swamp maire	*Syzygium maire*	Sparingly	Canopy. May be difficult to source.

When planting in the riparian zones and on alluvial forest slopes at Oakley Creek the following three gahnia species could be considered for diversity planting. The most appropriate species needs to be considered, as well as the suitability of the site and potential survival success rate / competition from other species.

Species	Composition in planting	Planting notes
Gahnia lacera	Sparingly	Colonising a variety of substrates which may be seasonally waterlogged, though otherwise dry. Usually found in scrub or open forest.
Gahnia setifolia	Sparingly	Mostly in lowland areas in light forest, scrub and lining streams. Sometimes colonising the fringes of swamps.
Gahnia xanthocarpa	Sparingly	Not recorded in surveys at Oakley Creek. Occupying a diverse range of habitats, seems to prefer permanently damp situations within alluvial forest, swamp forest and the margins of waterways.

8.5.4 Slopes

Slopes of varying steepness generally arise from either the flood plain or back wetland. Slopes are drier than stream flats, however flooding can often extend to the toe of the slope. The substrate varies at Oakley Creek (i.e. volcanic or alluvial) and the species composition of planting needs to vary accordingly, as described below.

Plant species on the slopes above the flood plain should primarily be chosen for their ability to establish and grow quickly to form a 'nursery crop' to form cover, to prevent the re-establishment of environmental weeds. Later diversity and canopy species can be added to enhance the forest structure. On the upper slopes plants must be able to tolerate dry, hot conditions as opposed to the wet conditions on the flood plain and toe of the slope.

8.5.5 Alluvial slope (western banks and lower reaches)

The western banks and lower reaches of Oakley Creek are more suited to species appropriate for alluvial slopes (as shown in the geology map, Figure 4). Alluvial slope areas exist in MU 1, MU 3b, MU 4, MU 5, MU 6, MU 7 and MU 12. The following planting list should be used on these slopes, Table 8.

Table 8. Appropriate species for the alluvial slope planting (western banks and lower reaches)

Common name	Species	Composition in planting	Planting notes
Coloniser species			
harakeke, flax	*Phormium tenax*	Abundant	Plant throughout the slope.
kanuka	*Kunzea robusta**	Common	Plant throughout the slope.
karamu	*Coprosma robusta*	Abundant	Plant throughout slope.
mahoe	*Melicytus ramilflorus*	Common	Plant throughout the slope.
manuka	*Leptospermum scoparium*	Common	Plant throughout the slope.
ti kouka, cabbage tree	*Cordyline australis*	Common	Plant in groups in the lower portions of the slope.
mapou	*Myrsine australis*	Common	Plant thoughout the slope.
toetoe	*Austroderia fulvida*	Abundant	Plant throughout the slope, especially in open areas.
Diversity species			
five-finger	*Pseudopanax arboreus*	Sparingly	Understorey.
karaka	*Corynocarpus laevigatus*	Sparingly	Canopy.
kawakawa	*Piper excelsum subsp. excelsum*	Sparingly	Understorey.
kohekohe	*Dysoxylum spectabile*	Sparingly	Canopy.
koromiko	*Hebe stricta var. stricta*	Sparingly	Understorey.
kowhai, small-leaved	*Sophora microphylla*	Sparingly	Canopy. Plant at minimum of 2-3m spacing.
pate	*Schefflera digitata*	Sparingly	Understorey. Requires shelter and shade.
puriri	*Vitex lucens*	Sparingly	Canopy. Plant throughout the slope, at minimum 3-5 m spacing.
taraire	*Beilschmiedia tarairi*	Sparingly	Canopy.
titoki	*Alectryon excelsus*	Sparingly	Canopy and understorey. Plant throughout slope

Common name	Species	Composition in planting	Planting notes
totara	*Podocarpus totara*	Sparingly	Canopy.
rewarewa	*Knightia excelsa*	Sparingly	Canopy.
gully fern	*Pneumatopteris pennigera*	Sparingly	Plant in appropriate locations.

*Kanuka species (*Kunzea sp.*) in NZ have recently been re-classified by Peter de Lange and he has recommended that the appropriate *Kunzea* species to be planted in the central Auckland area is *Kunzea robusta*.

8.5.6 Volcanic slopes / Mahoe Rock Forest areas

The eastern slopes in the southern half of the restoration area form the edge of the lava flow from Owairaka / Mt Albert. Therefore it is recommended to use plants suitable to volcanic soils in this area. These plants are best placed above the area that is likely to be subject to flooding.

There is an established canopy in the six identified remnant Mahoe Rock Forest (MRF) areas A-E, which is dominated by natives (with a high component of mahoe) with occasional large weed trees present. The understorey and ground layer were dominated by weed species before weed control started. Therefore, there is a lack of natural forest structure in the lower vegetation layers. As restoration progresses, large exotic trees will be controlled and weed issues will be reduced in the understorey.

Natural regeneration of native seedlings should be encouraged, wherever possible, and is starting to occur in understorey areas with limited weed presence. Seedlings and young saplings of mahoe, karaka, titoki, pigeonwood, karo, karamu, houhere, mapou and lemonwood are present.

In some areas, where the understorey is particularly bare and regeneration is expected to occur very slowly, or the location has high visual public amenity value e.g. it is adjacent to a track, it will be appropriate to carry out revegetation planting.

The aim of revegetation is to restore the habitat structure of the existing MRF, through mirroring the composition of native species which are present across the six identified remnant MRF areas along Oakley Creek, as well as enhancement with approtiate volcanic forest species. Mahoe Rock Forest is a type of lava flow forest, and this unusual habitat is restricted to only a few small sites in central Auckland. The rock forests at Oakley Creek appear to differ slightly from those at Mt Eden sites and Withiel Thomas Reserve, as they are notably lacking in some typical volcanic rock forest species, such as puka (*Griselinia lucida*), shining karamu (*Coprosma lucida*) and mangeao (*Litsea calicaris*). Kohekohe and puriri were particularly scarce in MRF areas. and were planted in some cases.

Revegetation should aim to maintain a high component of mahoe in these Oakley Creek rock forest remnants, whilst supplementing the understorey with forest diversity species associated with volcanic slopes and lava flow forests. The following planting list has been prepared for revegetation of the identified MRF areas and volcanic slopes at Oakley Creek. It draws on findings from Oakley Creek rock forest survey assessments, various planting lists for volcanic slopes in the Auckland Region and published articles / reports on Auckland lava flow forest sites.

MRF areas A-E are found in MU 8-11. The volcanic soils cover the eastern slopes in Phyllis and Harbutt Reserve (MU 8-11), see Figure 4 for geology map. Small parts of the edge of the western stream slopes in MU 12 have a volcanic soil influence. The following planting list is to be used for these areas, Table 9.

Table 9. Appropriate species for volcanic slopes and Mahoe Rock Forest areas

Common name	Species	Composition in planting	Planting notes
Coloniser species			
hangehange	*Geniostoma ligustrifolium var. ligustrifolium*	Common	Understorey.
karamu	*Coprosma robusta*	Common	Understorey. Plant throughout slope.
mahoe	*Melicytus raimiflorus*	Common	Canopy and understorey. Plant throughout slope.
mapou	*Myrsine australis*	Common	Understorey. Plant throughout slope.
shining karamu	*Coprosma lucida*	Sparingly	Understorey. Plant throughout slope. Not noted in Mahoe rock forest areas at Oakley Creek (but may be present).
Diversity species			
karaka	*Corynocarpus laevigatus*	Sparingly	Canopy.
kawakawa	*Piper excelsum subsp. excelsum*	Sparingly	Understorey.
kohekohe	*Dysoxylum spectabile*	Sparingly	Canopy. Plant at minimum 2-3m spacing.
mangeao	*Litsea calicaris*	Sparingly	Canopy. Difficult to source - use local rock forest sites. Plant sparingly as not dominant part of canopy.
pigeonwood	*Hedycarya arborea*	Common	Understorey.
puriri	*Vitex lucens*	Sparingly	Canopy. Plant throughout the slope, at minimum 3-5m spacing. Only found rarely occurring naturally in Oakley Creek mahoe rock forest MU 8 areas.
titoki	*Alectryon excelsus*	Common	Canopy and understorey.

There are some steep dry / open slopes with more of a clay influence in the lower reaches at Oakley Creek (e.g. MU 4b and MU 6). Here the following colonising species could be planted, which are adapted to these conditions:

Whau (*Entelea arborescens*)
Akepiro (*Olearia furfuracea*)
Kumarahou (*Pomaderris kumeraho*)
Kanuka (*Kunzea robusta*)
Totara (*Podocarpus totara var. totara*)
Flax / harakeke (Phormium tenax)

8.5.7 Archaeological sites

As there are an extensive number of archaeological sites throughout the Oakley Creek project area, prior to planting, all proposed planting sites need to be checked for presence of potential archaeology.

Table 10 presents recommended species for planting on archaeological sites, as adapted from Jones (2007). The listed plants are possible options for each archaeological site, but also need to be identified as appropriate for the Oakley Creek environs. This list needs to be reviewed following the updated Oakley Creek Archaeological Survey Report to be prepared by Brent Druskovich in winter 2015.

Table 10. Revegetation species list for archaeological sites (adapted from Jones, 2007)

Latin name	**Common name**	**Archaeological sites**									
		R11/521	R11/2473	R11/2373	R11/2205	R11/2383	R11/2500+	R11/2206+	R11/2108	R11/2209#	R11/2210
Acaena anserinifolia	Bidibid, piripiri	√	√		√	√	√	√	√	√	√
Arthropodium cirratum	Rengarenga lily	√	√		√	√	√	√	√	√	√
Brachyglottis repanda	Rangiora				√	√	√	√	√	√	
Carex lessoniana	Rautahi			√	√					√	
Carex virgata	Small swamp sedge	√	√	√	√		√	√	√	√	√
Cortaderia fulvida	Toetoe			√	√	√				√	√
Gahnia lacera	Cutty grass				√					√	√
Haloragis erecta subsp. erecta	Toatoa, haloragis		√		√		√		√	√	√
Hebe stricta	Hebe				√		√	√	√	√	√
Piper excelsum var. excelsum	Kawakawa	√			√	√	√	√	√	√	
Microlaena stipoides	Meadow rice grass, patiti	√	√		√	√	√	√	√	√	√
Phormium cookianum	Mountain flax				√				√	√	√
Poa anceps	Broad-leaved	√		√	√	√	√		√	√	√

Latin name	Common name	Archaeological sites									
	poa										
Solanum laciniatum	Poroporo				√		√		√	√	√
Uncinia distans, Uncinia unciniata	Hook grass				√	√		√	√	√	√

# Denotes replacement trees could be planted within the vicinity if deemed unlikely to cause future structural damage to the wall
+ Denotes dependent on decision on visibility

8.6 Revegetation Programme

The following areas have been identified for future planting, refer to Table 11. A flexible approach is needed when planning planting, as a number of factors may affect when a site is ready for planting, such as weed levels being sufficiently controlled, availability of budget, soil factors (such as buried rubbish), availability of suitable plants and archaeological requirements. The suggested revegetation timings below should be reviewed as restoration progresses and adjusted accordingly.

From 2020 onwards, depending of progress of the planting timings, it is possible that there may not be that many areas remaining to be planted in the main restoration work area (MU 1-11). This should be viewed as successful restoration outcome and efforts should shift to maintaining weeds at low levels and carrying out ongoing planting maintenance. Opportunities will remain to plant the Western esplanades in appropriate areas, as weed control progresses.

Table 11. Revegetation Planting Programme 2015-2025

Management Unit	Revegetation location details	Approximate timing
1A	Infill planting in specific areas, including by path at walkway entrance and open rocky patch near 0.10 marker.	Riparian infill - WCA 2016, 2019 General infill - 2016
1B	Understorey planting under tree privet and as removed. Wetland infill planting if required.	Riparian infill - WCA 2016, 2019 Tree privet under planting - ongoing
1C	Understorey planting under tree privet and as removed.	Riparian infill - WCA 2016, 2019 Tree privet under planting - ongoing
2	Northwest – Replacement planting as exotic / weed trees removed. Understorey planting below Chinese privet and hawthorn. Riparian infill planting.	Riparian infill – WCA 2015, 2018 Understorey planting – 2017, 2020

Management Unit	Revegetation location details	Approximate timing
3A	Southwest – riparian infill and where willows are removed.	Riparian, northern part - WCA 2016 Further riparian infill – 2017 After willow removal – tbc
3B	Open slope and floodplain (potential old mill site) needs archaeological assessment and planting options to be established. In future, if bamboo patch is controlled, planting will be needed.	Open slope – tbc, as approach established and weed control complete Bamboo patch – tbc, after regrowth controlled
4A	Understorey planting below Chinese privet and hawthorn. Assess planting of open spaces/ by new path (post WCA works).	Riparian infill - WCA 2015 Understorey planting – 2017, 2019 Open areas/ new path – WCA tbc
4B	Planting following future removal of pines.	Pine area – tbc after removal
5 (east)	East (of creek) – Cabbage Tree Swamp – infill planting on floodplain and along west edge.	Floodplain – 2017, ongoing Western edge – 2018
5 (west)	West (of creek) – plant once weeds are controlled, especially on bend.	Riparian - WCA 2016 / 2017 Gorse / Chinese Privet area above track – 2017, 2018
5A	Understory planting as weeds are controlled.	Understorey – 2018
6 (east)	East – plant area / bank around waterfall & riparian.	Waterfall – 2017 Riparian – 2017, 2019
6 (west)	West - Bracken area / steep bank (between covenant area and waterfall viewing platform), once weed control complete. Infill planting under pines on west bank.	Bracken area - 2017 Slope under pines - 2018
7 (east)	East – Gabion Wall (Nth) – continue understory planting on slope. Riparian planting below path (maintain view of creek, use low growing species).	Slope understorey – 2016 (Te Ngahere potentially) Riparian – 2017
7 (west)	West – between MU6 planting and Waterview Downs houses. Riparian planting south of Waterview Down houses. Esplanade Reserves below 1602/1604 Great North Road. North of Phyllis Reserve Bridge – understorey planting once weeds controlled and weed trees removed.	Slopes/ esplanades – 2017 onwards, assess following weed control Riparian south of houses – 2016 Esplanade reserve around Phyllis Reserve Bridge and to north – 2017 onwards, tbc following weed control

