Huia WTP Upgrade

Assessment of Ecological Values
Prepared for Watercare Services Limited

5 July 2018

Boffa Miskell

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1.0 Introduction

1.1 Background

The Huia water treatment plant, located at the corner of Woodlands Park Road and Manuka Road, is Auckland's third-largest water treatment plant. It treats water from the Upper and Lower Huia Dams and Upper and Lower Nihotupu Dams, comprising almost 20 percent of Auckland's water supply. The plant is nearing the end of its operational life and needs to be replaced.

In June 2017, Manuka Road, Waima was selected by the Watercare Board as the preferred site for the replacement treatment plant. Huia water treatment plant has an unconstrained peak production of 126ML/d. The new treatment plant will allow for more efficient treatment of the water from the four supply dams, increasing maximum production to 140ML/d.

1.2 Site Context

The preferred site ("the Project Site") is located in Waitakere Ecological District, in the peri-urban foothills of the Waitakere Ranges, and within the Waitakere Ranges Heritage Area[1].

The Waitakere Ranges Heritage Area Act 2008 describes the ecological importance of the ranges as follows:

"*The Waitakere Ranges and its foothills and coasts comprise an area of some 27,720 ha of public and private land located between metropolitan Auckland and the west coast of Waitakere City and Rodney District. The area is of local, regional, and national significance. The area is outstanding in northern New Zealand for its terrestrial and aquatic ecosystems, which include large continuous areas of primary and regenerating lowland and coastal rainforest, wetland, and dune systems with intact ecological sequences. The area contains distinctive and outstanding flora, fauna, and landscapes…The Waitakere Ranges also contribute to metropolitan Auckland's water supply*…"

The Waitākere Ranges ecosystem as a whole is nationally significant as one of the largest areas of coastal and lowland forest with intact sequences remaining in the Auckland Region. The forest types reflect the history of forest clearance and milling but include remnant kauri and podocarp broadleaf forest, coastal forest and large areas of regenerating manuka and kanuka shrubland. Forest in the foothills of the Ranges provides the ecological connections, linkages and stepping stones for wildlife from the Ranges to the Manukau Harbour and across the Auckland isthmus to the Hauraki Gulf. The Waitakere Ranges are part of the Northwest Wildlink, a corridor of interlinking habitat between the Ranges and the Hauraki Gulf Islands.

The land parcel that comprises the Project Site is largely bush-clad, encompassing 11.6 ha of native forest and scrub that forms part of Significant Ecological Area (SEA) T_5539 in the Auckland Unitary Plan Operative in part (AUP-OiP). This SEA encompasses approximately 24,000 ha of predominantly indigenous forest across the Waitakere Ranges (excluding cleared

[1] The Waitākere Ranges Heritage Area Act 2008 (the Act) was put in place to recognise the area's national, regional and local significance and to promote the protection and enhancement of its heritage features for present and future generations. The Act requires any council decisions, documents, policies and regulations or resource consent applications affecting the heritage area to be considered against the Act's objectives. Act intersects with a wide range of other legislation, including designations for Waitākere's water supply network.

and developed parts such as roads, residential houses, gardens and recreation areas, rural farmland etc) that extends from the remote western coastline to the rural and suburban foothills in the north and east. Approximately 17,000 ha of indigenous vegetation and habitat within SEA_T_5539 is managed as regional parkland. Forest ecosystems characteristic of the Waitakere Ranges including kauri podocarp forest and regenerating secondary forest are dominant in the site, and representative freshwater habitats are also present.

The vegetation within the Project Site reflects the history of forest clearance and milling throughout the Ranges generally (c.f. Esler 2006), and includes remnant kauri, podocarp-broadleaved forest and large areas of regenerating forest and shrubland. As with much of the surrounding landscape, historic aerial photographs illustrate the site's history of vegetation clearance, modification and regeneration (Figure 2).

The Project Site is within the parcel of land titled Nihotupu Filter Station property (AC GeoMaps). This land parcel is located within the Little Muddy Creek catchment, within the wider Manukau Harbour catchment. The existing Huia WTP currently sits within the upper reaches of Armstrong Gully, while the proposed new WTP will primarily be located within the headwaters of the Yorke Gully (left branch). The Yorke Gully receiving environment is located within Waitakere Ranges Regional Parkland, commonly referred to as Clarks Bush. Both of these streams discharge into the Waituna Stream, before discharging into Little Muddy Creek.

Within the local context, the site is connected to and forms a linkage with regional parkland to the south (which contains two of the oldest kauri trees in the Auckland region[2]) and west, and to a network of forest patches in the Titirangi-Waima area. Forest is fragmented by roads and urban settlement, but forest canopy cover is dense and characterised by stands of regenerating kauri. The site therefore has an important connecting function within the local context, and is part of a wider area of adjoining kauri forest and regional parkland.

The Waitakere Ranges are a botanically rich area containing 20% of New Zealand's vascular plant species and 60% of New Zealand fern species. Kauri forest, and kauri, podocarp, broadleaved forest (generally derived from logged kauri forest[3]) largely comprise the mature forest remnants, within a matrix of regenerating kanuka-dominated forest containing emerging kauri rickers and podocarps. Historically kauri forest seems to have been best developed on river terraces, coastal plains and the generally flat flood basalts[4]. Due to historic logging, extensive tracts of mature kauri forest is now largely restricted to hill country in Coromandel, Northland, Great Barrier and Little Barrier Islands, and the Waitākere and Hunua Ranges. The Waitakere Ranges contains approximately 2,500 ha of dense kauri forest as well as many small stands and extensive areas containing individual trees (Hill et al 2017).

[2] Clarks tree and Bishop tree; New Zealand Tree Register 56

[3] Singers et al 2017

[4] Agathis australis http://nzpcn.org.nz/flora_details.aspx?ID=2047

File Ref: A16055C_10_Site_Context.mxd

Boffa Miskell
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0 100 200 m
1:5,000 @ A3

Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend
Site Boundary
Land Parcels

A16055C HUIA WTP ALTERNATIVES ASSESSMENT

Figure 1: Site Context

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Figure 2: 1940 (above) and 1959 (below) aerial photographs of the Project Site (source: Auckland Council Geomaps).

2.0 Survey Methods

2.1 Vegetation

2.1.1 Desktop Review

A preliminary assessment of ecological values within the project site had been undertaken as part of the alternative site evaluation process (Tonkin & Taylor 2012, Boffa Miskell 2017), including production of a preliminary vegetation map which was used to stratify sampling for the detailed survey work. Auckland Council's GeoMaps Biodiversity (Current Ecosystems) layer identifies all bush within the Project site and much of the surrounding landscape as WF11 - Kauri podocarp broadleaved forest (as described in Singers 2017[5]).The Project Site is identified as part of SEA_T_5539 which covers much of the forested Waitakere Ranges, however this evaluation is also evidently at a broad scale, as there does not appear to be any specific assessment data for the Project Site. Hence Council's Biodiversity classification and SEA status were primarily of relevance to our overall significance evaluation.

NZ Plant Conservation Network (http://nzpcn.org.nz) data available for the Project Site and its environs were compiled, while members of the Auckland Botanical Society also supplied records of notable species observations for the area.

2.1.2 Recce Plots

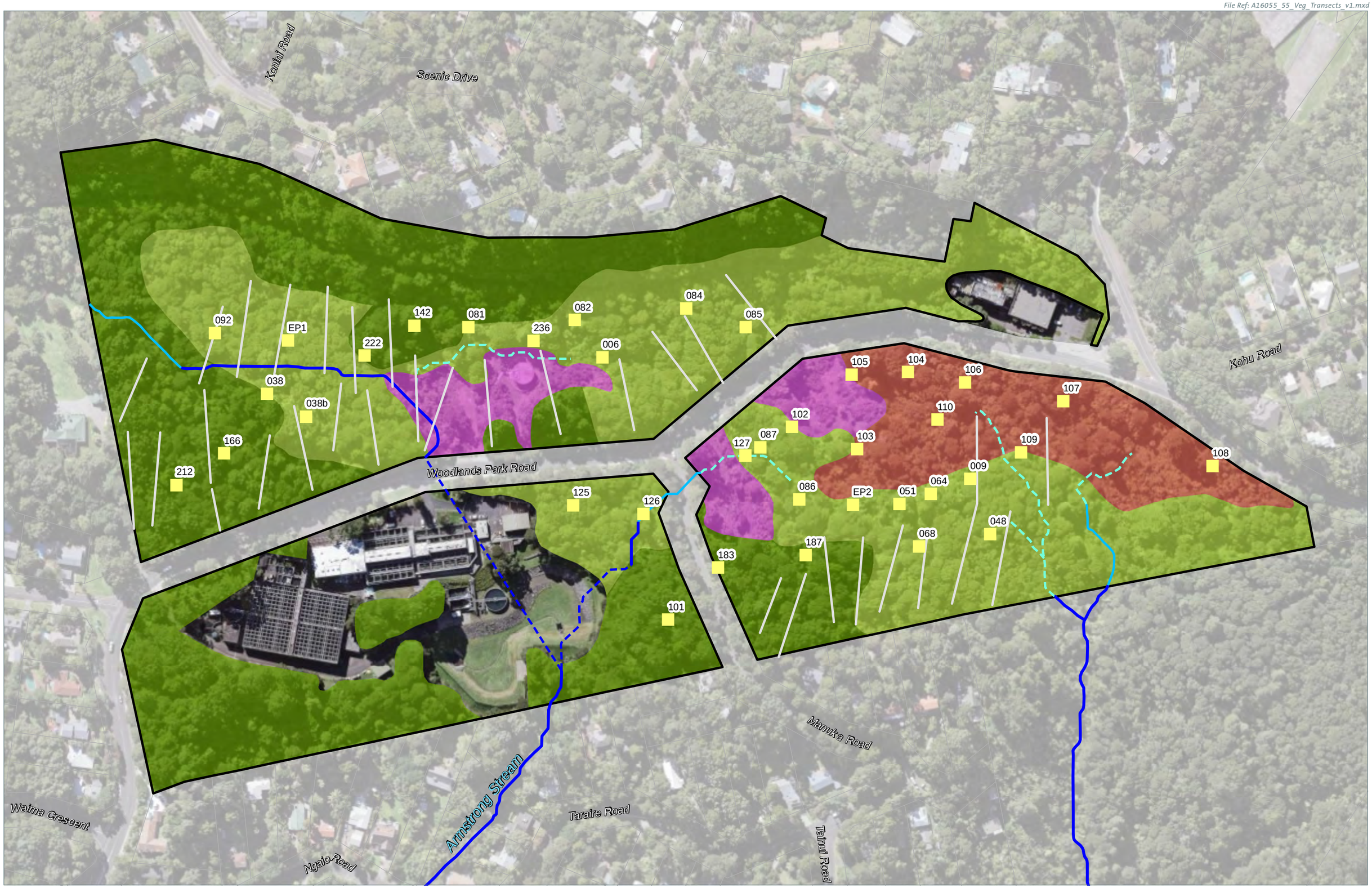
Vegetation composition data were collected via recce (reconnaissance plot) surveys of 37 10x10m plots[6] (randomly generated using an algorithm prior to commencing field work), stratified within vegetation types identified on the preliminary vegetation map (Figure 3). Objectives of this assessment were to identify habitats and plant communities present within the project area, including species composition, species abundance and vegetation structure, and to relate vegetation patterns to physical and historic site factors.

Within each plot, the cover-abundance of all species present is assessed in six standard height tiers. Six cover-abundance classes are used (< 1%, 1– 5%, 6–25%, 26–50%, 51–75%, 76–100%). A detailed description of the method is provided in Hurst & Allen (2007).

In addition to standard recce data collection, canopy tree species, height, and diameter of all specimens greater than 5 cm DBH were recorded to enable incorporation of plot data into biomass analyses.

[5] Singers et al 2017 notes (p.11) "*not all sites in the Auckland region support the full species composition described under the 'Characteristic native biota' headings. Regional variability, past disturbance or management may mean that some species are not present at a site. Therefore, some sites in Auckland may be classified as an ecosystem for which the description is not an exact match.*"

[6] The plot size used is the smallest required to sample all species present, so that sufficient numbers of plots will adequately sample the community composition.



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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell
Projection: NZGD 2000 New Zealand Transverse Mercator

Legend
- Vegetation Plots
- Vegetation Transects

Vegetation
- Kanuka Forest
- Kauri - Podocarp Forest
- Kanuka Broadleaf Scrub Mosaic
- Modified Scrub

Streams
- Permanent
- Permanent Piped
- Intermittent
- Ephemeral

A16055 HUIA WTP UPGRADE

Figure 3: Vegetation Sampling Locations

Date: 16 April 2018 | Revision: 1
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Advantages of the recce survey method are that it is relatively fast and efficient way to collect comprehensive and detailed information on species composition, species abundance and vegetation structure. Cover abundance is better correlated with biomass than plant density per se, and therefore gives a reliable indication of the influence of species in a community. Recce is a useful method when individuals cannot be consistently identified and counted, and is better at recording rare species and 'non-structural' life forms compared with other vegetation sampling methods. All species are listed, enabling identification of the distribution of uncommon and rare species.

Assumptions are that the plot size is large enough to capture most or all species present, and that all species present are recorded; and that observer accuracy is similar between sites and over time. Gradient analysis assumes that known/ measured site factors (topography, drainage, disturbance history, etc) represent main environmental gradients influencing composition. Limitations of the recce plot method are that cover abundance estimates are somewhat subjective and imprecise, with an unknown level of observer bias, while conspicuous species are likely to be overestimated. Nor does this method provide population density estimates (i.e., numbers of individuals).

2.1.1 Transect Surveys

Canopy trees were surveyed in a series of 33 belt transects across the site to provide additional information on forest structure and composition, including basal area, relative frequency and dominance within mapped vegetation types. Canopy tree species, height, and diameter of all specimens greater than 5 cm DBH were recorded along 50m x 3m belt transects, systematically sampled at 20 m intervals across the site (from a random starting point).

We used this information to assist in interpretation of ordination and classification analyses, description of vegetation types and assessment of ecological integrity. Measurements of individual trees also provided information on the age structure of the stand and the relationship between dominance and stem density.

The transect survey method assumes that the precision and accuracy of abundance estimates are not influenced by the selected length, layout or number of transects. Advantages of the transect method are that observer bias is less likely to influence results, as parameters are not subjectively estimated. Limitations are that non-random distribution of sample populations (as is usual for most populations) reduces precision and accuracy of the method. We note that the purpose of transect surveys for this study is primarily descriptive (i.e., no detailed statistical comparisons between experimental sites or treatments are undertaken), nevertheless these limitations are noted in our interpretation of results.

2.1.2 Data capture and supplementary information

Latitudes and longitudes were recorded for plots and transects using an ipad with GPS capability, along with incidental/ ad hoc records of conifers and other large trees, and site features of note. Geographic site data (watercourses and flood-prone areas, historic photographs showing site disturbance history, existing infrastructure) were compiled from information available online at Auckland Council's GeoMaps site. All mapped features were ground-truthed in the field using GPS navigation on an ipad.

A detailed topographic survey of the site undertaken for the project was used to ascertain physical gradients (slope, elevation, aspect etc).

2.1.3 Data analysis

Statistical analyses were undertaken using PAST (PAleontological STatistics), a software package developed for executing a range of standard numerical analysis and operations used in quantitative paleontology, earth sciences and ecology.

Classification and ordination were used to analyse recce plot data and describe vegetation patterns. Classification groups plots with similar species composition into distinct associations or communities, while ordination finds hypothetical variables that account for as much of the variance in a data set as possible, derives axes and orders the plots so that compositionally similar plots are close to each other. The distribution of plant communities and the ordination arrangement of plots are compared with the site factors to infer the causes for spatial changes in species composition.

Quantitatively based vegetation classification requires the use of a clustering algorithm. Our classification used UPGMA (Unweighted Pair Group Method with Arithmetic Mean), a simple agglomerative (bottom-up) hierarchical clustering method that is widely used for the classification of sampling units (such as vegetation plots) on the basis of their pairwise similarities in relevant descriptor variables (such as species composition).

Cluster analysis requires a subjective assessment of the 'logical break point' where sample groups represent meaningful ecological units. Ordination of the plot data assists in validating potential clusters and provides insight into "diagnostic species" that most strongly influence the groupings. We used Principal Components Analysis (PCA) to generate ordination axes.

Prior to analysis, we weighted cover classes by doubling scores of the top three canopy tiers, recognising the influence that the large stature vegetation components on environmental conditions within the stand (microclimate, soil, etc). No other data transformations or exclusions were made.

Stem density and DBH data analyses included calculation of basal area and stem density per transect/ plot. The basal area/ m^2 of transects was calculated by adding the basal areas ($BA=0.00007854 \times DBH^2$) of all trees in an area and dividing by the area surveyed ($150m^2$). Stem density/ m^2 was calculated by dividing the number of stems per transect. These figures were standardised to $10m^2$ to enable comparison between plots and transects.

Canopy dominance patterns across the site were derived by identifying the largest tree per 10 m interval along a transect. Results for each transect were summed to give species an overall score between 0 (never dominant) and 5 (always dominant). Patterns of species dominance were plotted on an aerial photograph of the site, using the mid-point of the transect as the location of the summary point.

2.2 Herpetofauna

2.2.1 Desktop Review

Department of Conservation Bioweb Database (Herpetofauna) (30 November 2017) and Auckland Council Lizard records (March 2017) within 20 km of the site were assessed to provide context for lizard fauna recorded within the site and inform an assessment of ecological values for the Project Area.

2.2.2 Survey site selection

A preliminary field assessment was carried out on 6 October to identify prospective areas of suitable lizard habitat. Sample points were generated across the site in GIS using a random number algorithm. Ten survey sites were selected throughout the Project envelope, stratified within areas of suitable habitat, in order to encompass all broadly categorised vegetation and habitat types suitable for lizards.

Potential native frog habitats within the project area were assessed and found to be unsuitable because of sediment deposition or lack of loose refugia.

2.2.3 Sampling methods

Lizard survey methods included:

- Systematic searching (checking refugia and nocturnal spotlight surveys)
- Live trapping (pitfall traps), and
- Artificial retreats (Onduline boards)

Lizard surveys were used to assess species presence, not to determine relative or absolute density of populations.

Five pitfall traps and five artificial retreats were installed at each survey site (Figure 4). Pitfall traps and artificial retreats were micro-sited next to potential lizard habitats including loose rocks and piles of wood to increase to potential to attract lizards. Geckos were surveyed by roaming spotlight survey, focussing on vegetation edges and incorporating all potential gecko habitat types.

Lizard survey methodology was consistent with techniques described in the DOC Herpetofauna Inventory and Monitoring Toolbox and was carried out under the Wildlife Act Authority number 61087-FAU.

Department of Conservation Bioweb Database (Herpetofauna) and Auckland Council Lizard records within 20 km of the site were assessed to provide context for lizard fauna recorded within the site and inform an assessment of ecological values for the Project Area.

Figure 4: Lizard pitfall trap (left) and artificial refuge (right).

2.2.4 Timing

Lizard surveys were timed to avoid unsuitable weather, including extremely hot and dry weather (December – February) and scattered rain or cold weather (various). Nocturnal surveys were carried out after sunset between 8 pm and 11 pm on warm, dry nights. Pitfall trapping and systematic searching and artificial retreat checks were carried out daily, in the morning from 26 February – 2 March 2018 (Table 1) during a period of fine, warm weather.

Table 1: Lizard survey effort, timing and weather conditions.

Date	Activity	Weather conditions
11/9/17	Pitfall trap and AR setup	n/a
25/10/17	Nocturnal survey (4 person hours)	Calm conditions, light cloud 14°C.
26/10/17	Nocturnal survey (3.5 person hours)	Calm conditions, light cloud 15°C.
7/11/17	Nocturnal survey (4 person hours)	Warm, calm conditions with light cloud.
26/2/18	Check ARs, open pitfall traps	Warm (15-24°C).
27/2/18	Check ARs and pitfall traps	Warm (19-25°C).
28/2/18	Check ARs and pitfall traps	Warm (19-24°C).
1/3/18	Check ARs and pitfall traps	Warm (19-25°C)
2/3/18	Check ARs and pitfall traps. Remove traps.	Warm (19-26°C)

2.3 Bats

2.3.1 Desktop Review

The Waitakere Ranges is key habitat for long-tailed bats in Auckland and multiple bat surveys have undertaken in the vicinity of the Site. Literature from bat surveys undertaken in the area was reviewed including bat data previously collected by Boffa Miskell. Further data was requested from the Auckland Council fauna database (B Paris 2017, pers. comm., December 22).

File Ref: A16055_58_Acoustic_Bat_Survey_Locations.mxd

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0 25 50 m
1:2,000 @ A3

Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend
- Automatic Bat Monitors
- Swamp Area
- Vegetation / Existing Use
- Kanuka Forest
- Kauri - Podocarp Forest
- Kanuka Broadleaf Scrub Mosaic
- Modified Scrub
- Existing WTP
- Decomissioned WTP
- Land Parcels

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Figure 5: Acoustic Bat Survey Locations

Date: 10 April 2018 | Revision: 0
Plan prepared by Boffa Miskell Limited
Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* SGa | *Checked:* GCu

2.3.2 Baseline Acoustic Survey

The baseline bat survey was undertaken using automatic bat monitors (model ARM v1.2, henceforth referred to as ABM) which passively record both long-tailed bat (40 kHz) and lesser short-tailed bat (28 kHz) echolocation calls on two concurrently operating frequency channels. They operate remotely by recording and storing each echolocation call (bat pass), along with the date and time of occurrence. Spatial survey design

A 100 m by 100 m grid was overlaid on the project area in ArcGIS. From this grid, six transects were created each 100 m apart and acoustic recording devices placed at 100 m intervals along the transects to cover different vegetation types across the site as well as key habitat features used by bats including roads, open areas, watercourses and vegetation edges. This transect layout was used an indicative survey design when deploying the recording devices in the field. However, the final placement of the ABMs was determined by the bat specialist in the field and the survey locations shifted from the proposed grid layout to increase the probability of bat detections by targeting high quality habitat features (Figure 5).

2.3.1 Timing

ABMs were deployed during the spring and summer period when pups are young and maternity roosts are occupied. This monitoring period was chosen as during the breeding season, breeding female bats and their dependant young are occupying maternity roosts that generally occur in the most productive habitat within their colony's range (Pryde, O'Donnell, & Barker, 2005). Consequently, if high levels of bat activity are recorded in the project area during this period it is likely the project area is in the vicinity of core habitat for a bat colony. The timing of bat activity can also be analysed to provide an indication of maternity roosts being located in close vicinity to the site. The deployment period of the acoustic recorders was 11 November 2017 – 11 January 2018. During this time, some recorders were redeployed at new locations within the site, Table 1 shows the deployment period at each survey location. Recorders were programmed to record from one hour before sunset to one hour after sunrise each night.

2.3.1 Data analysis

Long-tailed bat activity is influenced by overnight temperatures and rainfall (O'Donnell, 2000). Weather data from the survey period was analysed to ensure conditions were suitable for bats to be active and therefore detectable via acoustic recordings. Suitable conditions are henceforth referred to as 'fine weather nights' and are defined for the purpose of this report as nights where the temperature was above 10°C at sunset and there was less than 5 mm of rainfall during the night.

Acoustic data from fine weather nights was analysed using BatSearch 3.12, a programme designed by the Department of Conservation.

2.4 Birds

2.4.1 Desktop Review

New Zealand Bird Atlas data (OSNZ 2007, derived from surveys undertaken in 1999-2004) was obtained for the 10 km x 10 km "square" within which the project area is located, and 5MBC data collected by Auckland Council from nine locations within the Waitakere Ranges over the

December – January 2017/18 survey interval as part of Council's Operation Forestsave monitoring programme (data supplied by Tim Lovegrove, Auckland Council). This data was used to compare species composition and relative abundance data from a range of habitat types across the Waitakere Ranges with the same data from within the Proposed Project Site (collected during the BML survey).

