report

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Graham Block Structure Plan
Ecological Assessment

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1.0 Introduction

DFH Joint Venture (DFH) is undertaking a residential and industrial land development project at Pokeno. The Graham Block situated at Hitchen Road comprises approximately 31 ha in area and is located adjacent to the current development (Figure 1). This report describes the terrestrial and freshwater ecology values within the Graham Block and assesses the ecological effects associated with changing the land use from rural to residential.

2.0 Ecological Setting

2.1 Ecological Context

The site is located within the Waikato Ecological Region and Meremere Ecological District on the boundary with the Auckland Ecological Region and Manukau Ecological District (McEwen 1987). The Meremere Ecological District was characterised on the basis of topography and the presence of important wetlands including Whangamarino Swamp, several shallow lakes (including Whangape, Waikare, Rotongaro and Wahi) and the lower reaches of the Waikato River (McEwen 1987). The district comprises a well-defined interior basin with alluvial flats, wetlands and lakes bordering the lower reaches of the Waikato River. The more dissected, higher elevation ecological districts of Hapuakohe and Raglan are located to the east and west respectively, with the Hamilton Ecological District to the south-west. To the north are the Awhitu, Manukau and Hunua ecological districts which together comprise the southern portion of the Auckland Ecological Region.

Geologically the Waikato Region is characterised by three parallel blocks of hill country separated by two extensive parallel basins established after differential uplift (McCraw 2002). The district includes mostly Holocene river and swamp deposits with Miocene to Oligocene calcareous sandstone and siltstone forming elevated ridges. The ecological district includes coal seams in the south (near Rotowaro and Huntly) and north-east (near Maramarua). Soils are mainly friable and well drained from old strongly weathered volcanic ash, but poorly drained, gleyed alluvial and peaty soils occur in places along with weakly to moderately leached soils from sedimentary rocks in the hill country and limited areas of reddish volcanic loam soils from basaltic lava and scoria in the north (McCraw 2002).

Pokeno is located on the boundary between the eastern side of the Western Uplands and the western side of the Lower Waikato Valley (the northern extension of the Hamilton Basin) within the Waikato Ecological Region. As such the local soils consist of a mixture of uplifted alluvium deposited by the Waikato River on previous courses and friable clays derived from basalt and andesite basement materials (McEwen 1987, McCraw 2002).

The ecological district covers 105,307 ha, and in 1840, was vegetated with around 31% primary forest, 23% wetland and 39% secondary scrub (Leathwick et al. 1995). Primary forest at the site would have consisted of kauri *(Agathis australis)* – conifer – broadleaved forest, although at the time of European settlement it seems likely that the area was already covered by secondary vegetation arising from earlier clearance by Maori (Nicholls 2002). This vegetation would most likely have consisted of various mixes of mānuka *(Leptospermum scoparium)*, flax *(Phormium tenax)*, rushes and sedges with small enclaves of kahikatea *(Dacrydium dacrydioides)* (Leathwick et al. 1995).

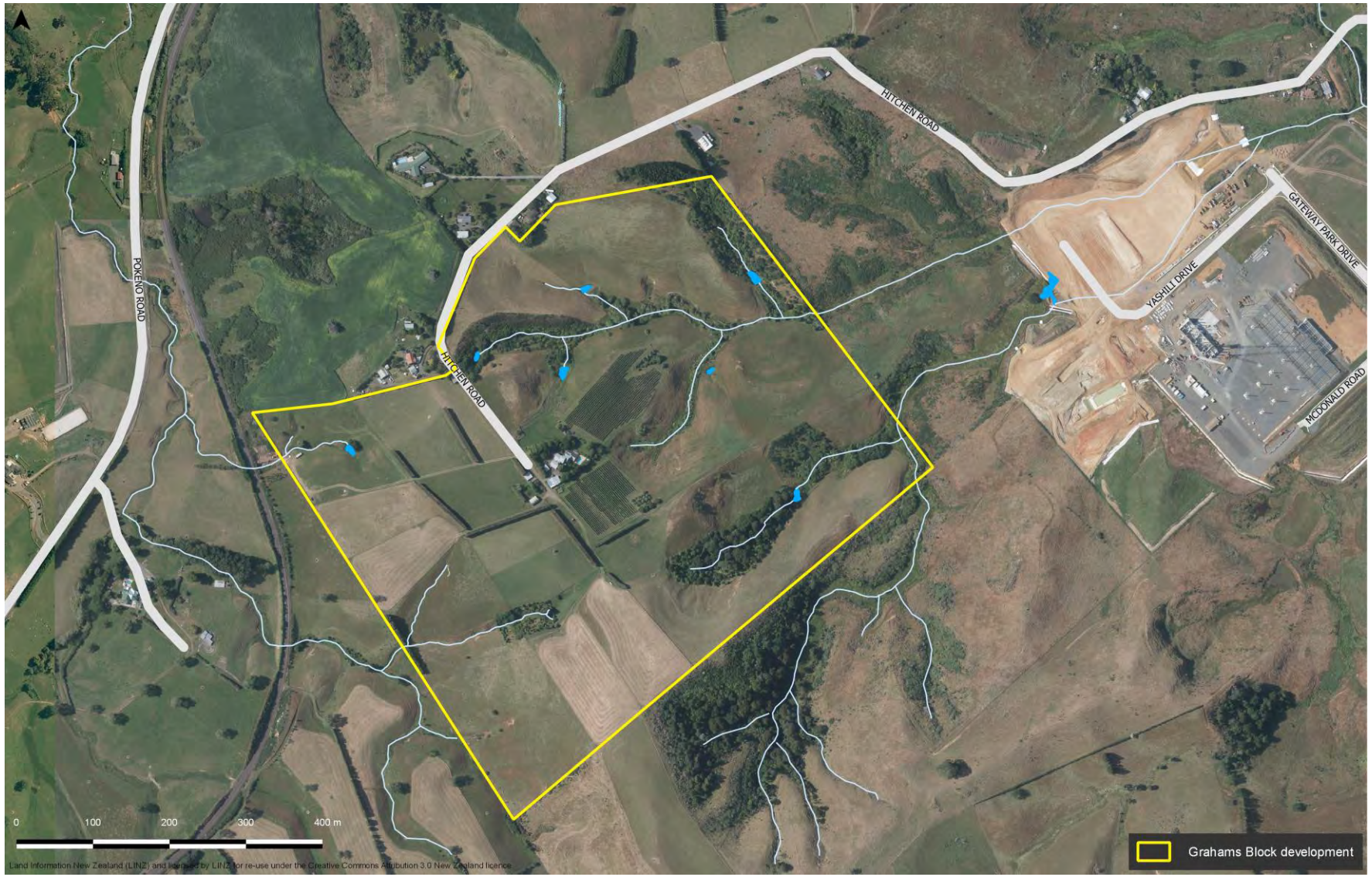

Figure 1: Location of the Graham Block site.

Primary forest at the site would likely have included kauri, northern rata *(Metrosideros robusta)*, tawa *(Beilschmiedia tawa)*, hīnau *(Elaeocarpus dentatus)*, rewarewa *(Knightia excelsa)*, rimu *(Dacrydium cupressinum)*, miro *(Prumnopitys ferruginea)*, Hall's tōtara *(Podocarpus cunninghamii)* and tānekaha *(Phyllocladus trichomanoides)*. Taraire *(Beilschmiedia tarairi)* reaches its natural southern limits within the district (near Onewhero). The district has been heavily modified primarily for pastoral farming (McEwen 1987).

Both kauri forest and dense podocarp forest are reduced to <2% of their original extent even though together they originally covered an estimated 75% of the Meremere District, while wetlands have been reduced to 20.6% of their original extent (Harding 1997).

A narrow portion of the Meremere Ecological District was included within the Auckland Conservancy prior to falling under the governance of Waikato District Council in 2010. The Auckland Conservancy portion of the Meremere Ecological District covered a narrow band along the top of the District above the Waikato River where the site is located. Within this area wetlands cover just 23% of their original extent (Lindsey et al. 2009). In the national context, this represents a smaller than typical reduction in wetland area.

Priorities for protection in the Auckland Conservancy portion of the Meremere Ecological District include freshwater wetlands, coastal ecosystems including estuarine, wetlands, shrublands and forest, and sites of originally rare ecosystems such as coastal rock stacks, estuary, lake margin and subterranean basalt fields (Lindsey et al. 2009). Opportunities for protection in the district include the restoration of wetlands and protection of various forest remnants in specific locations throughout the district (Harding 1997).