Management Unit	Revegetation location details	Approximate timing
8	Plant initial control area south of willow on slope and floodplain, once weed control carried out. Complete riparian planting at west edge of RMRF Area A. Plant open weedy slope below Dog Clubrooms, between MRF B and C.	South of willow – initial control - tbc; planting 2018 onwards Riparian edge of MRF Area A – 2016 Betw MRF B & C – 2018, 2019 tbc, depending on weed control
9	New reserve land – below shared path between Phyllis & Harbutt Reserve. Carry out weed control and plant in future. NW corner – bamboo slope, dependent on archaeological assessment. Continue understorey planting in MRF Area E. Slope above path and above MRF Area E – control weeds and weed trees, understorey plant in future. Extend edge into open grass at top. Cradock St bridge, to north and south – floodplain planting following erosion works and willow control. Unknown time frame. Bush islands on flat area – understorey plant as required and enhance edges. Low priority.	New reserve below shared path – 2020 onwards NW Bamboo slope – 2016 tbc Understorey MRF E – 2015, 2016 Slope above path/ MRF E & edges – 2018, 2020 Erosion control planting AC Stormwater - tbc (dependant on erosion works and willow control)Bush islands – 2020
10	As weed control progresses carry out planting. Riparian areas are initial priority, then understorey planting. Weedy gully – further infill once weed issues reduced. Bush islands on flat area – understorey plant as required and enhance edges. Low priority.	Riparian – opposite 61 Powell St (specimens) – 2015. Continue riparian in 2017, 2019 Understorey – 2019, 2020 onwards tbc Weedy gully – 2018 Bush islands – 2020

Management Unit	Revegetation location details	Approximate timing
11	MRF - allow natural regeneration rather than planting. Reassess after winter 2020, to see what species are establishing and only then consider minimal planting with recommended mahoe rock forest species. Tree privet dominated areas, carry out understorey planting over time as weed control progresses and weed canopy is thinned, using volcanic slope / rock forest species. Plant riparian areas as initial priority, where open and as willows removed.	MRF F – assess regeneration after winter 2020 Tree privet areas – from 2017 onwards, ongoing Riparian – opp 47 Powell St – AC Stormwater 2015. Continue 2016, 2017, ongoing
12	West esplanade reserves – plant as weed control complete. Assess appropriate areas and work with local community / neighbours.	West esplanade – 27, 29 & 43 Powell Street as part of development – 2015. West esplanades – 2019 onwards, assess areas.

9 Community Involvement

Community engagement is encouraged and vitally important to ensure a long-term focus, and success of this project. Ecological restoration along Oakley Creek has been initiated and continues to be driven by Friends of Oakley Creek, an active group of volunteers. Local volunteers and community groups have contributed to a large portion of the restoration work undertaken on the creek, with significant advances in restoring ecological diversity of this important urban stream.

There is a high level of interest in the future management of Oakley Creek. Continued co-operation and communication between FOOC, neighbouring landowners, Auckland Council and contractors working in the area is vital to ensure all efforts are combined and focused towards achieving a common goal.

Restoration tasks that are ideally suited to volunteers should continue. These tasks make a significant contribution to this project and can be used to engage the local community, and school groups, scout groups, youth groups etc., in education opportunities.. Through engagement in this restoration programme locals can develop a sense of community stewardship and ownership. It also increases awareness of environmental and stream restoration issues (such as the impacts of environmental weeds and the impacts of urbanisation on stream quality).

Suitable community restoration tasks on Oakley Creek include:

- Planting
- Planting maintenance - it is recommended that volunteers be involved in plant maintenance of new / young plantings, as this can be more cost effective than using contractors.
- Manual weed control (such as cutting of vines)
- Animal pest control e.g. rodents, possums, hedgehogs and mustelids.
- Biodiversity monitoring e.g. birds, weta, lizards and water quality.

9.1 Weed control

It is recommended that a comprehensive programme of weed control continue to be undertaken by qualified contractors due to the variety and extent of weed issues that exist across Oakley Creek, which requires spraying to be managed effectively. The weed control focus of volunteers should be on manual methods that do not require herbicide, or managing weeds that can be cut and pasted effectively. This can involve:

- Hand releasing of exotic vines from trees and shrubs.
- Pulling out weed seedlings.
- Digging out small areas of weed infestation, where feasible, (note that care must be taken to ensure the entire root system is removed).
- Possible removal of seedlings at identified archaeological sites (Druskovich 2009), that do not require cutting.

Where appropriate, some weeds such as bindweed and tradescantia can be put into weedbags, and left to compost down. The control of any species that can regrow from small fragments (e.g. tradescantia) should be carried out with extreme care. In most cases it is likely that foliar spraying the weed on site would prove more beneficial and so should be

undertaken by contractors. However, small areas of these weeds can be dealt with, effectively by volunteers, to prevent them from spreading.

9.2 Community plantings

Community plantings, co-ordinated by Friends of Oakley Creek, have made a significant contribution to the restoration of Oakley Creek. Volunteers and local community groups should continue to be engaged in planting opportunities wherever possible.

The planting activity from 2004-2014 is summarised in the table below, Table 12. Summary of planting carried out at Oakley Creek between 2004-2014. A total of 45,543 plants have been planted in the Oakley Creek restoration plan management area since 2004, with at least 28 different groups involved in planting.

Table 12. Summary of planting carried out at Oakley Creek between 2004-2014

Year	Groups involved in planting	Number of plants *	Management Units
2004	Friends of Oakley Creek (FOOC)	200	9
2005	FOOC, Buchanan Rehab Centre, Metrowater, Gladstone Primary School, Wai Care	4129	1a, 1b, 1c, 2, 3a, 4a, 5, 7 & 9
2006	FOOC, Te Ngahere, Buchanan Rehab, Unitec, Corrections Department, Gladstone Primary School	6081	1a, 1b, 1c, 2, 3a, 3b, 5, 6
2007	FOOC, Envirotech, Buchanan Rehab, Conservation Volunteers NZ (CVNZ), Gladstone Primary School, Sustainable Business Network (SBN), Te Ngahere, Unitec, Metrowater	4348	1a, 1b, 1c, 2, 3a, 3b, 5, 6, 7 & 9
2008	FOOC, SBN, Buchanan Rehab, Te Ngahere, CVNZ, Gladstone Primary School	3730	1a, 1b, 2, 3a, 3b, 4a, 5, 6, 7 & 9
2009	FOOC, SBN, Buchanan Rehab, Te Ngahere	2724	1a, 1b, 1c, 2, 3a, 3b, 4, 5 & 7
2010	FOOC, Te Ngahere, CVNZ, Alldrains, Buchanan Rehab, Kodesh Community, A Rocha, Gladstone Primary School	4097	1a, 1b, 1c, 2, 3a, 3b, 4b, 5, 6, 7, 8 & 9
2011	FOOC, Buchanan Rehab, Waterview Primary School, A Rocha, Te Ngahere, Cadburys, Collectively Kids	2935	1a, 1b, 1c, 2, 3a 4a, 5, 6, 7, 8 & 9
2012	FOOC, BNZ, Envirotech, Auckland Council, A Rocha, Buchanan Rehab, Well-Connected Alliance (WCA), Auckland Council, Telecom/Vector, Open Polytechnic, CVNZ, World Wildlife Fund for Nature (WWF), Gladstone Primary School	5243	1a, 1c, 2, 3a, 4a, 5, 6, 7, 8 & 9
2013	FOOC, Gladstone Primary School, Buchanan Rehab, Collectively Kids, A Rocha, CVNZ, Chorus, Open Polytechnic, Te Ngahere, BNZ, HSBC	5839	1a, 1b, 1c, 2, 3a, 4a, 5, 6, 7, 8 & 9

Year	Groups involved in planting	Number of plants *	Management Units
2014	FOOC, Buchanan Rehab, Open Polytechnic, Te Ngahere, A Rocha, Wildlands, Manukau Institute of Technology (MIT), BNZ, HSBC	6217	1a, 1b, 2, 3a, 3b, 4a, 4b, 5, 6, 7, 8, 9 & 10
Total		**45,543**	

* NB: Does not include plants planted in areas outside Oakley Creek restoration area.

10 Monitoring

It is important to undertake some form of monitoring to gauge the effectiveness and success of the ecological restoration programme, including the weed and animal pest control operations and revegetation plantings. A comprehensive review of monitoring data was carried out for the first 10 years of the Oakley Creek ecological restoration programme – refer to *Review of Oakley Creek Restoration Plan (2005-2015)*, (Te Ngahere, June 2015).

An extensive monitoring and pest control programme was established by FOOC in 2009. The programme includes:

- Animal pest monitoring for rodents, possums, hedgehogs and mustelids.
- Fauna monitoring for birds, weta and lizards.
- Aquatic / water quality monitoring.
- Vegetation monitoring.

It is important to collate and manage the monitoring data that is collected by various groups working along Oakley Creek to ensure this data is kept in a central location for future reference and analysis. Processes should be investigated as to how this should be done effectively.

10.1 Animal pest monitoring

Purpose: To see if pest control is reducing pest numbers / density in the area.

Objective for rodents and possums: To control possums and rodents within the pest management area of Oakley Creek to less than 15% Bite Mark Index (BMI) for possums, and less than 10% tracking rate for rodents. These levels should enable a population increase of native birds, lizards and invertebrates and allow palatable native plant species to germinate and grow.

Objective for hedgehogs and mustelids: To control hedgehogs and mustelids to less than 10% tracking in order to allow an increase in the numbers of native birds, lizards and invertebrates (Objectives from FOOC, 2010b - modified).

5 % tracking indexes are recommended by the Department of Conservation (DOC) for large rural / remote forest blocks, but these targets are very hard to reach in urban areas, especially along a narrow corridor. This is due to constant reinvasion of animal pests from surrounding areas (e.g. Unitec grounds and residential gardens), which provide plentiful food sources and breeding habitat.

Initially animal pest monitoring was carried out throughout the full length of the Oakley Creek project area, to determine presence of the various animal pests. When animal pest control commenced, pest monitoring was used to determine the effectiveness of the pest control by comparing results from both the pest control and no pest control areas.

Then, once this research was complete (from 2013), the monitoring programme was reduced to just in the pest control area, to continue to monitor the population levels. These results are used to inform any changes that might be required to improve on the

effectiveness of the pest control. Refer to Figure 13 showing the location of FOOC monitoring stations for rodents, possums, and mustelids at Oakley Creek.

10.1.1 Rodent monitoring

Two rodent monitoring lines, each containing 10 tracking tunnels, are present in the pest control area (northern half of the project area). Tracking tunnels are placed at 50 metre intervals along the line, with lines spaced 200 metres apart. Rodent monitoring is carried out three times a year, 2-3 weeks after each period of rodent control has been completed.

An increase in mice numbers is common once rat levels are reduced. Mice numbers are particularly hard to decrease due to their small home ranges and rapid breeding (even if bait station spacings were decreased to 25m apart). Increased numbers of mice are likely to have some detrimental effects on lizards (especially juveniles) and invertebrates, as well as the survival of seeds and seedlings.

10.1.2 Possum monitoring

Possum monitoring at Oakley Creek involves checking of wax tags for bite marks. Wax tags are left out for seven nights with lured luminescent markers and a flour and icing sugar (5:1) mix with an orange or aniseed flavour.

In 2013, possum monitoring was changed to 40 wax tags, with one at each distance marker (50m), and one, half way between the markers (25m), and reduced from twice yearly to once a year.

10.1.3 Hedgehog and mustelid monitoring

Friends of Oakley Creek have set out two lines of 10 tracking tunnels each for hedgehogs and mustelids (ferrets, weasels and stoats). Monitoring is undertaken for three fine nights using *Erayz* Rabbit paste or sardines as a lure. As with possums, monitoring has been reduced to once a year.