2.4.2 Five-minute bird counts and Incidental observations

Five-minute bird counts 5MBCs were carried out at eight locations across the site (Figure 6). The locations for individual 5MBCs were chosen to ensure a representative sample of habitats present was surveyed, with the assistance of the preliminary map of vegetation communities and site walkovers prior to commencement of surveys. Six individual 5MBCs were carried out at each site giving a total of 48 5MBCs undertaken during the site survey. The 5MBCs were carried out over three separate days (07/12/2017; 12/12/2017 and 21/12/2017) within a two-week period in December 2017, during which each of the eight sites was sampled twice.

The 5MBCs consisted of recording all bird species seen and/or heard during the count period (Dawson & Bull 1975). Individual birds were recorded once, the first time they were seen or heard. Counts began no earlier than 1.5 hours after sunrise and ended no later than 1.5 hours before dusk and avoided busy 'commuting' times (7:30 am to 8:30 am and 4:30 pm to 5:30 pm) to reduce the level of noise interference from traffic. Each count lasted five minutes and was preceded by a five-minute stand down period to allow activity to settle following observer arrival. To limit observer variability all counts were carried out by the same person and counts were on days with similar weather conditions with wet and windy conditions avoided. Individual locations for 5MBC are generally recommended to be spaced 200 m apart, however, several roads run through the site and so we attempted to balance adequate coverage of the site and vegetation types as well as a small set back from the road edge, and as a result several of the sites were closer than this.

All bird species heard or seen during 5MBCs as well as any bird species of note that were heard or seen incidentally during the course of the site survey were recorded. Binoculars (Bushnell 10 × magnification, 42 mm objective lens) were used to identify bird species during 5MBCs and incidental observations during the site survey.

In the event that any 'At Risk' or 'Threatened' species were recorded at the site, additional, species specific monitoring techniques (e.g. call playbacks) were to be utilised.

2.4.3 Acoustic monitoring

Acoustic surveys are widely used to sample avian communities for ecological research (Shonefield & Bayne 2017). Acoustic recording devices (ARDs) were used during these surveys to enhance the potential detection of bird species from 5MBCs undertaken during daylight hours as well as monitoring for nocturnal species. ARDs are most useful when utilised in conjunction with 5MBCs (that involve visual and call identification) as ARDs rely on birds to call or make distinctive wing flapping noises.

Nine ARDs (Version B.2) were set up at the site and spaced between 150 m to 200 m apart (Figure 6) and each was attached to a tree out of reach of people. ARDs were programmed to record daily from 7:00 pm until 1:00 am and then from 5:30 am to 8:30 am and were left in place for 14 consecutive days and nights (07/12/2017 to 21/12/2017). Night time monitoring enabled nocturnal species to be identified whilst the early morning and evening monitoring captured the dawn chorus and crepuscular activity. Acoustic files were analysed using the software package RavenLite (Version 2.0) and the location and species of all detected birds was recorded.

File Ref: A16055_50_5_Minute_Bird_Counts_v1.mxd

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0 25 50 m
1:2,000 @ A3

Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

- 5 Minute Bird Counts
- Acoustic Recording Devices - Deployed Dec 17
- Acoustic Recording Devices - Deployed Apr 18
- Site Boundary

Vegetation / Existing Use

- Kanuka Forest
- Kauri - Podocarp Forest
- Kanuka Broadleaf Scrub Mosaic
- Modified Scrub
- Existing WTP
- Decomissioned WTP

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Figure 6: Bird survey points - 5MBC and ARD Locations

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Vegetation data collected during the BML surveys was used to identify seasonal food sources and maximise the potential to detect wide-ranging and transient species that may be visiting the site for specific resources like fruiting or flowering trees or cavities in mature trees. These points were then targeted using ARDs and two ARDS were deployed for eight consecutive days (05/04/2018 to 13/04/2018). These two ARDs were deployed adjacent to two large fruiting puriri trees within the Proposed Project Site (Figure 6) and the setup and recording intervals were identical to those deployed from 07/12/2017 to 21/12/2017.

2.4.4 Data analysis

Analysis of 5MBCs involved calculating the average number of each bird species recorded (seen and/or heard) per 5MBC station over the six count periods. The average number of birds per species for each 5MBC station was graphed (with error bars) to determine variability within the site. The average number of each species recorded across the entire site over the six count periods was compared with 5MBC data collected by Auckland Council from nine locations within the Waitakere Ranges (Figure 7). Each of the nine Auckland Council monitoring lines consisted of 15 individual 5MBC sites. Each count station had a radius of 100m and all birds seen and heard were counted, including within the column of air above. Stations were 200 m apart.

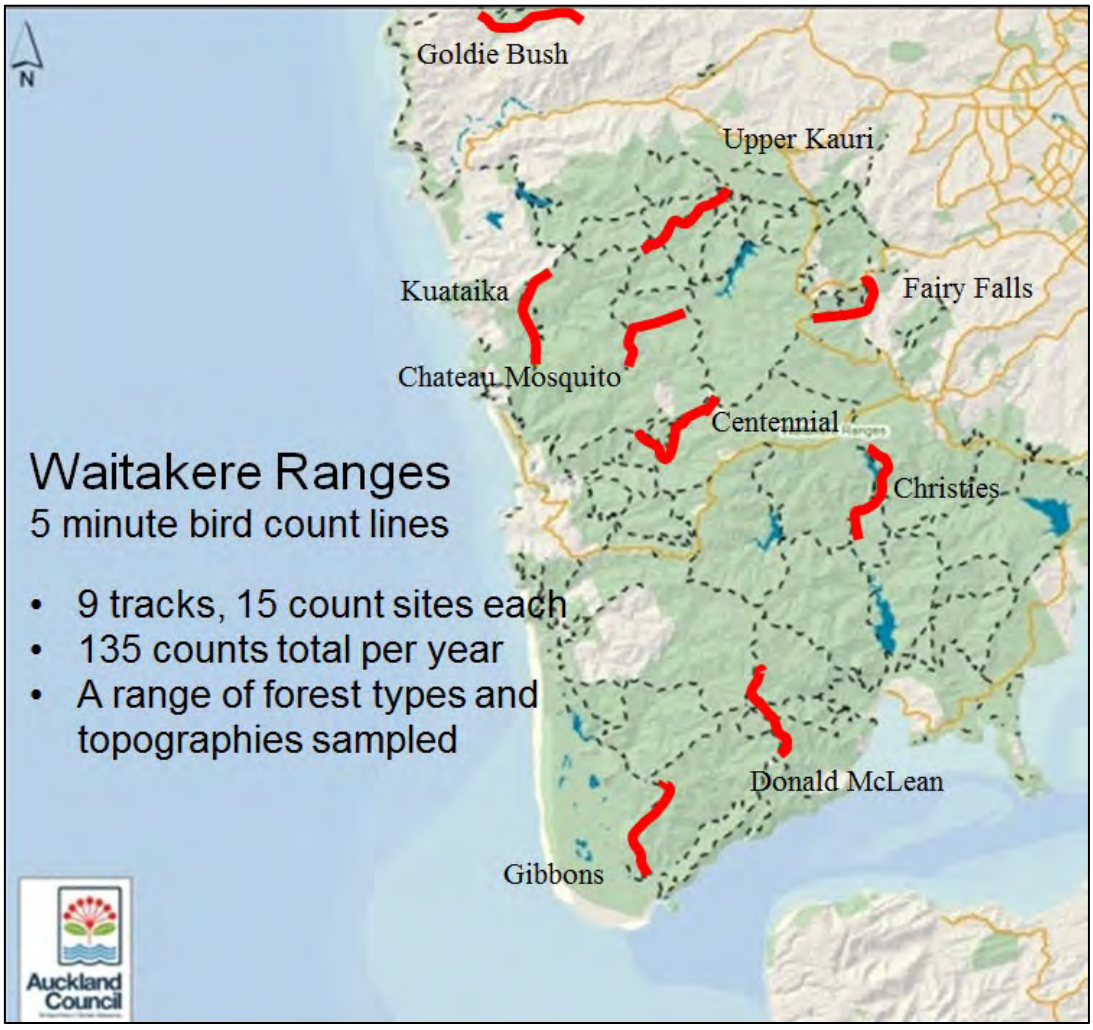

Figure 7: 5MBC data collected by Auckland Council from nine locations within the Waitakere Ranges.

2.5 Invertebrates

Dr Peter Maddison conducted a survey of the invertebrate fauna between July and December 2017 to inform Watercare's consent application, encompassing patches around Scenic Drive, Exhibition Drive, the Huia Aquaduct Track and Manuka road/Clark's Bush Reserve. The complete survey report is included in Appendix 1, while methods and results are summarised in this report.

Invertebrate surveys sampled soil, litter and ground level faunal elements, as these components are directly associated with the subject site, whereas the influence of the surrounding landscape is likely to influence the composition of mobile flying insect fauna present.

Sample locations included mature forest within Clark's Bush, along the Huia Aqueduct and in kahikatea-dominated wet forest opposite the existing water treatment plant. Three main sampling methods were used, including pitfall trapping, malaise trapping and litter extraction.

10 pitfall traps per site were laid along a transect in Clark's Bush and along the Huia Aqueduct at 20 m intervals, and installed in drier areas in a rough circle around the kahikatea wetland. Samples were collected at monthly intervals.

Two malaise traps were operated for 3 months, in the Clarks Bush and kahikatea forest sites.. 6 samples were collected in total.

Two leaf litter samples were collected for litter extraction from near the Clark's Bush track entrance, along with two samples from the kahikatea forest site.

All samples were examined under a dissecting microscope (X20) and sorted and recorded by recognisable taxonomic unit (RTU). Identifications were made by reference to existing specimens (e.g. in the National Arthropod Collection) or examination by expert taxonomists or systematists as required.

2.6 Freshwater Ecology

2.6.1 Desktop Review

Prior to any field surveys being undertaken the location of the proposed footprint of works were assessed relative to freshwater habitats. The desktop review informed the type of freshwater habitats that may be encountered. A preliminary site visit was also undertaken at some locations by a BML freshwater ecologist, prior to the formal freshwater survey fieldwork. The Auckland Council GIS platform, overland flow path layers, relevant New Zealand Freshwater Fish Database records, River Environment Classification stream orders and topographic maps were also utilised to inform the ecological value assessment.

2.6.2 Stream Classification

Prior to any formal ecological assessment all watercourses within the proposed footprint of works were assessed for their permanence. This assessment was undertaken in the field by walking the length of all watercourses and was based on the definitions within the Auckland Unitary Plan

– Operative in Part (Updated 14 December 2016)[7]. The permanence classification informed the survey site selection.

2.6.3 Habitat Assessment

Ecological values were assessed through a combination of methods. The Auckland Council Stream Ecological Valuation methodology, an Auckland Regional Council Habitat Assessment methodology and visual assessments were utilised across the different reaches.

Basic stream attributes were recorded for all watercourses while the stream permanence assessment was being undertaken. Stream attributes recorded included the following:

- Channel and bank habitat
- In-stream habitat
- Riparian habitat

Full habitat assessments were undertaken at selected permanent and intermittent stream sites. These full habitat assessments were predominantly in the form of Auckland Council Stream Ecological Valuation (SEV) Assessment Methodology as outlined in Auckland Council (2011). However, some sites were unsuitable for the SEV methodology and instead an assessment based upon an Auckland Regional Council habitat assessment methodology were undertaken (see Appendix 2).

Fish and macroinvertebrate communities were assessed at three sites. Fish communities were surveyed through electric fishing and the use of a NIWA backpack mounted EFM300 electric fishing machine and following standard protocols as outlined in the New Zealand Freshwater Fish Sampling Protocols (Joy et al 2013). These protocols recommend that a length of 150 m is fished in order detect >90% of the fish species present within the reach. Fishing this length of stream

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- [7] River or stream - A continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal except where it is a modified element of a natural drainage system).
- Intermittent stream - Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:
  a) it has natural pools;
  b) it has a well-defined channel, such that the bed and banks can be distinguished;
  c) it contains surface water more than 48 hours after a rain event which results in stream flow;
  d) rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;
  e) organic debris resulting from flood can be seen on the floodplain; or
  f) there is evidence of substrate sorting process, including scour and deposition.
- Ephemeral stream - Stream reaches with a bed above the water table at all times, with water only flowing during and shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.
- Overland flow path - Low point in terrain, excluding a permanent watercourse or intermittent river or stream, where surface runoff will flow, with an upstream contributing catchment exceeding 4,000m²
- Artificial watercourse - Constructed watercourses that contain no natural portions from their confluence with a river or stream to their headwaters. Includes; canals that supply water to electricity power generation plants; farm drainage canals; irrigation canals; and water supply races, but excludes naturally occurring watercourses.

was not practical for this assessment, and a reach of 50 m was fished at each site. This reach matched the reach for the habitat assessment.

Macroinvertebrates were collected and processed in accordance with national standard protocols C1 and/or C2 and P3 as described in Stark et al (2001).

Stream Ecological Valuation

The SEV is recommended by Auckland Council for providing an ecological valuation of stream functionality. The SEV uses a set of fourteen qualitative and quantitative variables to assess the integrity of stream ecological functions (**Table 2**; Auckland Council 2011). Field work consists of a comprehensive assessment of the in-stream and riparian environment. This includes a fish survey, aquatic macroinvertebrate sampling and cross-sections of the stream to measure width, depth and substrate, as well as using qualitative parameters for reach-scale attributes.

The SEV methodology recommends that a stream reach (or length) of 20 times the average stream width is surveyed, with a minimum length of 50 metres recommended. A length of 50 m was surveyed at each of the SEV sites.

***Table 2**: Summary of 14 ecological functions used to calculate the SEV score (Auckland Council 2011).*

Hydraulic functions:	Biogeochemical functions:
Processes associated with water storage, movement and transport. Natural flow regime Floodplain effectiveness Connectivity for species migrations Natural connectivity to groundwater	Relates to the processing of minerals, particulates and water chemistry. Water temperature control Dissolved oxygen levels maintained Organic matter input In-stream particle retention Decontamination of pollutants
Habitat provision:	Biotic functions:
The types, amount and quality of habitats that the stream reach provides for flora and fauna. Fish spawning habitat Habitat for aquatic fauna	The occurrences of diverse populations of native plants and animals that would normally be associated with the stream reach. Fish fauna intact Invertebrate fauna intact Riparian vegetation intact

This data is analysed using a series of formulae in order to produce an SEV score of between 0-1, where a 0 is a stream with no ecological functionality and 1 is a pristine stream with maximum ecological function. Accepted interpretation of SEV scores is provided in Table 3.

***Table 3**: Interpretation of SEV scores (Adopted from Golder Associates, 2009).*

Score	Category
0 - 0.40	Poor
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81+	Excellent

The application of the SEV methodology to intermittent streams has recently been tested through field trials, with the suitably of this method confirmed (Auckland Council 2016). The field

assessment and variables assessed remains the same for intermittent reaches, with the only change being the reference data within the calculation spreadsheet (Auckland Council 2016). The recommended season for SEV assessments of intermittent streams is between July and October, following a minimum of two months of winter flows.

The field surveys were undertaken on 19 October (Armstrong_impact), 20 October (Yorke_Impact; Yorke_receiving) and 16 November (Armstrong_receiving). Site Yorke_impact is an intermittent watercourse had almost no surface water present at the time of surveying, with only three very shallow, isolated pools present. A partial SEV assessment was undertaken, with data collected on as many attributes as possible. However, owing to the lack of surface water velocity, macroinvertebrate sample and fish surveys were unable to be undertaken.

The SEV methodology also allows the calculation of mitigation through the use of Environmental Compensation Ratio, which will inform mitigation options within the AEE.

Biological Indices

Macroinvertebrate Community Index

The Macroinvertebrate Community Index (MCI) score is a biotic index that can be used as an indicator of stream water quality. It relies on the fact that biological communities are a product of their environment – with different organisms having different habitat preferences and pollution tolerances (Stark & Maxed 2007). The MCI involves assigning tolerance values to all taxa based on their tolerance to pollution. Taxa that are characteristic of pristine conditions score higher than taxa that are found in polluted conditions, where 0.1 is the lowest and 10 is the highest. The final MCI scores are calculated using presence-absence data, with the score range from 0 to 200. The streams with no taxa present a score zero and streams in exceptionally pristine conditions score 200 (**Table 4**; Stark 1993).

The MCI-sb is a variation of the MCI designed for streams with a predominantly soft substrate (soft bottom), with adjusted taxa tolerance values. The MCI-sb is analogous with the MCI and either score may be used depending on the stream habitat.

Other Indices

Taxa richness and EPT taxa richness was also calculated for each site at which a macroinvertebrate sample was collected. Taxa richness is a count of the total number of different taxa present at each site. EPT taxa refers to the number of taxa present from within three pollution-sensitive orders of insects; Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). The purse-caddisfly species Oxyethira and Paroxyethira will be excluded from EPT calculations as they are considered to be generally pollution tolerant.

Fish Index of Biotic Integrity, or Fish IBI, is calculated for use within the SEV calculator. The Fish IBI is a measure of how intact the native fish community is within a stream reach or stream. Utilising a number of metrics including altitude and distance inland, and a large background of data from sites across Auckland, a number of between zero and sixty is calculated (Table 5; Storey et al 2011).

***Table 4**: MCI score interpretations (Stark & Maxted 2007).*

Quality Class	Descriptions	MCI or MCI-sb Score
Excellent	Clean Water	> 119
Good	Doubtful quality or possible mild pollution	100 - 119
Fair	Probably moderate pollution	80-99
Poor	Probably severe pollution	<80

***Table 5:** Attributes and suggested integrity classes for the Auckland Fish IBI (Storey et al. 2011).*

Total IBI Score	Integrity Class	Attributes
50–60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present. Site is above the 97th percentile of Auckland sites
4 –49	Very Good	Site is above the 90th percentile of all Auckland sites species richness is slightly less then best for the region
36–42	Good	Site is above the 70th percentile of Auckland sites but species richness and habitat or migratory access reduced some signs of stress
28–35	Fair	Score is just above average but species richness is significantly reduced habitat and or access impaired
18–27	Poor	Site is less than average for Auckland region IBI scores, less than the 50th percentile, thus species richness and or habitat are severely impacted
6–17	Very Poor	Site is impacted or migratory access almost non existent
0	No Fish	Site is grossly impacted or access non existent

3.0 Results and Interpretation

3.1 Vegetation Communities

3.1.1 Classification and Ordination

A total of 87 native vascular plant species were recorded during the vegetation survey (Appendix 3), comprising 7 gymnosperm tree species, 20 fern species, 40 trees and shrubs, 9 climbers and epiphytes and 11 herbaceous plants.

Hierarchical cluster analysis (UPGMA) of recce plot species assemblage data identified five groups of plots with similar composition (Figure 8), along with a further two classes (yellow and green) that had distinctive features (e.g., an understorey of parataniwha (*Elatostema rugosum*) at the yellow site) or unusual combinations (the two green sites contained both weedy scrub and large conifers) which set them apart from the main groups.

Assemblages i- iii described in Table 6 are somewhat related, and represent the less modified/ more mature forest types within the site. Groups iv and v are distinct from each other, but both contain a substantial component of broadleaved scrub.

Table 6: UPGMA Classification groupings

Group name[8]	Colour	Assemblage characteristics
i. Kauri forest	Red	Kauri dominant, with common mamangi and matipo; tanekaha, ponga, kohekohe, pigeonwood, rimu and rewarewa are usually present.
ii. Kauri-podocarp forest	Purple	Common mamangi, kanuka, matipo, kohekohe and ponga; patchy kauri, kahikatea and other podocarps.
iii. Kanuka – kahikatea forest	Dark blue	Abundant kanuka, usually with kahikatea. Ponga, mahoe, nikau and kohekohe are common.
iv. Kanuka - mahoe forest and scrub	Light blue	Abundant mahoe, generally with a patchy emergent tier of kanuka. Common kawakawa, hangeange, pate, ponga and nikau. Plots in this grouping are arranged along the toe of the escarpment that extends along the northern site boundary, and on the steep slope below Woodlands Park Road in the eastern corner of the site. However, the cluster analysis separates these two geographic areas into two subgroups, as only the northern plots in this group contain kohekohe and pigeonwood, while the plots below Woodlands Park Road contain abundant *Bartlettina* (an exotic 'garden escape' weed).
v. Mahoe scrub	White	Mahoe dominates this assemblage, while kanuka is sparse or absent. Nikau, hangehange and climbing asparagus are common, while kohekohe and Tradescantia are patchily present.

3.1.2 Canopy Dominance and Basal Area

Canopy dominance and basal area were plotted on aerial photographs and compared against UPGMA classifications and historic aerial photographs to validate and refine vegetation community boundaries. Patterns of canopy dominance for key species are shown in Figures 9(a) – (e).

Kanuka is the most common and widespread canopy dominant throughout the site (Figure 9a), but is notably sparse in areas where kauri is abundant (Figure 9b, 10b) and in mahoe scrub (Figure 9c). Patterns of kanuka distribution are a helpful guide in delineating the boundaries of these two vegetation types.

[8] Nomenclature follows Atkinson (1985) terminology for structural classes. See Appendix 4.

File Ref: A16055_54_Cluster_22_v1.mxd

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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell
Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Vegetation
- Kanuka Forest
- Kauri - Podocarp Forest
- Kanuka Broadleaf Scrub Mosaic
- Modified Scrub

Streams
- Permanent
- Permanent Piped
- Intermittent
- Ephemeral

Site Boundary

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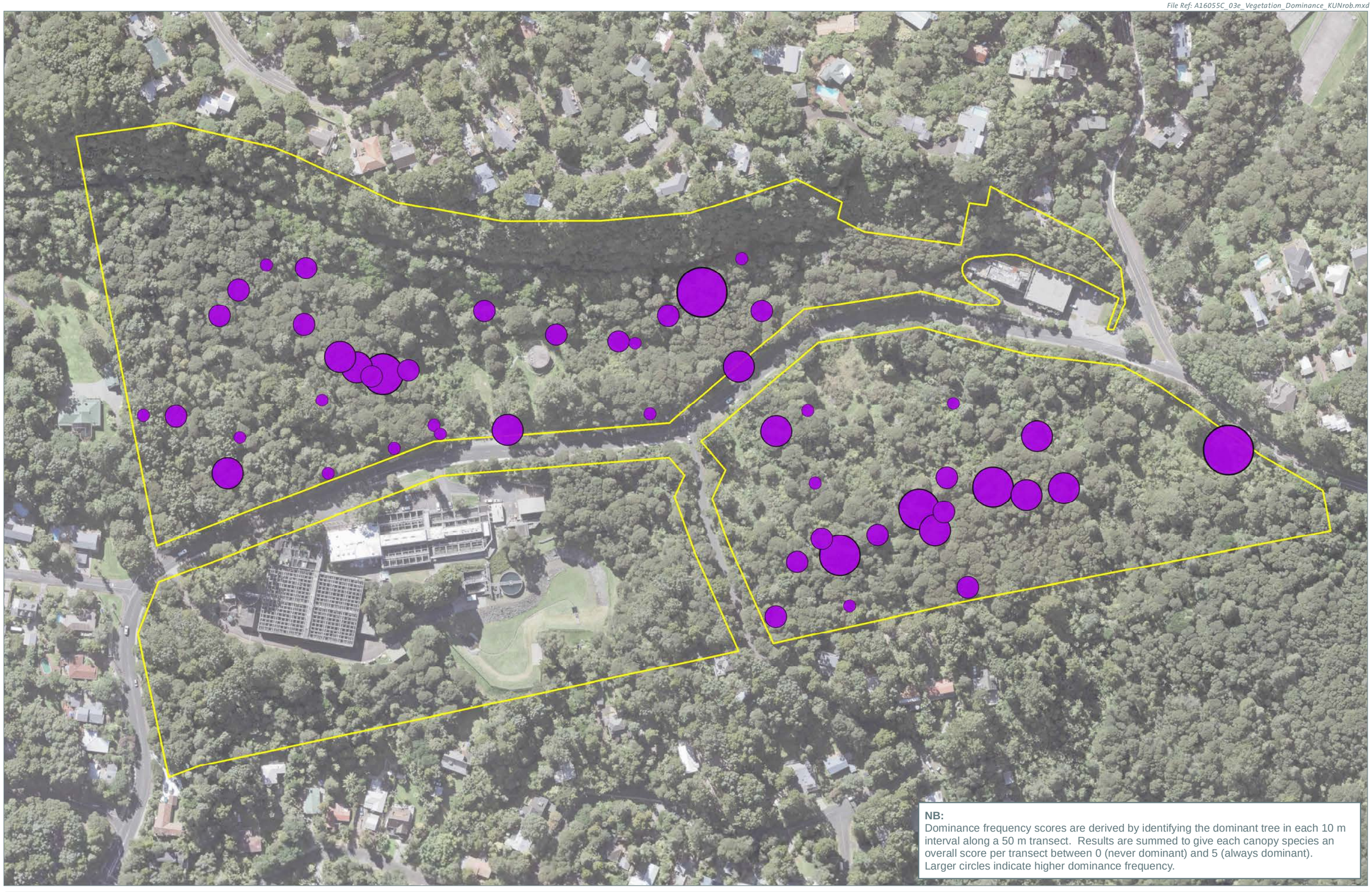
Figure 8: Vegetation Plot Cluster analysis

Date: 16 April 2018 | Revision: B
Plan prepared by Boffa Miskell Limited
Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* SFl



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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 9a: Dominance Frequency - Kanuka

Date: 16 April 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited
Project Manager: **ian.boothroyd@boffamiskell.co.nz** | *Drawn:* GCu | *Checked:* SFl

NB:
Dominance frequency scores are derived by identifying the dominant tree in each 10 m interval along a 50 m transect. Results are summed to give each canopy species an overall score per transect between 0 (never dominant) and 5 (always dominant). Larger circles indicate higher dominance frequency.