2.2 Land and Threatened Environments Classification

Land Environments of New Zealand (LENZ) mapping uses 15 drivers of biological patterns to classify New Zealand into discrete environments to provide a spatial context for defining ecological units (Leathwick et al. 2003). According to the Threatened Environments Classification (TEC) for 2012 (Walker et al. 2015), the land environments identified within the site include A7 .2b and D2.1b. These land environment units are low elevation (45 m (A7.2) – 145 m (D2.1) above sea level) with imperfectly drained soils. Land unit A7.2b is described as a very gently undulating landform with soils of low fertility from rhyolitic tephra and alluvium with some peat and greywacke. Land unit D2.1b is described as easy rolling hills with soils of moderate fertility from calcareous mudstone or greywacke with argillite (Leathwick et al. 2002).

Once ecological units have been identified using LENZ, the current level of protection for natural vegetation within those units can be defined using the Threatened Environments Classification (TEC) (Walker et al. 2007). Land environment units and their TEC 2012 classification are outlined in Table 1 while TEC 2012 classifications within the site and wider area shown on Figure 2. The TEC 2012 of indigenous vegetation within the Graham block site is '<10% indigenous cover remaining and 10-20% indigenous cover remaining.

Table 1: Threatened Environments Classification within the site.

Land Environment Classification	Elevation	Threatened Environment Classification
A7.2b	58	<10% indigenous cover left
D2.1b	90	10–20% indigenous cover left

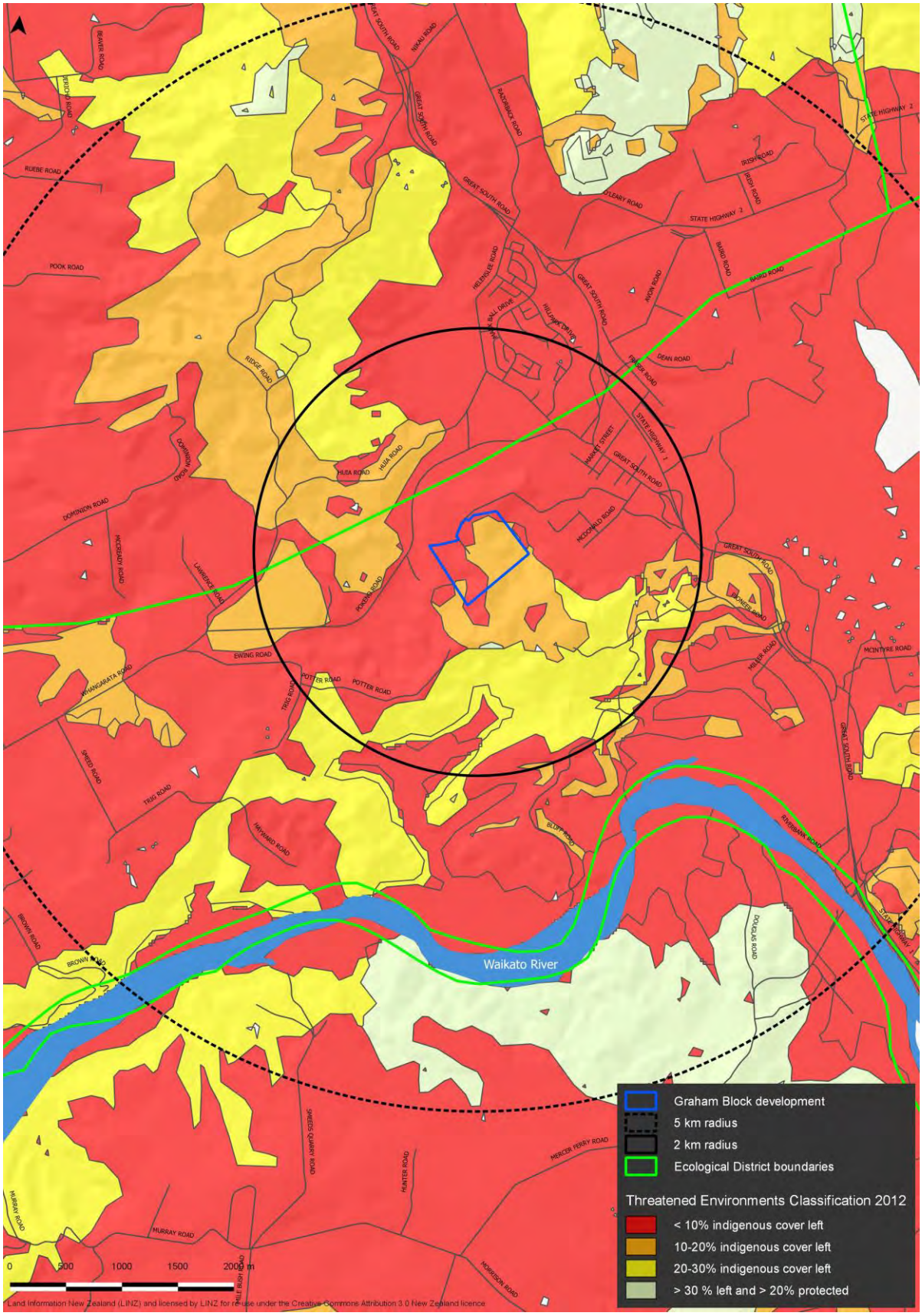

Figure 2: Threatened Environments Classification (2012) for the Pokeno area.

3.0 Assessment Methodology

3.1 Introduction

Four gully systems and associated watercourses within the site are located within the headwaters of the Tanitewhiora Stream catchment. The Tanitewhiora Stream has been the subject of extensive ecological assessments including for the Pokeno Catchment Management Plan (Coffey 2008) and consultant reports (e.g., Freshwater Solutions 2011a, 2011b, 2013a, 2013b, 2014a, 2014b, 2014c, 2014d, 2015, 2016a and 2016b).

The approach included a review of existing information supplemented with field data collected between November 2016 and 27 February 2017. Existing information was obtained from the Department of Conservation BioWeb Herpetofauna Database, Coffey 2008, Freshwater Solutions (2011a, 2011b, 2013a, 2013b, 2014a, 2014b, 2014c, 2014d, 2015, 2016a and 2016b) and the New Zealand Freshwater Fish Database (NZFFD; accessed February 2017).

3.2 Terrestrial Environment

The approach used in this report consisted of a review of existing information supplemented with new data collected during a site walkover on 7 December 2016 and 17 February 2017. Terrestrial plant, bird and mammal species encountered were recorded and the communities described. Plant and bird species recorded are listed in Appendix A and B.

A desktop assessment was undertaken to assess the potential herpetofauna values within the site. The assessment was conducted by literature obtained for the Waikato Ecological Region, reviewing herpetofauna location records sourced from the Department of Conservation's BioWeb Herpetofauna database, along with examining habitat information collected during the site walkover.

3.3 Freshwater Environment

Streams within the Graham Block are referred to in this report as watercourses NE (1–5), NW (1–2), SE (1–2) and SW (1–2) and are shown on Figure 3. The stream ecological assessment is based on a review of existing literature supplemented with field data collected during surveys on 4 November, 7 December 2016, 15 February 2017 and 27 February 2017. Field data collected included water physicochemistry, habitat, WRC habitat score data, macroinvertebrate samples and fish community data from representative stream reaches. Sampling locations are shown on Figure 3 and methods applied described below.

Water Quality

Water physicochemistry including temperature, dissolved oxygen, conductivity and pH was measured at macroinvertebrate sampling sites (i.e., M1, M2 and M3; Figure 3) using calibrated hand held YSI meters on 7 December 2017 (between 2:30 and 3:45 p.m.). Field data was compared with water physicochemistry data held in existing reports including for seven sites within the wider Tanitewhiora Stream catchment (Coffey 2008) and for small streams draining an adjacent site immediately north of Hitchen Road and the Graham Block site (Freshwater Solutions 2016b).

Aquatic Habitat and Wetlands

General aquatic and riparian habitat data was collected during the 7 December 2016 and 17 February 2017 surveys and included estimates of channel width, water depth, streambed

substrate, macrophyte cover, periphyton cover, woody debris cover, channel shade and riparian habitat characteristics. WRC stream habitat scores were determined at three sites (H1, H2 and H3; Figure 3). Survey data was supplemented with information held in existing reports for the wider Tanitewhiora Stream catchment (Coffey 2008) and for nearby streams around Pokeno (Freshwater Solutions (2011a, 2011b, 2013a, 2013b, 2014a, 2014b, 2014c, 2014d, 2015, 2016a and 2016b).

Wetland areas were described and plant species identified. The extent of the wetland was mapped approximately (without the use of GPS) using aerial photographs and ground truthing. The delineation of the wetland versus dryland species was determined using New Zealand wetland plant indicator status ratings obtained from Clarkson et al. (2013a). The most commonly used species to determine this boundary was the 'facultative wetland' species *Juncus effusus* var *effusus*. The delineation between seasonal and permanent wetland areas was done so using the presence/absence of water as a determinant (no obligate wetland plant species were identified during the survey).