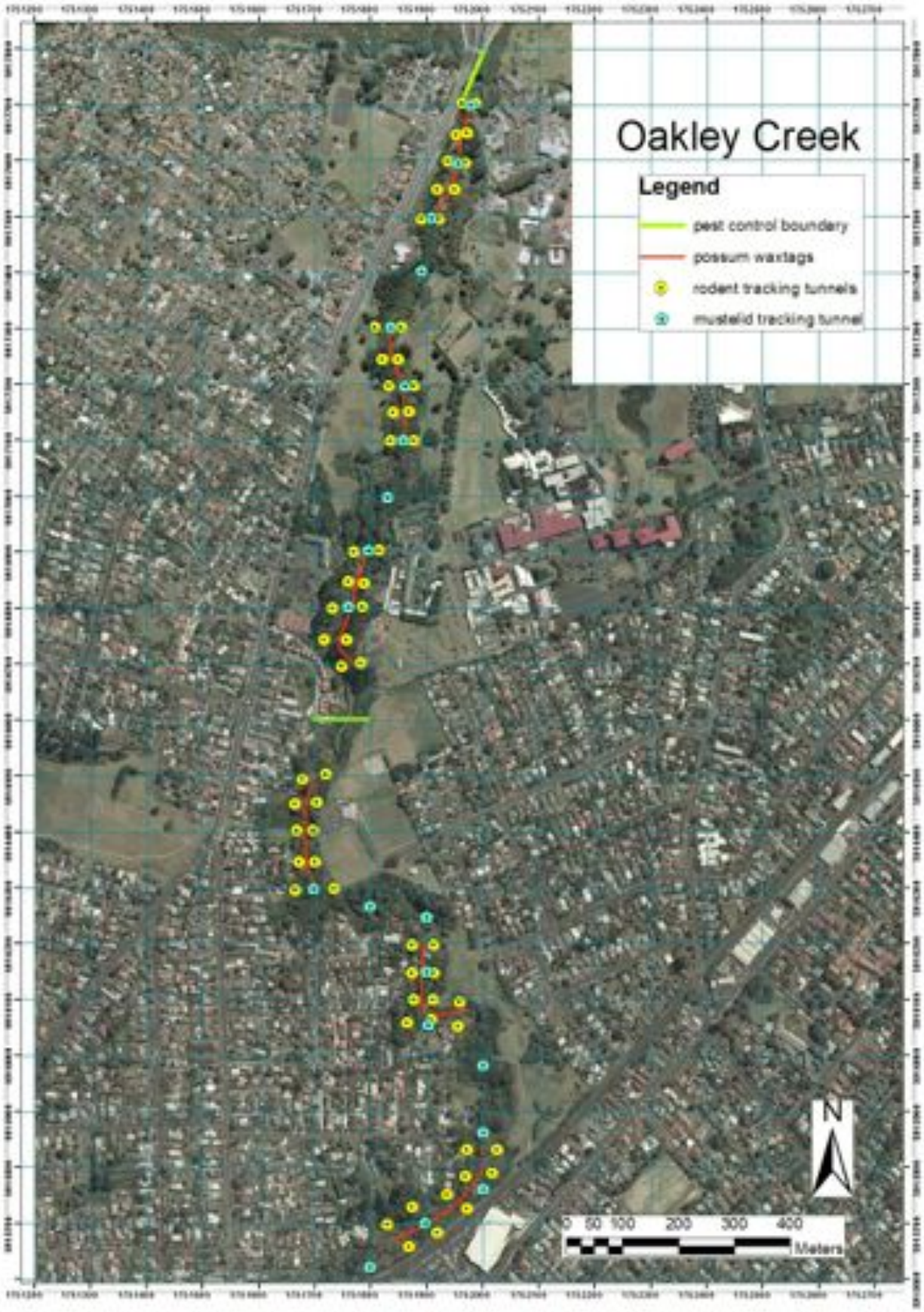

Figure 13. FOOC monitoring locations for rodents, possums and mustelids at Oakley Creek

10.2 Fauna monitoring

Purpose: To see how the populations of birds, lizards and weta are changing and, hopefully, increasing along Oakley Creek, as a result of the restoration planting and pest control.

Objective: Control of major pests within Oakley Creek is intended to improve the native biodiversity within the reserve. This will enhance the natural environment experience for reserve users and local residents, and allow Oakley Creek to act more effectively as a wildlife corridor.

The key components to try to measure are:

- increased numbers of native birds and lizards,
- increased terrestrial invertebrates (weta used as indicator species) and diversity of aquatic macroinvertebrates. (FOOC, 2010b).

Refer to Figure 14for locations of FOOC bird listening stations and weta monitoring sites.

10.2.1 Birds

Bird indicators:

- Species diversity of native species,
- Abundance of indicator species: grey warbler, fantail, tui, kereru.

The presence of native birds such as tui, kereru and morepork in the reserve is a key milestone to success. Successful breeding of these species will be the ultimate success (FOOC, 2010b).

The national garden bird survey method designed by Eric Spurr of Landcare Research is used for annual bird monitoring along Oakley Creek, at the same time as the national survey (end June-early July). Two transects have been set up along the creek, each approximately 1 km long, with bird survey positions spaced at 200m. There are a total of ten bird monitoring sites along the creek, five in the pest control area and five in the no-pest-control area.

10.2.2 Weta

Indicator: Large invertebrates are preyed upon by rodents, hedgehogs and other pest mammals. Weta are a good indicator species for large invertebrates and are easier to monitor than many other invertebrates. The use of artificial refuges is a useful way of detecting changes in weta abundance (FOOC, 2010b).

The artificial weta homes are 10 cm long bamboo tubes fastened to tree trunks. There are eight sites each with five weta homes in the pest control area, and the same in the no pest control area; a total of 80 artificial refuges. They are checked annually in winter (June/July).

10.2.3 Lizards

FOOC

Native skinks are eaten by cats, mustelids, hedgehogs, rats, mice, magpies, kingfishers, and even blackbirds. Native skinks eat fruits and invertebrates. If pest control is effective, and consistently maintained, juvenile native skinks should increase in number. The simplest monitoring technique for ground dwelling lizards is to provide permanent artificial cover objects (ACOs) made of two-three stacked Onduline tiles (with spacers between) on the ground and to check these periodically (FOOC, 2010b).

Native copper skinks are known to be present along Oakley Creek (and also have been re-located to MU 3a). The introduced rainbow (plague) skink is also present in the reserve.

FOOC monitored skinks from 2009-2010. 40 Lizard refuges made of Onduline tiles were used, with half of the refuges put in the pest control area and half in the no-pest-control area. They were checked once per year in winter.

Lizard monitoring by FOOC was stopped after 2010, as number of lizard sightings were low and would require much more extensive effort to carry out comprehensive regular surveys. Also placement of ACOs was not ideal along this narrow easily accessible corridor due to high disturbance and insufficient 'warm' habitat locations (e.g. edge of open areas), which would be too visible.

Recommendation: It is recommended that due to the urban nature of the reserve, narrow site and habitat types it is not the most effective species to be monitoring and energy is better focused on continuing bird and weta monitoring. Previous efforts have confirmed the presence of the translocated copper skink population but are not providing any significant data to recommend continuing monitoring.

WCA lizard management area

In total 192 native copper skinks were released into the Lizard Relocation Management Area (LMA) in MU 3a, as part of the Waterview Connection / SH 20 works.

Objective: The purpose of the post-release lizard monitoring programme is to determine if efforts to mitigate the impacts of the proposed development are successful and whether further management is required. Specifically, the objectives are to conclude if the copper skink population is stable, increasing, or decreasing over time, and to verify that the mammalian pest control programme at the release site is effective at suppressing threats from key predators.

Monitoring involves the checking of 100 ACOs that have been laid out in a 10 x 10 m grid over the Lizard Relocation Management Area. During each annual monitoring event, ACOs are checked weekly over three consecutive weeks in March/April. The monitoring programme is scheduled to run until 2017 and will aim to determine the dynamics of the native copper skink population present at the LMA (WCA/Tonkin & Taylor report, October 2014).

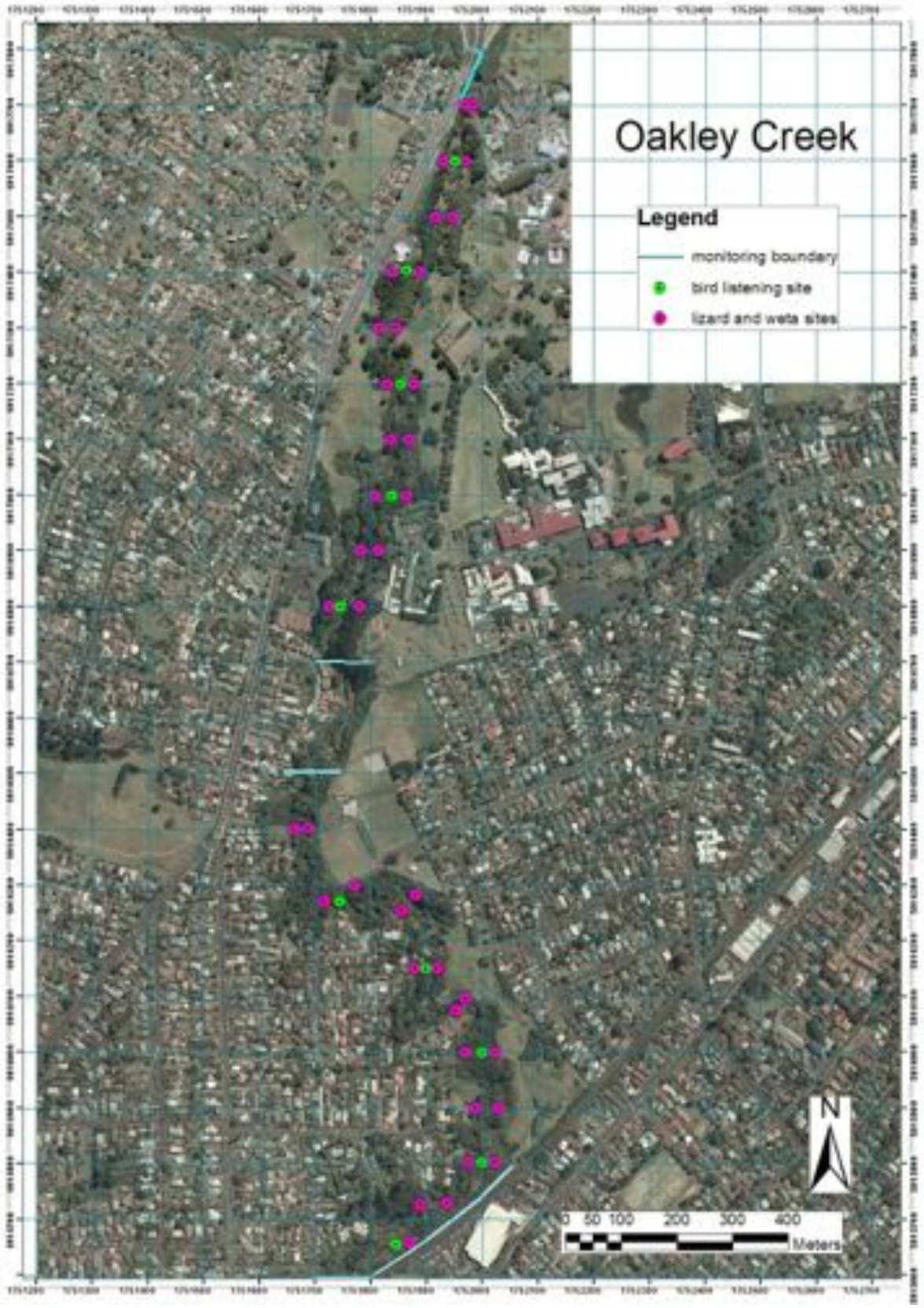

Figure 14. Location of FOOC monitoring sites for birds and weta (and historically lizards)

10.3 Aquatic monitoring

10.3.1 Water quality

Wai Care

Water quality monitoring is undertaken by a number of different community groups, with the support of Wai Care and Friends of Oakley Creek, using Wai Care monitoring kits. A number of sites along the full length of Oakley Creek have been monitored at various times, but three sites in the project area are now actively monitored on a quarterly basis (shown in Table 13).

Water quality monitoring data collected includes: air temperature, water temperature, water clarity, turbidity, pH, dissolved oxygen, nitrate, nitrite, phosphorous, phosphate and aquatic macroinvertebrates.

Table 13. Details of Wai Care monitoring locations

Site Name	Monitoring Group	Site Location		Monitoring period
		Easting	Northing	
Wairaka Stream, Unitec Nursery (above confluence with Oakley Creek)	Wairaka Stream Care Group	1751981.739	5917529.764	2005-2014
Oakley Creek, Unitec Bridge	Unitec Bridge Group	1751780.14	5916941.72	2011-2014
Oakley Creek, End of Cradock St	Cradock Street Bridge Group	1751909.984	5916104.127	2010-2014

Other Water Monitoring

Apart from the regular community monitoring under the Wai Care programme, other aquatic monitoring / surveys have been carried out by Stephen Moore in 2006, Morphum / Mahurangi Institute of Technology in 2011, and FOOC have been involved in a NIWA community research project in 2014-15. The Auckland Council Research and Evaluation Unit (RIMU) have regional aquatic monitoring sites at Oakley Creek.

10.3.2 Inanga spawning

Inanga rely strongly on long, rank vegetation in the spawning zone to both protect their eggs from harmful UV rays and to keep the eggs moist for the month long period they spend out of water. Relative humidity has to be maintained at around 99%.

Investigations have been carried out Auckland Council Biodiversity Team and Wai Care into the saltwater wedge extent and potential inanga spawning habitat along Oakley Creek.

Method: This method involves modelling a stream reach, undertaking saline surveys and where possible completing a spawning survey (looking either for signs of spawning activity or preferably eggs).

1. **Saline modelling:** The modelling predicts how far upstream the saline wedge extends on a spring tide and the upstream toe (of the wedge) is normally where the inanga spawn.

2. **Saline survey:** This modelling information provides a pointer on how far upstream we should go to begin our saline wedge survey (required because the modelling uses LIDAR data only and does not correct for flows and water levels which can modify the wedge i.e. the freshwater lens pushes down on the saltwater wedge below it and forces the wedge downstream).
3. **Spawning survey:** Once the salt wedge is mapped, the site can be revisited in autumn to look for spawning activity.

Saline modelling and saline surveying have been undertaken at Oakley Creek and the potential spawning area has been identified, as show as the circled purple area on the map (Figure 15).

Specific spawning surveys have not yet been undertaken, but inanga have been recorded in the creek up to the waterfall. FOOC has carried out informal spawning observations, with sightings of inanga, but not of actual spawning activity.