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 9b: Dominance Frequency - Kauri

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NB:
Dominance frequency scores are derived by identifying the dominant tree in each 10 m interval along a 50 m transect. Results are summed to give each canopy species an overall score per transect between 0 (never dominant) and 5 (always dominant). Larger circles indicate higher dominance frequency.

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 9c: Dominance Frequency - Mahoe

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NB:
Dominance frequency scores are derived by identifying the dominant tree in each 10 m interval along a 50 m transect. Results are summed to give each canopy species an overall score per transect between 0 (never dominant) and 5 (always dominant). Larger circles indicate higher dominance frequency.

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 9d: Dominance Frequency - Kahikatea

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NB:
Dominance frequency scores are derived by identifying the dominant tree in each 10 m interval along a 50 m transect. Results are summed to give each canopy species an overall score per transect between 0 (never dominant) and 5 (always dominant). Larger circles indicate higher dominance frequency.

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 9e: Dominance Frequency - Mamangi (*Coprosma arborea*)

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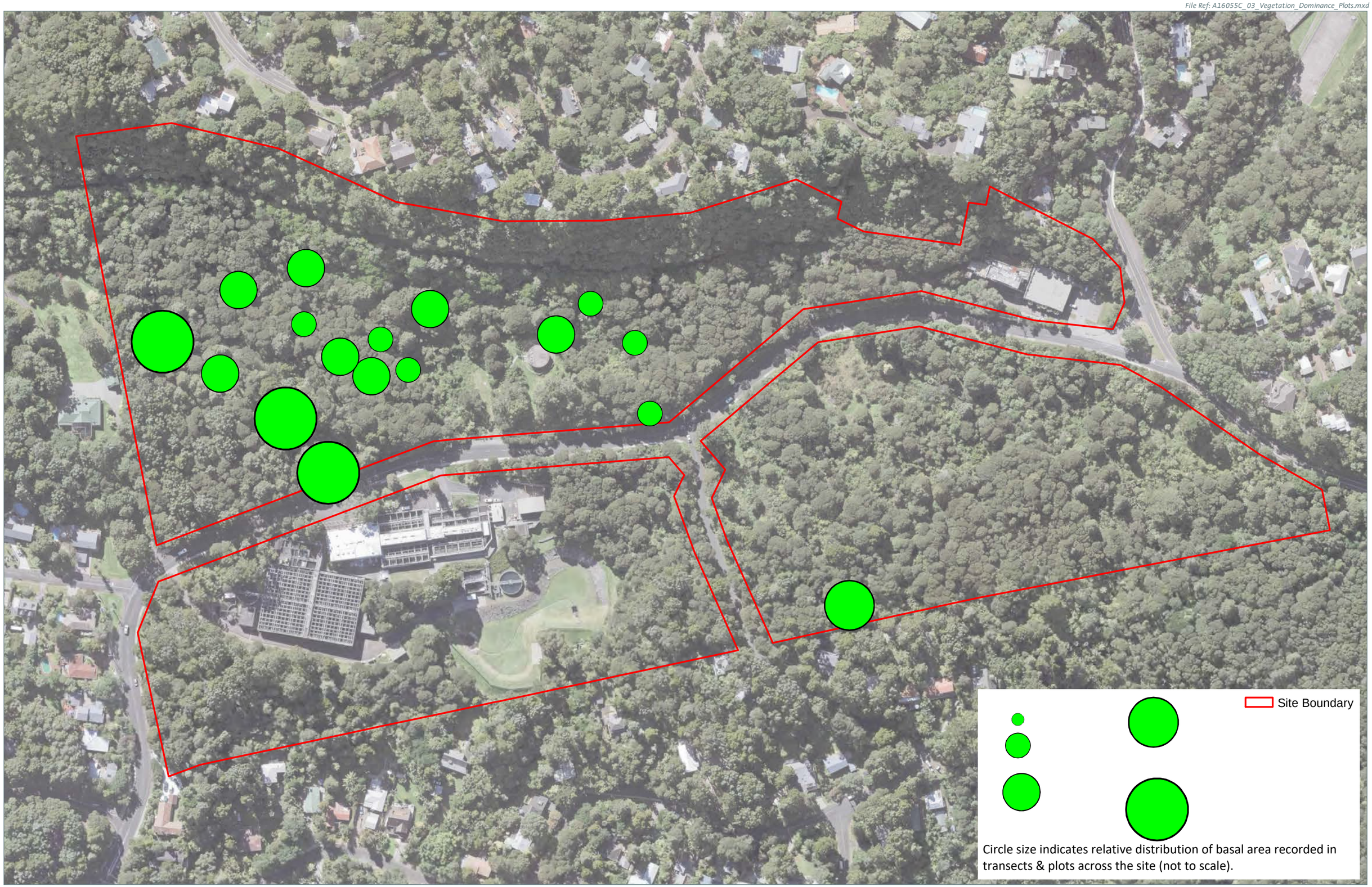

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 10a: Basal Area per Sample Unit - Kahikatea

Date: 24 January 2018 | Revision: 0

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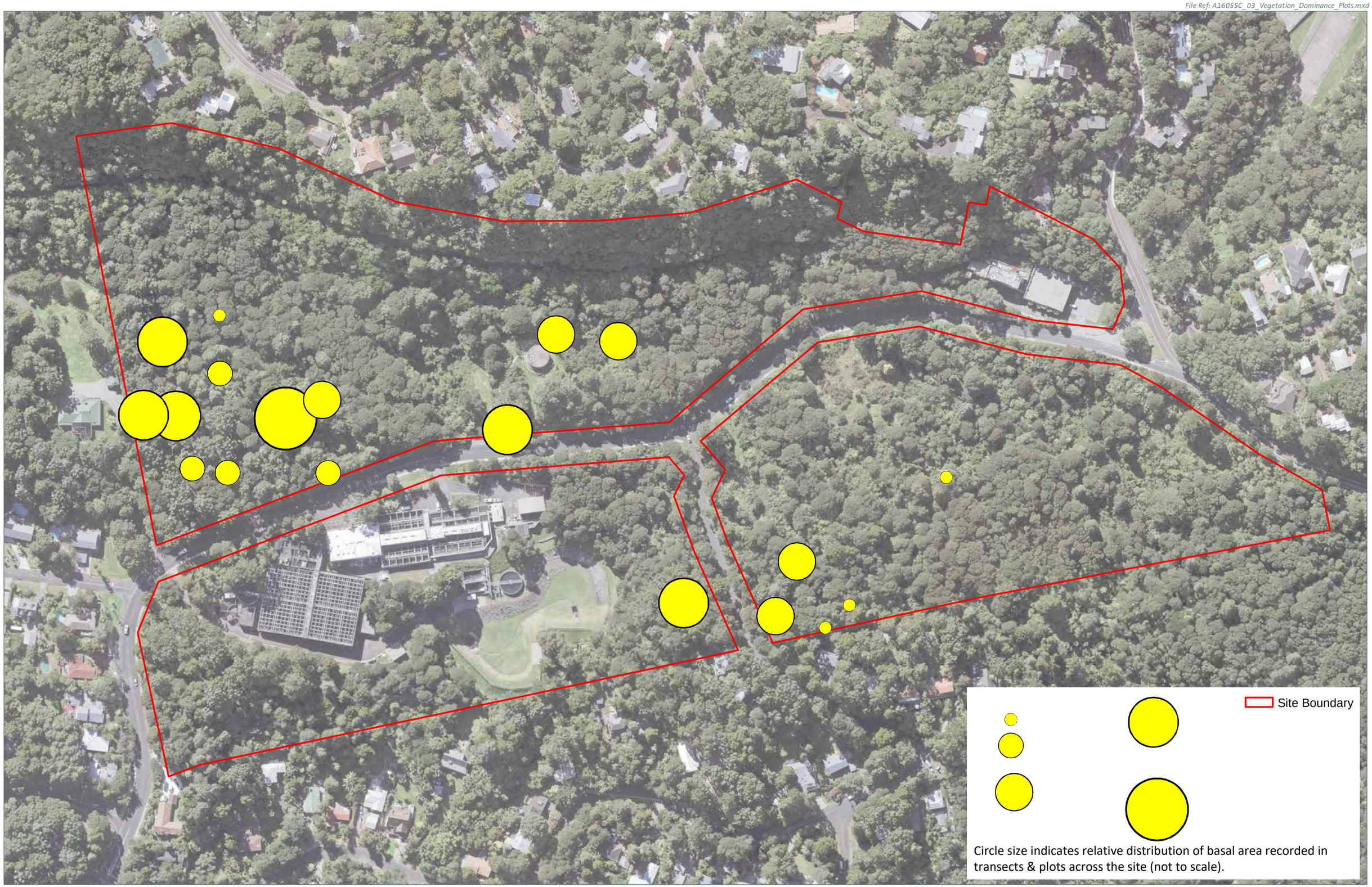

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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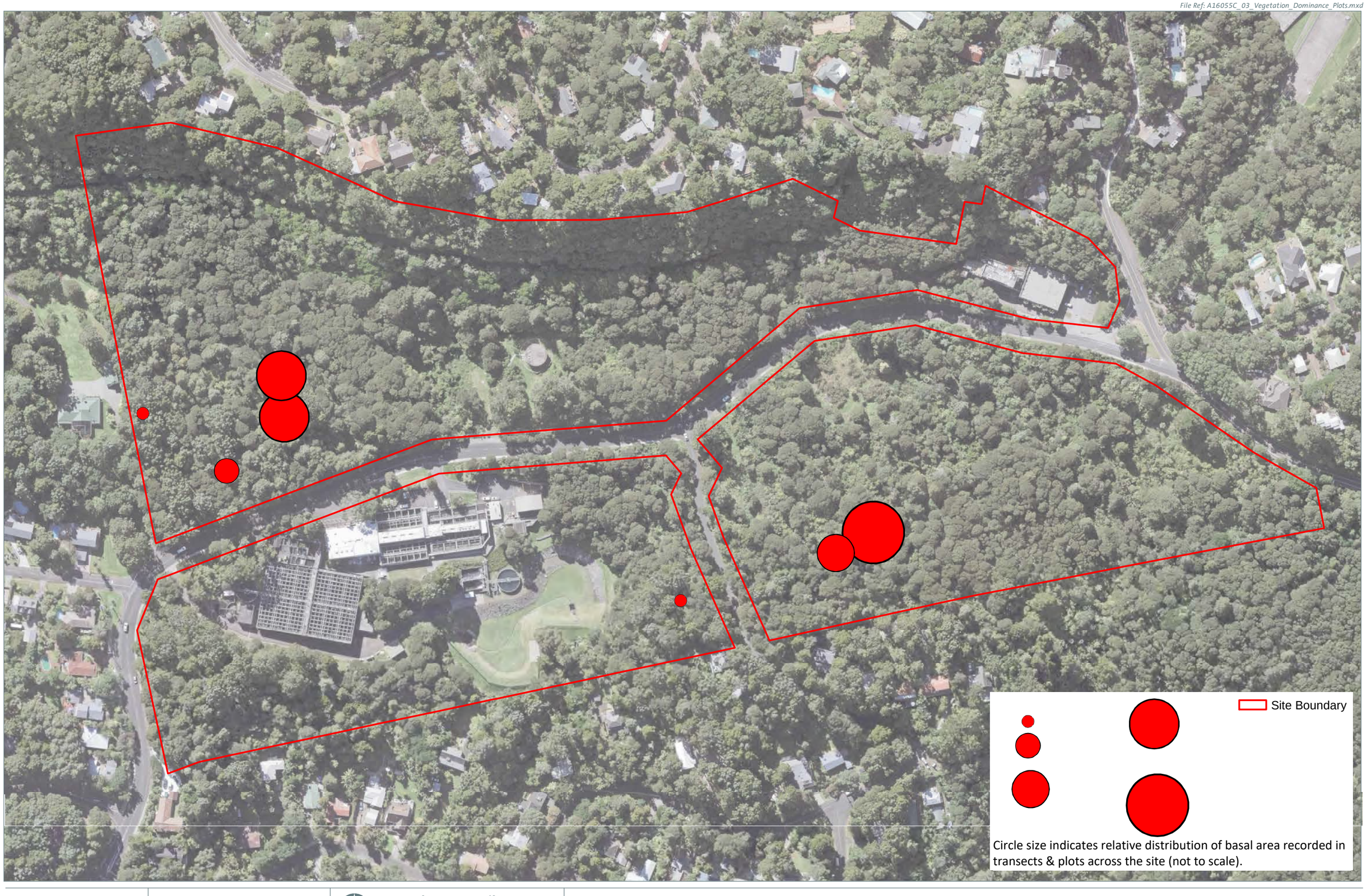
Figure 10b: Basal Area per Sample Unit - Kauri

Date: 24 January 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: **ian.boothroyd@boffamiskell.co.nz** | *Drawn:* MDu | *Checked:* SFl



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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055C HUIA WTP ECOLOGY ASSESSMENT OF EFFECTS

Figure 10c: Basal Area per Sample Unit - Rimu

Date: 24 January 2018 | Revision: 0

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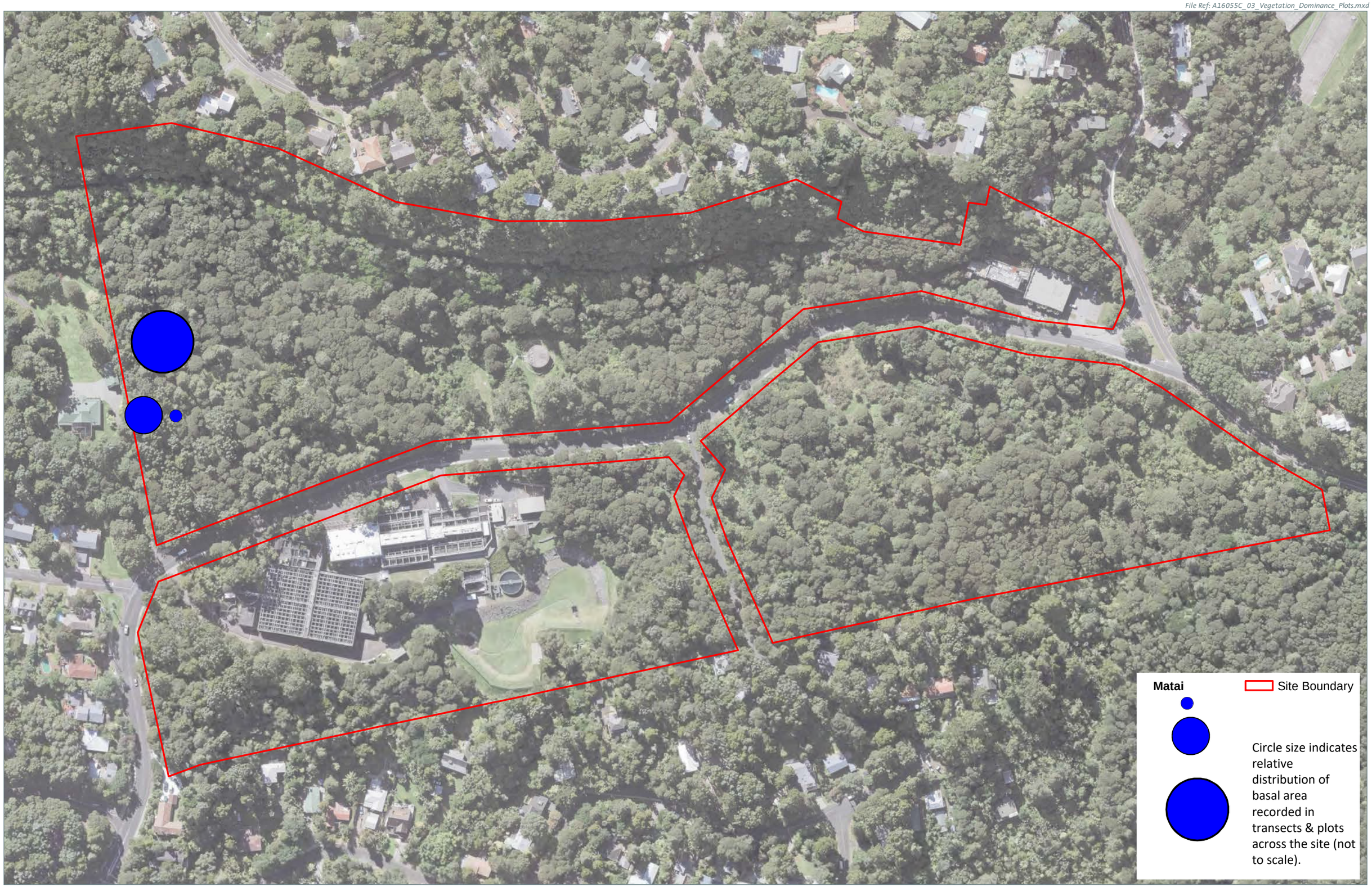

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

A16055C HUIA WTP ECOLOGY ASSESSMENT OF EFFECTS

Figure 10d: Basal Area per Sample Unit - Matai

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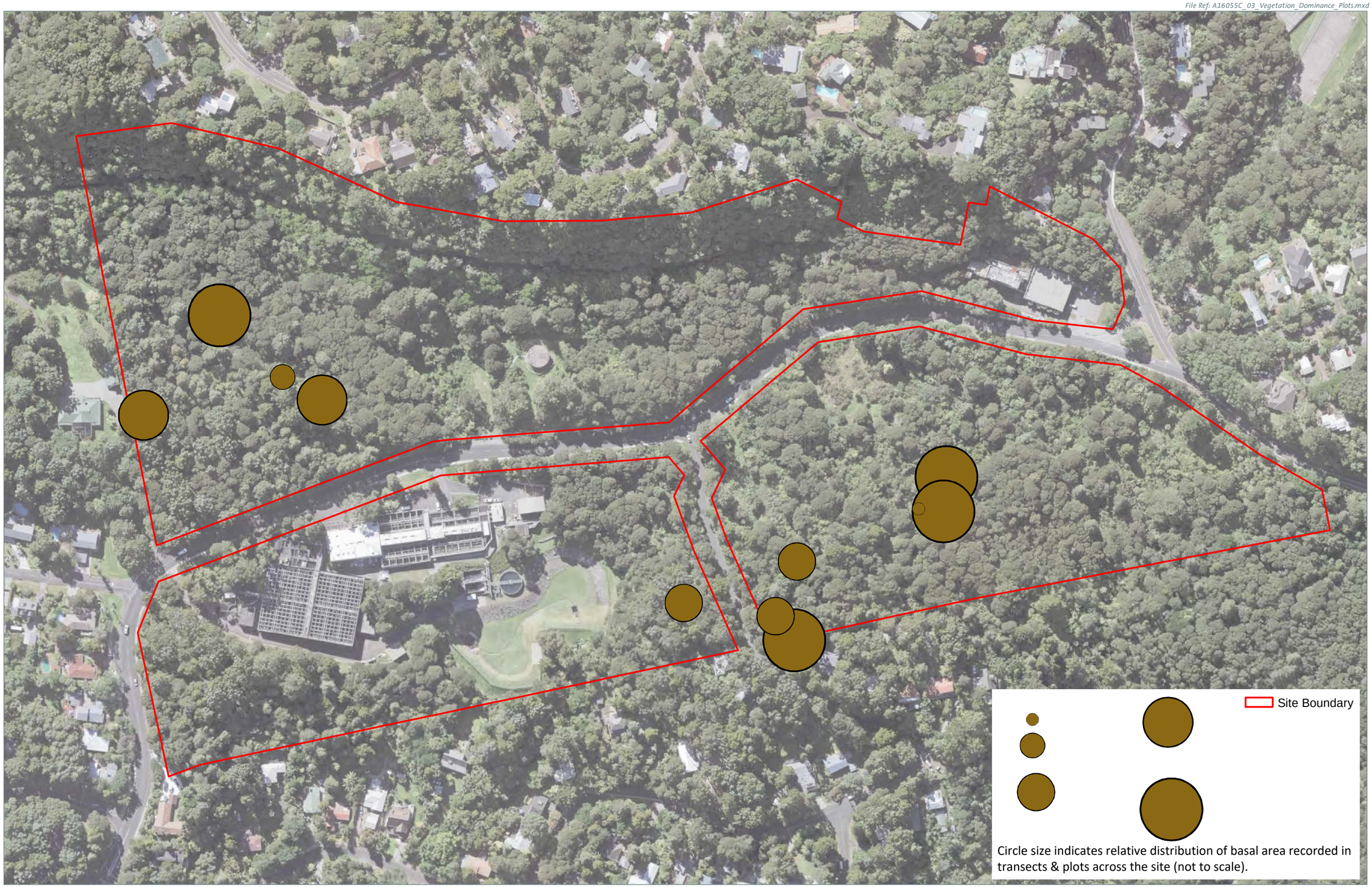

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 10e: Basal Area per Sample Unit - Tanekaha

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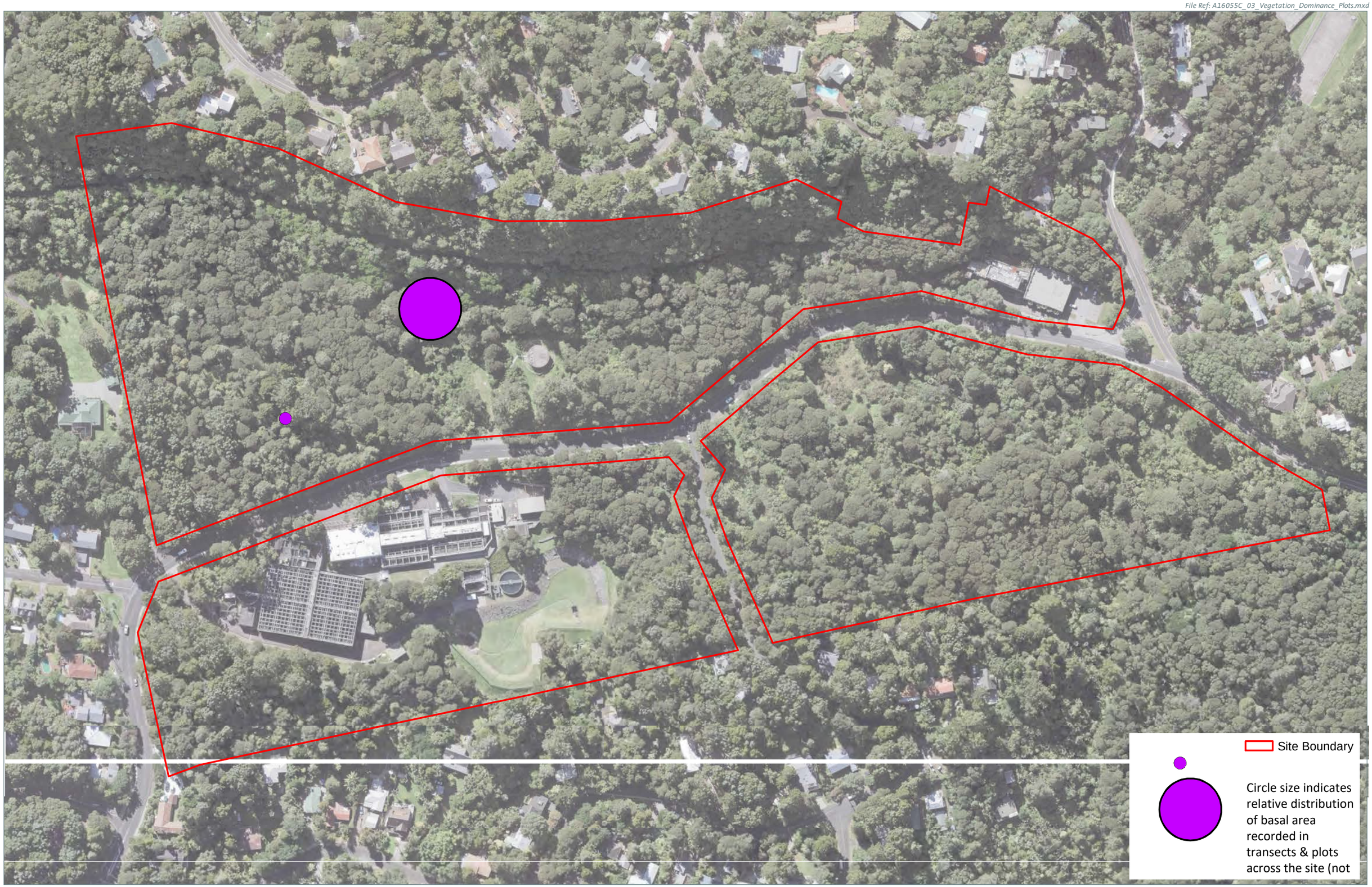

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Data Sources: LINZ, BML

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 10f: Basal Areas per Sample Unit - Totara

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Mahoe is a clear canopy dominant in the mahoe scrub community and more modified parts of the site and a common dominant in kanuka- mahoe forest and scrub. We infer from comparison with historic aerial photography (refer Figure 2) that abundant mahoe is likely to be associated with historic clearance.