Stream Classification

The Waikato Regional Plan defines watercourses as ephemeral or perennial. Ephemeral streams flow continuously for at least three months between March and September but do not flow all year. Perennial streams are defined as streams that flow all year round assuming average annual rainfall. These definitions are particularly difficult to apply as they require knowledge of stream flows and rainfall throughout the year. Streams were assessed on four occasions between 4 November 2016 and 27 February 2017. Streams were not inspected between March and September so classifications were conservatively determined based on factors such as the amount of surface water present (or not present) and the nature of the channels present (i.e., streambank definition, streambed sorting processes, organic matter, terrestrial vegetation within channel).

Macroinvertebrate Communities

A single macroinvertebrate kick-net sample (mesh size 500 µm) was collected from three sites (M1, M2 and M3; Figure 3) in accordance with the semi-quantitative soft-bottomed Protocol C2 in Stark et al. (2001). Samples were processed using Protocol P3 (full count with sub-sampling option) in Stark et al. (2001). Analysis of the data included as assessment of community composition (relative taxonomic group abundance), taxa number, abundance, MCI-sb and EPT taxa number. Data was compared with information held in Coffey (2008) for 12 sites throughout the Tanitewhiora Stream catchment (mainstem and tributaries) and for streams draining a site immediately north of the Graham Block site and Hitchen Road (Freshwater Solutions 2016b).

Fish Fauna

An electric fishing machine survey was carried out along four reaches on perennial stream sections or wetland areas where adequate surface water was present on 4 November 2016. Survey reaches were at least 30 m in length. Captured fish were identified, counted and released. Fish data was compared with records of fish held in the New Zealand Freshwater Fisheries Database (NZFFD) for the wider Tanitewhiora catchment (NZFFD; accessed February 2017). Field data was compared with fish data collected from streams within the same sub-catchments (downstream of Graham Block site), within nearby sub-catchments around Pokeno and within the wider Tanitewhiora Stream catchment (Freshwater Solutions 2013a, 2014a, 2014b, 2015, 2016a, 2016b, Coffey 2008).

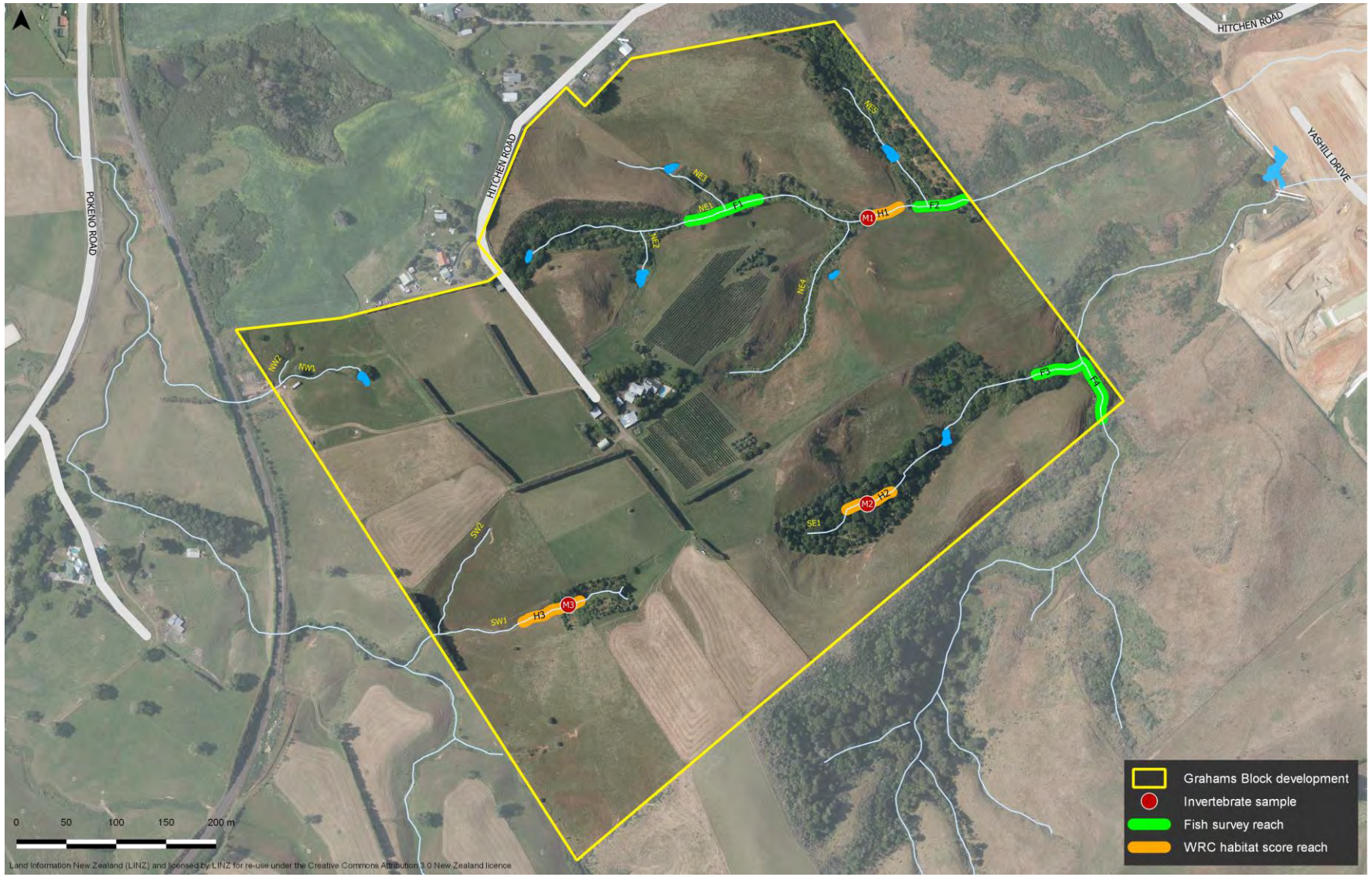

Figure 3: Stream sampling sites within the Graham Block site.

4.0 Terrestrial Environment

4.1 General Site Vegetation Characteristics

Vegetation within the site is predominantly pasture grasses and herbs used for grazing sheep and cattle with exotic and native trees/shrubs limited to gully areas, around the homestead and along fence lines. A vineyard known as Hitchen Road Vineyard (Pokeno) covers approximately 2.02 ha within the site and was operational at the time of the survey.

The most common vegetation throughout the site included grasses such as cocksfoot *(Dactylis glomerata)*, sweet vernal *(Anthoxanthum odoratum),* and perennial rye grass *(Lolium perenne)*. The exotics soft rush *(Juncus effusus* var. *effusus)* and jointed rush *(Juncus articulatus)* were common throughout each of the gully areas and formed a significant component of riparian vegetation at some locations.

Pasture herbs were common and included creeping buttercup *(Ranunculus repens)*, plantain *(Plantago lanceolata)*, carrot weed *(Daucus carota)*, oxeye daisy *(Leucanthemum vulgare)*, chicory *(Cichorium intybus),* dandelion *(Taraxacum officinale)*, hawkbit *(Leontodon taraxacoides)*, catsear *(Hypochoeris radicata)* and red and white clover (*Trifolium* spp.).

Around the homestead exotic garden shrubs and amenity trees such as pin oak *(Quercus palustris),* redwood *(Sequoia sempervirens)* and other species consistent with exotic species across the rest of the site (as described below) were common.

Most native vegetation was confined to particular areas within the gully systems at the property, which typically contained a mixture of hand planted native and exotic specimen trees with some remnant and naturally regenerating natives concentrated in the deeper gullies with weedy species occurring around the edges. The four gully systems within the property are described in further detail below. A full list of species identified within the property can be found within Appendix A.

4.2 North-east Gully

The canopy vegetation in upper NE1 comprised a mixture of exotic specimen trees combined with the occasional mature native nearer the gully bottom (Figure 4). The understory (and areas that lacked a mature canopy) comprised common native species interlaced with orchard trees and weedy exotics. Common exotic canopy species included Algerian oak *(Quercus canariensis*), English oak *(Quercus robur)*, ash (*Fraxinus* sp.), horse chestnut *(Aesculus* spp*.),* sweet chestnut *(Castanea sativa),* western balsam poplar *(Populus trichocarpa*), and necklace poplar and others (Figure 5). A number of mature taraire *(Beilschmiedia tarairi)* 10–12 m high were identified in the upper NE1 canopy. These taraire are listed as item C. 33 in Appendix 2, Inventory of Historic Buildings, Structures, Trees and Areas in the Waikato District Plan. These trees were noted as 'mature trees in good health and form' in the plan however both trees had significant decay around the base of the trunk at the time of the survey and had below average canopy vigour.