Figure 15. Saline modelling and mapping for Oakley Creek, with potential inanga spawning area shown by purple circle (includes stream edges and Wairaka Wetland)

10.4 Vegetation monitoring

10.4.1 Botanical survey

The Auckland Botanical Society carried out a site visit to the lower stretches of Oakley Creek Walkway (up until the start of Phyllis Reserve) on Saturday 16th May 2009 and recorded plants, mosses, liverworts, fungi and algae observed. A full list of species recorded can be found in the Auckland Botanical Society Journal, Volume 64 (2), December 2009 and is compiled in the Appendix.

It should be noted that these are the species observed at time of site visit and that many of these have been planted (natives and exotics), so do not represent what the natural character of the site would have been historically. Therefore, this survey cannot be used as a baseline record of what species should be present along Oakley Creek or planted in future.

Additions to native and weed/ exotic species lists should be compiled regularly to record changes in vegetation over time at Oakley Creek, as the restoration programme progresses.

10.4.2 Vegetation plots

FOOC

Five long-term vegetation monitoring plot sites (2m x 5m) have been established by FOOC along Oakley Creek, with the intention of extending this to 8-10 sites over time. None of the sites have been revisited so far, as the intention is to look at long-term changes in vegetation character as the restoration programme progresses. The ongoing monitoring approach will have to be assessed, taking into account changes due to plantings and animal pest control. Plots 1-4 were established in 2012 and Plot 5 in 2014. It is suggested that vegetation plots are re-surveyed every 5 years.

The location for the five FOOC vegetation plots are:

- Plots 1 & 2 – St Judes Scouts Den restoration area adjacent to Oakley Creek. Plot 1 in Area C and Plot 2 in Area D. *NB: This is outside of the restoration work area.*
- Plots 3 & 4 – North and south side of Cradock Street Bridge (west side of bridge), mid-slope below the steep slope on the north, and below the Kodesh path on the south. This is approximately half way between distance markers 1.90 and 1.95 (which are on the east side of the creek).
- Plot 5 - Plot 5 is 10m upstream of the 2.0 distance marker in Harbutt Reserve, on the slope above the path, in RMRF Area D.

Over time, the aim is to carry out vegetation monitoring in a range of environs, including the rock forest, where there has been planting, and where there may / will be natural regeneration, e.g. in MU11.

Regional Forest Monitoring

The Auckland Council Research and Evaluation Unit (RIMU) installed a Forest Monitoring Plot (ref C140a) in Harbutt Reserve in late 2012, as part of the Auckland Region Forest Monitoring Programme. This programme looks at changes across the region for forest habitats and is part of the long-term State of the Environment monitoring. The intention is to re-visit forest plot monitoring sites every 5 years. The location of this forest monitoring plot is in the tree privet dominated canopy towards the southern end of MU 10 (as shown in Figure 6).

10.4.3 Photopoints

A simple way of monitoring revegetation and weed control success is by permanent photopoints. This involves returning to the same point each year and taking photos at the same bearing. Over time this will show growth of plantings and the success of weed control. Ten photopoints were originally set-up by Te Ngahere in 2008 along Oakley Creek and monitored until 2012.

From 2012 the number of photo monitoring sites was reduced to three, as it was found that ongoing changes were not being seen at all photopoints. Photos have been taken annually at the remaining three photopoints by Te Ngahere, as part of the ecological restoration contract (ERC). In addition two photopoints were added at the southern end of Harbutt Reserve (in MU 11) in 2013, when ERC began restoration work in the southern part of the restoration area. The location of the five current photopoints is shown in Figure 16.

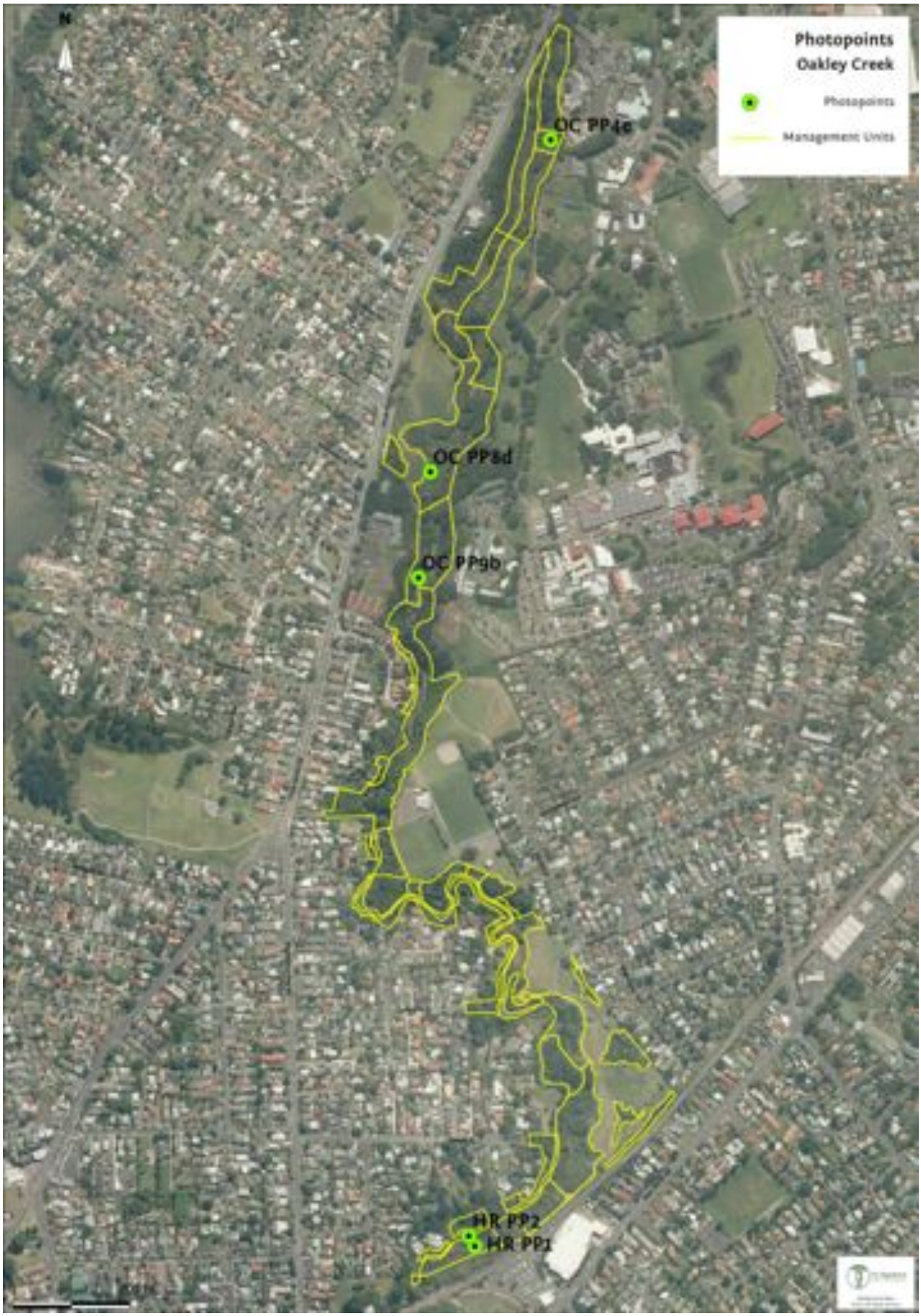

Figure 16. Map showing five current photopoints at Oakley Creek

11 References

Andrew Stewart, March 2015, Soil Handling Plan: Oakley Creek Ecological Restoration Project

Auckland Botanical Society, December 2009, Field Trip Report: Oakley Creek Te Auaunga, Waterview – Saturday 16 May 2009, Auckland Botanical Society Journal, Volume 64 (2), pgs 123-133.

Auckland Council, Sustainable Catchments Programme, September 2014, Oakley Creek: Urban 10 Year Implementation Plan South Waitematā (Draft)

Auckland Council, Sustainable Catchments Programme (Morphum Environmental), April 2013, Phyllis Street Reserve Restoration Design Plan: Oakley Creek

de Lange, P.J.; Norton, D.A.; Courtney, S.P.; Heenan, P.B.; Barkla, J.W.; Cameron, E.K.; Hitchmough, R.; Townsend, A.J., 2009: Threatened and uncommon plants in New Zealand (2008 revision). New Zealand Journal of Botany 47: 61-96.

Druskovich, Brent, March 2009, Revegetation programme - Oakley Creek Walkway archaeological assessment

Druskovich, Brent, various – Oakley Creek revegetation programme annual reports and planting site assessments (2010 – 2014)

Friends of Oakley Creek (Alicia Warren), 2010a, Oakley Creek Wildlife Monitoring and Pest Control Report (1 April 2009 to 31 March 2010) - Report to Friends of Oakley Creek AGM.

Friends of Oakley Creek (Alicia Warren), 2010b, Pest control and monitoring plan for Oakley Creek, April 2010 – updated

McKain, Chris, 2004, Carex in Auckland : a field guide, Waitakere City Council

Moore, Stephen, April 2006, Summary of freshwater biological sampling of Oakley Creek

Morphum Environmental Ltd, October 2010, Oakley Creek Watercourse Management Plan

Morphum Environmental Ltd, June 2011, Torrentfish in Oakley Creek– News article on http://www.morphum.com/news.asp?pageID=2145880545&RefID=2141740685

Morphum Environmental Ltd, 2012, The Wairaka Stream Restoration Plan Discussion Document

Morphum Environmental Ltd, 2012, Lower Oakley Creek Erosion Assessment

Singers, N et al, 2014, Draft Indigenous terrestrial and freshwater ecosystems of Auckland, version 6.1

Stanley, R.; de Lange, P.; Cameron, E.K., 2005. Auckland Regional Threatened & Uncommon Vascular Plants List. Auckland Botanical Society Journal 60: 152-157.
Te Ngahere (Melinda Habgood), October 2005, Environmental Weed Control and Native Revegetation Programme for Oakley (Te Auaunga) Creek

Te Ngahere (revised by Samantha Happy), March 2009, Environmental Weed Control and Native Revegetation Programme for Oakley (Te Auaunga) Creek – Revised March 2009

Te Ngahere (Michelle Dublon), final version August 2013, Assessment of Mahoe Rock Forest at Phyllis and Harbutt Reserves, Oakley Creek.

Te Ngahere (Michelle Dublon), October 2012 – updated August 2013, Assessment of Remnant Mahoe Rock Forest at Phyllis and Harbutt Reserves

Te Ngahere (Michelle Dublon), June 2015, Review of Oakley Creek Restoration Plan (2005-2015)

Te Ngahere (Michelle Dublon & Joel Leong), January 2014, Animal Pest Control Volunteer Handbook (produced for Auckland Council Local Parks)

Unitec Institute of Technology, (undated), Biodiversity Strategy for Wairaka Sub-Precinct (with maps and planting lists by Morphum Environmental Ltd)

Well-Connected Alliance (Kieran Miller & Brett Ogilvie, Tonkin & Taylor), October 2014, Herpetofauna and Significant Vegetation Management (revised March 2015) – Document # 025-RPT-03746

12 Appendices

Appendix 1 Weed species recorded at Oakley Creek since 2005

Appendix 2 Exotic species recorded at Oakley Creek since 2005

Appendix 3 Native species recorded at Oakley Creek since 2005

Appendix 4 Recommended species to plant – summary list

Appendix 5 Future diversity planting and eco-sourcing considerations reference table

Appendix 6 Threatened Plant Translocation Planning Template

Appendix 6 Stormwater Planning maps

Appendix 7 Archaeological Survey and Recommendations for management – to be added once updated survey completed by Brent Druskovich (winter 2015)

Appendix 8 Soil Handling Plan for Oakley Creek

Table 14. Appenix 1 - Weed species recorded at Oakley Creek since 2005

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
African clubmoss	*Selaginella kraussiana*	Surveillance	Y	Y	Y	Y	Y	Y	Y
African love grass *[2]	*Eragrostis curvula*	Surveillance							
agapanthus	*Agapanthus orientalis*	Surveillance	Y		Y		Y		
alligator weed	*Alternanthera philoxeroides*	Surveillance	Y	Y	Y	Y	Y	Y	Y
aristea	*Aristea ecklonii*	Surveillance						Y	
arrow bamboo	*Pseudosasa japonica*							Y	
arum lily	*Zantedeschia aethiopica*	Surveillance	Y	Y	Y	Y	Y	Y	Y
bamboo	*Bambusa sp., Phyllostachys sp.*		Y	Y	Y	Y	Y		Y
bamboo, black	*Phyllostachys nigra var. nigra*							Y	
bamboo, Oldham's	*Bambusa oldhamii*							Y	
bangalow palm	*Archontophoenix cunninghamiana*	Research			Y				
bartlettina	*Bartlettina sordida*	Surveillance					Y		
bears breeches	*Acanthus mollis*	Research	Y	Y	Y		Y	Y	Y
bindweed (probably hybrid sp.)	*Calystegia sp.*								Y
bindweed, great	*Calystegia silvatica subsp. disjuncta*							Y	