Kahikatea is a common canopy dominant surrounding the watercourse and floodplain in the northwestern quarter of the site (Figure 9d), but diminishes in both dominance frequency and basal area (Figure 10a) towards the northeastern quarter, and is infrequently dominant in the southeastern quarter of the Project Site. The pattern of kahikatea distribution and biomass has led us to separate the kanuka-kahikatea forest class identified using the UPGMA analysis into kanuka forest and kahikatea forest vegetation types.

UPGMA analysis produced a mixed pattern of vegetation classes in the Project Site east of Manuka Road. Basal area plots of podocarps and kauri (Figures 10b - f) show an assemblage of large conifers in the area immediately adjacent to Manuka Road classed as kauri-podocarp forest, but few large conifers in the forest approximately 100m eastward of Manuka Road, though this is ostensibly the same vegetation class. Mamangi (an early successional forest tree) is a consistent canopy dominant throughout this area (Figure 9e), and may indicate that the vegetation pattern reflects a gradient of disturbance, with early and late successional stages of a single ecosystem unit present.

3.1.3 Vegetation mapping

Vegetation types were delineated using combined results from the UPGMA analysis and transect survey results (Figure 11). As detailed in the previous sections, these datasets generally concur, while transect canopy data helped to clarify some idiosyncrasies in the hierarchical cluster analysis.

Due to the disturbance history of the site, vegetation classes do not fully represent the presence and distribution of mature, mid-late successional canopy trees that were retained while the surrounding land was cleared. These trees contribute to habitat complexity and facilitate regeneration of the surrounding bush. Large canopy trees (i>30 cm diameter) encountered within and adjacent to the development footprint during surveys and site walkovers are shown in Figure 12. Note that early-successional species such as kanuka and mamangi are not mapped as the distribution of these populations are well represented in the vegetation classification.

We included two vegetation types in the vegetation map that were not derived from the vegetation classification or dominance analyses. Maire tawake – pukatea – kahikatea wetland forest was encountered during field surveys (transects intersect this feature) but not sampled using recce plots as this assemblage was was delineated using GPS. Areas of grassland and weedfield were not sampled in recce plot surveys but were mapped onto an aerial photograph and ground-truthed during site walkovers.

The vegetation mapping exercise confirms the broad Singers et al (2017) ecosystem classification of kauri, podocarp, broadleaved forest (WF11 - Endangered), but provides a finer-grained analysis that also identifies the presence of other forest ecosystems including swamp and flood-plain kahikatea forests (WF8 and MF4 – both Critically Endangered), and kauri forest (WF10 - Endangered), along with early and mid-successional stages of forest regeneration. Vegetation types are generally consistent with characteristic forest communities of the Waitakere Ranges.

Anthropogenic modification and disturbance remains a key influence on current vegetation composition, as indicated by species composition, stature, stem density and biomass, along with patterns of weed infestation. Species assemblages also differentiate areas that were once inhabited from parts of the site that were fully or partially cleared but allowed to revert to bush with minimal subsequent disturbance. The more modified arts of the site were inhabited for a period, with dwellings and gardens. The nature of this activity is reflected in the presence of scattered mature kahikatea and other canopy trees amongst areas of modified scrub (Figure 12), as well as substantial infestations of ornamental garden escapes (bartlettina, plectranthus, etc.)

Topographic and fertility gradients are evident in the pattern of kauri dominance on ridges & upper slopes, merging into kauri – podocarp forest on more fertile middle and lower slopes. Soil moisture is also a factor in forest composition, with kahikatea emerging as the predominant mature phase species in flood-prone areas, and swamp forest (maire tawake, pukatea and kahikatea) in the permanently wet site on the northwestern margin of the project area.

3.1.1 Kauri dieback

Likely symptoms of kauri dieback were observed on a single large kauri tree within the mature kauri forest stand in the northwestern quarter of the Project Site.

Kauri dieback has emerged as a major and significant threat to the future of the Waitakere Ranges Heritage Area's forest ecosystems. Mapping and surveillance (Hill et al 2017) has established that there are 344 distinct areas of kauri ecosystem within the Waitakere Ranges, and 33.4% of these areas have kauri dieback or possible kauri dieback symptoms present. Kauri dieback zones show a strong association with tracks and watercourses, while presence of bait lines may also be a factor.

3.1.2 Threatened ecosystem types

Mature or well-advanced successional stages of endangered or critically endangered forest ecosystem types (Singers et al 2017) cover more than 70% of the Project Site, with secondary forest and scrub communities, cleared areas and existing infrastructure comprising the remainder.

3.1.3 Threatened Plants

The Department of Conservation's most recent revision of the conservation status of New Zealand indigenous vascular plant taxa (de Lange et al 2018) includes kauri *(Agathis australis)* and all Myrtaceae in the nationally threatened plant list. Kauri, and all *Metrosideros* species recorded within the site including pohutukawa and climbing ratas *(M. diffusa, M. perforata* and *M. carminea),* are now assessed as Threatened – Nationally Vulnerable, while maire tawake *(Syzygium maire)* is now Nationally Critical. Kanuka *Kunzea robusta)* is classified as Nationally Vulnerable, and manuka *(Leptospermum scoparium)* is classified as At Risk.

The inclusion of kauri on the nationally threatened plants list is due to the appearance of Kauri Dieback disease, which is now known to occur in populations of kauri throughout its range (though large portions of kauri forest still appear free of the disease). Intact examples of kauri forest and kauri, podocarp, broadleaved forest within the Project Site are identified in Figure 11, however individual kauri trees, saplings and seedlings are sparsely scattered throughout the site.
Figure 11: Vegetation communities

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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

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Figure 11: Vegetation Map

Date: 04 July 2018 | Revision: C
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Project Manager: Ian.Boothroyd@boffamiskell.co.nz | *Drawn:* SGa | *Checked:* SFl

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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Vegetation
- Kahikatea - Kanuka Forest
- Kanuka - Kohekohe - Mahoe - Nikau Forest & Scrub
- Kanuka - Mamangi Forest
- Kanuka Forest
- Kauri - Podocarp Forest
- Kauri Forest
- Swamp Maire - Puketea - Kahikatea Forest
- Kanuka - Mahoe Forest & Scrub
- Mahoe Scrub
- Rough Grass & Weedfield
- Existing Infrastructure

Site Boundary

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Figure 12: Large Trees

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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Vegetation
- Kahikatea - Kanuka Forest
- Kanuka - Kohekohe - Mahoe - Nikau Forest & Scrub
- Kanuka - Mamangi Forest
- Kanuka Forest
- Kauri - Podocarp Forest
- Kauri Forest
- Swamp Maire - Puketea - Kahikatea Forest
- Kanuka - Mahoe Forest & Scrub
- Mahoe Scrub
- Rough Grass & Weedfield
- Existing Infrastructure

Site Boundary

A16055C HUIA WTP ECOLOGY ASSESSMENT OF EFFECTS

Figure 13: Threatened Plants

Date: 05 July 2018 | Revision: A
Plan prepared by Boffa Miskell Limited
Project Manager: Ian.Boothroyd@boffamiskell.co.nz | *Drawn:* SGa | *Checked:* SFl

Most new classifications of Myrtaceae as Nationally Vulnerable are a precautionary measure due to the as yet unknown impact of myrtle rust on native species. In particular, de Lange et al (2018) notes that the classifications for manuka, kanuka and common *Metrosideros* species are Designated, i.e., these abundant and widespread species do not meet standard threat status criteria. Kanuka is abundant throughout the entire site, and climbing ratas are also common, and particularly abundant in more mature vegetation. A single pohutukawa – rata hybrid is present within the Project Site immediately south of Woodlands Park Road.

Maire tawake is likely to be severely affected by myrtle rust, and has a fragmented distribution due to historic clearance and reclamation of wetland habitat. The maire tawake population within the Project Site is located in maire tawake – pukatea – kahikatea wetland forest (figure 13).

A mature specimen of *Elaeocarpus hookerianus* (Regionally Critical) was recorded within the Project Site, in the area mapped as kauri-podocarp forest (Figure 13).

3.1.4 Ecological integrity

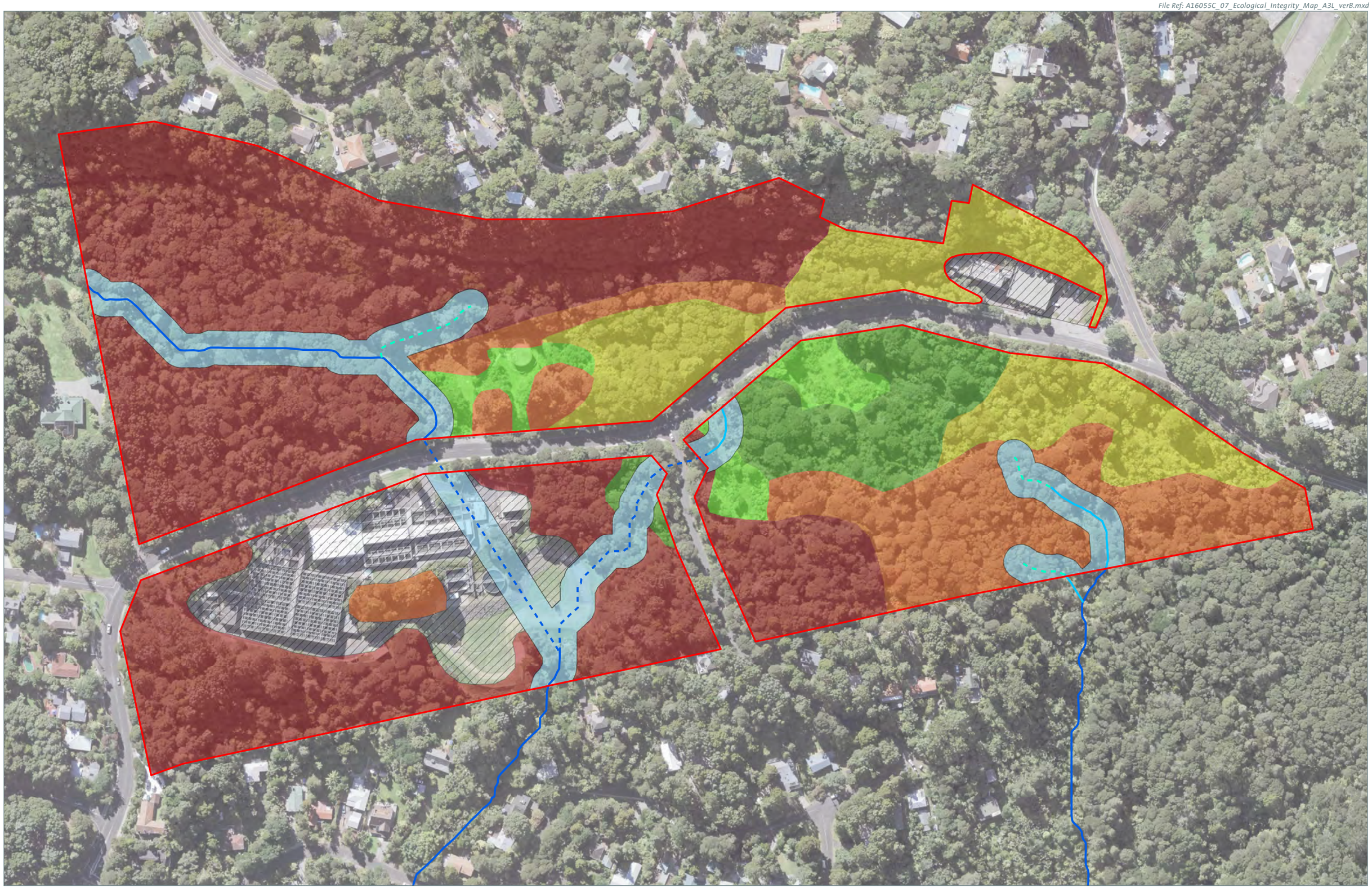
Ecological integrity assessment compares the structure, composition, and function of an ecosystem to reference ecosystems operating within natural or historic disturbance regimes. Metrics for assessing ecosystem integrity are increasingly being used in conservation management to enable comparative evaluation of prospective conservation areas, and to assess changes in ecosystem condition (Tierney et al, 2009).

A proper evaluation of ecological integrity requires inventory of reference sites and development of ecosystem-specific metrics, and site assessments would generally be undertaken at a larger scale than that of the Project Site. However, the approach of comparing component vegetation communities against a set of metrics that distinguish an impacted, degraded, or depauperate state from a relatively unimpaired, complete, and functioning state is useful to assist decision-making around ecosystem values and priorities for the site.

The following evaluation assesses the integrity of vegetation communities present. Mature indigenous forest is assumed to be the 'natural state' for the site. Kauri forest plots were used as the model 'reference state' (relatively unmodified old-growth forest) against which other vegetation types are assessed.

Each of the vegetation types identified in Figure 11 are evaluated against a set of factors that describe vegetation structure, condition and composition, and ranked on a 5-point scale from high integrity (red) to low integrity (light green). Factors chosen for evaluation included parameters that could be assessed using plot and transect data. Relative rankings against Ecological Integrity factors for vegetation types present within the site are presented in Table 7, and mapped in Figure 14.

The vegetation classification and ecological integrity evaluation identifies a gradient in the quality and condition of the ecosystem within the Project Site, and recognises that the more modified parts of the site are primarily of contextual value as buffers and connective linkages to areas of better quality.



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0 40 m
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Data Sources: LINZ Data Service (Aerials), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Ecological Integrity
- 1 Highest
- 2
- 3
- 4
- 5 Lowest
- Existing Infrastructure

- Site Boundary
- 10 m Stream Buffer

Streams
- Permanent
- Permanent Piped
- Intermittent
- Ephemeral

A16055C HUIA WTP ECOLOGY ASSESSMENT OF EFFECTS

Figure 14: Ecological Integrity

Date: 04 July 2018 | Revision: B
Plan prepared by Boffa Miskell Limited
Project Manager: ian.boothroyd@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* SFl

Table 7: Ecological Integrity Analysis

Ecological Integrity factors	*kauri forest*	*kauri – podocarp forest*	*kahikatea - kanuka forest*	*maire tawake - puketea - kahikatea forest*	*kanuka - mamangi forest*	*kanuka forest*	*kanuka-kohekohe-mahoe - nikau forest & Scrub*	*kanuka - mahoe forest & Scrub*	*mahoe Scrub*	*rough grass & weedfield*
Canopy health/ intactness										
Vegetation structure (3+ canopy tiers present & distinguishable)										
Regeneration of 2^0 successional species										
Native vegetation dominance in all tiers										
Native species richness and presence of significant flora										
Vegetation biomass										
IUCN threat status										

3.2 Herpetofauna

Database records within 10 km of the site included five native terrestrial lizard species (Table 8; Figure 15). The database contains three records of forest gecko within the Project area. Further, a diverse native lizard community has been detected the surrounding area, and suitable habitat for these species occurs on the site. Hence, there is a reasonable likelihood that a range of lizard species recorded in the wider vicinity are present.

Table 8: Lizard records within a 20 km radius of the proposed Huia WTP site.

Species	No. of records	Threat class
Copper skink (*Oligosoma aeneum*)	11	Not Threatened
Ornate skink (*Oligosoma ornatum*)	3	At Risk - Declining
Striped skink (*Oligosoma striatum*)	1	At Risk - Declining
Elegant gecko (*Naultinus elegans*)	5	At Risk - Declining
Forest gecko (*Mokopirirakau granulatus*)	25	At Risk - Declining

Six copper skinks and one unidentified skink were detected during site surveys (Figure 16). No geckos were detected. Skinks were recorded across the site in a variety of vegetation types, including kauri - podocarp forest, kanuka-mamangi forest, kanuka - kohekohe - mahoe - nikau forest & scrub, kahikatea - kanuka forest and at the edge of mahoe scrub.

Detection rates and diversity of native lizards within the Project Site were both very low, nevertheless the availability of appropriate habitat on the site, presents a reasonable likelihood that those species recorded in the surrounding are present.

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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, DOC, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Herpetofauna Records 5 km
- Copper Skink
- Elegant Gecko
- Forest Gecko
- Hochstetter's Frog
- Ornate Skink
- Pacific Gecko
- Striped Skink
- Unidentifed Skink

WTP Site

Approximate location of long-tailed bat roosting habitat

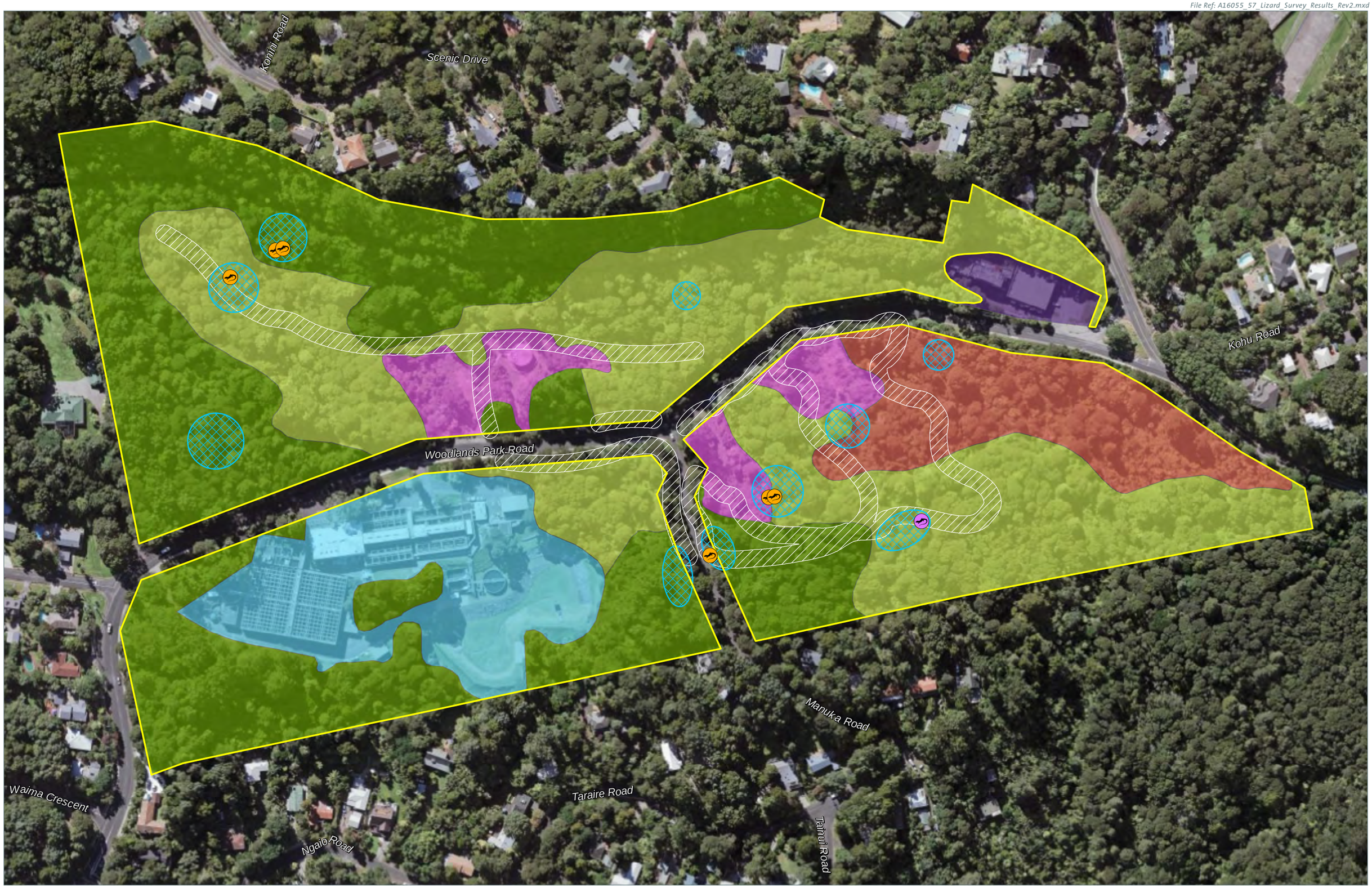
A16055 HUIA WTP UPGRADE

Figure 15: Fauna Records in Vicinity of Site

Date: 16 April 2018 | Revision: 1

Plan prepared by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* SFl



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0 25 50 m
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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell
Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

- Lizard Survey Areas
- Gecko Spotlighting Areas
- Lizard Observations
  - Copper skink (6)
  - Unidentified skink (1)
- Site Boundary

Vegetation / Existing Use

- Kanuka Forest
- Kauri - Podocarp Forest
- Kanuka Broadleaf Scrub Mosaic
- Modified Scrub
- Existing WTP
- Decomissioned WTP

A16055 HUIA WTP ALTERNATIVES ASSESSMENT

Figure 16: Lizard Survey Results

Date: 16 April 2018 | Revision: 2
Plan prepared by Boffa Miskell Limited
Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* GCu | *Checked:* KMu

3.3 Bats

During the survey period for acoustic monitoring, the minimum overnight temperature averaged 15.8°C and it dropped below 10°C on two nights. Rainfall was limited during the survey period with an average of 0.5 mm cumulative throughout the night (19:00 – 07:00 hr). Cumulative nightly rainfall measured above 5 mm on one night during the survey period. Based on the above data, the number of 'fine weather nights' analysed for each acoustic recorder during the survey period are listed in Table 1 below.

A single bat echolocation call was recorded across all 16 ABMs deployed (Table 9).

Table 9: Summary table of data collected from acoustic bat recorders deployed across the Huia Water Treatment Plant Site during November 2017 - January 2018.