Weedy species throughout upper NE1 included gorse *(Ulex europaeus)*, Chinese privet *(Ligustrum sinense)*, barberry *(Berberis glaucocarpa)*, woolly nightshade *(Solanum mauritianum)* and climbers such as pink bindweed *(Calystegia sepium roseata*), Japanese honeysuckle *(Lonicera japonica)* and blackberry (*Rubus fruticosus* agg.). The native large-leaved muehlenbeckia *(Muehlenbeckia australis)* was also common in upper NE1 and forming dense thickets across riparian vegetation (Figure 6).

Native regenerating species formed a substantial component of the vegetation in this gully and included common species such as māhoe *(Melicytus ramiflorus)*, karamū *(Coprosma robusta),* māpou *(Myrsine australis),* cabbage tree *(Cordyline australis)*, silver fern *(Cyathea*

dealbata), whekī *(Dicksonia squarrosa),* whekī-ponga *(Dicksonia fibrosa*), and mamaku *(Cyathea medullaris) (*Figure 7*).*

Dense areas of bracken fern *(Pteridium esculentum)* and gorse *(Ulex europaeus)* along with scattered juvenile mānuka *(Leptospermum scorparium)* and pine *(Pinus radiata)* were identified on the true left upper bank slopes where the pine was removed. A single pōhutukawa *(Metrosideros excelsa)* was identified in upper NE1.

Figure 4: Vegetation in the upper area of NE1.

Figure 5: Primarily exotic canopy vegetation in upper NE1.

Figure 6: Large-leaved muehlenbeckia forming a dense thicket within the understory of upper NE1.

Figure 7: Common native species throughout upper NE1.

Orchard trees were common in the outer edges of upper NE1 and included walnut *(Juglans* sp.*), Citrus* spp., avocado *(Persea americana*), fig *(Ficus carcia)*, apple *(Malus x domestica), Macadamia* sp. and *Prunus* sp. (Figure 8).

The ground cover tier in the upper NE1 comprised predominantly rank grasses and herbs, with the occasional macrophyte species (including *Persicaria* spp.) along the channel and within the pond.

Mid-way down NE1, the channel became less defined and the area had more wetland type

characteristics. Vegetation at this point graded into a patchy and predominantly exotic canopy of grey and crack willow (*Salix* spp.) with scattered clusters of mature kahikatea *(Dacrycarpus dacrydioides)* and the occasional cabbage tree (Figure 9). There was no understory layer present in this area. Large expanses of *Carex geminata* were common along the wetland floor, along with other water adapted species such as *Carex secta*, marsh bedstraw *(Galium palustre)*, spearwort *(Ranunculus flammula) Persicaria* spp. and soft rush *(Juncus effusus* var*. effusus)*. Arum lily was common throughout, occasionally forming dense clusters. This vegetation type also extended up NE3 (Figure 10).

Figure 8: Orchard trees at the convergence of NE1 and NE2.

The lower extent of NE1 (before its convergence with NE5) had a defined stream channel and at this point, very little riparian vegetation was present aside from the occasional willow or tree fern, with soft rush, macrophytes (*Persicaria* spp.) and pasture grasses lining the channel (Figure 11).

The vegetation within NE4 was distinctly different from the rest of north-east Gully, comprising a wetland of predominantly native species such as tree ferns, raupō *(Typha orientalis), Carex geminata,* spike sedge *(Eleocharis acuta), Carex secta,* swamp kiokio*,* umbrella sedge *(Cyperus ustulatus)* and baumea *(Machaerina rubiginosa)* (Figure 12)*.* Exotic species such as soft rush, sweet vernal and arum lily *(Zantedeschia aethiopica)* were common along the edges of the gully, bordering dryland species*.* Mature kahikatea and cabbage tree were occasional throughout the gully, while large-leaved muehlenbeckia formed scattered dense thickets throughout. One single pukatea *(Laurelia noave-zealandia)* approximately 14 m tall was identified at the head of the gully.

The vegetation within NE5 was very like that of upper NE1 comprising a mixture of similar exotic and native species, and some additional species planted by the property owners. Native species commonly occurring in NE5 (in addition to those listed within upper NE1) included karo *(Pittosporum crassifolium),* tarata *(Pittosporum eugenioides),* kōhūhū *(Pittosporum tenuifolium)*, lacebark *(Hoheria populnea*), kānuka *(Kunzea robusta)*, kōwhai *(Sophora microphylla),* tōtara (Podocarpus tōtara), koromiko *(Hebe stricta* var. *stricta)* and pigeonwood *(Hedycarya arborea)*. Exotic species in addition to those noted in upper NE1, included *Rhododendron* spp., Camellia (*Camellia* sp.*)*, cork oak *(Quercus suber)* and common horse chestnut *(Aesculus hippocastanum)*.

Figure 9: Canopy of willow (*Salix* spp.) mid-way down NE1.

Figure 10: Canopy of willow (*Salix* spp.) within NE3.

Figure 11: Channel in the lower reaches of the NE1, before its convergence with NE5, with scarce riparian vegetation.

Figure 12: Vegetation dominated by tree ferns and raupō along NE4.

Figure 13: Native species along NE5 (top) and bottom with area of arum lily.

Figure 14: Typical vegetation along NE5.

4.3 South-east Gully

Vegetation in upper SE1 comprised established native bush covering approximately one hectare some of which had been planted by the property owners and some of which was remnant gully vegetation. The bush area was listed as Item C. 34 in Appendix 2, Inventory of Historic Buildings, Structures, Trees and Areas in the Waikato District Plan, for amenity value as a significant stand of remaining bush including pūriri, kahikatea, taraire, tawa and rewarewa.

Common canopy species included taraire, tōtara, karo, kahikatea, tarata, kōwhai, kānuka, mānuka, karaka *(Corynocarpus laevigatus)*, rewarewa *(Knightia excelsa)*, tawa *(Beilschmiedia tawa)*, pukatea *(Laurelia novae-zelandiae)*, mataī *(Prumnopitys taxifolia)*, pūriri *(Vitex lucens)*, nīkau *(Rhopalostylis sapida)* and kauri *(Agathis australis)* (Figure 15).

The understory comprised predominately māhoe, tree ferns, nīkau, māpou, kawakawa *(Piper excelsum)* and supplejack *(Ripogonum scandens)* (Figure 16 and Figure 17). The stream gully floor was mainly comprised of leaf litter, with pockets of *Oplismenus hirtellus* subsp*. imbecillis* and seedlings of the species listed above.

Figure 15: Canopy species such as karaka, kahikatea and rewarewa in upper SE1.

Figure 16: Understory composition in upper SE1.

Figure 17: Understory composition in upper SE1.

Mid-way down SE1, the channel widened, bearing more wetland type characteristics. Vegetation at this point graded into a relatively sparse predominantly exotic canopy of grey and crack willow (*Salix* spp.), while further down nearing the property boundary, the canopy of willow thickened. Reed sweet grass *(Glyceria maxima*) dominated the watercourse from mid NE1 down to the property boundary.

Figure 18: Vegetation in the mid to lower extent of South-east Gully comprising predominantly of willow (*Salix* spp.) and reed sweet grass.

4.4 North-west Gully

Vegetation along NW1 comprised pasture grasses, *Juncus* spp. and herbs with a single common oak, olive *(Olea europea)* and NZ flax located within a fenced area adjacent to the online pond. Macrophytes were common throughout the channel below the pond and included water pepper and *Ludwigia*.

Figure 19: Vegetation in the mid-lower extent of North-west Gully comprising pasture with *Juncus* spp. and water pepper within the channel.

4.5 South-west Gully

The lower extent of SW1 comprised pasture grasses and *Juncus* spp. which was open to grazing stock. Willow weed, watercress and *Isolepis sepulcralis* were common throughout the channel (Figure 20). At the head of the gully a fenced area of approximately 0.29 ha which included predominantly native vegetation and an area of planted exotics. Native vegetation comprised predominantly such as taraire, tōtara, kahikatea, tarata, karaka, kōwhai, kānuka, mānuka, rewarewa, pukatea, pūriri, nikau, kauri, māhoe, tree ferns, māpou, kawakawa, karamū, koromiko, kōhūhū, flax, pōhutukawa, whau *(Entelea arborescens)*, akeake *(Dodonaea viscosa)* and lancewood *(Pseudopanax crassifolius)* (Figure 21). Most of these species were approximately 3–8 m high, except for 2–3 taraire which reached 15–20 m in height.

Exotic species (6–8 m high) were more frequent in the lower extent of the bush area and comprised 5–8 fir *(Pseudotsuga* sp.*)* and some scattered sweet chestnut, barberry and common oak (Figure 22).

The groundcover and understory tier in the lower extent of the bush area was predominantly rank grasses, which graded into a more native composition of ferns and seedlings of the species noted above in the upper extent and particularly nearest the watercourse.

Figure 20: Vegetation in the mid to lower extent of SW1 comprising predominantly of pasture and *Juncus* spp. within the channel.