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
bindweeds	*Calystegia spp.*		Y	Y	Y				
blackberry (wild aggregates)	*Rubus fruiticosus agg.*	Surveillance	Y	Y	Y	Y	Y	Y	Y
blue morning glory	*Ipomoea indica*	Surveillance	Y	Y	Y	Y	Y	Y	Y
brush cherry	*Syzygium australe*						Y		
buddleia	*Buddleja davidii*	Surveillance	Y						Y
canna lily	*Canna indica*		Y		Y	Y	Y	Y	Y
cape honeysuckle	*Tecomaria capensis*				Y				
castor oil plant	*Ricinus communis*	Surveillance	Y		Y	Y	Y	Y	Y
climbing asparagus	*Asparagus scandens*	Surveillance	Y	Y	Y	Y	Y	Y	Y
climbing dock	*Rumex sagittatus*	Surveillance	Y		Y	Y	Y	Y	Y
convolvulus	*Convolvulus arvense*		Y	Y	Y	Y	Y		
coral tree, flame tree	*Erythrina x sykesii*		Y			Y	Y	Y	
cotoneaster	*Cotoneaster glaucophyllus*	Surveillance	Y			Y			
cretan brake fern	*Pteris cretica*	Research				Y		Y	
egeria	*Egeria densa*	Surveillance					Y	Y	
elaeagnus	*Elaeagnus x reflexa*	Surveillance	Y	Y	Y	Y		Y	Y
elephant's ear	*Alocasia brisbanensis*	Surveillance	Y		Y		Y		Y
English ivy	*Hedera helix*	Surveillance	Y		Y				Y
fruit salad plant	*Monstera deliciosa*		Y						
giant reed grass	*Arundo donax*	Surveillance	Y				Y	Y	
ginger, kahili	*Hedychium gardnerianum*	Surveillance	Y	Y	Y	Y	Y	Y	Y

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
ginger, yellow	*Hedychium flavescens*	Surveillance	Y				Y		
gorse	*Ulex europaeus*	Surveillance	Y	Y	Y	Y	Y	Y	Y
grey sedge	*Carex divulsa*	Surveillance	Y					Y	
hawthorn	*Crataegus monogyna*	Surveillance	Y			Y		Y	
hemlock	*Conium maculatum*	Surveillance						Y	Y
Himalayan honeysuckle	*Leycesteria formosa*	Surveillance	Y		Y				
Italian evergreen buckthorn	*Rhamnus alaternus*	Surveillance						Y	
ivy, German	*Delairea odorata*	Surveillance	Y	Y	Y		Y	Y	Y
Japanese honeysuckle	*Lonicera japonica*	Surveillance	Y	Y	Y	Y	Y	Y	Y
Japanese spindle tree	*Euonymus japonicus*	Surveillance	Y	Y	Y	Y	Y	Y	Y
jasmine	*Jasminum polyanthum*	Surveillance	Y	Y	Y				Y
Jerusalem cherry, false	*Solanum diflorum*		Y	Y	Y	Y			
Jerusalem cherry	*Solanum pseudocapsicum*							Y	
kikuyu grass	*Pennisetum clandestinum*		Y		Y			Y	
lodgepole pine	*Pinus contorta*	Surveillance	Y						
loquat	*Eriobotrya japonica*	Research	Y		Y			Y	Y
madeira vine	*Anredera cordifolia*	Surveillance	Y	Y	Y	Y	Y		Y

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Mexican daisy	*Erigeron karvinskianus*	Surveillance	Y			Y		Y	
Mexican devil	*Ageratina adenophora*	Surveillance	Y						
mile a minute	*Dipogon lignosus*	Surveillance			Y				
mistflower	*Ageratina riparia*	Surveillance	Y		Y		Y	Y	
acmena, monkey apple	*Syzygium smithii*	Surveillance	Y		Y	Y			Y
montbretia	*Crocosmia x crocosmiiflora*	Surveillance	Y	Y	Y		Y	Y	Y
moth plant	*Araujia sericifera*	Surveillance	Y	Y	Y	Y	Y	Y	Y
palm grass	*Setaria palmifolia*	Surveillance	Y		Y	Y	Y	Y	Y
palm, Chinese windmill/ fan	*Trachycarpus fortunei*	Research			Y				
pampas sp.	*Cortaderia jubata/ selloana*	Surveillance							Y
pampas, purple	*Cortaderia jubata*	Surveillance	Y		Y	Y			
pampas, white	*Cortaderia selloana*	Surveillance	Y		Y		Y	Y	
panic veldt grass	*Ehrharta erecta*		Y		Y			Y	
passionfruit, banana	*Passiflora tripartita*	Surveillance	Y		Y				
periwinkle	*Vinca major*	Surveillance	Y	Y	Y	Y	Y	Y	Y
phoenix palm	*Phoenix canariensis*	Surveillance	Y		Y		Y	Y	Y
pine sp.	*Pinus sp.*						Y		Y
pine, radiata	*Pinus radiata*							Y	
plectranthus	*Plectranthus ciliatus*	Surveillance			Y		Y	Y	Y
privet, Chinese	*Ligustrum sinense*	Surveillance	Y	Y	Y	Y	Y	Y	Y
privet, tree	*Ligustrum lucidum*	Surveillance	Y	Y	Y	Y	Y	Y	Y

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
queen of the night	*Cestrum nocturnum*	Research	Y	Y	Y	Y			Y
Queensland poplar	*Homalanthus populifolius*	Surveillance	Y	Y	Y	Y	Y		Y
smilax	*Asparagus asparagoides*	Surveillance	Y			Y		Y	
Taiwan cherry	*Prunus campanulata*	Research	Y	Y	Y	Y			Y
Tasmanian blackwood	*Acacia melanoxylon*							Y	
tradescantia	*Tradescantia fluminensis*	Surveillance	Y	Y	Y	Y	Y	Y	Y
tree lupin	*Lupinis arboreus*		Y						
tuber ladder fern	*Nephrolepis cordifolia*	Surveillance	Y						
tutsan	*Hypericum androsaemum*	Surveillance	Y	Y	Y	Y	Y	Y	Y
wattle, black	*Acacia mearnsii*		Y	Y	Y			Y	Y
wattle, brush	*Paraserianthes lophantha*	Surveillance	Y	Y	Y	Y	Y	Y	Y
wattle, sydney golden	*Acacia longifolia*	Research	Y						
willow, crack	*Salix fragilis*	Surveillance	Y		Y	Y	Y	Y	Y
woolly nightshade	*Solanum mauritianum*	Containment	Y	Y	Y	Y	Y	Y	Y
Total number of weeds			**65**	**32**	**55**	**39**	**43**	**53**	**45**

***** Auckland RPMS = Auckland Regional Pest Management Strategy 2007-2012 Pest Plant Category, currently being updated

*[2] Recorded by FOOC.

Table 15. Appendix 2 - Exotic species recorded at Oakley Creek since 2005

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
alder, common	*Alnus glutinosa*							E	
angels trumpet	*Brugmansia candida*					E			
annual meadow grass	*Poa annua*							E	E
annual mouse-ear chickweed	*Cerastium glomeratum*							E	
apple of Peru	*Nicandra physalodes*							E	
Australian fireweed	*Senecio bipinnatisectus*							E	
Australian hydrocotyle	*Hydrocotyle tripartita*							E	
avocado	*Persea americana*							E	
banana palm	*Musa sp.*								E
bangalay	*Eucalyptus botryoides*							E	
bellis daisy	*Bellis perennis*							E	
black calla lily*[2]	*Arum palaestinum*								
black nightshade	*Solanum nigrum*							E	E
blue vervain	*Verbena litoralis*							E	
brittle bladder fern	*Cystopteris fragilis*							E	
broad-leaved dock	*Rumex obtusifolius*							E	
broad-leaved flea-bane	*Conyza sumatrensis*							E	
broad-leaved plantain	*Plantago major*							E	

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Bull bay, southern magnolia, laurel magnolia	*Magnolia grandiflora*							E	
Butt ixia	*Ixia paniculata*							E	
buttercup	*Ranunculus repens*							E	
cape gooseberry	*Physalis peruviana*								E
caper spurge	*Euphorbia lathyrus*							E	
cleavers	*Galium aparine*							E	
clover, red	*Trifolium pratense*							E	
clover, white	*Trifolium repens*							E	
cluster pine	*Pinus pinaster*							E	
cocksfoot	*Dactylis glomerata*							E	
creeping bent	*Agrostis stolonifera*							E	
curly pondweed	*Potamogeton crispus*							E	
cut-leaved cranesbill	*Geranium dissectum*							E	
Eucalyptus sp.	*Eucalyptus sp.*		E				E		
fairy bells	*Melasphaerula ramosa*							E	
fennel	*Foeniculum vulgare*		E					E	E
fiddle dock	*Rumex pulcher*							E	
field madder	*Sherardia arvensis*							E	
field speedwell, corn speedwell	*Veronica arvensis*							E	
floating sweetgrass	*Glyceria fluitans*							E	
freesia	*Freesia refracta*							E	

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
gardner's Geranium	*Geranium gardneri*							E	
grassland forget-me-not	*Myosotis discolor*							E	
gravel groundsel	*Senecio skirrhodon*							E	
groundsel	*Senecio vulgaris*							E	
hairy birdsfoot trefoil	*Lotus suaveolens*							E	
hawksbeard	*Crepis capillaris*							E	
hedge bedstraw	*Galium mollugo*								E
hedge woundwort	*Stachys sylvaticus*								E
henbit	*Lamium amplexicaule*							E	
hydrangea	*Hydrangea spp.*			E					
Indian mustard, brown mustard, mizuna	*Brassica juncea var. juncea*							E	
inkweed	*Phytolacca octandra*		E	E	E	E		E	
ivy-leaved toadflax	*Cymbalaria muralis*							E	
Japanese cedar	*Cryptomeria japonica*							E	
Japanese hill cherry	*Prunus serrulata*							E	
lemon balm	*Melissa officinalis*								E
Liquid amber	*Liquidambar sp.*						E		
lotus	*Lotus pedunculatus*							E	
macrocarpa	*Cupressus macrocarpa*								E

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Mexican cypress	*Cupressus lusitanica var. lusitanica*							E	
milkweed	*Euphorbia peplus*							E	
nasturtium	*Tropaeolum majus*		E	E	E	E	E	E	E
nipplewort	*Lapsana communis*							E	
oak sp.	*Quercus sp.*						E		E
oak, European oak	*Quercus robur*							E	
oxalis sp.	*Oxalis sp.*								E
oxalis, large-flowered	*Oxalis purpurea*							E	
ox-eye daisy	*Leucanthemum vulgare*							E	
ox-tongue	*Helminthotheca echioides*							E	E
paspalum	*Paspalum dilatatum*							E	
peach	*Prunus persica*							E	
perennial rye grass	*Lolium perenne*							E	
pimpernel	*Anagallis arvensis subsp. arvensis*							E	
pink head knotweed	*Persicaria capitatum*		E						
plantain, narrow-leaved	*Plantago lanceolata*							E	
poplar	*Populus spp.*		E		E	E			
poplar, lombardy	*Populus nigra*							E	
poplar, white/ silver	*Populus alba*						E	E	

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
poplar, Yunnan	*Populus yunnanensis*							E	
prairie grass	*Bromus willdenowii*							E	
purple vervain/ verbena	*Verbena bonariensis*								E
rampant fumitory	*Fumaria capreolata subsp. capreolata*							E	
rat's tail	*Sporobolus africanus*							E	
red hot poker	*Kniphofia uvaria*							E	
ripgut brome	*Bromus diandrus*							E	
Scotch thistle	*Cirsium vulgare*							E	
scrambling speedwell, Persian speedwell	*Veronica persica*							E	
self-heal	*Prunella vulgaris*							E	
she oak	*Casuarina cunninghamiana*		E						
silky oak	*Grevillea robusta*							E	
slender bedstraw	*Galium divaricatum*							E	
small herb Robert	*Geranium purpureum*							E	
sow thistle	*Sonchus oleraceus*							E	
spear thistle	*Cirsium vulgare*								E
stinking iris	*Iris foetidissima*					E			
strawberry, wild	*Fragaria vesca*								E
swan plant, narrow leaf cotton	*Gomphocarpus fruticosus*							E	

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
bush									
sycamore	*Acer pseudoplatanus*						E	E	
tall fescue	*Schedonorus arundinaceus*							E	
tall oat grass	*Arrhenatherum elatius subsp. elatius*							E	
thistle	*'All' spp.*				E	E			
three cornered garlic, onion weed	*Allium triquetrum*		E				E	E	E
track rush	*Juncus tenuis subsp. tenuis*							E	
tree dahlia *[2]	*Dahlia imperialis*								
turnip, wild	*Brassica rapa subsp. sylvestris*							E	
umbrella sedge	*Cyperus eragrostis*		E		E		E	E	E
umbrella sedge, purple	*Cyperus congestus*							E	
velvety nightshade	*Solanum chenopodioides*							E	
vetch	*Vicia sativa*							E	
violet	*Viola odorata*							E	
water starwort	*Callitriche stagnalis*							E	
watercress	*Nasturtium officinale*							E	
watsonia	*Watsonia bulbillifera*					E			

Common Name	Scientific Name	ARC RPMS Designation*	Controlled by Te Ngahere				Surveys		
			Oakley MU1-7 (ERC)	Harbutt MU 9-11 (ERC)	Mahoe Rock Forest (MU 8-11)	ERBNA 2007-2012 (MU 1-part7)	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
wattle, cedar	*Acacia elata*							E	
willow herb	*Epilobium ciliatum*							E	
willow weed	*Persicaria maculosa*		E	E	E	E	E	E	
willow, tortured	*Salix matsudana*								E
yellow bristle grass	*Setaria pumila*							E	
Yorkshore fog	*Holcus lanatus*							E	E
Total number of exotic species			**10**	**4**	**6**	**8**	**9**	**94**	**20**

***** Auckland RPMS = Auckland Regional Pest Management Strategy 2007-2012 Pest Plant Category, currently being updated

*[2] Recorded by FOOC.