Location ID	Date Deployed	Nights Deployed	Nights Analysed[9]	Total No. of Passes
Huia 01	13 November	24	22	0
Huia 02	13 November	24	22	0
Huia 03	13 November	24	22	0
Huia 04	13 November	24	22	0
Huia 05	13 November	24	22	0
Huia 06	13 November	24	22	0
Huia 07	13 November	24	22	0
Huia 08	13 November	24	22	0
Huia 09	13 November	24	22	0
Huia 10	13 November	24	22	0
Huia 11	7 December	14	14	0
Huia 12	7 December	14	14	0
Huia 13	7 December	15	15	0
Huia 14	21 December	22	21	0
Huia 15	21 December	22	21	1[10]
Huia 16	21 December	22	21	0

Surveys undertaken on behalf of Auckland Council at eight monitoring locations all within 2.6 km of the site did not record bats (B Paris 2017, pers. comm., December 22). However, the closest records from previous bat surveys in and around the wider Waitakere Ranges area include the Opanuku Stream corridor approximately 5.5 km to the north (Bioresearches, 2014; Envirologic, 2007), and a likely roost site adjacent to the Lower Huia Reservoir, 7.5 km to the west of the site (Boffa Miskell Ltd., 2017). Although only a single bat pass was recorded during the survey, long-tailed bats are wide-ranging animals that can have home ranges of more than 1000 ha and travel upwards of 15 km in a night (O'Donnell, 2001).

[9] Nights were analysed if weather conditions were considered favourable for bat activity. These being: minimum overnight temperature of 10°C and above and less than 5 mm of rainfall cumulative through the night (7 pm to 7 am).

[10] A single uncertain pass over 21 nights of monitoring.

Given the relative proximity of known bat roosts and the habitat connectivity between the site and the aforementioned records, we consider that long-tailed bats may use the area occasionally for foraging and possibly for solitary roosts but are unlikely to regularly roost in the Project Site.

3.4 Birds

Fourteen bird species were detected during the 48 × 5MBCs carried out within the Proposed Project Site and consisted of seven native and seven exotic species (Figure 17; Appendix 5). Within the site there was little variation between 5MBC stations in terms of both the average number of individual species detected and the assemblage of bird species. Tui were the most abundant species detected during 5MBCs across the Proposed Project Site with very high counts recorded at Site 3, associated with tui feeding on a large pohutukawa in full flower recorded during the 12/12/2017 5MBCs. Kereru were only detected at two of the 5MBC sites within the Proposed Project Site, however, they are not very vocal and are often only detected when observed flying or when their wing beat is heard.

ARDS results (Table 10 and 11) essentially corroborate the results of 5MBC surveys, with the addition of morepork, spur-winged plover, barbary dove and mallard. Welcome swallows were not detected during 5MBCs within the Proposed Project Site but were consistently observed feeding and nesting in and around the existing WTP. Swamp harrier (Not Threatened) were incidentally observed in flight over the site.

Comparison with 5MBC data collected by Auckland Council from nine sample sites within the Waitakere Ranges (Figure 18) indicates that the assemblage and conspicuousness of native bird species detected within the project site is representative of similar habitat in the wider Waitakere Ranges. Bird populations present include fruit and nectar-feeders (tui and kereru in particular) that have a role in pollination and dispersal of many native tree and shrub species.

Native bird species absent from the Proposed Project Site (compared to the Auckland Council sites[11]) were tomtit (Not Threatened), fernbird (At Risk Declining) and North Island robin (At Risk - Declining) (Robertson et al. 2017). As reflected by their threat classification, both fernbird and North Island robin have patchy distributions and are not common within the unmanaged areas of the Waitakere Ranges. The absence of these species from the Proposed Project Site is likely due in part to the lack of suitable habitat, pest mammal densities and close proximity to urban areas.

OSNZ records list 63 terrestrial bird species previously recorded within the 10 km × 10 km grid square encompassing the Project Site, comprising 31 native and 32 introduced species (Appendix 6). 16 species are classified as At Risk or Threatened, though only North Island kaka (At Risk – Recovering), North Island fernbird (At Risk – Declining), New Zealand pipit (At Risk – Declining) and long-tailed cuckoo (At Risk – Naturally Uncommon) would utilise habitats present within the Project Site (Robertson et al. 2017). None of these species were detected during 5MBCs or acoustic monitoring surveys.

[11] Auckland Council survey sites cover the equivalent of 60 ha, while the Proposed Project Site is 15 ha. The majority of Auckland Council sites are within the Waitakere Ranges and are buffered from edge effects by surrounding habitat and contain a wider diversity of habitat types and topography than the Proposed Project Site.

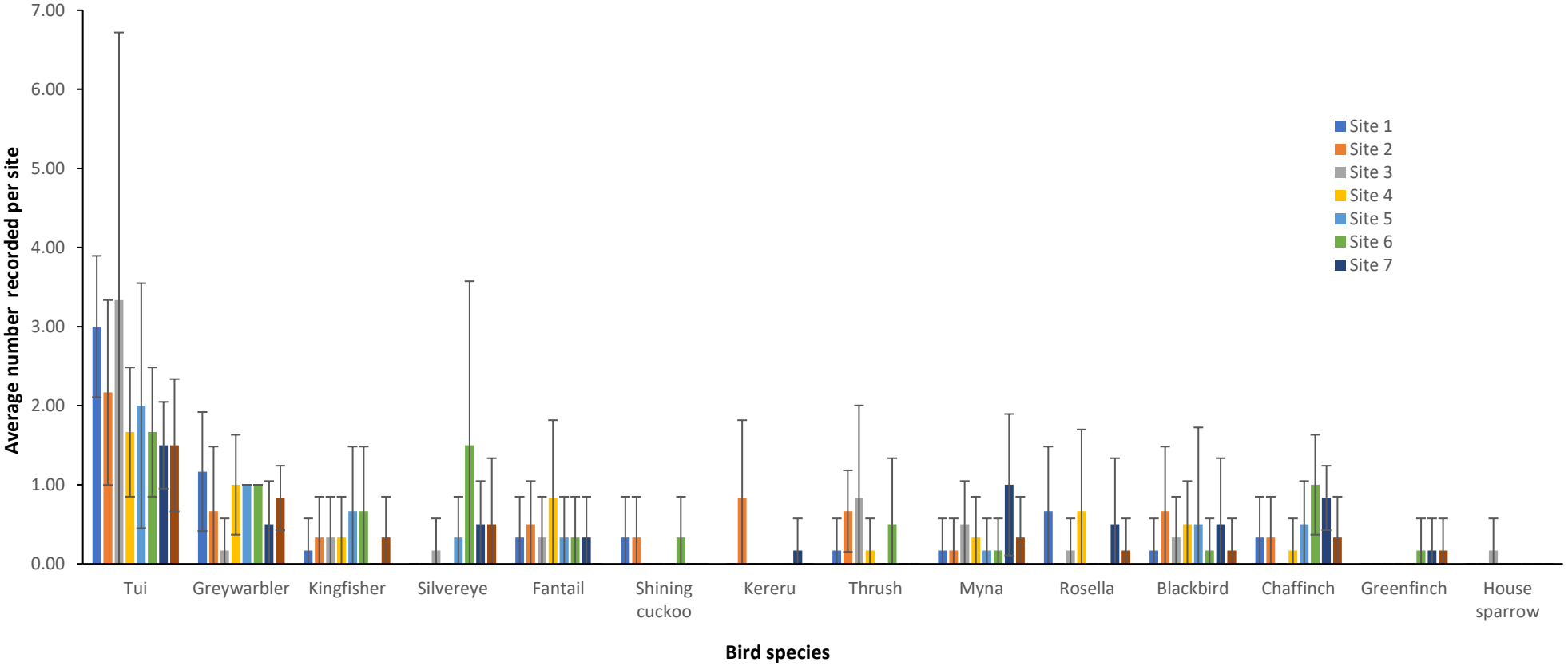


Figure 17: The average number of each bird species detected during six counts periods at each of the eight 5MBC sites within the Proposed Project Site (error bars are standard deviations)

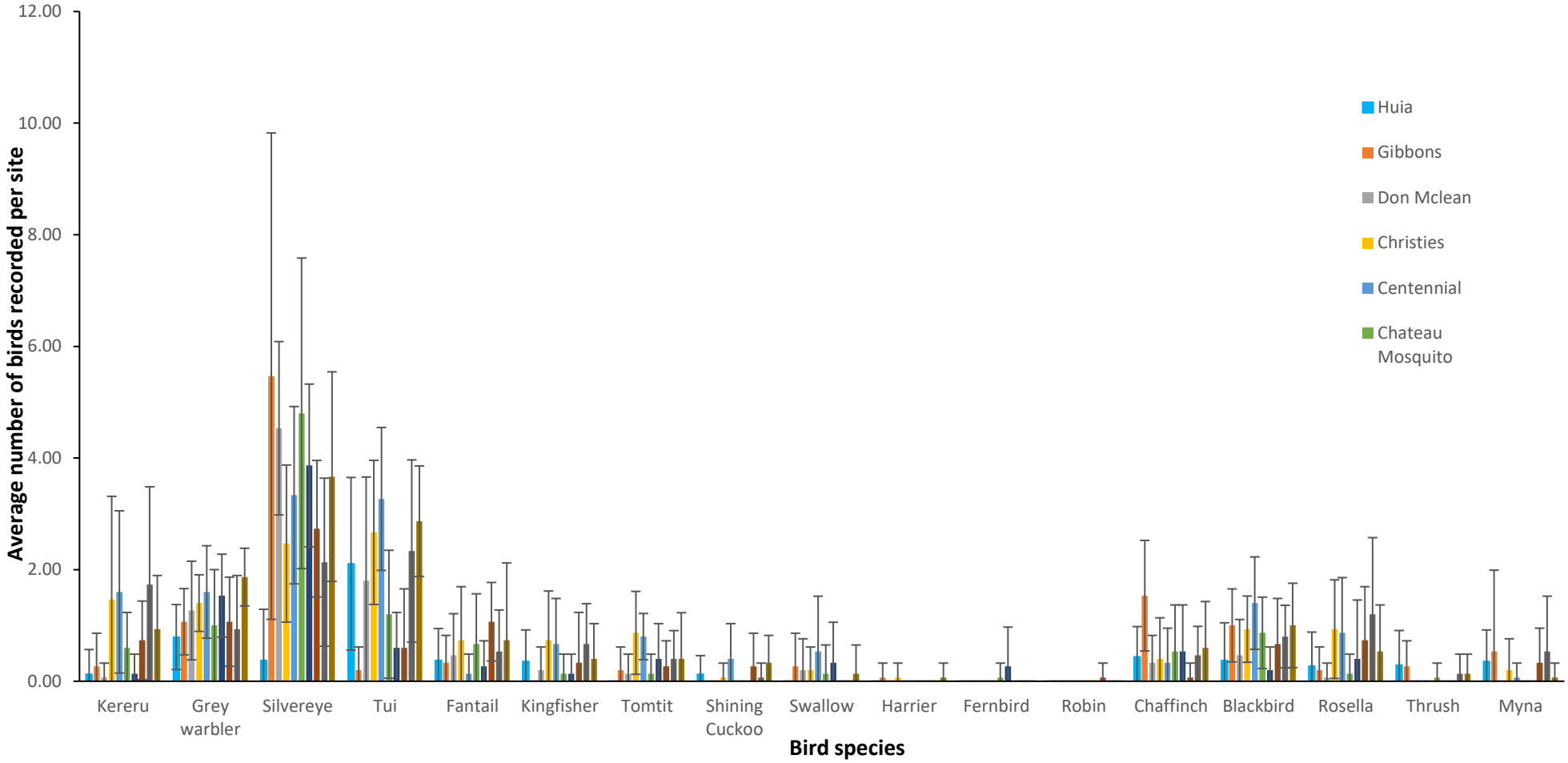


Figure 18: The average number of each bird species detected during six counts periods across the entire Proposed Project Site and during one count period at each of the nine Auckland Council 5MBC sites (error bars are standard deviations).

Table 10: Bird species recorded on ARDs at nine sites within the Proposed Project Site (between 07/12/2017 and 21/12/2017).

Species	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
Fantail	✓	✓	✓	✓	✓	✓	✓	✓	
Grey warbler	✓	✓	✓	✓	✓	✓	✓	✓	
Kingfisher	✓	✓	✓	✓	✓	✓	✓	✓	✓
Morepork	✓	✓	✓		✓		✓	✓	✓
Shining cuckoo	✓	✓	✓	✓	✓	✓	✓	✓	
Silvereye	✓		✓	✓	✓	✓	✓	✓	✓
Tui	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chaffinch	✓	✓	✓	✓				✓	
Rosella		✓		✓				✓	✓
Blackbird	✓	✓	✓	✓				✓	✓
Myna		✓						✓	✓
House sparrow			✓						✓
Thrush	✓	✓	✓	✓		✓			✓
Spur-winged plover	✓	✓	✓					✓	
Mallard								✓	
Barbary dove									✓

Table 11: Bird species recorded on ARDs at two sites within the Proposed Project Site (between 05/04/2018 and 13/04/2018).

Species	SITE 10	SITE 11
Fantail	✓	✓
Grey warbler	✓	✓
Kingfisher	✓	✓
Morepork	✓	✓
Kereru	✓	
Silvereye	✓	✓
Tui	✓	✓
Chaffinch	✓	✓
Blackbird		✓
Myna		✓
Thrush	✓	✓
Spur-winged plover	✓	

The avifauna assemblage within the project site is representative of Waitakere Ranges bush habitats. No threatened or uncommon birds were detected within the Proposed Project Site. wide-ranging species such as kaka are not resident in the Proposed Project Site but may use the area occasionally as they favour emergent trees, and are attracted to periodically abundant food sources (e.g., during mast kahikatea fruiting seasons).

3.5 Invertebrates

The combination of sampling methods detected 732 RTUs (separate taxa) across all areas sampled. In general, the invertebrate fauna found is comparable with that of similar bush-clad areas of the southern Waitakere Ranges (notwithstanding the extreme micro-scale variability of invertebrate communities across the landscape, and current limits of scientific knowledge of the invertebrate fauna, both locally and nationally).

The two mature forest areas sampled (kauri and kauri-podocarp forest, respectively) had a large component of native (and mostly endemic) invertebrate species associated typically with kauri, broadleaved, and secondary kanuka forest types. A species of ngaokeoke or velvet worm (*Peripatoides*), was found in both mature forest sites. The taxonomy, distribution and threat status of ngaokeoke is not well understood, and the status of known and any newly described species will need to be reviewed following formal clarification of the taxonomy of this group in New Zealand (Department of Conservation 2014). Ngaokeoke are generally restricted to damp environments within and beneath logs and leaf litter, and are therefore vulnerable to habitat disturbance.

Few adventive species, and no aggressive invaders such as Argentine ant (*Linepithema humile*) were recorded, though sampling primarily focused on less modified parts of the site.

Samples from the kahikatea swamp included some specialised fauna (Ostracoda, Copepoda and Turbellaria) which are relatively uncommon in Waitakere Ecological District, reflecting the rarity of the ecosystem type in which they occur.

3.6 Animal pests

Pest fauna surveys were excluded from the values assessment as mammalian pest numbers fluctuate widely from season to season, and in response to pest management activity in the vicinity[12]. Predator management data collected as part of Ark in the Park research and management [ref] indicate that mammalian predators are ubiquitous throughout the Ranges in any areas not subject to intensive control.

It is reasonable to assume native fauna populations within the Project Site face significant pressure from predatory animals.

3.7 Freshwater Ecology

3.7.1 Overview

The ecological values of the aquatic habitats are presented by catchment. Survey reaches are named by their impact status: impact (i.e. are within the Project Site) or receiving (i.e. are downstream of development areas and will potentially receive stormwater from the development site).

[12] We understand that there are coordinated pest management initiatives in the immediate and wider catchment areas, however no specific information on how these are coordinated or resourced has been supplied.

3.7.2 Armstrong Gully

The portion of the Project Site to the north of Woodlands Park Road encompasses the headwaters of the Armstrong Gully. South of Woodlands Park Road, the Armstrong Gully watercourses are currently piped under the existing Huia WTP, discharging into open channel near the southern boundary of the Huia WTP property.

The watercourses termed "impact" are those north of Woodlands Park Road (Armstrong_impact; Armstong_impact_ephemeral) and near the corner of Manuka Road and Woodlands Park Road (Armstrong_manuka_impact). The receiving watercourse is located to the south of the existing Huia WTP (Armstrong_receiving; Figure 19). An SEV survey was undertaken on each of the permanent watercourses (Armstrong_impact and Armstrong_ receiving). An ARC habitat assessment was undertaken on a smaller intermittent channel (Armstrong_manuka), while a visual assessment was undertaken at ephemeral channel (Armstrong_ephemeral), both of which are also present within the Project Site.

Habitat Descriptions

- *Armstrong_impact*

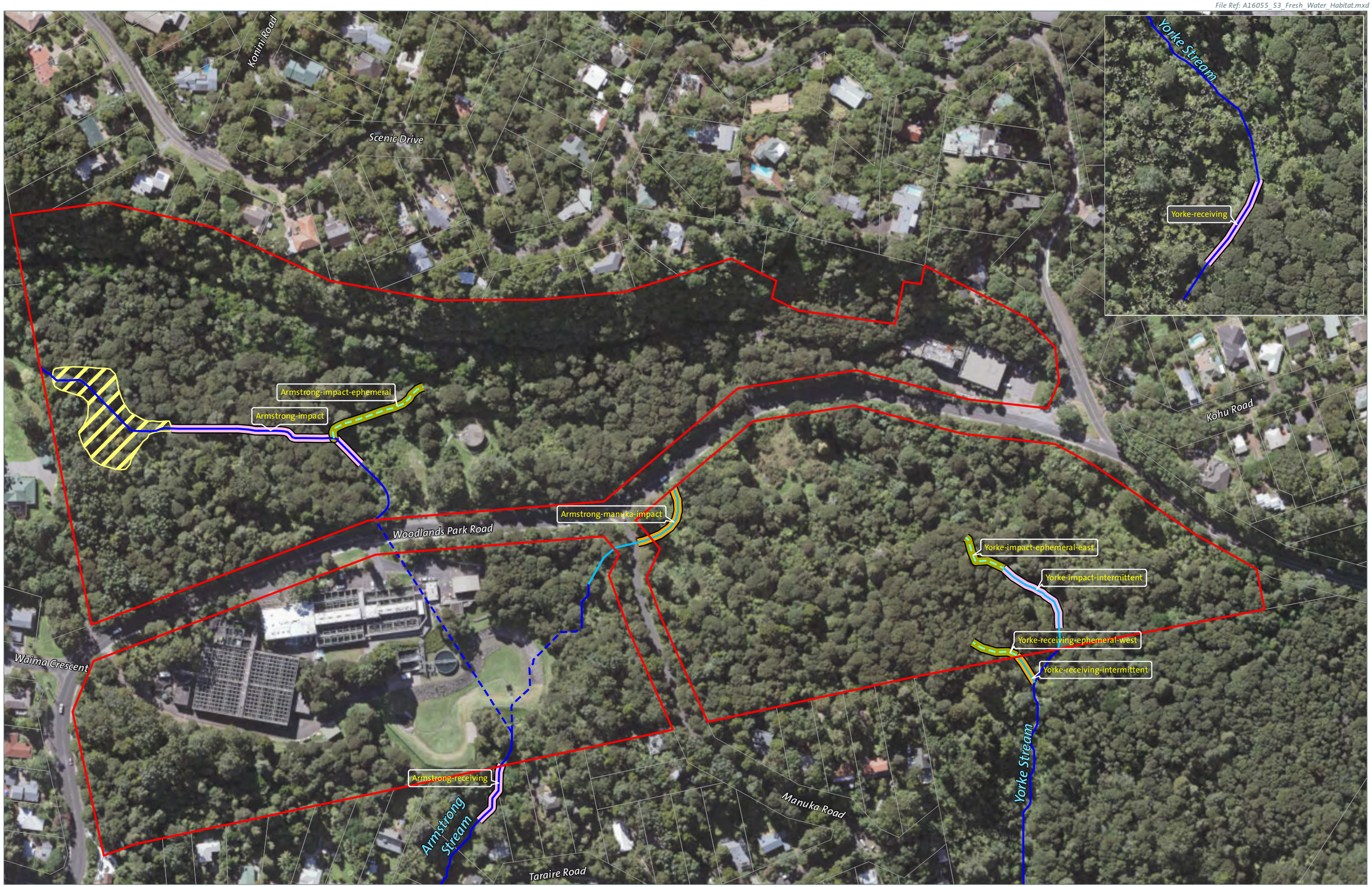
Watercourse Armstrong_impact has an average channel width of 0.47 m, and a silt/sand streambed with occasional small wood and leaf litter (Table 12). Water flow was slow (0.09 m/s), predominantly run habitat with no deep or shallow pools. Small debris jams were present along the reach. Downstream of the SEV reach the channel surface water was dry, with subsurface flow for approximately 30 m, before surface water returned just upstream of the culvert under Woodlands Road. Riparian vegetation consists of mature and regenerating native species dominated by nikau and tree fern. Streambanks at site Armstrong_impact are 0.2- 0.7 m high with no areas of active erosion.

- *Armstrong_receiving*

Discharge from the Huia WTP enters the stream channel some 35 m upstream of the Watercourse Armstrong_receiving survey reach. The SEV survey reach was confined by upstream and downstream natural waterfalls. The reach has an average channel width of 1.0 m with a mixed streambed of bedrock, large cobbles, boulders and areas of silt/sand (Table 12). Woody debris was rare, while leaf litter was uncommon. Water flow was slow (0.06 m/s) and the channel a mixture of run and riffle habitat, with small chutes, waterfalls and deep and shallow pools. Bryophytes were abundant along stream edges without recent erosion. Riparian vegetation is regenerating native forest with emergent large kauri and podocarps, with patches of weedy groundcover (tradescantia and Kahili ginger).

Armstrong_receiving is located within a steep gully. Streambanks range from 3 – 6 m in height with some bank sections near vertical. The stream bank is mainly clay and finer sediments, with some areas of hard bedrock banks. Numerous areas of active and historical erosion are present along the SEV reach, as detailed in Table 6 below. The largest area of active erosion is located at the upstream end of the SEV reach surrounding the pool at the base of the waterfall. Surrounding this pool is a large active escarpment of approximately 3 m x 3 m. The pool itself was filled with fine silt/sand and recently fallen coarse woody debris (See Table 13 and Table 14).

Evidence of historic erosion prevention works were noted along reach Armstrong_receiving with waratahs, steel reinforcing bar and varying types of mesh present at various locations (See Table 14). All these measures look to be some years old and are no longer providing any protection from erosion. Above the SEV reach, between the Huia WTP outfall and the SEV reach, the stream bed and banks have been lined in places with a plastic trellis mesh with cobbles placed on top.



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Data Sources: LINZ Data Service (Aerials, Cadastre), Auckland Council, GHD, Boffa Miskell

Projection: NZGD 2000 New Zealand Transverse Mercator

Legend

Streams
- Permanent
- Permanent Piped
- Intermittent
- Ephemeral

Swamp Area
SEV Site
ARC Habitat Assessment
Visual Assessment
Site Boundary

Land Parcels

A16055 HUIA WTP ALTERNATIVES ASSESSMENT

Figure 19: Fresh Water Habitat

Date: 31 January 2018 | Revision: 0

Plan prepared by Boffa Miskell Limited

Project Manager: Rachel.deLambert@boffamiskell.co.nz | *Drawn:* SGa | *Checked:* KMc

Table 12: Images of Armstrong Gully survey sites.

Armstrong_impact

Armstrong _receiving

Armstrong_Manuka

Armstrong_ephemeral

Table 13: Erosion assessment at Armstrong_receiving Site. Note: All measurements are distance upstream from the downstream end of the SEV reach.

True Left Bank	
7 – 8 m	BRIDGE
13 – 15 m	Large old bank slump present approximately 8 m wide by 6 m high. Fine chicken wire present at the base of slump. Growth of bryophytes, ferns, parataniwha. Dead juv. Kauri at top of slip.
16 m	Waratah driven deep into bank
22 – 24 m	Old erosion scar present. Waratahs present, vegetation growing. Some areas of loose soil still present.
25 – 26 m	Small recent erosion scar
30 – 31 m	Recent erosion scar
True Right Bank	
1.5 – 2 m	Small recent erosion scar
7 – 8 m	BRIDGE
9 m	Recent fern/ponga fallen across stream channel

12 – 16 m	Recent erosion scar, clay eroded in stream. No vegetation re-growth on erosion scar face.
21 – 24 m	Large old erosion scar with debris still present. Steel bars in ground, looks like old erosion control. Dead trees. Stream channel has silt and fine sediment within. Channel wider.