Figure 21: Vegetation in the upper extent of SW1 comprising predominantly of native species.

Figure 22: Vegetation in the lower extent of the bush block at the head of SW1 comprising spruce and other exotics.

4.6 Herpetofauna

There were no opportunistic sightings of herpetofauna during the site visit. The following herpetofauna assessment is based on a desktop review of existing information, and survey of habitat values within the site.

The nearest lizard records from the DOC BioWeb Herpetofauna database (until 2012) include copper skink *(Oligosoma aeneum)* at Drury Quarry, Papakura, an old record (1933) of Pacific gecko *(Dactylocnemis pacificus)* at Waiuku and the elegant gecko *(Naultinus elegans)* (plus a yellow variant) at Lake Waikare, Te Kauwhata.

The following geckos and skinks were also found in the wider Waikato Region (Huntly) during the recent construction of the Waikato expressway: elegant gecko, forest gecko *(Mokopirirakau granulatus)*, Pacific gecko, copper skink, and ornate skink *(Oligosoma ornatum)* (NZ Transport Agency 2016), indicating they could be present in the region.

The most likely species to occur within the site would be the copper skink, and to a lesser extent, ornate skink. Both species are terrestrial and prefer forest, scrub and shrub type habitats where there is adequate cover. Both species have also been found in rank grasses such as kikuyu. Areas within the site that have the highest habitat value with regards to these characteristics include the fenced and vegetated gully areas such as the top of NE1, NE5, the top of SE1 and the top of SW1. Copper skink could also be utilizing habitat outside these areas such as open areas of rank grass, compost heaps, under leaf litter, and under rocks or piles of human debris.

Elegant gecko and forest gecko are arboreal (or mostly arboreal) species that prefer native forest and shrub habitats, particularly where there is loose bark, hollows, or crevices to inhabit. These two species could potentially be within the site, the most likely habitat being the bush block located in upper SE1 which contains the most mature growth native vegetation and structural complexity (canopy, understory, and groundcover tiers) followed

by that located in upper SW1 and to a lesser extent, gully NE5.

Pacific gecko is both an arboreal and terrestrial species, found in native forest, scrub and shrubland and also within creviced clay banks, rock bluffs, rock outcrops and associated scrubby vegetation. There is the potential for this species to occur in similar habitat to forest and elegant gecko, however it would be less likely to occur.

Copper skink is regarded as 'not threatened', while forest gecko, ornate skink and elegant gecko are regarded as 'At Risk' (declining), pacific gecko is regarded as 'At Risk' (relict) (Hitchmough et al. 2013).

4.7 Birds

Thirteen birds were identified during the site visit, six were native, and one was of conservation status. Native species included New Zealand pipit *(Anthus novaeseelandiae)*, sacred kingfisher *(Todiramphus sanctus)*, Australasian harrier *(Circus approximans)*, North Island fantail *(Rhipidura fuliginosa placabilis)*, pūkeko *(Porphyrio melanotus)*, and silvereye *(Zosterops lateralis)*. The New Zealand pipit has a conservation threat ranking of 'At Risk' (declining) (Robertson et al. 2013).

Pipits are commonly found in farmland, but also use coastal, wetland and forested habitats. Pipits are absent from much of the Waikato Region and are only sparsely present where they do occur (Robertson et al. 2007). Pipits are considerably more common along the west coast of the region and are only patchily distributed in the east, including through Coromandel and the northern Bay of Plenty. They are absent from the more intensively farmed parts of the Hamilton Basin (Robertson et al. 2007). Nationally New Zealand pipits are more common through the central North Island (south of Taupo), Northland, East Cape and throughout the South Island (Robertson et al. 2007). The Waikato Region is not regarded as a stronghold area for pipit populations because of its history of intensive farming.

4.8 Bats

The site is located within the potential ranging distance of one known population of the long-tailed bat *(Chalinolobus tuberculatus).* Long-tailed bats in the North Island are regarded as 'Threatened' (nationally vulnerable) by O'Donnell et al. (2013). The nearest population of long-tailed bat is within the Hunua Ranges (Auckland Council 2016) located approximately 16 km north-east of the site. Long-tailed bats have also been recorded between Pukekohe and Waiuku some 16 km north-west of the site (NatureWatch NZ[1]).

Long-tailed bats favour forest edge and riparian habitats and forage over farmland and urban areas. Long-tailed bats can fly at 60 km/hr and have a very large home range (100 km^2) (Department of Conservation fact sheet). Long tailed bats find roosts in large old native canopy trees either beneath the bark or in cavities and can also find suitable roosts in mature exotic trees such as old pine and macrocarpa (Auckland Council 2016).

Given the sites proximity to known populations and sightings of long-tailed bats, and the remnant old trees at the site, there is the potential for them to be using the area. Such areas include the occasional remnant tree in upper NE1 and NE2, native forest associated with SE1 and potentially the tall pine and poplar planted across the site as windbreaks although these are unlikely to be old and gnarly enough to provide good roosts.

Short-tailed bats are a deep forest bat but have been detected at forest edges (Molloy

[1] NatureWatch NZ http://naturewatch.org.nz/taxa/40550-Chalinolobus-tuberculatus

1995). Short-tailed bats are invariably associated with old growth indigenous forest and have been found roosting both communally and singly in hollow trees (Molloy 1995). Short tailed bats are only known to be found on Little Barrier Island in the Auckland Region (Auckland Council 2016) making their presence at the site very unlikely.

4.9 Terrestrial Significance Assessment

Waikato Regional Policy Statement

The Waikato Regional Policy Statement outlines the criteria used to identify areas of significant indigenous vegetation and significant habitats of indigenous fauna, as they exist at the time the criteria are being applied in Part B, Section 11A.

One relevant criterion within Section 11A is Ecological Values Criterion (4), which deems indigenous vegetation, habitat or ecosystem types that are under-represented (20% or less of its known of likely original extent remaining) in an Ecological District, or Ecological Region, or Nationally, as significant.

All ecosystems in the Meremere Ecological District are severely depleted. Less than 10% of the district retains any indigenous vegetation, and much of this is wetland or regenerating vegetation (Harding 1997). Both kauri forest and dense podocarp forest are reduced to less than 2% of their original extent even though together they originally covered an estimated 75% of the district (Harding 1997). Hence any examples of unmodified forest within the site would meet Criterion (4). The Auckland conservancy strategy includes the upper narrow portion of the Meremere Ecological District above the Waikato River where the site is located. In this portion of the Meremere Ecological District, podocarp/ broadleaf and kauri forest has been reduced to an estimated 1% of its original extent (Lindsey et al. 2009).

The threatened environments classification of indigenous vegetation within the site (discussed in Section 2.2) is '<10% indigenous cover remaining' and '10–20% indigenous cover remaining'. On this basis, areas of relatively unmodified indigenous podocarp and broadleaf vegetation within the site would be significant (at least locally) because of their severe reduction in extent within the Meremere Ecological District.

While scattered semi-mature native broadleaves and podocarps are common in the gullies across the site, most of the remnant vegetation is interspersed amongst young regenerating and planted natives. Most of the areas are also combined with exotic species such as chestnut, oak, walnut or other specimen trees.

The stand of native bush in upper SE1, which is noted for its visual amenity values as item C.34 in Appendix 2, Inventory of Historic Buildings, Structures, Trees and Areas within the Franklin Section of the Waikato District Plan, is an area of bush that stands out with regard to Criterion (4) of Section 11A. As such it has been discussed with regard to the significance criteria in the Waikato District Plan (Franklin Section) below.

A small stand of mixed native/ exotic vegetation occurs within upper SW1, however this vegetation is considered unlikely to meet any of the criteria since the remaining remnant canopy of native species only makes up a small portion of the area and much of the vegetation is young regenerating common shrubs interlaced with planted native shrubs and exotic trees.

Franklin District Plan

Although the Pokeno area became part of the Waikato District with the creation of the Auckland Council in November 2010, the Franklin District Plan (the plan) still applies to land management decisions in that area.

Objective 5.2.3 of the Franklin District Plan is to sustainably manage the natural heritage resources of the District by:

1. *Protecting the following items from inappropriate subdivision, use, and development:*

    a) Outstanding natural feature's and landscapes;

    b) Areas of significant indigenous vegetation, and

    c) Significant habitats of indigenous fauna including trout and salmon.

2. *Ensuring that representative samples of natural features, areas of indigenous vegetation, and habitats of indigenous fauna that are of value at a Regional and District level are protected.*

    Some significant natural features, areas of indigenous vegetation and habitats of indigenous fauna are listed in Schedule 5A of the plan. Schedule 5A does not include the site discussed here. Assessment of the significance of natural features, areas of indigenous vegetation and habitats of indigenous fauna not listed in Schedule 5A are required to consider the following criteria:

    Whether the native bush:

    a) Is of sufficient size and shape to maintain its intrinsic qualities;

    b) Consists of a coherent well-developed canopy of native species;

    c) Consists of a range of native species appropriate to that forest type;

    d) Contains a significant percentage (at least 25 per cent) of mature native trees;

    e) Represents a significant or prominent landscape feature;

    f) May contain native species threatened in the Franklin District;

    g) The area has wildlife habitat values, or provides or contributes to a habitat corridor facilitating the movement of wildlife species in the local area.