Table 16. Appendix 3 - Native species recorded at Oakley Creek since 2005

Latin name	**Common name**	**Threat Status**	**Oakley Creek Restoration Plan 2005**	**Botanical Society Survey 2009**	**Mahoe Rock Forest Survey 2011**
Adiantum aethiopicum	maidenhair, makaka	Not Threatened		Y	
Adiantum cunninghamii	common maidenhair	Not Threatened		Y	
Adiantum hispidulum	rosy maidenhair	Not Threatened		Y	
Agathis australis	kauri	Not Threatened		Y	
Alectryon excelsus subsp. excelsus	titoki	Not Threatened	Y	Y	Y
Alternanthera nahui	nahui	Not Threatened		Y	
Aristotelia serrata	makomako, wineberry	Not Threatened		Y	
Arthropodium bifurcatum	rengarenga	At Risk - Relict		Y	
Asplenium flaccidum	drooping spleenwort, hanging spleenwort	Not Threatened		Y	
Asplenium oblongifolium	shining spleenwort	Not Threatened		Y	Y
Astelia grandis	swamp astelia	Not Threatened		Y	
Austroderia fulvida	toetoe	Not Threatened		Y	
Austroderia splendens	toetoe	Not Threatened		Y	
Beilschmiedia tarairi	taraire	Not Threatened	Y	Y	Y
Blechnum chambersii	rereti	Not Threatened	Y		
Blechnum discolor	crown fern, petipeti, piupiu	Not Threatened		Y	
Blechnum membranaceum		Not Threatened	Y	Y	
Blechnum novae-zelandiae	kiokio	Not Threatened	Y	Y	Y
Blechnum parrisiae	rasp fern	Not Threatened	Y	Y	Y
Blechnum zeelandicum		At Risk - Naturally Uncommon		Y	
Brachyglottis repanda	rangiora, bushman's friend	Not Threatened		Y	
Calystegia sepium subsp. roseata	pink bindweed	Not Threatened		Y	
Carex dissita	flat-leaved sedge	Not Threatened		Y	

Latin name	Common name	Threat Status	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Carex flagellifera	Glen Murray tussock, trip me up	Not Threatened		Y	
Carex inversa	creeping lawn sedge	Not Threatened		Y	
Carex lambertiana	forest sedge	Not Threatened	Y	Y	Y
Carex lessoniana	rautahi	Not Threatened		Y	
Carex secta	purei	Not Threatened		Y	
Carex solandri	forest sedge, Solander's sedge	Not Threatened		Y	
Carex virgata	small swamp sedge	Not Threatened		Y	
Carpodetus serratus	putaputaweta, marbleleaf	Not Threatened		Y	
Centella uniflora	centella	Not Threatened		Y	
Coprosma lucida	shining karamu	Not Threatened		Y	
Coprosma macrocarpa subsp. minor		Not Threatened		Y	
Coprosma propinqua var. propinqua	mingimingi	Not Threatened		Y	
Coprosma repens	taupata	Not Threatened		Y	
Coprosma robusta	karamu	Not Threatened	Y	Y	Y
Cordyline australis	ti kouka, cabbage tree	Not Threatened	Y	Y	Y
Corokia cotoneaster	korokio	Not Threatened		Y	
Corynocarpus laevigatus	karaka	Not Threatened	Y	Y	Y
Cyathea dealbata	silver fern, ponga	Not Threatened	Y	Y	Y
Cyathea medullaris	mamaku	Not Threatened	Y	Y	Y
Cyperus ustulatus	giant umbrella sedge	Not Threatened	Y	Y	
Dacrycarpus dacrydioides	kahikatea	Not Threatened		Y	Y
Dacrydium cupressinum	rimu	Not Threatened	Y	Y	Y
Deparia petersenii subsp. congrua		Not Threatened	Y	Y	
Dianella nigra	turutu	Not Threatened		Y	
Dichondra repens	Mercury Bay weed	Not Threatened		Y	
Dicksonia squarrosa	wheki	Not Threatened	Y	Y	
Diplazium australe		Not Threatened	Y	Y	

Latin name	Common name	Threat Status	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Dodonaea viscosa	akeake	Not Threatened	Y	Y	
Dysoxylum spectabile	kohekohe	Not Threatened		Y	Y
Entelea arborescens	whau	Not Threatened	Y	Y	Y
Epilobium pedunculare	willowherb	Not Threatened		Y	
Epilobium rotundifolium	round-leaved willowherb	Not Threatened		Y	
Gahnia lacera	gahnia	Not Threatened		Y	
Gahnia setifolia	mapere, gahnia	Not Threatened		Y	
Gahnia sp.	gahnia sp.				Y
Geniostoma ligustrifolium var. ligustrifolium	hangehange	Not Threatened		Y	
Geranium homeanum		Not Threatened		Y	
Geranium retrorsum	turnip-rooted geranium	Threatened - Nationally Vulnerable		Y	
Griselinia littoralis	kapuka, broadleaf	Not Threatened		Y	
Griselinia lucida	puka, shining broadleaf	Not Threatened	Y	Y	
Haloragis erecta subsp. erecta	toatoa	Not Threatened		Y	Y
Hebe parviflora	hebe	Not Threatened		Y	
Hebe speciosa	napuka, titirangi	Threatened - Nationally Vulnerable		Y	
Hebe stricta var. stricta	koromiko	Not Threatened	Y	Y	
Hedycarya arborea	pigeonwood, porokaiwhiri	Not Threatened		Y	Y
Hoheria populnea	houhere, lacebark	Not Threatened	Y	Y	
Hoheria sexstylosa	houhere, long-leaved lacebark	Not Threatened		Y	
Hydrocotyle heteromeria	waxweed pennywort	Not Threatened		Y	
Hydrocotyle moschata var. moschata	hairy pennywort	Not Threatened		Y	
Juncus pallidus	giant rush, leafless rush	Not Threatened		Y	
Knightia excelsa	rewarewa	Not Threatened		Y	

Latin name	Common name	Threat Status	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Kunzea ericoides	kanuka	Not Threatened	Y	Y	Y
Laurelia novae-zelandiae	pukatea	Not Threatened		Y	Y
Leptospermum scoparium var. scoparium	manuka, tea tree	Not Threatened	Y	Y	
Leucopogon fasciculatus	mingimingi	Not Threatened	Y	Y	
Libertia ixioides	mikoikoi, New Zealand iris	Not Threatened		Y	
Libocedrus plumosa	kawaka	At Risk - Naturally Uncommon		Y	
Litsea calicaris	mangeao, tangeao	Not Threatened		Y	
Melicope ternata	wharangi	Not Threatened		Y	Y
Melicytus ramiflorus	mahoe	Not Threatened	Y	Y	Y
Metrosideros excelsa	pohutukawa	Not Threatened	Y	Y	Y
Microlaena stipoides	meadow rice grass, slender rice grass	Not Threatened		Y	
Microsorum pustulatum subsp. pustulatum	hounds tongue, kowaowao, paraharaha	Not Threatened		Y	Y
Myoporum laetum	ngaio	Not Threatened	Y	Y	Y
Myrsine australis	mapou	Not Threatened	Y	Y	Y
Olearia albida		Not Threatened		Y	
Olearia furfuracea	akepiro	Not Threatened	Y		
Olearia paniculata	akiraho	Not Threatened	Y		
Olearia traversiorum	Chatham Island tree daisy	Threatened - Nationally Vulnerable		Y	
Oplismenus hirtellus subsp. imbecillis		Not Threatened		Y	
Oxalis exilis	creeping oxalis, yellow oxalis	Not Threatened		Y	
Persicaria decipiens		Not Threatened		Y	
Phormium cookianum subsp. cookianum	mountain flax, whararikí	Not Threatened		Y	

Latin name	Common name	Threat Status	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Phormium tenax	flax, harakeke	Not Threatened	Y	Y	Y
Phyllocladus trichomanoides	tanekaha	Not Threatened		Y	
Piper excelsum subsp. excelsum	kawakawa	Not Threatened	Y	Y	Y
Piper excelsum subsp. peltatum	kawakawa	At Risk - Naturally Uncommon	Y	Y	
Piper sp.	kawakawa hybrid / Three King's sp. (unconfirmed)				Y
Pittosporum crassifolium	karo	Not Threatened	Y	Y	Y
Pittosporum eugenioides	tarata, lemonwood	Not Threatened	Y	Y	Y
Pittosporum tenuifolium	kohuhu	Not Threatened	Y	Y	Y
Plagianthus regius subsp. regius	lowland ribbonwood, manatu	Not Threatened		Y	Y
Planchonella costata	tawapou	At Risk - Relict		Y	
Pneumatopteris pennigera	gully fern, piupiu	Not Threatened	Y	Y	
Podocarpus totara var. totara	totara	Not Threatened	Y	Y	Y
Prumnopitys ferruginea	miro	Not Threatened		Y	
Prumnopitys taxifolia	matai	Not Threatened		Y	
Pseudognaphalium luteoalbum		Not Threatened		Y	
Pseudopanax arboreus	five-finger, whauwhaupaku	Not Threatened		Y	Y
Pseudopanax lessonii	houpara	Not Threatened		Y	Y
Pteridium esculentum	bracken	Not Threatened	Y	Y	Y
Pteris macilenta	sweet fern	Not Threatened		Y	
Pteris tremula	shaking or tender brake, Australian bracken	Not Threatened	Y	Y	
Pyrrosia eleagnifolia	leather-leaf fern	Not Threatened		Y	
Rhopalostylis sapida	nikau palm	Not Threatened	Y	Y	
Schefflera digitata	pate	Not Threatened		Y	
Senecio esleri	Esler's fireweed	Not Threatened		Y	

Latin name	Common name	Threat Status	Oakley Creek Restoration Plan 2005	Botanical Society Survey 2009	Mahoe Rock Forest Survey 2011
Solanum aviculare var. aviculare	poroporo	At Risk - Declining	Y	Y	
Solanum laciniatum	poroporo, bullibulli	Not Threatened		Y	
Solanum nodiflorum	small-flowered nightshade	Not Threatened		Y	
Sophora chathamica	kowhai, coastal	Not Threatened			Y
Sophora microphylla	kowhai, small-leaved kowhai	Not Threatened		Y	
Streblus banksii	large-leaved milk tree, turepo	At Risk - Relict		Y	
Syzygium maire	swamp maire	Not Threatened		Y	Y
Vitex lucens	puriri	Not Threatened	Y	Y	Y
Total number of species recorded			**44**	**122**	**40**

Table 17. Summary list of species recommended for Diversity Plantings at Oakley Creek (combined summary of planting lists shown by habitat in revegetation section)

Common name	Botanical Name	Mentioned in 2005 Restoration Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	OC Location (for more unusual plants, if known)	Eco-sourcing Reference Site (outside of OC)	Notes and Recommendations
Ferns and lycopods							
black tree fern, mamaku	*Cyathea medullaris*		x	x			Generally self-establishing, plant sparingly in appropriate locations.
gully fern	*Pneumatopteris pennigera*	x	x	x			Generally self-establishing, plant sparingly in appropriate locations.
kiokio	*Blechnum novaezelandiae*	x	x	x			Generally self-establishing, plant in appropriate locations.
silver fern, ponga	*Cyathea dealbata*	x	x	x			Generally self-establishing, plant sparingly in appropriate locations.
Conifers							
kahikatea	*Dacrycarpus dacrydioides*	x	x	x			In wet and floodplain areas.
totara	*Podocarpus totara*	x	x	x			
Dicot trees, shrubs and woody climbers							
akepiro	*Olearia furfuracea*	x		x			Dry open slopes.

Common name	Botanical Name	Mentioned in 2005 Restoration Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	OC Location (for more unusual plants, if known)	Eco-sourcing Reference Site (outside of OC)	Notes and Recommendations
broadleaf, puka	*Griselinia littoralis, G. lucida*			x			Confirm most appropriate species, *G. littoralis or G. lucida*. Plant only in rock forest areas.
five-finger	*Pseudopanax arboreus*		x	x			
hangehange	*Geniostoma ligustrifolium var. ligustrifolium*		x	x			
kanuka	*Kunzea robusta*	x	x	x			Most appropriate *Kunzea* species for central Auckland region.
karaka	*Corynocarpus laevigatus*	x	x	x			
karamu	*Coprosma robusta*	x	x	x			
kawakawa	*Piper excelsum subsp. excelsum*		x	x			Consider removing other forms of *Piper* sp.
kohekohe	*Dysoxylum spectabile*	x	x	x			
koromiko	*Hebe stricta var. stricta*	x	x	x			
kowhai, small-leaved	*Sophora microphylla*	x	x	x			
kumarahou	*Pomaderris kumeraho*		x				Dry open slopes. Shortlived colonising species.
lacebark, houhere	*Hoheria populnea*		x	x			
mahoe	*Melicytus ramiflorus*	x	x	x			
mangeao	*Litsea calicaris*	x	x	x			Rock forest area only, limited use

Common name	Botanical Name	Mentioned in 2005 Restoration Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	OC Location (for more unusual plants, if known)	Eco-sourcing Reference Site (outside of OC)	Notes and Recommendations
manuka	*Leptosermum scoparium var. scoparium*	x	x	x			
mapou	*Myrsine australis*	x	x	x			
pate	*Schefflera digitata*	x	x	x			
pigeonwood	*Hedycarya arborea*		x	x			
pukatea	*Laurelia novae-zelandiae*	x	x	x			
puriri	*Vitex lucens*	x	x	x			
putaputaweta, marbleleaf	*Carpodetus serratus*	x	x	x			
rewarewa	*Knightia excelsa*		x	x			Alluvial / lowland broadleaf forest.
shining karamu	*Coprosma lucida*	x	x	x			Rock forest areas.
swamp maire	*Syzygium maire*	x	x	x		Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	
taraire	*Beilschmiedia tarairi*	x	x	x			Alluvial / lowland broadleaf forest only.
titoki	*Alectryon excelsus*	x	x	x			
whau	*Entelea arborescens*		x	x			Open areas and near stream.
Monocots							
flat-leaved sedge	*Carex dissita*	x	x	x			

Common name	**Botanical Name**	**Mentioned in 2005 Restoration Plan**	**Planted by FOOC (or Te Ngahere)**	**Included on Bot Soc Plant Species List**	**OC Location (for more unusual plants, if known)**	**Eco-sourcing Reference Site (outside of OC)**	**Notes and Recommendations**
giant umbrella sedge	*Cyperus ustulatus*	x	x	x			
harakeke, flax	*Phormium tenax*	x	x	x			
rautahi	*Carex lessoniana*	x	x	x			
small swamp sedge	*Carex virgata*	x	x	x			
ti kouka, cabbage tree	*Cordyline australis*	x	x	x			
toetoe	*Austroderia fulvida*	x	x	x			
gahnia	*Gahnia lacera*		x	x			Colonising a variety of substrates which may be seasonally waterlogged, though otherwise dry. Usually found in scrub or open forest.
gahnia	*Gahnia setifolia*	x	x	x			Mostly in lowland areas in light forest, scrub and lining streams. Sometimes colonising the fringes of swamps.