Table 14: Images of selected erosion hotspots within the Armstrong_receiving Site. Note: All measurements are distance upstream from the downstream end of the SEV reach.

True Left Bank	True Right Bank
	
47-50 m: Erosion surrounding pool	*21-24 m: Large old erosion scar.*
	
13-15 m: Old erosion scar	*12-16 m: Recent Erosion Scar*

- *Armstrong_manuka*

Streambanks at site Armstrong_manuka vary between 0.1 m in the upper section, to 0.3 m in the lower section. No active erosion was present on these stream banks.

The open channel is fed by a 0.2 m diameter pipe flowing from under Wooodlands Park Road. A 10 m long culvert is located in the middle of the reach, below an old access-way. The morphology of the watercourse differs somewhat above and below the culvert (Table 12). Upstream of the culvert the channel is 0.2 m wide with a silt/sand streambed infested with tradescantia.

Most of the upper section of the reach had no surface water, other than a single pool approximately 0.2 m deep. Below the culvert, a moderate size pool 0.65 m deep was present at the culvert outlet while the average water depth in the remaining stream channel (approximately 0.2 m wide), was 0.01 m with. No water flow was present. The riparian vegetation at the upper

and lower sections was a mixture of low native and exotic scrub, with a heavily weed-infested groundcover and abundant climbing asparagus and jasmine. No water was flowing into either the culvert within the reserve or the culvert under Manuka Road at the time of the survey.

- *Armstrong_ephemeral*

Watercourse Armstrong_ephemeral is a small ephemeral watercourse that is located north of Woodlands Park Road, along the base of the steep hill, and flows into Armstrong_impact.

Macroinvertebrates

Macroinvertebrate community samples were collected from Sites Armstrong_impact and Armstrong_receiving. A single replicate sample was collected from each reach. Macroinvertebrates were not sampled from site Armstrong_manuka or Armstrong_ephemeral.

- *Armstrong_impact*

Site Armstrong_impact had limited aquatic habitat abundance or diversity along the survey reach, with small amounts of woody debris and stream edge providing the primary macroinvertebrate habitat.

A total of 17 macroinvertebrate taxa and 2291 individuals were recorded from the kick-net sample. The community was dominated by the amphipod *Paraleptamphopus*, and the chironomid midges (*Polypedilum* and *Tanypodinae*), accounting for 49 % and 34 % of individuals, respectively. The amphipod *Paraleptamphopus* is a crustacean and it is commonly found throughout New Zealand in slow-flowing, soft bottom streams with moderate to good water quality. The midge *Polypedilum* is commonly found in streams of varying water quality, from bush covered hard-bottom streams to soft-bottom farmland streams (Landcare Research, 2018). The snail *Potamopyrgus* and the finger clam (Sphaeriidae) were also relatively abundant (6 % each). Other invertebrate taxa were present in low numbers including beetles (*Scirtidae*), springtails (*Collembola*), spiders, flatworms (Platyhelminthes) and segmented worms (oligochaetes).

There we no EPT taxa present within the sample.

MCI-sb score was 95.3 which is indicative of 'Fair' water quality, and possible moderate pollution.

- *Armstrong_receiving*

Site Armstrong_receiving had a moderate habitat diversity with woody debris, undercut banks, cobble and the occasion overhanging vegetation present.

Macroinvertebrate taxonomic richness was high, with a total of 26 macroinvertebrate taxa and 481 individuals recorded from the kick-net samples. The chironomid midge *Polypedilum* dominated the community, accounting for 31 % of individuals. This was closely followed by the net-building caddis *Orthopsyche* accounting for 25 % of individuals. The presence of *Orthopsyche,* particularly when in conjunction with mayflies and stoneflies, is an indication of good water quality (Landcare Research, 2018). Other invertebrate taxa present included Dobsonfly, beetles, true flies, springtails (*Collembola*), spiders. The snail *Potamopyrgus* was also abundant comprising 18 % of individuals. The amphipod *Paraleptamphopus* that was present upstream at site Armstrong_impact was present, albeit in very low abundance (0.8 %).

Six EPT taxa were present; one mayfly taxa (*Zephlebia*) and five caddisflies (*Hydrobiosis, Oeconesidae, Orthopsyche, Polyplectropus* and *Psilochorema).* No stonefly taxa were present. EPT taxa accounted for 23% of taxa present and 31 % of individuals present.

The MCI score was 106, which is indicative of 'Good' water quality, with possible mild pollution.

Fish

Fish populations were surveyed using electric fishing at sites Armstrong_impact, Armstrong_wetland and Armstong_receiving. Fish populations were not surveyed at site Armstrong_manuka or Armstrong_ephemeral.

- *Armstrong_impact*

Electric fishing was undertaken along a 50m reach at Site Armstrong_impact. No fish species were caught or observed along the reach.

- *Armstrong_receiving*

A single shortfin eel was the only fish observed at Site Armstrong_receiving, within one of the larger pools within the reach (Table 15).

Table 15: Fish species caught at Sites within the Armstrong Gully catchment.

Site	Species	Threat Status	Size (mm)
Armstrong_receiving	Shortfin Eel (*Anguilla australis*)	Not Threatened	600.

Stream Ecological Valuation

- *Armstrong_impact*

Site Armstrong_impact scored an SEV value of 0.747 indicative of a good quality stream (Table 16).

Hydraulic functions are a measure of the naturalness of the stream channel, the flow regime connectivity to the floodplain and connectivity for species migration within the reach. Site Armstrong_impact achieved the highest possible score (1.00) for this group of functions, indicating a natural, stable stream channel with no external modifications inputting stormwater or preventing access to the full floodplain during storm events.

Biogeochemical functions are a measure of the in-stream biological and chemical conditions of the stream that drive ecosystem productivity. The calculation of the biogeochemical function score includes measurements of stream water velocity, water depth and macrophyte abundance. This group scored 0.90, indicating that is functioning well in terms of these elements. Functions of water temperature control and decontamination of pollutants scored less well due to patchy shading by vegetation, and the predominantly silt/sand substrate which provides limited surface area for biofilms.

Habitat Provisions functions measure fish spawning habitat and physical habitat available for aquatic fauna. The quality of spawning habitat for Galaxiidae fish is driven by the availability of well shaded and damp bank areas, whereas Gobiidae fish spawning area requires the availability of in-stream hard surfaces such as cobbles and gravels. The quality of physical habitat diversity and availability is related to the hydraulic and geochemical functions, and upstream catchment shade and imperviousness. This function scored 0.36, indicating poor habitat for aquatic fish and

fauna. This score is predominantly driven by the unsuitable spawning habitat for fish due to the lack of low-growing bank-side vegetation and gravels, or instream gravels and cobbles.

Biodiversity Provision functions is a combined measure of the fish and macroinvertebrate communities present within the reach and the condition of the adjoining riparian vegetation. This function scored moderately low at 0.41, as no fish species or high value EPT taxa were present within the community, though riparian vegetation intactness scored reasonably well.

- *Armstrong_receiving*

Site Armstrong_impact scored an SEV value of 0.770 indicative of a good quality stream (Table 16).

Hydraulic functions within site Armstrong_impact scored a value of 0.83, indicating moderate hydraulic functionality. The channel itself appears moderately natural but is highly incised in parts, reducing the floodplain effectiveness. The channel also has unnatural loading of fine sediments in some sections of the reach, reducing the natural connectivity to groundwater.

Biogeochemical functions showed good functionality, scoring 0.85. Dissolved oxygen levels and organic matter input were excellent. Reduced functionality in water temperature control was due to patches of low shade along the reach.

Habitat provisions showed moderate functionality, scoring 0.60, mainly due to unsuitable *Galaxiidae* spawning habitat along the reach. Gobiidae spawning scored high in this reach.

Biodiversity provisions scored moderately well with a score of 0.65. This score was the result of a poor fish population, but a good abundance of EPT taxa with six different EPT taxa present, and good riparian condition and connectivity.

Table 15: SEV attributes scores for Sites draining into the Armstrong Gully Stream.

Function	Armstrong_impact *Permanent*	Armstrong_receiving *Permanent*
Natural Flow Regime	1.00	0.81
Floodplain Effectiveness	1.00	0.60
Connectivity for natural species migrations	1.00	1.00
Natural connectivity to groundwater	1.00	0.89
Hydraulic Functions	**1.00**	**0.83**
Water temperature control	0.82	0.62
Dissolved oxygen levels	1.00	1.00
Organic matter input	1.00	1.00
Instream particle retention	1.00	0.90
Decontamination of pollutants	0.68	0.72
Biogeochemical Functions	**0.90**	**0.85**
Fish Spawning Habitat	0.10	0.50
Habitat for aquatic fauna	0.62	0.78
Habitat Provisions Functions	**0.36**	**0.64**
Fish Fauna Intact	0.00	0.37
Invertebrate Fauna Intact	0.44	0.78
Riparian Vegetation Intact	0.80	0.80
Biodiversity Provision Functions	**0.41**	**0.65**
SEV Score (Maximum Value 1)	**0.747**	**0.770**

3.7.3 Yorke Gully

The portion of the Project Site to the south of Woodlands Park Road and east of Manuka Road is within the headwater catchment of the Yorke Gully. Watercourses running through this footprint discharge into the open channel of the Yorke Gully Stream which intersects the adjoining Clarks Bush Reserve.

The watercourses termed *impact* are located within Project Site (Yorke_impact_ephemeral; Yorke_impact_intermittent) (Figure 19). The *receiving* sites, including a small intermittent channel (Yorke_receiving_intermittent) and the larger main stream (Yorke_receiving), are located within Clarks Bush Reserve.

An SEV survey was undertaken at Yorke_impact_intermittent and Yorke_receiving. At the time of surveying Yorke_impact_intermittent there was no flowing water, with only three small isolated pools of water present. The survey was undertaken within the month of October (19 October 2017), with flowing water present within the channel at a scoping visit some two weeks prior (6 October 2017). As a consequence of only three very small isolated pools being present a number of stream attributes such as water velocity were unable to be collected and no fishing or macroinvertebrate samples were collected during the survey. Visual assessments were undertaken on reaches Yorke_ephemeral and York_intermittent_receiving. A visual assessment was also undertaken on the Yorke Gully stream between the Yorke_receiving reach and Yorke_impact_intermittent reach.

Habitat Descriptions

- *Yorke_impact_intermittent*

Watercourse *Yorke_impact_intermittent* has an average bank to bank width (not wetted width) of 0.5 m (Table 18). The streambed is entirely silt/sand with moderate amounts of roots present across the stream channel, creating what would be small cascades during times of water flow. Three isolated pools of water were present with average water depth of 0.05 m. Shading along the stream channel is moderate, with nikau trees dominating the canopy. Ground cover is sparse, with some small areas of tradescantia present in the downstream end of the reach. The downstream section of the reach has steeper stream banks with some bryophyte patches.

Table 16: Images of Yorke Gully survey sites.

Yorke_impact_intermittent

Yorke_ephemeral_east

Yorke_receiving

Yorke_receiving_intermittent

Yorke_impact_ephemeral_west

Stream banks were typically higher in the downstream section of the reach (0.3 m) than the upstream (0.15 m). There were small areas of undercut banks in the lower section of the reach. There was no active erosion present, but there was historical erosion evident around a pool located at the upstream extent of the reach.

- *Yorke_impact_ephemeral_east*

Yorke_impact_ephemeral_east is upstream of site Yorke_impact_intermittent. This watercourse extends to a cascade where the downstream intermittent channel begins. The ephemeral reach is short and was covered in leaf litter, with juvenile nikau and hangehange the predominant riparian species (Table 18). The reach has no discernible stream banks and no erosion was evident.

- *Yorke_receiving*

Watercourse *Yorke_receiving* is a substantial stream with an average width of 1 m and streambanks in excess of 6 m high in places (Table 18). The stream bed is mainly bedrock with a variety of cobbles and gravels. Silt/sand substrate was generally concentrated around recent areas of erosion and the bottom of pools. Woody debris and leaf litter were present, albeit also rare. Water velocity varied between 0.03 – 0.57 m/s (average of 0.9 m/s) across the site. The reach has high hydrologic heterogeneity, with pools, riffles, runs, chutes and waterfalls present. Shading along the reach varies from low to very high, with the majority of the reach having high

(71-90 %) shading. Periphyton was present on the stream bed in areas of low shading with green short filamentous and brown film algae present. Riparian vegetation cover comprises broadleaved indigenous scrub and secondary forest. Dense parataniwha covers the stream margins, and bryophytes are abundant along banks.

The stream is located within a gully and has steep, high stream banks. The lower streambanks are a mixture of bedrock, large boulders and areas of soil. Upper streambanks are well vegetated. A number of areas of both active and historical erosion are detailed in Table 17 below. A large area of bank slumping was restricting water flow downstream and had created a pool behind the debris.

Table 16: Erosion assessment at Yorke_receiving Site. Note: All measurements are distance upstream from the downstream end of the SEV reach.

True Left Bank	
15 – 17.5 m	Debris has created a pool upstream.
True Right Bank	
0 – 2 m	Active area of bank slumping.
38.7 - 40.8 m	Area of bank slumping which is partially blocking the watercourse; predominantly comprises clay and small gravels.

- *Yorke_receiving_intermittent*

This is an intermittent reach approximately 30 m in length feeds into the main Yorke Gully Stream, bound upstream by a waterfall approximately 2 m in height, and downstream at the confluence. The reach itself contains a waterfall approximately 1.5 m high. The majority of the reach had no surface water at the time of the survey (Table 18). A small pool was present at the base of the upstream waterfall, and a 2 m section of flowing water was present between the lower waterfall and the main Yorke Gully Stream. Average channel width is 0.3 m, with a silt/sand bed. Channel shading is moderate with riparian cover of nikau, parataniwha, hange hange, puriri, pate and small patches of Kahili ginger.

The channel is small and incised, with almost vertical banks 1 – 2 m in height. Small areas of active erosion were present along the majority of the channel and at the base of both waterfalls along the reach. The waterfalls are overhanging, with undercutting present where roots do not provide stabilisation.

- *Yorke_impact_ephemeral_west*

A small ephemeral reach extends upstream of Yorke_receiving_intermittent. A waterfall defines the extent of the reach and the start of the downstream intermittent channel. The channel comprises a small depression in the forest floor (Table 16). The channel contained high amounts of leaf litter, juvenile nikau and ground ferns. The reach has no discernible stream banks and no erosion was evident.

A large erosion hotspot was identified on the Yorke Gully stream TLB, outside of the survey reaches (see Figure 19). This hotspot was approximately 15 m^2 and had released a large slump of sediment into the stream; blocking the stream channel. The eroded bank section still had healthy vegetation intact and it appeared that water had flowed over the newly eroded surface.

Located on the TRB of this erosion hotspot was an old buried concrete culvert, approximately 0.4 m diameter, that was sitting perched some 1 m above the stream bed. This culvert was located some 1 m below the top of the stream bank and was dry at the time of the survey with roots growing out. The inlet end of the culvert could not be located.

Macroinvertebrates

Macroinvertebrate community samples were only collected from Site Yorke_receiving, where a single replicate sample was collected. Macroinvertebrates were not sampled from sites Yorke_impact, Yorke_ephemeral_east/west, or Yorke_receiving_intermittent. At the time of the survey the reach Yorke_impact only contained water within three small, isolated pools that were not suitable for macroinvertebrate community sampling.

Aquatic habitat diversity at this site scored moderately high with woody debris, riffles, undercut banks, root mats and cobbles all present within the reach, though cobble was the most common. Riffles and stream edge habitat provided the primary kick-net sampling habitat.

Macroinvertebrate taxonomic richness was high, with 30 taxa and 256 individuals present. The community was dominated by the EPT taxa double gill may fly (*Zephlebia*) which comprised 31 % of individuals present. The snail *Potamopyrgus* (13 %) and the double gill mayfly *Arachnocolus* (9 %) were also abundant. The rest of the community showed high diversity with the majority of taxa being either rare (1-4 individuals), or common (5-19 individuals). Other taxa present included the water strider (Microvelia), dobsonfly (*Archichauliodes*), beetles, true flies, springtails (*Collembola*), crustaceans, spiders, and the snail *Potamopyrgus*.

EPT taxa richness and abundance was high within this reach, with EPT accounting for 40 % of taxa and 55 % of individuals present. EPT Taxa present included Mayflies (*Arachnocolus, Austroclima, Coloburiscus, Deleatidium, Neozephlebia*), Stoneflies (*Austroperla, Zelandoperla*) and caddisflies (*Ecnomina, Orthopsyche, Polyplectropus, Psilochorema*). The good diversity and abundance of EPT taxa is an indication of good water quality.

The MCI score was 119, which is the threshold between 'Good' (100 – 119) and 'Excellent' (> 119) water quality.

Fish

Fish community surveys were only undertaken at site Yorke_receiving as there was not enough available water at site Yorke_impact.

The site was fished along the 50 m SEV reach and a total of 10 individuals were observed from the three species; longfin eel, inanga and koura (Table 18). Two of the species present, of which four individuals were observed, are listed as At Risk – Declining.

Table 17: Fish species caught at Sites within the Yorke Gully catchment. [1]Goodman et al, 2014.

Site	Species	Threat Status[1]	Size (mm)
Yorke_receiving	Longfin Eel (*Anguilla dieffenbachia*)	At Risk - Declining	600; 600.
	Inanga (*Galaxis maculatus*)	At Risk - Declining	30; 30.
	Koura (*Paranephrops planifrons*)	Not Threatened	15; 20; 20; 20; 15; 15.

Stream Ecological Valuation

- *Yorke_impact*

Site Yorke_impact was classified as intermittent and at the time of the survey water within the reach was reduced to three small isolated pools (Table 19). As a consequence, a number of stream attributes were unable to be measured and an SEV score was unable to be calculated for this site. However, the results of those attributes that were able to be measured are discussed below.

Site Yorke_impact achieved the highest possible score (1.00) for this hydraulic functions, indicating a natural, stable stream channel with no external modification or inputs of stormwater and full access to the floodplain during storm events.

Biogeochemical function score includes measurements of stream water velocity, water depth and macrophyte abundance. While water depth was measured (with most depths 0.00), water velocity and macrophyte abundance were unable to be measured. Dissolved oxygen levels, and organic matter input both scored 1.00 showing high functionality. Functionality of pollutant decontamination and shade were both moderate, a result of patchy shade provided by overhead vegetation and the predominantly silt/sand substrate which provides limited surface area for biofilms.

This reach scored poorly for habitat provisions functions, mainly due to the unsuitability of fish spawning habitat, both for Galaxiidae and Gobiidae species.

Fish and macroinvertebrate communities were not surveyed as part of this SEV and are not included in the Biodiversity Provision functions score. Riparian condition and connection scored 0.80, demonstrating good functionality.

- *Yorke_receiving*

Site Yorke_receiving scored an SEV value of 0.845 indicative of an excellent quality stream (Table 20).

Hydraulic functions within Site Yorke_receiving scored highly at 0.93, indicating good hydraulic functionality. The channel was highly incised in places with some patches of fine sediment caused by bank slips which reduced the hydraulic functionality.

Biogeochemical functionality was moderate to high with a score of 0.87. Dissolved oxygen levels and organic matter input all scored 1.00. However, there were patches of open canopy which reduced the shading to the stream channel. The stream bed had a high proportion of bedrock substrate which reduces hydraulic functionality.

Habitat provisions demonstrated high functionality with a score of 0.87. The availability of Galaxiidae and Gobidae spawning areas was high, although the Galaxiidae spawning habitat quality was only moderate.

Biodiversity provisions scored moderately well with a score of 0.67. This score was primarily driven by relatively low fish diversity. The macroinvertebrate community returned a good MCI score with good EPT abundance and community diversity. Riparian condition and connectivity was very good.

Table 19: *SEV attributes scores for Sites draining into the Yorke Gully Stream.*

Function	Yorke_impact *Intermittent*	Yorke_receiving *Permanent*
Natural Flow Regime	1.00	0.93
Floodplain Effectiveness	1.00	0.84
Connectivity for natural species migrations	1.00	1.00
Natural connectivity to groundwater	1.00	0.97
Hydraulic Functions	**1.00**	**0.93**
Water temperature control	0.64	0.72
Dissolved oxygen levels	1.00	1.00
Organic matter input	1.00	1.00
Instream particle retention	-*	0.96
Decontamination of pollutants	0.48	0.70
Biogeochemical Functions	**-***	**0.87**
Fish Spawning Habitat	0.05	0.88
Habitat for aquatic fauna	0.56	0.87
Habitat Provisions Functions	**0.31**	**0.87**
Fish Fauna Intact	-*	0.47
Invertebrate Fauna Intact	-*	0.73
Riparian Vegetation Intact	0.80	0.80
Biodiversity Provision Functions	**-***	**0.67**
SEV Score	**-***	**0.845**

Note: * unable to be calculated.

Wetland Invertebrates

A single kicknet invertebrate sample was collected from the maire tawake – pukatea – kahikatea wetland. A total of 2057 individuals from 16 taxa were present.

The chironmid midge *Polypedilum* was the most abundant taxa present (34% of individuals), while the amphipod species *Paraleptamphopus* was the second most abundant species (30% of individuals). *Polypedilum* are commonly found in both hard and soft-bottom streams where they often burrow into soft plant matter (LandcareResearch, 2018). They are found in watercourses of varying water quality. *Paraleptamphopus* are one of the most common freshwater amphipod genera, being abundant in slow-flowing, soft bottom watercourses. They can be abundant in watercourse with moderate to good water quality.

Other species present include the worms *Oligochaetes* (12 %), the water flea *Cladocera* (10 %) and the midge *Paradixa* (5 %). Both *Oligochaetes* and *Cladocera* are found from pristine streams to sewage treatment plants, while *Paradixa* are commonly found along the margins of wetlands with moderate to good water quality.

Of particular interest is the present of the snail *Glyptophysa* (1%) which has become increasingly rare over recent decades.

Freshwater habitats were varied across the potential impact and receiving environments of the Huia WTP. The permanent watercourses within the receiving environments of the Armstrong Gully and Yorke Gully were incised gully streams of high ecological value. Freshwater habitats within the potential areas of impact were typically intermittent or ephemeral in nature, with the exception of Armstong_impact which was permanent. This permanent watercourse was of moderate-high ecological value. The smaller intermittent watercourses were typically of moderate-low ecological value, with limited surface water at the time of sampling.

4.0 Summary of Ecological Values

Vegetation classification and ecological integrity evaluation identified a gradient in the quality and condition of the ecosystem within the Project Site, to the extent that the more modified parts of the site qualify as SEA on the basis of their contextual value as buffers and connective linkages to areas of better quality

The site has potential habitat value for significant indigenous fauna known to be present in surrounding catchments and the Waitakere Ranges forest environments more generally, however no populations of threatened or at risk fauna were detected, and we do not consider the site represents an important refuge for significant resident indigenous fauna populations, though significant fauna may incidentally utilise the site. In particular, the site may contain native lizard populations that remain undetected in surveys, as no survey methods are available that can confidently achieve high detection rates for native lizard fauna. The Proposed Project Site consists of high quality habitat for native birds and reptiles, however, mammalian pests including rats and stoats are likely a key factor limiting population sizes of these fauna.

5.0 Ecological Significance

5.1 Auckland Unitary Plan

The Auckland Unitary Plan (AUP – operative in part) has mapped Significant Ecological Areas throughout the Auckland Region on the basis of 5 factors (with sub-factors) that are used to determine whether a site has significant ecological value. Schedule 3 of the AUP lists the full set of factors, sub-factors and associated explanations (Appendix 7). The 5 main factors include:

(a) representativeness;

(b) stepping stones, migration pathways and buffers;

(c) threat status and rarity;

(d) uniqueness or distinctiveness; and

(e) diversity.

We have re-evaluated the site against the Schedule 3 factors with reference to ecological data compiled from field surveys in order to validate the AUP overlay, and identify the specific features of the site that contribute to its ecological significance.

Representativeness

The indigenous vegetation types (as a proxy for ecosystem units) identified within the Project Site are generally consistent with characteristic mature and successional forest communities of the Waitakere Ranges and reflect environmental gradients, particularly those of topography, fertility and soil moisture.