    The stand of bush associated with SE1 is discussed in relation to the criteria in Schedule 5A below.

a) Size and Shape

The bush block in SE1 covers approximately 10,000 m^2 (1 ha) in area, in the headwaters of a perennial/ephemeral stream.

The Land Cover Database (LCDBv4.1) groups indigenous vegetation similar to the type in SE1 as indigenous forest and indigenous broadleaved hardwood forest. Within the Meremere Ecological District, the average size of indigenous bush blocks is around 12 ha, ranging from 0.3–2,319 ha. Of more relevance is the median size of bush blocks in the district, approximately 2.9 ha (number = 644). Within the Auckland Conservancy portion of the Meremere Ecological District, the sizes of bush blocks mapped in the LCDBv4.1 are reduced, with a median size of 2.6 ha, range of 0.3–96 ha and average of 7.4 ha (number = 83).

The bush block in SE1 is of similar size to the median sized bush blocks elsewhere in the Meremere Ecological District, (including the Auckland Conservancy portion of the district), but is small when compared to the average size bush block in each respective area. In general terms, such a size would be considered small, but in the context of the Meremere Ecological District, the area is typical.

In terms of shape, the bush block in SE1 comprises a long (195 m) and relatively narrow

oval with an abrupt boundary transition into pasture. At its narrowest point the bush measures approximately 10 m across, while at its widest point it measures approximately 30 m across. As a consequence of its shape and the land-use surrounding it, the area is subject to a high degree of edge effects such as the encroachment of weeds, wind and light. The area is currently fenced, which protects it from stock encroachment, trampling and also the spread of weed seed via grazing animals. No particularly troublesome terrestrial weedy species were identified within the immediate vicinity of the bush block but the lack of a ground layer (at least around the edges) indicates that sufficient light is penetrating the canopy to allow grass to persist.

The size and shape criterion and viability criterion (which both repeat the use of size and shape as a determinant of significance) were used as part of the criteria for assessing significance within the Protected Natural Areas Programme which began in the 1980s and have consequently formed part of various council plans and policies throughout New Zealand. The premise for these criteria, was that generally speaking, larger areas and those of compact shape have greater life-supporting capacity and are subject to fewer edge effects. As part of the development of the Auckland Unitary Plan, both these criteria have been excluded as determinants of significance of Significant Ecological Areas. The argument for the exclusion of viability is expressed in Sawyer and Stanley (2012) which states that rather than denote significance, the 'viability' (including size and shape) of a site, only highlights the level of management required to protect it in perpetuity. It is therefore a management criterion, rather than a significance criterion.

There is also increasing evidence of the importance of even small degraded forest fragments to maintain the overall maintenance of biological diversity across a landscape, particularly an urban one such as Auckland City (Sawyer and Stanley 2012). This also applies to other highly modified landscapes, such as within the Meremere Ecological District, where small remnants of vegetation are all that remain.

On that basis, while the bush block associated with SE1 is small, it is comparable to the median size of native bush blocks within the Meremere Ecological District (2.9 ha) and in the Auckland Conservancy Portion of the District (2.6 ha) and holds some significance for that reason. The area is also relatively sheltered from wind through, being located within a gully, and requires low effort in terms of management, given it is currently fenced from grazing animals and has a low presence of weed species, which is relevant, given this is one of the key drivers of the criteria.

It is also worth noting that within the Waikato Conservancy Strategy, Harding (1997) acknowledges that long-term protection of lowland dense podocarp and kauri forest in the district will only be achieved by restoration, as the protected remnants within the Meremere Ecological District are too small and isolated to be truly viable.

b) Canopy Species

The bush block in SE1 is considered to meet Criterion (b) comprising a well-developed canopy of at least 14 native podocarp and broadleaved species as described in Section 4.3.

c) Forest Type

Forest within in the Meremere Ecological District would have formerly comprised kauri–conifer – broadleaved forest and included species such as kauri, northern rata, tawa, hīnau, rewarewa, rimu, miro, Hall's tōtara, tānekaha, and taraire (McEwen 1987).

The bush block in SE1 comprises a high portion of the species listed above, on which basis it is considered characteristic of vegetation that would have historically occurred at the site and meets Criterion (c).

d) Species Maturity

The bush block in SE1 is considered to meet Criterion (d) with >25% of the canopy being comprised of mature trees exceeding 8–10 m in height.

e) Landscape Feature

The bush block in SE1 is noted for its visual amenity values as item C.34 in Appendix 2, Inventory of Historic Buildings, Structures, Trees and Areas Waikato District Plan (Franklin Section). It therefore meets Criterion (e).

f) Threatened Species

No rare or threatened species of flora or fauna were identified within the SE1 bush block, although a specific search for fauna was not undertaken.

The Department of Conservation geographic information system lists two locally rare or threatened plants very close to Pokeno township; King fern *(Ptisana salicina)*, and green mistletoe *(Ileostylus micranthus)*. Neither of these species were identified within the bush block. Plant species currently known to be endemic to the Waikato Region include: giant wire rush (*Sporadanthus ferrugineaus)*, swamp helmet orchid *(Corybas carsei)*, and Awaroa koromiko *(Veronica scopulorum)*. None of these species were identified within the bush block and would be unlikely to occur there due to their habitat requirements.

As discussed in Section 4.6, it is possible that forest gecko, ornate skink and elegant gecko which are regarded as ‘At Risk’ (declining) and pacific gecko which is regarded as ‘At Risk’ (relict) (Hitchmough et al. 2013) may be using the forested area in SE1 as habitat.

Therefore, while unconfirmed, the bush block in SE1 has some significance for the likelihood of providing habitat for some ‘At risk’ species.

g) Wildlife Values and Corridors

The bush block in SE1 makes no direct connection with other native vegetation within the site, however it makes an aquatic connection to wetland habitat (with exotic vegetation) downstream, which connects to mixed native/exotic vegetation associated with wetland and terrestrial habitat upstream and to the south of the site. The nearest block of indigenous vegetation identified within the LCDBv4.1 forms part of this habitat matrix and covers 7.7 ha, 100 m south of the bush block. A larger block of indigenous vegetation (75.5 ha) occurs a further 550 m south.

Most of the remaining bush remnants near the site (identified in the LCDBv4.1) occur to the south of the bush block, with very few occurring to the north.

While the bush block does not meet Criteria (g) in the traditional sense (i.e. join an area of significant native vegetation), it does contribute holistically to the aquatic values within the catchment and acts as a stepping stone for native birds.

Summary

The bush block in SE1 is significant at a local scale with regard to the Waikato Policy Statement, due to the severe reduction in extent within the Meremere Ecological District. At a district level (Franklin) the bush block meets Criteria (b), (c), (d) and (e) under the district plan. It also has some significance with regard to Criterion (f) for its potential to provide habitat to native lizards and skinks of conservation status and Criterion (g), for its contribution to aquatic values in the catchment and as a stepping stone for native birds. While the size and shape Criterion (a) of the bush block is small, it is comparable to other forest remnants in the Meremere Ecological District where remaining remnants are typically

small, and on that basis, holds some value for its contribution to maintenance of biological diversity in the ecological district. Therefore, the bush block in SE1 is significant at both a local and district level.

5.0 Wetlands

5.1 Introduction

There are two highly modified wetlands within the site referred to as Wetland 1 and Wetland 2 as shown on Figure 23. Wetland 1 is situated in the north-east gully and Wetland 2 is situated in the south-east gully. Wetland 1 has been labelled as areas 1a to 1d for ease of description. The indicative boundaries of each wetland and vegetation quality within them is presented in Figure 24 and discussed per wetland in Sections 5.2 to 5.6.

Based on hydrological character and remnant and regenerating vegetation in Wetlands 1 and 2, both are best described as swamps (Johnson and Gerbeaux 2004). The water table in both wetlands was mainly above the ground and standing water and surface channels with moderate flow were common, particularly in the lower lying areas. Both wetlands were surveyed in summer (December and January) confirming they are hydrologically supported year-round. The vegetation within each of the wetlands areas was typically composed of very competitive exotic species such as willow and reed sweet grass, combined with common native and widespread species. Remnant and regenerating vegetation comprised species such as kahikatea, raupō and *Carex* sedges that are typical of swamps.

Both wetlands are headwater gully systems that were historically connected as part of a wider wetland system. Wetland 1 maintains a hydraulic connection to wetland areas downstream, while Wetland 2 is now disconnected from wetland located downstream, only maintaining a connection with wetland areas upstream.