Common name	Botanical Name	Mentioned in 2005 Restoration Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	OC Location (for more unusual plants, if known)	Eco-sourcing Reference Site (outside of OC)	Notes and Recommendations
gahnia	*Gahnia xanthocarpa*						Not recorded in surveys. Occupying a diverse range of habitats, seems to prefer permanently damp situations within alluvial forest, swamp forest and the margins of waterways.

Table 18. Species **not** recommended for planting at Oakley Creek and justifications (To be used as a reference list when considering diversity planting)

Common name	**Botanical Name**	**Mentioned in 2005 Restor-ation Plan**	**Planted by FOOC (or Te Ngahere)**	**Included on Bot Soc Plant Species List**	**Oakley Creek Location (for more unusual plants, if known)**	**Reference Site (outside of OC)**	**Justification for not including in proposed plantings**	**Notes (from Te Ngahere and Auckland Council)**
Ferns and lycopods								
button fern	*Pellaea rotundifolia*			x			Self establishing	Not necessary to plant
common maidenhair	*Adiantum cunninghamii*			x			Self establishing	Not necessary to plant
crown fern	*Blechnum discolor*		x	x			Distribution	Cool climate species, not suitable for site. Discontinue planting.
hen & chicken fern	*Asplenium bulbiferom*		x		Damp gully (with *Elatostoma rugosum*)		Self establishing	Not necessary to plant
maidenhair	*Adiantum aethiopicum*			x			Self establishing	Not necessary to plant
rasp fern	*Blechnum parrisiae (syn. Doodia australis)*		x	x			Self establishing	Not necessary to plant
rosy maidenhair	*Adiantum hispidulum*		x	x			Self establishing	Not necessary to plant
shining spleenwort	*Asplenium oblongifolium*		x				Self establishing	Not necessary to plant
wheki	*Dicksonia squarrosa*		x	x			Self establishing	Not necessary to plant
	Deparia petersenii		x	x	Cradock St Bridge		Self establishing	Not necessary to plant
	Diplazium australe			x			Self establishing	Not necessary to plant
	Blechnum zeelandicum (Doodia squarrosa)		x	x			Threatened species	**Translocation record required. Clarify if planted?**

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
	Pellaea falcata		x		Rock Forest	Maungawhau / Withiel Thomas	Threatened species, distribution, hybridisation risk	**Translocation record required and source of those planted**. This species is primarily an offshore island species, but is associated with rock forests in Auckland. There is potential for hybridisation with other *Pellaea* spp.
Conifers								
kauri	*Agathis australis*		x		MU7 between path and Ngati Whatua land		Biosecurity risks, not recommended forest type	Not recommended to plant kauri or create Kauri Forest due to small size of site and urban location. Soil type is not appropriate for kauri forest. Spread of PTA is also a risk.
kawaka	*Libocedrus plumosa*			x	Unitec West covenant area		Other species preferred	Not looking to create podocarp forest.
matai	*Prumnopitys taxifolia*	x		x	Unitec West covenant area		Other species preferred	Not looking to create podocarp forest.
miro	*Prumnopitys ferruginea*			x	Unitec West covenant area		Other species preferred	Not looking to create podocarp forest.
rimu	*Dacrydium cupressinum*			x	MU5 & Unitec West covenant area		Other species preferred	Not looking to create podocarp forest.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
tanekaha, celery pine	*Phyllocladus trichomanoides*			x		Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Other species preferred	Not looking to create podocarp forest.
Dicot trees, shrubs and woody climbers								
hebe	*Hebe parviflora*		x	x	Harbutt Reserve		Distribution	Not naturally present. Discontinue planting.
heketara	*Olearia rani*		x			Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Distribution	Not recorded in surveys, only recorded in plantings. More associated with Waitakeres.
hinau	*Elaeocarpus dentatus*					Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Other species preferred	Uncommon in Auckland and habitat type / site is not suitable.
houpara	*Pseudopanax lessonii*		x	x			Distribution	Coastal species. Discontinue planting.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
karo	*Pittosporum crassifolium*		x	x			Distribution	Coastal species. Discontinue planting.
kawakawa	*Piper excelsum subsp. Peltatum*						Distribution	Discontinue planting. Consider replacing.
kohuhu	*Pittosporum tenuifolium*		x	x			Other species preferred. May self colonise.	Usually used in amenity plantings. Could be considered later.
korokio	*Corokia cotoneaster*			x	Unitec West covenant area		Outside natural range	Discontinue planting, consider replacing.
kotukutuku / tree fuchsia	*Fuchsia exorticata*		x			Kepa Bush / Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Uncommon in Ecological District	Not recommended to plant.
kowhai, coastal	*Sophora chathamica*		x				Distribution	Coastal species. Discontinue planting.
lancewood	*Pseudopanax crassifolius*						Other species preferred	More associated with Waitakeres. Not common in central Auckland bush remnants.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
maire taike, willow-leaved maire	*Mida salicifolia*					Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Forest type	Associated with kauri forest.
milk tree	*Streblus banksii*		x	x		Withiel Thomas/ Almorah, Tamaki Ecological District	Threatened species/ hybridisation risk/ unsure if naturally present	**Need records of existing plantings and sources of plants**. This species can hybridise with *S. heterophyllus* (not recorded at Oakley Creek).
mingimingi	*Coprosma propinqua*		x	x			Other species preferred, self establishing	Not necessary to plant.
mingimingi	*Leucopogon fasciculatus*		x	x			Other species preferred, self establishing	Not necessary to plant.
napuka, titirangi	*Hebe speciosa*		x	x			Distribution	West coast species which would not naturally be present. Discontinue planting.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
parataniwha	*Elatostema rugosum*		x		Damp gullies x 2 (gifted by AC)		Uncommon	Not necessary to plant. Rare in central Auckland reserves.
pohutukawa	*Metrosideros excelsa*	x	x	x			Other species preferred	Not aiming for coastal forest and not a component of lava rock forest in the area.
poroporo	*Solanum aviculare var. aviculare*		x?	x			Threatened species	Could consider planting if want to encourage threatened species. Mainly on outer Hauraki Gulf islands. Discuss with Biodiversity Team.
poroporo, bullibulli	*Solanum laciniatum*		x	x			Already planted	Relatively common in Auckland region, spread by birds.
prickly mingimingi	*Cyathodes juniperina*		x				Other species preferred, self establishing	Not necessary to plant.
rangiora	*Brachyglottis repanda*		x			Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Other species preferred	Not priority to plant. Uncommon in central Auckland bush reserves.
ribbonwood	*Plagianthus regius*		x	x			Distribution	Not common in the Auckland Region. Not recommended to plant.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
shining broadleaf	*Griselina lucida*		x	x			Naturally epiphytic	Usually establishes as an epiphye in maturing forest. Discuss potential use in rock forest areas versus *G.littoralis*.
taurepo	*Rhabdothamnus solandrii*		x			Waikowhai Reserve, Tamaki Ecological District	Other species preferred	Not recorded in surveys, only recorded in plantings. Not necessary to plant.
tawa	*Beilschmiedia tawa*					Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Distribution / Forest type	Not recorded in surveys, only recorded in plantings. Not appropriate forest type for site.
tawapou	*Planchonella costata*		x	x			Distribution	Outside natural range. Consider replacing.
toropapa	*Alseuosmia macrophylla*		x			Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Distribution	Probably not naturally present. Not recorded in surveys, only recorded in plantings. Associated more with Waitakeres or North Shore remnant kauri reserves.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
turepo	*Streblus hererophyllus*					Lowtherhurst Reserve/ Wattle Bay Reserve, Tamaki Ecological District	Hybridisation risk	This species can hybridise with *S. banksii*. Do not plant. *S.banksii* already present along creek and should be retained.
wharangi	*Melicope ternata*		x	x			Other species preferred	Not recommended to plant coastal species.
wineberry	*Aristotelia serrata*		x	x		Rahui Kahika Reserve, boundary of Waitakere and Tamaki Ecological District	Other species preferred	Not common in central Auckland bush reserves. Generally planted where seen.
	Coprosma arborea		x		Powell St Sustainable Neighbourhood		Other species preferred	Not common in local area. More associated with Waitakeres.
	Coprosma rhamnoides		x				Other species preferred, self establishing	Not necessary to plant.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
	Coprosma spathulata		x				Other species preferred, self establising	Not necessary to plant
	Coprosma macrocarpa subsp. minor						Distribution	Usually more of a coastal species and moving away from planting coastal species on site.
	Hebe macrocarpa var. macrocarpa						Distribution	Not planted frequently in urban Auckland. Could consider.
Climbers								
clematis	*Clematis paniculata*					Kepa Bush, Tamaki Ecological District	Other species preferred, self establishing	Not recommended to plant.
native jasmine	*Parsonsia heterophylla*		x			Kepa Bush / Kurt Brehmer Walkway Reserve, Tamaki Ecological District	Other species preferred, self establishing	Not necessary to plant. Should not be collected from sources which could have been planted (Kurt Brehmer and Whau River).
Monocots								
coastal astelia	*Astelia banksii*		x				Distribution	Coastal species. Discontinue planting.
forest sedge	*Carex lambertiana*		x	x			Habitat	Could be potentially planted in future in established forest areas.
forest sedge, Solander's sedge	*Carex solandri*			x			Habitat	Other *Carex spp.* are considered more suitable

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
Glen Murray tussock, trip me up	*Carex flagellifera*		x	x			Habitat	Other *Carex spp.* are considered more suitable
mikoikoi, libertia	*Libertia ixioides*		x	x			Distribution	Usually used in amenity plantings. Not common in urban Auckland forest remnants.
nikau	*Rhopalostylis sapida*		x	x			Self establishing, other species preferred	Slow growing. Resources best spent elsewhere.
purei	*Carex secta*		x	x			Habitat	Not appropriate for riparian areas. This species is naturally only found in areas of standing water.
rautahi	*Carex geminata agg.*		x				Hybrid / separate species	*Carex lessoniana* is included in plant lists. Disagreement regarding hybridisation / location appropriateness.
rengarenga	*Arthropodium bifurcatum*		x	x			Threatened species/ distribution	Not naturally occurring in Ecological District. If planting use *A. cirratum* (not listed in surveys of Oakley Creek)
turutu, blueberry	*Dianella nigra*		x	x			self establishing	Not necessary to plant. Could be used by walkways.

Common name	Botanical Name	Mentioned in 2005 Restor-ation Plan	Planted by FOOC (or Te Ngahere)	Included on Bot Soc Plant Species List	Oakley Creek Location (for more unusual plants, if known)	Reference Site (outside of OC)	Justification for not including in proposed plantings	Notes (from Te Ngahere and Auckland Council)
whararíki, mountain flax	*Phormium cookianum*		x	x			Distribution/ hybridisation risk	It is included in the archaeological planting list. It is naturally a westcoast species in Auckland. Could be used in rocky areas around the waterfall or where lower planting is needed. If planted, *P. c. subsp. hookeri* rather than subsp. *cookianum*. Probably already hybridising with *P. tenax*

Threatened Plant Translocation Planning Template

PROJECT NAME

Translocation Prepared by

Translocation Project Owner

<u>Project Approval (technical and management)</u>

Project Accepted/ Declined (please circle)

Comments on decision:

Senior Regional Advisor Flora
Biodiversity Group
Environmental Services
Auckland Council

Date

Signature

Biodiversity Manager
Biodiversity Group
Environmental Services

Date

Signature

Relevant Asset Manger(s)

Date **Signature**

PROJECT DETAILS

Identify Project lead. Person who is ultimately responsible for ensuring translocation plan is followed.

Identify key stakeholders relevant roles and deliverables.

Who	Contact Details	Role	Deliverables

1. SPECIES TO BE TRANSLOCATED:

Latin name:

Threat Status:

Maori/common name:

Source of plants:

1.2 Primary reason for translocation is (a) to save a species from imminent destruction? (b) to reinforce or enhance a species population already present? (c) to establish a species at a site where was recorded historically? (d) to establish a species at a new site where there is suitable habitat but the species has never been recorded previously

1.3 Project Objectives e.g. to establish a new self-sustaining population of X at Y within 5 years

1.4 Was the species to be translocated previously known to occur at the site?

1.4.1 If yes- the record or reference to this occurrence may be found in the following publication, report, species list or herbarium voucher:

1.4.2 If yes and no longer at the site, the species is believed to have disappeared because

1.5 Threats to the species

1.6 Is this cause of decline still operating?

1.7 Is the translocation site within the known historic range of the species?

2. HABITAT REQUIREMENTS OF SPECIES TO BE TRANSLOCATED

2.1 Is the site large enough to accommodate a translocation of the species?

2.2 Species commonly associated with the threatened plant are present at this site (e.g., pollinators, seed dispersers, plant associates)?