Areas of mahoe scrub with a large component of exotic species, and patches of grassland and weedfield, are not representative of original ecosystem types in the Waitakere E.D.

Threat status and rarity

A site qualifies under this factor if it comprises an indigenous habitat, community or ecosystem assessed (using the IUCN threat classification system) to be threatened, supports plant, animal or fungi species with a national conservation status of threatened or at risk; or a regional threatened conservation status of Gradual Decline ore above, or is indigenous vegetation that occurs in Land Environments New Zealand Category IV where less than 20% native vegetation cover remains.

Mature or well-advanced successional stages of endangered or critically endangered forest ecosystem types (based on the IUCN classification in Singers et al 2017) cover more than 70% of the Project Site. Wetland ecosystems are heavily depleted relative to their original (pre-human) extent due to reclamation and drainage, and therefore fall well within the Land Environments of New Zealand Category IV where less than 20% remains. Hence, the wetland feature meets "threat status and rarity" factors.

Kauri and several climbing ratas, all classed as Threatened – Nationally Vulnerable, are present throughout the sites (though infrequent in modified scrub and not observed in grassland/ weedfield), while maire tawake (Nationally Critical) is present in the wetland. A few mature pohutukawa tees (including a pohutukawa – northern rata hybrid) are present within the Project Site. A single *Metrosideros carminea* is present on the escarpment below Exhibition Drive. Kanuka (Nationally Vulnerable) is a dominant component of the vegetation cover throughout much of the site, and manuka (At Risk) is occasionally present. A mature specimen of *Elaeocarpus hookerianus* (Regionally Critical) is present in kauri-podocarp forest adjacent to Manuka Road.

DIversity

Indigenous vegetation within the site and surrounding continuous forest contains a variety of ecosystem types that reflect underlying environmental gradients. Vegetation assemblages and associated species richness are characteristic of the vegetation types present.

Stepping-stones, migration pathways and buffers

Common native bird species permanently or intermittently inhabit forest areas within the Project Site. Modified mahoe scrub (though it contains a significant component of weed species) is immediately adjacent to, higher-quality ecosystem units identified as significant under the 'threat status and rarity' factor, and is therefore significant as a buffer. The Project Site as a whole supports the resilience and ecological integrity of the Muddy Creek catchment and forms part of a network of forested areas within the wider Waitakere foothills that together make an important contribution to the provision of lowland kauri-podocarp forest in the landscape.

Uniqueness and distinctiveness

The project site is not known to meet any of the factors for Uniqueness or distinctiveness.

5.2 Waitakere Ranges Heritage Area (2008)

The Project Site is covered by the Waitakere Ranges Heritage Area Act (WRHA 2008), which identifies the WRHA as of national significance. The objectives of the Act broadly include

protection, restoration, and enhancement of the area and its heritage features. The Act aims to ensure that impacts on the WRHA as a whole (including cumulative effects) are considered when decisions are made affecting any part of it; and to manage aquatic and terrestrial ecosystems in the area to protect and enhance indigenous habitat values.

The WRHA (2008) describes the WRHA as of national significance and lists a number of features that individually or collectively contribute to its significance. Relevant ecological features include

(a) its terrestrial and aquatic ecosystems of prominent indigenous character that—

(i) include large continuous areas of primary and regenerating lowland and coastal rainforest, wetland, and dune systems with intact ecological sequences:

(ii) have intrinsic value:

(iii) provide a diversity of habitats for indigenous flora and fauna:

(iv) collect, store, and produce high quality water:

(v) provide opportunities for ecological restoration:

The Project Site is appropriately considered as part of the WRHA as it forms part of a larger area of primary and regenerating lowland rainforest and contains diverse habitats for indigenous flora and fauna.

All indigenous vegetation within the Project Site meets Unitary Plan SEA criteria of representativeness, rarity, diversity, buffering and connective linkages. We acknowledge the appropriateness of the site's inclusion within both the WRHA and the wider Waitakere Ranges SEA_T_5539, and note that vegetation types are generally consistent with characteristic forest communities of the Waitakere Ranges.

6.0 References

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Appendix 1: Waima invertebrate fauna report

Appendix 2: Auckland Regional Council Stream habitat assessment methodology

Appendix 3: List of native flora recorded within the Project Site

Gymnosperms (7)
Agathis australis
Dacrydium cupressinum
Dacrydium dacrydioides
Phyllocladus trichomanoides
Podocarpus totara
Prumnopitys ferruginea
Prumnopitys taxifolia

Monocotyledon trees and shrubs (3)
Cordyline australis
Cordyline banksii
Rhopalostylis sapida

Dicotyledon trees and shrubs (37)
Alectryon excelsus
Alseuosmia macrophylla
Aristotelia serrata
Beilschmiedia tawa
Brachyglottis repanda
Carpodetus serratus
Coprosma arborea
Coprosma grandifolia
Coprosma robusta
Coprosma rhamnoides
Corynocarpus laevigatus
Dysoxylum spectabile
Elaeocarpus hookerianus
Fuchsia excorticata
Geniostoma ligustrifolium
Hedycarya arborea
Hoheria populnea
Knightia excelsa
Kunzea robusta
Leucopogon fasciculatum
Melicytus ramiflorus
Melicytus micranthus
Myrsine australis
Myrsine salicina
Nestegis lanceolata
Olearia rani
Pennantia corymbose
Piper excelsum
Pittosporum tenuifolium
Pomaderris kumeraho
Pseudopanax arboreus
Pseudopanax crassifolius
Pseudopanax lessonii

Schefflera digitata
Sophora chathamica
Syzygium maire
Vitex lucens

Ferns and fern allies (20)
Adiantum aethiopicum
Asplenium bulbiferum
Asplenium flaccidum
Asplenium oblongifolium
Asplenium polyodon
Blechnum novaezelandiae
Blechnum filiformis
Blechnum fraseri
Cyathea dealbata
Cyathea medullaris
Dicksonia squarrosa
Elatostema rugosum
Grammitis billardieri
Lastreopsis hispida
Lygodium sp
Microsorum pustulatum
Microsorum scandens
Pneumatopteris pennigera
Pyrrosia eleagnifolia
Tmesipteris tannensis

Lianes, epiphytes (9)
Astelia solandri
Calystegia sepium
Clematis paniculata
Freycinetia baueriana
Metrosideros carminea
Metrosideros diffusa
Metrosideros perforata
Parsonsia heterophylla
Ripogonum scandens

Herbs (4)
Dianella nigrum
Elatostema rugosum
Nertera ciliata
Nertera scapanioides

Orchids (2)
Nematoceras aff. *trilobum*
Pterostylis agathicola

Grasses, rushes, sedges (5)
Carex dissita
Gahnia pauciflora
Oplismenus imbecillis
Uncinia uncinata
Uncinia zotovii
Total: 82 species

Appendix 4: Atkinson (1985) structural classes

Appendix 5: Average number of individual birds per species recorded at eight 5MBC sites across six count periods (± S.D.)

Species	Average ± SD							
	SITE 1	**SITE 2**	**SITE 3**	**SITE 4**	**SITE 5**	**SITE 6**	**SITE 7**	**SITE 8**
Fantail	0.33 ± 0.52	0.50 ± 0.55	0.33 ± 0.52	0.83 ± 0.98	0.33 ± 0.52	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00
Grey warbler	1.17 ± 0.75	0.67± 0.82	0.17± 0.41	1.00± 0.63	1.00± 0.00	1.00± 0.00	0.50± 0.55	0.83 ± 0.41
Kingfisher	0.17 ± 0.41	0.33 ± 0.52	0.33 ± 0.52	0.33 ± 0.52	0.67 ± 0.82	0.67 ± 0.82	0.00 ± 0.00	0.33 ± 0.52
Kereru	0.00 ± 0.00	0.83 ± 0.98	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00
Shining cuckoo	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.33 ± 0.52	0.00 ± 0.00	0.00 ± 0.00
Silvereye	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00	0.33 ± 0.52	1.50 ± 2.07	0.50 ± 0.55	0.50 ± 0.84
Tui	3.00 ± 0.89	2.17 ± 1.17	3.33 ± 3.39	1.67 ± 0.82	2.00 ± 1.55	1.67± 0.82	1.50 ± 0.55	1.50± 0.84
Chaffinch	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00	0.17 ± 0.41	0.50 ± 0.55	1.00 ± 0.63	0.83 ± 0.41	0.33 ± 0.52
Rosella	0.67 ± 0.82	0.00 ± 0.00	0.17 ± 0.41	0.67 ± 1.03	0.00 ± 0.00	0.00 ± 0.00	0.50 ± 0.84	0.17 ± 0.41
Blackbird	0.17 ± 0.41	0.67 ± 0.82	0.33 ± 0.52	0.50 ± 0.55	0.50 ± 1.22	0.17 ± 0.41	0.50 ± 0.84	0.17 ± 0.41
Myna	0.17 ± 0.41	0.17 ± 0.41	0.50 ± 0.55	0.33 ± 0.52	0.17 ± 0.41	0.17 ± 0.41	1.00 ± 0.89	0.33 ± 0.52
House sparrow	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Thrush	0.17 ± 0.41	0.67 ± 0.52	0.83 ± 1.17	0.17 ± 0.41	0.00 ± 0.00	0.50 ± 0.84	0.00 ± 0.00	0.00 ± 0.00
Greenfinch	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.17 ± 0.41	0.17 ± 0.41

Appendix 6: OSNZ records (derived from surveys undertaken in 1999-2004) obtained for the 10 km x 10 km "square" within which the proposed project site is located.

Species	Conservation status
Australasian bittern	Threatened Nationally Critical
Australasian harrier	Not Threatened
Australian magpie	Introduced
Banded rail	At Risk Declining
Barbary dove	Introduced
Black shag	At Risk Naturally Uncommon
Black swan	Introduced
Blackbird	Introduced
Budgerigar	Introduced
California quail	Introduced
Canada goose	Introduced
Chaffinch	Introduced
Domestic duck	Introduced
Eastern rosella	Introduced
Fantail	Not Threatened
Feral goose	Introduced
Feral turkey	Introduced
Fernbird	At Risk Declining
Golden pheasant	Introduced
Goldfinch	Introduced
Greenfinch	Introduced
Grey duck	Threatened Nationally Critical
Grey warbler	Not Threatened
Hedge sparrow	Introduced
House sparrow	Introduced
Kookaburra	Introduced
Little black shag	At Risk Naturally Uncommon
Little shag	Not Threatened
Long-tailed cuckoo	At Risk Naturally Uncommon
Mallard	Introduced
Marsh Crake	At Risk Declining
Morepork	Not Threatened
Myna	Introduced
New Zealand dabchick	At Risk Recovering
New Zealand kingfisher	Not Threatened
New Zealand pigeon	Not Threatened
New Zealand pipit	At Risk Declining
New Zealand tomtit	Not Threatened
New Zealand shoveler	Not Threatened
North Island Kaka	At Risk Recovering
Paradise shelduck	Not Threatened
Parakeet spp	Introduced
Peafowl	Introduced

Pied shag	At Risk Recovering
Pukeko	Not Threatened
Redpoll	Introduced
Reef heron	Threatened Nationally Endangered
Ring-necked pheasant	Introduced
Rock Pigeon	Introduced
Shining cuckoo	Not Threatened
Silvereye	Not Threatened
Skylark	Introduced
Song thrush	Introduced
Spotless crake	At Risk Declining
Spotted dove	Introduced
Spotted shag	Not Threatened
Spur-winged plover	Not Threatened
Sulphur-crested cockatoo	Introduced
Tufted guinea fowl	Introduced
Tui	Not Threatened
Welcome swallow	Introduced
White-faced heron	Not Threatened
Yellowhammer	Introduced

Appendix 7: Auckland Unitary Plan Schedule 3.

Appendix 1: Waima invertebrate fauna report

FIELD STUDIES

PETER MADDISON Ph.D., F.R.E.S.

Report 18/5/1

WAIMA INVERTEBRATE FAUNA
Report on Survey 2017-2018

May 2018

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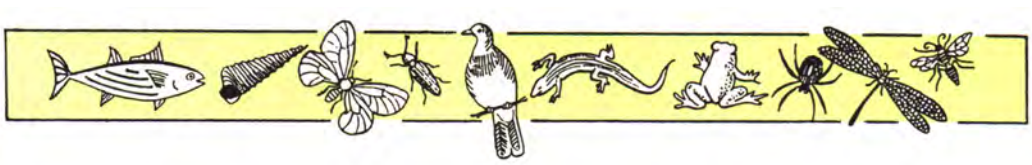


INTRODUCTION

Watercare is proposing the replacement of its existing Huia Water Treatment Plant in Woodlands Park Road, Waima to a site adjacent to the current one but on the opposite side of Manuka Road, with an associated reservoir between Woodlands Park Road and Exhibition Drive. This area is contiguous with, but forms the southern limit of the Waitakere Forest, the Great Forest of Tiriwa.

The work described here documents a survey of the invertebrate fauna found in Waima, roughly between Scenic Drive, Exhibition Drive, the Huia Aquaduct Track and Manuka road/Clark's Bush Reserve. This formed part of an ecological survey by Boffa Miskell, which focussed primarily on the effects of the proposed developments on the vegetation. Given that the forest links to the neighbouring Waitakere Forest, so that the more mobile flying insects associated with vegetation are by their behaviours more widespread, the survey concentrated on soil, litter and ground level faunal elements.

METHODOLOGY

SAMPLING

Three main sampling methods were used :

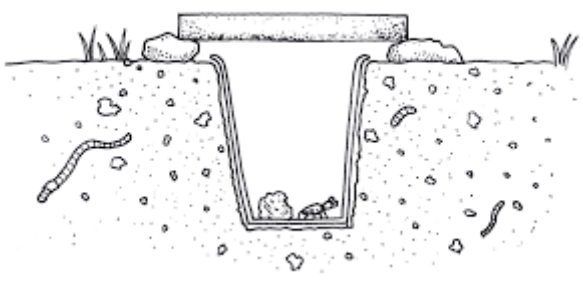
- Pitfall trapping
- Malaise trapping
- Litter extraction

[Note : no special attempt was made to light trap for Lepidoptera]

Pitfall trapping. This method of trapping is used for collected surface active invertebrates. There is great variability in the distribution of invertebrates on the forest floor, which not only reflects the forest floor topology, but the vegetation cover and leaf litter type and features such as the disposition of ant nests and the proximity to any decomposing animal or plant remains. So the traps were placed fairly regularly in the areas, avoiding tree roots and site liable to flooding where possible.

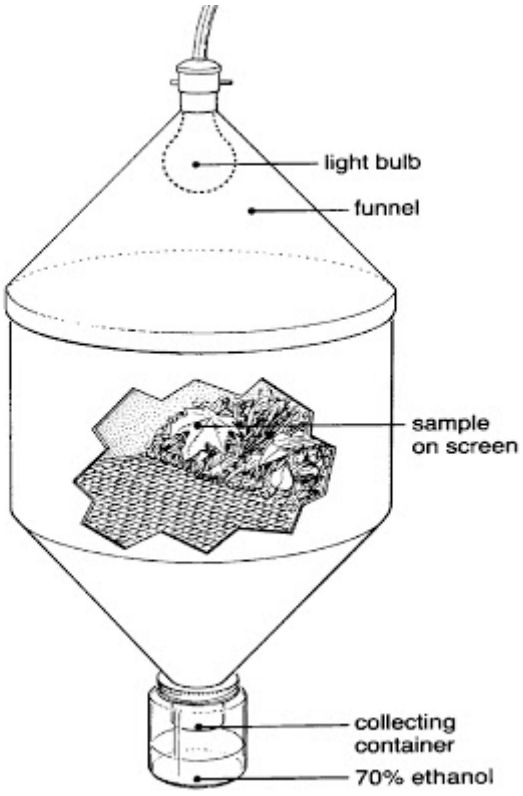
To get a good coverage of the site, pitfall traps were used at Clark's Bush Track, a kahikatea site on Woodlands Park Road, opposite the existing Treatment Plant, and along the Huia Aquaduct Track.

At each site pitfall traps were established and positioned using GPS. These traps were used pet food containers, provided with lids and a small gap (1 cm.) to allow invertebrates through. Glycerol (antifreeze) was used to kill the invertebrates falling into the trap. The traps will be left operating for 5 months, but collected at regular intervals. Samples from the field were transferred to labelled plastic jars. [Note : Given the sudden rainfall events during the survey period a few traps were flooded.]



Malaise trapping. This form of trapping is designed to collect low-flying insects. The aim is to "funnel" the insects into the capture jar (top left in photo). Because the sides of the trap connect with vegetation, this trap also collects invertebrates crawling on the ground and nearby bushes.
Two Malaise traps were used – one in the kahikatea area and the other near Clark's Bush Track. Samples were regularly collected over a 5-month period.

Litter extraction. This method involves the collection of leaf litter and the extraction of animals by the slow desiccation of the litter under a light source. It is useful for collecting the fauna living in the litter area, particularly small invertebrates. Litter was collected into old pillowcases (c. 2 litres in volume), kept out of the sun and transferred as soon as possible to the extraction funnels at Landcare Research, Tamaki. The Tullgren funnels separate the litter placed on a sieve from a light source above (20 watt); a funnel below the sieve directs the animals into the collecting jar with 70-90% ethanol below. Samples were extracted for one week.



All samples were examined under a dissecting microscope (X20) and sorted and recorded by recognisable taxonomic unit (RTU) – this is hopefully equivalent to "species". Samples sorted into separate tubes were preserved in 90% ethanol and labelled according with appropriate collection data. Some insect specimens that were suitable for dry-mounting (beetles, wasps, larger specimens of flies, etc.) were either pinned or card-pointed to help further identification. [This is an on-going process and though some specimens are easily identified by reference to existing specimens (e.g. in the National Arthropod Collection), others require examination by expert taxonomists or systematists. [Note : it was beyond the brief of this work to get detailed taxonomic identification.]

RESULTS and DISCUSSION

The data from the collections are given in the Appendix Tables – these are collected together in the folder "Waima Appendix Tables". They are
WAIMA KAHIKATEA AREA MALAISE TRAP 5/12/17-4/3/18
CLARK'S BUSH MALAISE TRAP
WAIMA LITTER SAMPLES
WAIMA – Litter Sample 27/7/17
CLARK'S BUSH TRACK Pitfall Traps 1-5 16/7-26/8/17
CLARK'S BUSH TRACK Pitfall Traps 26/8/17-12/11/2017
HUIA AQUADUCT PITFALL TRAPS 5/8-17/9/2017
HUIA AQUADUCT PITFALL TRAPS 17/9-12/11/2017
KAHIKATEA AREA PITFALL TRAPS 15/10-5/12/2017

These give the raw data and were used for summarising the invertebrates found. Over 10000 specimens were collected and summarised in the file
WAIMA INVERTEBRATE FAUNA SUMMARY
– also in the folder "Waima Appendix Tables". This should be read in parallel with the file :
WAIMA INVERTEBRATE FAUNA TEXT, which describes and illustrates features of the important fauna groups.

The data shows that, at present there were 732 RTUs (equivalent to "species") found in the areas sampled. In general the invertebrate fauna found, as with the vegetation can be said to be comparable with that of similar areas of the southern Waitakere Ranges. The invertebrate fauna also showed little presence of adventive species and no sign of the Argentine ant, *Linepithema humile,* was found. The Kahikatea Swamp area had some specialised fauna (Ostracoda, Copepoda and Turbellaria) that is unusual – as is the kahikatea swamp area – in this part of the ecological district. The two areas of typical forest sampled in Clark's Bush and the Huia Aquaduct had a large component of native (and mostly endemic) species associated typically with kauri (*Agathis australis*), puriri (*Vitex lucens*) and mamangi (*Coprosma arborea*), in some places successional to kanuka (*Kunzea robusta.*)

INTERESTING and NOTABLE FINDINGS

1. A species of peripatus, *Peripatoides,* was found both in Clark's Bush and along the Huia Aquaduct Track. This group of animals is thought to be the "missing link" between Annelids (worms) and Arthropoda like Chilopoda (centipedes.)
2. An unusual "shellless" snail, *Otoconcha,* found at Clark's Bush.

3. An unusually large number of peri-aquatic organisms at the kahikatea site – Copepoda{copepods), Ostracoda (seed shrimps) and Turbellaria (flatworms). This may indicate that the water level in the area rose to the level of the pitfall traps or may be a special feature of this site.
4. Most of the ants found belonged to New Zealand native species. The lack of invasive ant species and particularly of Argentine ant, *Linepithema humile*, is notable. Argentine ant has recently been found nearby in South Titirangi and Woodland Park, where measures aimed at control/eradication are already underway – this ant can have serious debilitating effects on ground-living invertebrates and it is recommended that measures are taken to prevent its introduction to the Waima area.
5. A large ground beetle, *Mecodema*, is indicative of a low presence of rodents. This is probably associated with pest control activities in the area.
6. The presence of millipedes of the family Polyxenidae is notable. Little is known of their biology.
7. Though the collecting methods are generally poor in collecting native snails, the finding of 18 species of endemic small land snail, and the larger *Rhytida* indicate that these are an important element of the fauna. The kauri snail, *Paryphanta busbyi*, has been found along Exhibition Drive.
8. The wedge-shaped beetle, *Allocinops brouni*, is unusual in this area. It was found in Clark's Bush. [The only record on iNaturalist is from Wellington.] Little is known of this species in New Zealand, but members of this family (Riphiphoridae) have larvae (planidia) which parasitize wasps, bees and cockroaches.
9, In the past 30 years, the first part of Exhibition Drive (= Hillary Trail), has been the place for a number of nightwalks – designed to educate local people in the night-active invertebrates of the area. Regularly seen are glow-worms, kawakawa looper caterpillars, native snails, stick insects – including one species regarded by the late Dr. Graeme Ramsay as "new to science" - and a very large colony of large cave weta, *Gymnoplectron*, in the pipe tunnels. It is recommended that long-term planning takes credence of this asset and ensures its persistence.

ACKNOWLEDGMENTS

I thank Watercare for allowing access to the site and to their staff for useful discussions. Considerable help with the field work was received form a number of people – particularly Rosemary Gilbert and locally Tina Hamlin. I thank Landcare Research, and particularly Grace Hall, for help with litter extractions at the Tamaki site. Several people have helped with the mounting and labelling of specimens – Rosemary Gilbert, Janet Price and Peggy Herbert in particular. I am also grateful to Landcare Research, as a research associate, for providing access and facilities to the New Zealand Arthropod Collection to allow identifications of the specimens. Finally thanks to Ian Boothroyd at Boffa Miskell for their long tolerance of my submitting this report.