While hydrology does not appear to be limiting either of the wetlands (i.e., both maintain sufficient water to operate as swamps during summer), there are several factors altering their natural hydrology. Pipes within the development of the catchment downstream (and wider downstream stormwater network) can slow or increase the release of water from the wetlands. Farm ponds that occur in Wetlands 1 and 2, directly upstream, or alongside the wetland boundaries have altered the natural hydrology of the wetlands. Pipes that occur in Wetland 1 could be slowing or increasing the flow of water at certain points. Clearance of bush vegetation for farming also tends to result in 'flashy' hydrological regimes. Converting forest to pasture increases the surface water runoff during rain events, which can cause scouring and/or deposition of sediment in downstream wetland areas. In this instance, it is likely that the land use within the site has contributed to the formation of the wetlands to some degree. The removal of riparian vegetation combined with the lower gradient and sediment run-off from upslope grazed areas appears to have combined over time to fill in what have may have formerly been a streambed and has slowed water flows effectively creating or at least growing the size of the wetlands. The steep gradient of the gullies and the stream habitat in the well vegetated Gully SE 1 suggests that the upper extent of some of the wetland areas within the Graham Block may have formerly been streams.

Plant communities within the wetlands lacked diversity and were dominated by a few fast growing and competitive (mostly weedy) species. This is most likely a result of edge effects due to the size and shape of the wetlands combined with eutrophication caused by nutrient inputs generated by the surrounding land use. Reed sweet grass and willow are known to respond explosively to groundwater nitrate inputs (Peters et al. 2010) and these formed a substantial component of vegetation (particularly Wetland 2). The presence of these species was notably higher in areas that were unfenced and contained no buffer vegetation.

Figure 23: Wetlands 1 (a – d) and 2 identified within the Graham Block site.

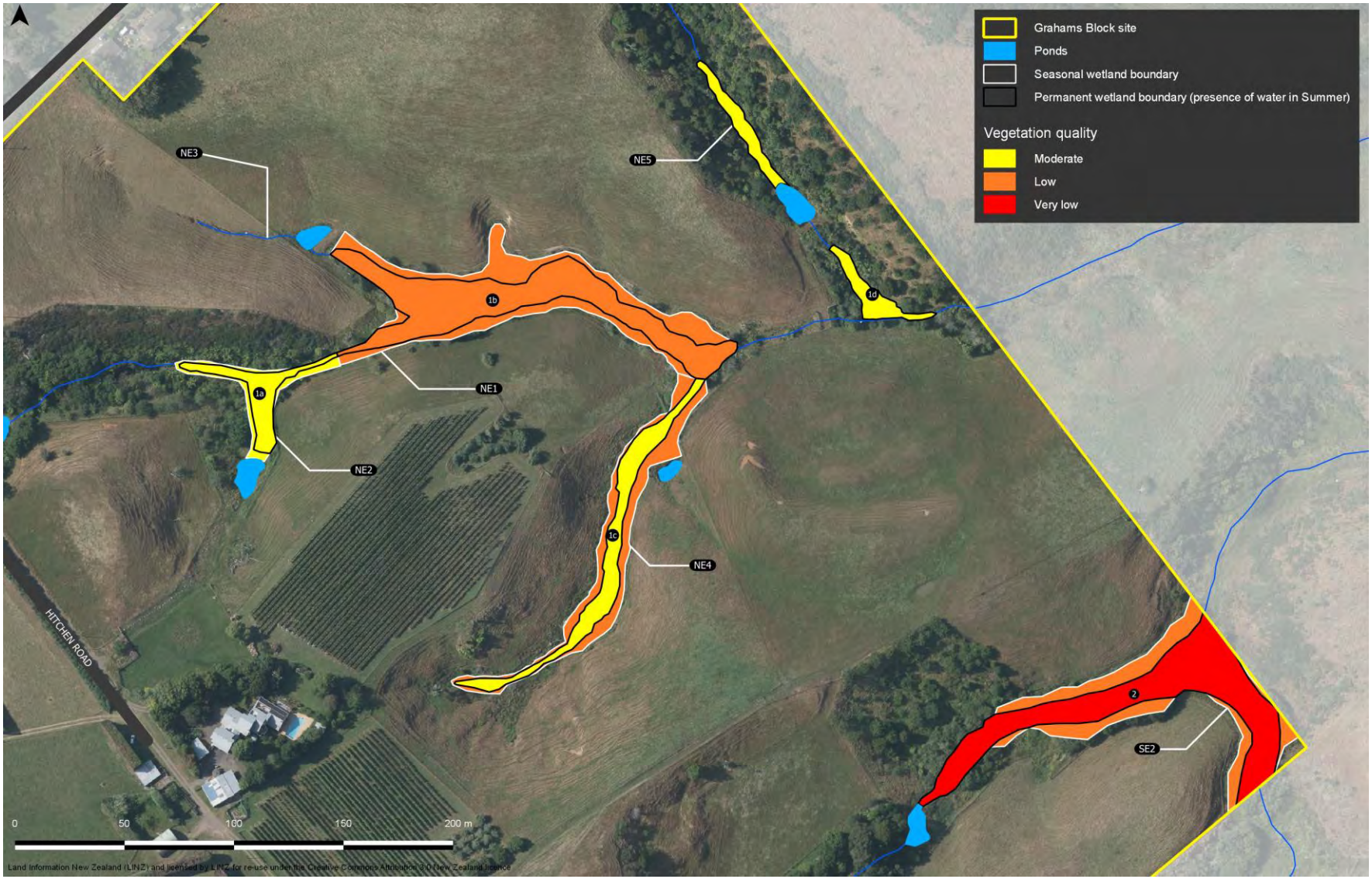

Figure 24: Wetlands vegetation quality and water permanence.

The presence of hydrophilic adapted plant species was used to determine the extent of each wetland. Generally speaking, the species in this edge area comprised a high proportion of *Juncus effusus* var. *effusus* combined with dryland pasture grasses such as sweet vernal. *Juncus effusus* var. *effusus*, is well known for infesting low lying pasture areas that have water present in the rainy season and are dry in summer. In Florida, this species typically does not grow where water is present year-round, but will be present at the perimeter of permanently wet areas such as ponds, lakes and streams (University of Florida 2009). During the site visit, the outer edges of each wetland were generally dry indicating that they are seasonally influenced. Vegetation quality in these seasonal areas was considered low (unless indicated) given that species composition was predominantly exotic.

The presence of water during the summer survey was used to determine the permanent areas of wetland as presented in Figure 24. This determination considered areas of heavily pugged sodden soil, surface water, standing pools of water and slow flowing water as permanent wetland habitat. No obligate wetland plant species were identified during the survey with most species recorded being characterised by Clarkson (2003) as facultative wetland species, which are 69–100% likely to occur in wetlands.

5.2 Wetland Area 1a

Wetland Area 1a was fenced from stock within mixed native/ exotic buffer vegetation. The area was reasonably shaded with multiple flowing channels and stable pools, that were disconnected at times (Figure 25). Vegetation quality in Area 1a was assessed as moderate as a result of the community containing more native than exotic species. Vegetation primarily comprised *Carex geminata* under a patchy canopy of common natives, very occasional juvenile kahikatea, with common native pioneer species forming the bulk of immediate buffer vegetation. The presence of weed species was low- moderate, and included arum lily and willow particularly nearing the boundary with the area marked as 1b which was unfenced.

Figure 25: Characteristics in Wetland Area 1a.

5.3 Wetland Area 1b

Wetland Area 1b was unfenced and open to grazing stock. Vegetation quality in permanently wet areas was assessed as low and dominated by several key undesirable wetland species such as grey willow, crack willow and jointed rush (Figure 26). Other dominant exotic species included *Ranunculus* spp., willow weed and *Juncus* spp. Some native species were recorded including pockets of *Carex geminata*, occasional clusters of mature kahikatea and scattered cabbage tree. Surface water within Wetland Area 1b was held in moderate-large pools and multiple channels, particularly in the lower gully.

Figure 26: View of Wetland Area 1b.

5.4 Wetland Area 1c

Wetland Area 1c lacked channels with flowing water and instead comprised a pugged and sodden bed with occasional areas of shallow standing water (Figure 27). Vegetation quality in the permanently wet areas of Wetland Area 1c was assessed as moderate, comprising a large component of native species such as tree ferns, raupō, *Carex* spp., spike sedge, swamp kiokio, umbrella sedge and baumea, with exotic species such as watercress and *Juncus* spp. more common along the edges and in the upper and lower extent.