2.3 Are the nutrient and water resources at the site adequate for the species?

2.4 Do you have permission from the land owner/manager to do this translocation?

2.5 Is the site at which you intend to establish the new population protected physically (i.e. fences and with low pest numbers) and/or legally (covenant or reserve)?

2.6 What threats operate at the new site that could cause this introduction to fail?

2.7 How will you manage these threats?

2.8 Has the species ever been translocated successfully before?

3. INTERACTIONS WITH OTHER SPECIES AND EFFECTS OF DISPERSAL

Is the translocated species likely to affect the native species of plant and animals at the receiving site in any of the following ways? Provide explanation

3.1 Through competition?

3.2 Through hybridisation?

3.3 Through introduction of pests and disease? *Risk of introducing pests and disease to a remnant threatened plant population and the wider environment needs to be evaluated. Suppliers of threatened species should have a biosecurity management plan in place to ensure plants are pest and disease free and this should be evidenced and referenced here. At the project management scale the Lead should ensure pre delivery inspection.*

Pre-delivery inspection.
If any of the following are found then the plants should not be accepted for the project.

- Argentine ants
- Rainbow skinks and eggs
- Invertebrates; slugs, snails, aphid, scale etc
- Any unusual fungal expression
- Weeds

Allow enough time between inspection and programed planting time for the nursery to rectify

3.4 Through negative effects on structure of plant community? *If yes The species with which it is likely to interact detrimentally are:*

3.5 Is it possible to monitor the impact of the translocated species on the plants and animals at the new site?

3.6 Will the introduction prevent, or make difficult, the control or eradication of problem weed or animal pest at the site? *If yes - what pest plant or animal?*

3.7 Will the translocation foreclose options for introducing other species to the site in the future? *If yes - what species in particular?*

3.8 Will options for the establishment of other threatened species be lost or compromised?

4. **SOURCE, NUMBERS, AGE, SITE AND TIMING OF TRANSLOCATION**

4.1 What is the most appropriate source(s) of plant propagules for the translocation? In order of preference

4.2 Why is this source the most appropriate? (e.g., to minimise distance between source and release; only source available in region or country; most similar environment to translocation site)

4.3 Do you need a permit to collect from this site? If yes – from whom?

4.4 How many individuals of the species should be translocated?

4.5 What should be the sex ratio of the founder population?

4.6 What should be the age structure of the founder population?

4.7 What type of plant material will be used (circle one or more):

Mature plants Juveniles Seedlings Seeds

4.8 If a mixture is needed should the mixture be varied in subsequent introductions?

4.9 What should be the timing of the release/planting?

Time of day, time of month, month of year

4.10 Will the removal of the plants from the source population have any unacceptable demographic or genetic effects on the source population?

4.11 What is the most suitable location at the site for establishment of the founder population? (indicate where this site is on an attached map).

4.12 Is a temporary lifeline approach required involving supplementary watering, fertiliser or releasing following their planting?

If yes - what form will the lifeline take?

5. RECORDING AND MONITORING

5.1 Where will details of the translocation be recorded?

5.2 Where will copies of reports relating to the translocation be filed or located?

5.3 How will the success or failure of the translocation be determined? (i.e. at what point will the translocation be deemed a success?)

Figure 17. Stormwater Planning map MU 1-6

Figure 18.Stormwater Planning map MU 7-11

Appendix 7 Archaeological Survey and Recommendations for management –
to be added once updated survey completed by Brent Druskovich (winter 2015)

Appendix 8 Soil Handling Plan, Andrew Stewart, March 2015

SOIL HANDLING PLAN

For Auckland Council
Parks, Sport & Recreation Group

Oakley Creek Ecological Restoration Project

March 2015

Auckland Council
Te Kaunihera o Tāmaki Makaurau

ANDREW . STEWART

REPORT QUALITY CONTROL

Document Name	Soil Handling Plan
Document Description	Soil Handling Plan to provide controls that minimise peoples exposure to potentially contaminated material during riparian planting works undertaken as part of Council's Oakley Creek Ecological Restoration Programme.
Version	Ver. 1.1 Updated Final
Date	March 2015
Document Reference	r_AC_SHP Oakley Creek_Mar 2015_v1.1

Author	Title	Signature
Simon Karl	Environmental Consultant Andrew Stewart Ltd	

Approved for Release	Title	Signature
Renate Schütte	Manager – Environmental Services Andrew Stewart Ltd	

CONTENTS

PAGE

List of Tables

List of Appendices

1 INTRODUCTION

Auckland Council Parks, Sport & Recreation (AC PSR) are continuing with their programme of ecological restoration along the lower reaches of Oakley Creek, which involves native riparian planting, weed removal and canopy control.

The programme will involve disturbance of the ground within or directly adjacent to Hazardous Activities and Industries List (HAIL) sites or potential HAIL sites. These sites include the closed landfills plus properties recorded on Auckland Council GIS as containing filled ground and refuse/tip material. Waste fill has the potential to contain elevated levels of contamination, and as such Auckland Council have considered areas of uncharacterised fill as possible HAIL sites and they should be managed as such.

Ground disturbance within HAIL sites can be undertaken as a permitted activity, provided certain criteria are met. One of these conditions is Regulation 8(3)(a) of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (the NES), which requires "controls to minimise the exposure of humans to mobilised contaminants".

This Soil Handling Plan (SHP) provides guidance and controls to ensure that peoples' exposure to potentially contaminated material is minimised whilst undertaking the proposed ecological enhancement work. It provides management measures in accordance with industry best practice to control potential health, safety and environmental issues during works within HAIL sites.

Appendix A illustrates the location of the various riparian planting Management Units (MU's) in relation to known and potential HAIL sites.

This SHP also provides instruction to assist in achieving compliance with the Permitted Activity controls of the Auckland Council Regional Plan: Air, Land and Water (ACRP:ALW) and Proposed Auckland Unitary Plan (PAUP) regarding small scale disturbance of contaminated land.

1.1 Site description

The reach of Oakley Creek subject to this ecological enhancement programme runs in a general south to north direction from the railway line near Avondale up to the intersection with the North-Western Motorway in Waterview, Auckland.

All of the MU's contain riparian vegetation, although the quality of this cover is variable and includes areas that have been invaded with weed species. Whilst the footprint of works is generally confined to heavily vegetated areas, the surrounding land use to the MU's varies from residential, commercial, transport, and schools to informal recreational reserves and sports fields.

Some MU's are located either within or directly adjacent to land that has historically been used for refuse tips. Phyllis Street Reserve is listed as a Closed Landfill in the Auckland Council Closed Landfill Asset Management Plan. Remedial works have been undertaken on Phyllis St Reserve between 1999 and 2002, which included clay capping and storm water management improvements. Despite remedial efforts, there may be an ongoing potential for risk to human health and the environment associated with leachate and landfill gas generation from closed landfills.

Further, Auckland Council Closed Landfill and Contaminated Land team have advised that the extent of landfill within Harbutt Reserve has not been well investigated (especially the river banks), and so a precautionary approach to soil handling in this area should be adopted.

2 PROPOSED WORKS

The scope of proposed work has been developed for Auckland Council by Te Ngahere Ltd, and includes the following:

2.1 Weed Control

- Initial site preparation.
- Specific weed control methods will vary from species to species and location, in accordance with the overall weed control strategy.
- Weed control activities undertaken by contractors may include spraying, cut-stumping, drilling, manual removal, canopy control of pest tree species, and potentially crown lifting of exotic but non-invasive tree species. A lowest toxicity policy will be adopted for spraying activities, which minimises risk to the project team, park users and the environment, by using herbicide with the lowest toxicity that is effective for the species being targeted.
- Weed control methods undertaken by volunteer / community groups typically uses hand releasing techniques, although simple 'cut and paste' chemical methods may be used as appropriate.
- Cut woody plant material is carefully stacked on site, which limits removal or dragging of vegetation, preventing any ground disturbance.
- Effects on slope stability will be assessed when considering plant removal.
- Weeds will be allowed to compost down onsite in situ.

2.2 Planting

- Planting preparation.
- Planting specifications and methodology will be in accordance with the Planting Plans which align with relevant technical publications and consider site constraints.
- Planting within the boundary of Closed Landfills will only utilise plants with shallow roots to avoid perforating or penetrating the landfill cap.
- The majority of planting will require hand-digging shallow holes approximately 25cm x 25cm and 25cm in depth at appropriate spacing. PB1, PB3, PB5 and PB8 plant sizes are to be used here.
- In certain and appropriate locations, larger specimen trees of PB95 size, will be planted and require 40cm x 40cm and 40cm deep hand-dug excavations.
- Machinery will not be required other than to deliver materials to site.
- Currently, there are no plans to undertake works within the creek itself.
- Planting will be undertaken either by community groups or Council contractors, depending on the physical characteristics of each site.

3 SITE MANAGEMENT PROCEDURES

3.1 Health and safety

A Health and Safety Plan for the proposed works will be documented and implemented by Auckland Council. This is in accordance with the requirements of the Health and Safety in Employment Act and standard Council protocols.

Potential health and safety hazards specifically associated with the HAIL sites have been identified in Table 1 below, along with the related mitigation measures.

The actual risks have not been fully quantified.

Table 1: Health and Safety Hazard Identification and Mitigation

Oakley Creek Ecological Restoration Project: Health & Safety Hazard Identification and Mitigation

HAZARD	LIKELIHOOD	MECHANISM	MITIGATION
Acute / chronic illness	Low	Ingestion of contaminated soil through mouth contact with dirty hands.	Workers to be fully briefed regarding potential exposures prior to starting work. No eating when working. Wash hands prior to eating. Wear gloves when working.
Acute / chronic illness	Low	Inhalation of contaminated dust.	Workers to be fully briefed regarding potential exposures prior to starting work. Avoid works during very dry soil conditions. Alternatively, wear dust masks. Avoid work during high wind conditions.
Irritation of skin	Low	Skin contact with contaminated soils.	Workers to be fully briefed regarding potential exposures prior to starting work. Wear clothing that covers body when working. Wear gloves when working.
Severe injury or death	Low	Spontaneous methane explosion due to ignition of methane by spark/flames.	Excavations for planting will be shallow and generally limited to a depth of approximately 25cm. No smoking on work site. No mechanical equipment will be used that has the potential to generate sparks/flames.

Plan prepared by: Andrew Stewart Ltd

3.2 Management of excavated material

Soil that is excavated during hand digging will be replaced in the same location, and on the same day, during planting. No soil will be stockpiled and no soil will be removed off site, or to another location on site.

3.3 Dust management

In order to minimise the generation of potentially contaminated dust, the following controls will be adopted:

- Avoiding digging during conditions of high winds or very dry soil conditions; and
- Minimising the area of hand digging at any one time.

3.4 Sediment and erosion control

The proposed works are not expected to generate significant erosion or sediment control issues.

Notwithstanding this, attention is to be given to minimising the extent and duration of exposed ground, as well as containing any sediment during rainfall events. There will be no stockpiling of soil.

3.5 Contingency plan

Possible contingency events related to soil contamination during works include the unexpected disturbance of chemical deposits, refuse or waste.

Contingency measures for dealing with these events are provided in **Table 2** below.

Table 2: Contingency Plan

Oakley Creek Ecological Restoration Project: Contingency Plan

EVENT	POTENTIAL IMPACTS	CONTINGENCY PLAN
Unexpected uncovering of refuse / waste materials	Discharges to environment and risks to the health and safety of workers.	Stop work. Site manager to contact Auckland Council's Environmental Health Officer (via AC Call Centre - ph. 09 301 0101) and Contaminated Land and Closed Landfill team (Mark Crooks – ph. 021 340 547), who will advise on how to proceed. Work to re-commence only once approved by Auckland Council's Environmental Health Officer and the Contaminated Land and Closed Landfill Manager.
Uncovering of asbestos or material suspected as being asbestos	Health and safety risks to workers associated with possible fibre inhalation	Stop work. Site manager to contact Auckland Council's Environmental Health Officer (via AC Call Centre - ph. 09 301 0101) and Contaminated Land and Closed Landfill team (Mark Crooks – ph. 021 340 547), who will advise on how to proceed. All workers to move at least 10m upwind of excavation. Any removal of asbestos to be undertaken by person certified under the Asbestos Regulations. Work to re-commence only once advised by the Auckland Council Environmental Health Officer.

Plan prepared by: Andrew Stewart Ltd

Contact a suitably qualified and experienced contaminated land practitioner if there is any doubt around appropriate actions to take in the event of encountering contaminate or suspect material.

3.6 Works notification

As a Permitted Activity requirement, Auckland Council Natural Resources & Specialist Unit (Contaminated Land & Closed Landfill Team) is to be notified of the intention to start works. Auckland Council's Environmental Health Officer should be similarly notified.

APPENDIX A

Oakley Creek Ecological Restoration Project HAIL Maps

AA1298 OAKLEY CREEK

Figure 2a: HAIL Sites

0 25 50 75 100 m

1:3,000 @A4

0 25 50 75 100 m

AA1298 OAKLEY CREEK

Figure 2b: HAIL Sites

Plan prepared for Auckland Council by Andrew Stewart Ltd

Date:
Version: 0.1
Author:
Checked:
Approved:

1:3,000 @A4

0 25 50 75 100 m

AA1298 OAKLEY CREEK

Figure 2c: HAIL Sites

Plan prepared for Auckland Council by Andrew Stewart Ltd

Date: 26/02/2015
Version: 0.1
Author: Paul Ironmonger
Checked: Simon Kall
Approved:

ANDREW STEWART