Appendix 2: Auckland Regional Council Stream habitat assessment methodology

Habitat Assessment - Field Data Sheet

Stream Name:
Date:
Location:
Field Crew:

Weather Conditions Current

Clear/sunny ☐
Cloudy ☐
Rain ☐

Photo(s)
Film No.
Photo No.(s)

Has there been heavy rain in the past week? Yes ☐ No ☐

Site location map

Predominant surrounding land use

Native forest ☐
Native scrub ☐
Planted forest ☐
Lifestyle ☐
Horticulture ☐
Pasture ☐
Urban ☐

Litter present ☐

Evidence of livestock access

Left bank ☐
Right bank ☐

Habitat Assessment - Field Data Sheet

Channel shading (%)

Filamentous algae coverage (%)

Periphyton	Rare	Common	Abundant
Diatom			
Mat algae			
Filamentous algae			
Bryophytes (moss, liverworts)			

Note: Rare = <10% cover
Common = 10-50% cover
Abundant = >50% cover

Macrophytes

Rare	Common	Abundant

Water Quality

Temperature (°C) _____ pH _____

Conductivity at temp (µS) _____ Turbidity (NTU) _____

Conductivity at 25 °C (µS) _____ WQ instrument(s) used:

Dissolved oxygen (mg/l) _____

Dissolved oxygen (%) _____

Time of day _____

Water Odour

Normal/none ☐
Petroleum ☐
Anaerobic ☐
Sewage ☐
Chemical ☐

Water Clarity

Clear ☐
Slightly turbid ☐
Turbid ☐

Water surface oils ☐
Anerobic sediment odour (H_2S) ☐

Macroinvertebrate Sampling - Habitat Details

Substrates Sampled (%)

Soft Bottomed	Rep 1	Rep 2	Rep 3
Woody debris			
Bank			
Macrophyte			

Hard Bottomed	Rep 1	Rep 2	Rep 3
Boulder (>256mm)			
Cobble (64-256mm)			
Gravel (2-64mm)			

Packing of cobble *(determined by kicking substrate)*

Tightly packed ☐ Moderately packed ☐ Loose ☐

Cobble Periphyton Sampled

Diatom ☐ Bryophytes ☐ Mat algae ☐ Filamentous algae ☐ None ☐

Qualitative Habitat Assessment

Stream: _____

Scorer: _____ **Date:** _____

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Aquatic Habitat Abundance	> 50% of channel favourable for epifaunal colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat. Also includes macrophyte dominated streams.	30-50% of channel contains stable habitat.	10-30% of channel contains stable habitat.	< 10% of channel contains stable habitat. *Note: Algae does not constitute stable habitat.*
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Aquatic Habitat Diversity	Wide variety of stable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Stable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream).	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Channel Alteration	Natural channel and meander pattern; no evidence of historic channel alteration e.g. dredging, channelisation stabilisation, or other human activity.	Natural channel. Minimal channel alteration. Channel shape and form may be influenced by recent sediment deposition.	Channelised. Channel form and shape unconstrained. Channel made of natural materials.	Channelised. Channel form and shape constrained by man-made materials (e.g. culverts, gabions, concrete).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Bank Stability (water level to bank full channel)	Stable: <5% bank effected; evidence of erosion or bank failure absent; minimal potential for future problems.	Moderately stable: 5-30% affected; areas of erosion mostly healed over; some potential for future problems.	Moderately unstable: 30-60% affected; high erosion potential during floods.	Unstable: 60-100% affected; eroded areas along runs and bends; bank sloughing and erosion scars common.
Left bank	10 9	8 7 6	5 4 3	2 1 0
Right bank	10 9	8 7 6	5 4 3	2 1 0

	Optimal	Suboptimal	Marginal	Poor
6. Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Riparian Vegetation Integrity (within 20 meters)	No direct human activity in the last 30 years; mature native tree canopy and intact native understory	Minimal human activity; mature native tree canopy or native scrub; understory shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understory; trees exotic (pine, willow, poplar); understory native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, carparks).
Left bank	10 9	8 7 6	5 4 3	2 1 0
Right bank	10 9	8 7 6	5 4 3	2 1 0

Comments:

- fish observed
- fish habitat
- barriers to fish passage
- evidence of stable pools
- catchment erosion
- seaps or springs
- discharges or outfalls
- evidence of grazing stock access
- unique features
- crossings / tracks
- litter, shopping trollies, batteries, tyres
- descriptions of sediment
- stock / feral grazing
- high water marks
- Age / maturity of trees

Number of crayfish (koura) released. *To be added to macroinvertebrate data*		
Rep 1	Rep 2	Rep 3

Quantitative Habitat Assessment **Stream:** _____

Scorer: _____ **Date:** _____

Legend	Riparian zone (L)		Bank *(True Left)*	Aquatic Substrate			Bank *(True Right)*	Riparian zone (R)	
	5-20m	0-5m		Inorganic				0-5m	5-20m
	Canopy		Stability	Organic			Stability	Canopy	
	Understory		Bank Type	Wetted width (m)	Max depth	Flow type	Bank Type	Understory	
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Appendix 3: List of native flora recorded within the Project Site

Gymnosperms (7)
Agathis australis
Dacrydium cupressinum
Dacrydium dacrydioides
Phyllocladus trichomanoides
Podocarpus totara
Prumnopitys ferruginea
Prumnopitys taxifolia

Monocotyledon trees and shrubs (3)
Cordyline australis
Cordyline banksii
Rhopalostylis sapida

Dicotyledon trees and shrubs (37)
Alectryon excelsus
Alseuosmia macrophylla
Aristotelia serrata
Beilschmiedia tawa
Brachyglottis repanda
Carpodetus serratus
Coprosma arborea
Coprosma grandifolia
Coprosma robusta
Coprosma rhamnoides
Corynocarpus laevigatus
Dysoxylum spectabile
Elaeocarpus hookerianus
Fuchsia excorticata
Geniostoma ligustrifolium
Hedycarya arborea
Hoheria populnea
Knightia excelsa
Kunzea robusta
Leucopogon fasciculatum
Melicytus ramiflorus
Melicytus micranthus
Myrsine australis
Myrsine salicina
Nestegis lanceolata
Olearia rani
Pennantia corymbose
Piper excelsum
Pittosporum tenuifolium
Pomaderris kumeraho
Pseudopanax arboreus
Pseudopanax crassifolius
Pseudopanax lessonii

Schefflera digitata
Sophora chathamica
Syzygium maire
Vitex lucens

Ferns and fern allies (20)
Adiantum aethiopicum
Asplenium bulbiferum
Asplenium flaccidum
Asplenium oblongifolium
Asplenium polyodon
Blechnum novaezelandiae
Blechnum filiformis
Blechnum fraseri
Cyathea dealbata
Cyathea medullaris
Dicksonia squarrosa
Elatostema rugosum
Grammitis billardieri
Lastreopsis hispida
Lygodium sp
Microsorum pustulatum
Microsorum scandens
Pneumatopteris pennigera
Pyrrosia eleagnifolia
Tmesipteris tannensis

Lianes, epiphytes (9)
Astelia solandri
Calystegia sepium
Clematis paniculata
Freycinetia baueriana
Metrosideros carminea
Metrosideros diffusa
Metrosideros perforata
Parsonsia heterophylla
Ripogonum scandens

Herbs (4)
Dianella nigrum
Elatostema rugosum
Nertera ciliata
Nertera scapanioides

Orchids (2)
Nematoceras aff. *trilobum*
Pterostylis agathicola

Grasses, rushes, sedges (5)
Carex dissita
Gahnia pauciflora
Oplismenus imbecillis
Uncinia uncinata
Uncinia zotovii
Total: 82 species

Appendix 4: Atkinson (1985) structural classes

Table 9 Diagnostic criteria for terrestrial vegetation structural classes (modified and extended from Atkinson 1962).

Structural class	Diagnostic criteria for structural classes and definitions of growth forms
1. FOREST	Woody vegetation in which the cover of trees and shrubs in the canopy is > 80% and in which tree cover exceeds that of shrubs. Trees are woody plants ⩾ 10 cm dbh. Tree ferns ⩾ 10 cm dbh are treated as trees.
2. TREELAND	Vegetation in which the cover of trees in the canopy is 20–80%, with tree cover exceeding that of any other growth form, and in which the trees form a discontinuous upper canopy above either a lower canopy of predominantly non-woody vegetation or bare ground e.g., mahoe/bracken treeland. (Note: Vegetation consisting of trees above shrubs is classified as either forest or scrub depending on the proportion of trees and shrubs in the canopy).
3. VINELAND	Vegetation in which the cover of *unsupported* (or artificially supported) woody vines in the canopy is 20–100% and in which the cover of these vines exceeds that of any other growth form or bare ground. Vegetation containing woody vines that are supported by trees or shrubs is classified as forest, scrub or shrubland. Examples of woody vines occur in the genera *Actinidia, Clematis, Lonicera, Metrosideros, Muehlenbeckia, Ripogonum, Vitis* and others.
4. SCRUB	Woody vegetation in which the cover of shrubs and trees in the canopy is > 80% and in which shrub cover exceeds that of trees (cf. FOREST). Shrubs are woody plants < 10 cm dbh.
5. SHRUBLAND (including tussock-shrubland)	Vegetation in which the cover of shrubs in the canopy is 20–80% and in which the shrub cover exceeds that of any other growth form or bare ground. It is sometimes useful to separate tussock-shrublands as a sub-class for areas where tussocks are > 20% but less than shrubs. (Note: The term scrubland is not used in this classification).
6. TUSSOCKLAND (including flaxland)	Vegetation in which the cover of tussocks in the canopy is 20–100% and in which the tussock cover exceeds that of any other growth form or bare ground. Tussocks include all grasses, sedges, rushes, and other herbaceous plants with linear leaves (or linear non-woody stems) that are densely clumped and > 10 cm height. Examples of the growth form occur in all species of *Cortaderia, Gahnia*, and *Phormium*, and in some species of *Chionochloa, Poa, Festuca, Rytidosperma, Cyperus, Carex, Uncinia, Juncus, Astelia, Aciphylla*, and *Celmisia*. It is sometimes useful to separate *flaxland** as a subclass for areas where species of *Phormium* are dominant.
7. FERNLAND	Vegetation in which the cover of ferns in the canopy is 20–100% and in which the fern cover exceeds that of any other growth form or bare ground. Tree ferns ⩾ 10 cm dbh are excluded as trees (cf. FOREST).
8. GRASSLAND	Vegetation in which the cover of grass in the canopy is 20–100% and in which the grass cover exceeds that of any other growth form or bare ground. Tussock-grasses are excluded from the grass growth-form.
9. SEDGELAND	Vegetation in which the cover of sedges in the canopy is 20–100% and in which the sedge cover exceeds that of any other growth form or bare ground. Included in the sedge growth form are many species of *Carex, Uncinia*, and *Scirpus*. Tussock-sedges and reed-forming sedges (cf. REEDLAND) are excluded.
10. RUSHLAND	Vegetation in which the cover of rushes in the canopy is 20–100% and in which the rush cover exceeds that of any other growth form or bare ground. Included in the rush growth form are some species of *Juncus* and all species of *Sporadanthus, Leptocarpus*, and *Empodisma*. Tussock-rushes are excluded.

*The term "flaxland" could not be used outside New Zealand because elsewhere the name flax is widely applied to species of *Linum*.

Table 9 *cont.*

Structural class	Diagnostic criteria for structural classes and definitions of growth forms
11. REEDLAND	Vegetation in which the cover of reeds in the canopy is 20–100% and in which the reed cover exceeds that of any other growth form or open water. Reeds are herbaceous plants growing in standing or slowly-running water that have tall, slender, erect, unbranched leaves or culms that are either hollow or have a very spongy pith. Example include *Typha, Bolboschoenus, Scirpus lacustris, Eleocharis sphacelata,* and *Baumea articulata.*
12. CUSHIONFIELD	Vegetation in which the cover of cushion plants in the canopy is 20–100% and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions. The growth form occurs in all species of *Donatia, Gaimardia, Hectorella, Oreobolus,* and *Phyllachne* as well as in some species of *Aciphylla, Celmisia, Centrolepis, Chionohebe, Colobanthus, Dracophyllum, Drapetes, Haastia, Leucogenes, Luzula, Myosotis, Poa, Raoulia,* and *Scleranthus.*
13. HERBFIELD	Vegetation in which the cover of herbs in the canopy is 20–100% and in which the herb cover exceeds that of any other growth form or bare ground. Herbs include all herbaceous and low-growing semi-woody plants that are not separated as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.
14. MOSSFIELD	Vegetation in which the cover of mosses in the canopy is 20–100% and in which the moss cover exceeds that of any other growth form or bare ground.
15. LICHENFIELD	Vegetation in which the cover of lichens in the canopy is 20–100% and in which the lichen cover exceeds that of any other growth form or bare ground.
16. ROCKLAND	Land in which the area of residual bare rock exceeds the area covered by any one class of plant growth-form. Cliff vegetation often includes rocklands. They are named from the leading plant species when plant cover $\geqslant$ 1% e.g., [koromiko] rockland.
17. BOULDERFIELD	Land in which the area of unconsolidated bare boulders (> 200 mm diam.) exceeds the area covered by any one class of plant growth-form. Boulderfields are named from the leading plant species when plant cover $\geqslant$ 1%.
18. STONEFIELD/ GRAVELFIELD	Land in which the area of unconsolidated bare stones (20–200 mm diam.) and/or gravel (2–20 mm diam.) exceeds the area covered by any one class of plant growth-form. The appropriate name is given depending on whether stones or gravel form the greater area of ground surface. Stonefields and gravelfields are named from the leading plant species when plant cover $\geqslant$ 1%.
19. SANDFIELD	Land in which the area of bare sand (0.02–2 mm diam.) exceeds the area covered by any one class of plant growth-form. Dune vegetation often includes sandfields which are named from the leading plant species when plant cover $\geqslant$ 1%.
20. LOAMFIELD/ PEATFIELD	Land in which the area of loam and/or peat exceeds the area covered by any one class of plant growth-form. The appropriate name is given depending on whether loam or peat forms the greater area of ground surface. Loamfields and peatfields are named from the leading plant species when plant cover $\geqslant$ 1%.

Table 11 Naming of structural classes in various kinds of vegetation: some examples.

Canopy composition of vegetation (% cover)		Structural class
	%	
trees	81	forest
shrubs	19	
trees	19	scrub
shrubs	81	
trees	50	forest
shrubs	50	
trees	49	scrub
shrubs	51	
trees	81	forest
tussocks	19	
trees	80	treeland
tussocks	20	(subclass: tussock-treeland)*
trees	50	treeland
tussocks	50	(subclass: tussock-treeland)*
trees	49	tussockland
tussocks	51	(subclass: tree-tussockland)*
trees	20	shrubland
shrubs	40	(subclass: tussock-shrubland)*
tussocks	40	
trees	20	tussockland
shrubs	39	(subclass: shrub-tussockland)*
tussocks	41	
trees	49	vineland
unsupported vines	51	(subclass: tree-vineland)*
trees	30	treeland
shrubs	20	(subclass: tussock-treeland)*
tussocks	20	Lower canopy is predominantly
grasses	20	non-woody
sedges	10	
trees	30	tussockland
shrubs	10	(subclass: tree-tussockland)*
tussocks	35	
grasses	20	
sedges	5	
shrubs	20	rockland
herbs	25	(subclass: herb-rockland)*
residual rock	40	
mosses	15	
boulders	15	gravelfield
stones	30	(subclass: stone-gravelfield)*
gravel	35	
plants	20	

*The use of these subclasses, based on Atkinson (1962), is not strongly advocated. They are included to make clear that these options are available for descriptive or mapping purposes if local needs make their use desirable.

Appendix 5: Average number of individual birds per species recorded at eight 5MBC sites across six count periods (± S.D.)

Species	Average ± SD							
	SITE 1	**SITE 2**	**SITE 3**	**SITE 4**	**SITE 5**	**SITE 6**	**SITE 7**	**SITE 8**
Fantail	0.33 ± 0.52	0.50 ± 0.55	0.33 ± 0.52	0.83 ± 0.98	0.33 ± 0.52	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00
Grey warbler	1.17 ± 0.75	0.67± 0.82	0.17± 0.41	1.00± 0.63	1.00± 0.00	1.00± 0.00	0.50± 0.55	0.83 ± 0.41
Kingfisher	0.17 ± 0.41	0.33 ± 0.52	0.33 ± 0.52	0.33 ± 0.52	0.67 ± 0.82	0.67 ± 0.82	0.00 ± 0.00	0.33 ± 0.52
Kereru	0.00 ± 0.00	0.83 ± 0.98	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00
Shining cuckoo	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.33 ± 0.52	0.00 ± 0.00	0.00 ± 0.00
Silvereye	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00	0.33 ± 0.52	1.50 ± 2.07	0.50 ± 0.55	0.50 ± 0.84
Tui	3.00 ± 0.89	2.17 ± 1.17	3.33 ± 3.39	1.67 ± 0.82	2.00 ± 1.55	1.67± 0.82	1.50 ± 0.55	1.50± 0.84
Chaffinch	0.33 ± 0.52	0.33 ± 0.52	0.00 ± 0.00	0.17 ± 0.41	0.50 ± 0.55	1.00 ± 0.63	0.83 ± 0.41	0.33 ± 0.52
Rosella	0.67 ± 0.82	0.00 ± 0.00	0.17 ± 0.41	0.67 ± 1.03	0.00 ± 0.00	0.00 ± 0.00	0.50 ± 0.84	0.17 ± 0.41
Blackbird	0.17 ± 0.41	0.67 ± 0.82	0.33 ± 0.52	0.50 ± 0.55	0.50 ± 1.22	0.17 ± 0.41	0.50 ± 0.84	0.17 ± 0.41
Myna	0.17 ± 0.41	0.17 ± 0.41	0.50 ± 0.55	0.33 ± 0.52	0.17 ± 0.41	0.17 ± 0.41	1.00 ± 0.89	0.33 ± 0.52
House sparrow	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Thrush	0.17 ± 0.41	0.67 ± 0.52	0.83 ± 1.17	0.17 ± 0.41	0.00 ± 0.00	0.50 ± 0.84	0.00 ± 0.00	0.00 ± 0.00
Greenfinch	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.17 ± 0.41	0.17 ± 0.41	0.17 ± 0.41

Appendix 6: OSNZ records (derived from surveys undertaken in 1999-2004) obtained for the 10 km x 10 km "square" within which the proposed project site is located.

Species	Conservation status
Australasian bittern	Threatened Nationally Critical
Australasian harrier	Not Threatened
Australian magpie	Introduced
Banded rail	At Risk Declining
Barbary dove	Introduced
Black shag	At Risk Naturally Uncommon
Black swan	Introduced
Blackbird	Introduced
Budgerigar	Introduced
California quail	Introduced
Canada goose	Introduced
Chaffinch	Introduced
Domestic duck	Introduced
Eastern rosella	Introduced
Fantail	Not Threatened
Feral goose	Introduced
Feral turkey	Introduced
Fernbird	At Risk Declining
Golden pheasant	Introduced
Goldfinch	Introduced
Greenfinch	Introduced
Grey duck	Threatened Nationally Critical
Grey warbler	Not Threatened
Hedge sparrow	Introduced
House sparrow	Introduced
Kookaburra	Introduced
Little black shag	At Risk Naturally Uncommon
Little shag	Not Threatened
Long-tailed cuckoo	At Risk Naturally Uncommon
Mallard	Introduced
Marsh Crake	At Risk Declining
Morepork	Not Threatened
Myna	Introduced
New Zealand dabchick	At Risk Recovering
New Zealand kingfisher	Not Threatened
New Zealand pigeon	Not Threatened
New Zealand pipit	At Risk Declining
New Zealand tomtit	Not Threatened
New Zealand shoveler	Not Threatened
North Island Kaka	At Risk Recovering
Paradise shelduck	Not Threatened
Parakeet spp	Introduced
Peafowl	Introduced

Pied shag	At Risk Recovering
Pukeko	Not Threatened
Redpoll	Introduced
Reef heron	Threatened Nationally Endangered
Ring-necked pheasant	Introduced
Rock Pigeon	Introduced
Shining cuckoo	Not Threatened
Silvereye	Not Threatened
Skylark	Introduced
Song thrush	Introduced
Spotless crake	At Risk Declining
Spotted dove	Introduced
Spotted shag	Not Threatened
Spur-winged plover	Not Threatened
Sulphur-crested cockatoo	Introduced
Tufted guinea fowl	Introduced
Tui	Not Threatened
Welcome swallow	Introduced
White-faced heron	Not Threatened
Yellowhammer	Introduced

Appendix 7: Auckland Unitary Plan Schedule 3.

Schedule 3 Significant Ecological Areas – Terrestrial Schedule

Factors for assessing ecological value [rps]

An area shall be considered to have significant ecological value if it meets one or more the sub-factors 1 to 5 below. These factors are also referred to in B7.2.2(1).

These factors have been used to determine the areas included in Schedule 3 Significant Ecological Areas – Terrestrial Schedule, and will be used to assess proposed future additions to the schedule.

Factors:

(1) REPRESENTATIVENESS

Sub-factor:

(a) It is an example of an indigenous ecosystem (including both mature and successional stages), that contributes to the inclusion of at least 10% of the natural extent[1] of each of Auckland's original ecosystem types[2] in each ecological district of Auckland (starting with the largest, most natural and intact, most geographically spread) and reflecting the environmental gradients of the region, and is characteristic or typical of the natural ecosystem diversity of the ecological district and/or Auckland.

(2) THREAT STATUS AND RARITY

Sub-factors:

(a) It is an indigenous habitat, community or ecosystem that occurs naturally in Auckland and has been assessed (using the IUCN threat classification system) to be threatened, based on evidence and expert advice (including Holdaway et al. Status assessment of NZ naturally uncommon ecosystems[3]).

(b) It is a habitat that supports occurrences of a plant, animal or fungi that has been assessed by the Department of Conservation and determined to have a national conservation status of threatened or at risk; or

(i) it is assessed as having a regional threatened conservation status including Regionally Critical, Endangered and Vulnerable and Serious and Gradual Decline.

(c) It is indigenous vegetation that occurs in Land Environments New Zealand Category IV where less than 20% remains.

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[1] "Natural extent" is intended to mean a combination of our understanding of the historic pre-human diversity, distribution and extent of ecosystems in Auckland and what we would expect this to be given past and current environmental drivers.

[2] The Department of Conservation's ecosystem classification system described over 135 ecosystems in New Zealand (Singers and Rogers in press). Of these 35 ecosystems are known to have occurred in Auckland and these are what is meant by original ecosystems. They include the more recent indigenous dominated shrub and scrublands that have evolved as a result of human modification of the landscape.

[3] Status Assessment of New Zealand's Naturally Uncommon Ecosystems, ROBERT J. HOLDAWAY, SUSAN K. WISER and PETER A. WILLIAMS. Conservation Biology. Volume 26, Issue 4, pages 619–629, August 2012

(d) It is any indigenous vegetation or habitat of indigenous fauna that occurs within an indigenous wetland or dune ecosystem.

(e) It is a habitat that supports an occurrence of a plant, animal or fungi that is locally rare; or

(i) it has been assessed by the Department of Conservation and determined to have a national conservation status of Naturally Uncommon, Range Restricted or Relict.

(3) DIVERSITY

Sub-factors:

(a) It is any indigenous vegetation that extends across at least one environmental gradient resulting in a sequence that supports more than one indigenous habitat, community or ecosystem type e.g., an indigenous estuary to an indigenous freshwater wetland.

(b) It supports the expected indigenous ecosystem diversity for the habitat(s).

(c) It is an indigenous habitat type that supports a typical species richness or species assemblage for its type.

(4) STEPPING-STONES, MIGRATION PATHWAYS AND BUFFERS

Sub-factors:

(a) It is an example of an indigenous ecosystem, or habitat of indigenous fauna that is used by any native species permanently or intermittently for an essential part of their life cycle (e.g. known to facilitate the movement of indigenous species across the landscape, haul-out site for marine mammals) and therefore makes an important contribution to the resilience and ecological integrity of surrounding areas.

(b) It is an example of an ecosystem, indigenous vegetation or habitat of indigenous fauna, that is immediately adjacent to, and provides protection for, indigenous biodiversity in an existing protected natural area (established for the purposes of biodiversity protection); or

(i) it is an area identified as significant under the ‘threat status and rarity’ or ‘uniqueness’ factor. This includes areas of vegetation (that may be native or exotic) that buffer a known significant site. It does not include buffers to the buffers.

(c) It is part of a network of sites that cumulatively provide important habitat for indigenous fauna or when aggregated make an important contribution to the provision of a particular ecosystem in the landscape.

(d) It is a site which makes an important contribution to the resilience and ecological integrity of surrounding areas.

(5) UNIQUENESS OR DISTINCTIVENESS

Sub-factors:

(a) It is habitat for a plant, animal or fungi that is endemic to the Auckland region (i.e. not found anywhere else).

(b) It is an indigenous ecosystem that is endemic to the Auckland region or supports ecological assemblages, structural forms or unusual combinations of species that are endemic to the Auckland region.

(c) It is an indigenous ecosystem or a habitat that supports occurrences of a plant, animal or fungi that are near-endemic (i.e., where the only other occurrence(s) is within 100km of the council boundary).

(d) It is a habitat that supports occurrences of a plant, animal or fungi that is the type locality for that taxon.

(e) It is important as an intact sequence or outstanding condition in the region.

(f) It is a habitat that supports occurrences of a plant, animal or fungi that is the largest specimen or largest population of the indigenous species in Auckland or New Zealand.

(g) It is a habitat that supports occurrences of a plant, animal or fungi that are at (or near) their national distributional limit.