5.5 Wetland Area 1d

Vegetation within Wetland Area 1d was assessed as moderate comprising *Carex* sedgeland with a predominantly native riparian buffer (Figure 28). Several vine species were common throughout including large-leaved muehlenbeckia and exotics such as *Convolvulus* sp. There was shallow surface water in the mid-reaches upstream of the pond but no surface water in the upper extent or below the pond in the lower reaches. There was however evidence of recent surface water and the bed remained sodden and pugged.

Figure 27: Vegetation characteristics of Wetland Area 1c showing the mid-section (top) and upper section (below).

Figure 28: Characteristics of Wetland Area 1d.

5.6 Wetland 2

Wetland 2 was reasonably shaded with multiple flowing channels and areas of shallow surface water amongst willow trees and held in deeper pools. Vegetation quality was assessed as very low and was almost entirely dominated by key undesirable wetland species reed sweet grass and grey and crack willow.

A sparse understorey of rushes (particularly *Isolepis sepulcralis*, but also *Juncus spp*.) and occasional willow weeds *(Persicaria strigosa, P. hydropiper)* were present beneath the reed sweetgrass along with small herbs such as water purslane *(Ludwigia palustris)*, spearwort *(Ranunculus flammula)*, and water celery *(Apium nodiflorum)*. Seedlings of grey willow were also commonly encountered throughout the reed sweetgrass habitat.

Figure 29: Wetland 2 showing monospecific sward of reed sweet grass in mid-section (top) and deep pool in lower reaches (below).

5.7 Wetland Significance Assessment

Waikato Regional Policy Statement

The Waikato Regional Policy Statement outlines the criteria used to identify areas of significant indigenous vegetation and significant habitats of indigenous fauna, as they exist at the time the criteria are being applied in Part B, Section 11A.

One relevant criterion within those listed in section 11A is ecological values Criterion (4), which deems indigenous vegetation, habitat or ecosystem types that are under-represented (20% or less of its known of likely original extent remaining) in an Ecological District, or Ecological Region, or Nationally, as significant.

Freshwater wetlands were identified as a priority for protection in the Meremere Ecological District, where only 23% of the original extent of freshwater wetland and forest wetland is estimated to remain (Lindsey et al. 2009). Only 20.6% of the original extent of wetlands are estimated to remain throughout the entire Meremere Ecological District, and restoration of depleted wetlands, especially by restoring the hydrological regime was deemed an opportunity for protection within the Waikato Protection Strategy (Harding 1997).

Nationally wetlands have been severely reduced in extent, the figure of 10% is often quoted for the area that now remains (Johnson and Gerbeaux 2004).

Wetland areas within the Graham Block have some ecological value due to their severe reduction in extent nationally and within the Meremere Ecological District, and due to the fact that wetlands are a priority for protection and restoration within both the Auckland and Waikato Conservancy Strategy's and nationally (Department of Conservation and Ministry for the Environment 2007).

Another relevant criterion amongst those listed in Section 11A is Ecological Values Criteria (6), which states:

It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with:

- *waste treatment;*
- *wastewater renovation;*
- *hydro-electric power lakes (excluding Lake Taupo);*
- *water storage for irrigation; or*
- *water supply storage;*

While the wetlands described comprise varying components of very competitive exotic species (including exotic pasture and *Juncus* species); there are areas with greater components of indigenous species assemblages including raupō reedland and *Carex* sedgeland, particularly in parts of Wetland 1. Wetland 2 is almost entirely comprised of exotic species.

Franklin District Plan

Significant natural features, areas of indigenous vegetation and habitats of indigenous fauna are listed in Schedule 5A of the Franklin District Plan. Schedule 5A does not include the site discussed here. Assessment of the significance of natural features, areas of indigenous vegetation and habitats of indigenous fauna not listed in Schedule 5A are required to consider the following criteria:

Whether natural features and habitats of indigenous fauna are:

a) Of sufficient size and shape to maintain its intrinsic qualities;

b) The habitat of threatened species (as defined by IUCN criteria);

c) An area of recognised wildlife or earth science significance;

d) Freshwater wetland;

e) An uncommon indigenous vegetation community;

f) Contribute to the National, Regional or District geological heritage.

Wetlands 1 and 2 are discussed with regard to the criteria in Schedule 5A below.

a) Size and Shape

The shape of an area affects its relationship to the surrounding land. The value and long term sustainability of an area is closely related to its size and shape, because it reflects the ability of external forces such as climate and weeds to influence the area. As previously discussed, some council bodies are no longer using this criterion to determine significance, rather, it is argued the size and shape of an area determines the level of management required to ensure it can exist in perpetuity.

Wetlands 1 and 2 are in headwater gully floors within a catchment that has been cleared of vegetation for farming. As such they are generally open, and comprise predominantly exotic weedy species, reflecting their elongated shapes and extensive exposed edges

Wetland 1 has a total area of approximately 0.94 ha in size (or 2.9 ha including surrounding gully sides). Wetland 2 has a total area of approximately 0.44 ha (or 1.6 ha including gully sides).

The Land Cover Database (LCDv2.4) groups wetlands as herbaceous freshwater vegetation. Within the Meremere Ecological District, the average size of these wetland areas is around 16 ha, ranging from 0.37–2,671 ha. Of more relevance is the median size of wetlands in the district, approximately 8.4 ha (number = 121). Within the Auckland Conservancy portion of the Meremere Ecological District, the sizes of wetlands mapped in the LCDv2.4 are reduced, with a median size of 7.7 ha, range of 0.6–52 ha and average of 16.2 ha (number =10). The combined area of Wetland 1 and 2 and their associated gully vegetation within the site is approximately 4.5 ha. This is small when compared to other wetlands within the Meremere Ecological District.

It is worth noting that outside the property boundary, Wetland 1 makes a direct connection to wetland habitat downstream which is in the process of being restored, while Wetland 2 makes a direct connection to wetland habitat upstream.

b) Presence of Threatened Species

No threatened species of flora or fauna were detected during the terrestrial or fish survey within the wetlands.

Plant species currently known to be endemic to the Waikato Region include: giant wire rush, swamp helmet orchid and Awaroa koromiko. None of these species were identified within the wetlands and would be unlikely to occur there due to the depleted nature of the wetlands, the presence of grazing livestock and lack of suitable habitat.

Giant kōkopu which have a threat status of ‘At Risk’ (declining) (Goodman et al. 2014) were recorded from wetland habitat immediately downstream of Wetland 2 in 2016, and downstream of Wetland 1 in 2012.

As discussed in Section 2.7, It is possible that New Zealand pipit *(Anthus novaeseelandiae)* may use the rough pasture in the area adjacent to the wetlands. New Zealand pipits have a

conservation threat ranking of 'At risk (declining)' (Miskelly et al. 2008).

As discussed in Section 2.6, it is possible that forest gecko, ornate skink and elegant gecko which are regarded as 'At Risk' (declining) and pacific gecko which is regarded as 'At Risk' (relict) (Hitchmough et al. 2013) may be using the areas of the wetland buffer vegetation as habitat, specifically in Wetland Areas 1a, 1c and 1d.

While unconfirmed, the wetlands and their buffer habitat have the potential to provide habitat for a number of species of conservation status. Therefore, they are considered to meet Criterion (b).

c) Wildlife Habitat Values

The preponderance of exotic species and the continued presence of livestock mean that the habitat value of the wetland areas described is very low. The wetland areas are becoming increasingly disconnected from terrestrial and aquatic habitat elsewhere in the catchment through land use and continued development, which impacts on wildlife species migration. It is worth noting that the wetland area downstream of the north-east gully is in the process of being restored, and this may allow for better dispersal of species into the area.

The wetland areas may offer some refuge for indigenous wildlife however considering the condition of the areas and the modified nature of the surrounding habitat (i.e., farming) the area does not exhibit the attributes necessary to qualify as significant wildlife habitat in its current state.

d) Freshwater Wetland

Indigenous vegetation associated with wetlands are an ecosystem type that has become uncommon due to human activity, and as such wetland habitats are recognised as a national priority for protection on private land (Priority 2, Department of Conservation and Ministry for the Environment 2007).

The wetlands are deemed to meet Criterion (d).

e) Uncommon Indigenous Vegetation Community

Wetlands 1 and 2 are not an uncommon indigenous vegetation community. Rather they are mostly composed of very competitive exotic species combined with common and widespread native species. They do not satisfy Criterion (e).

f) Contribution to the Geological Heritage

The geological heritage of the site is outside the scope of this report. The site has no known particular scientific value.

Summary

Based on the above assessment, Wetlands 1 and 2 while severely modified and depleted are considered significant at a local scale as they are an ecosystem type that has been severely reduced nationally and within the Meremere Ecological District.

6.0 Freshwater Environment

6.1 Stream Classification

Watercourses within the Graham Block site were classified as ephemeral or perennial based on Waikato Regional Plan definitions. Watercourses and their classifications along with identified wetland areas are shown on Figure 30 with stream length and wetland area details presented in Table 2.

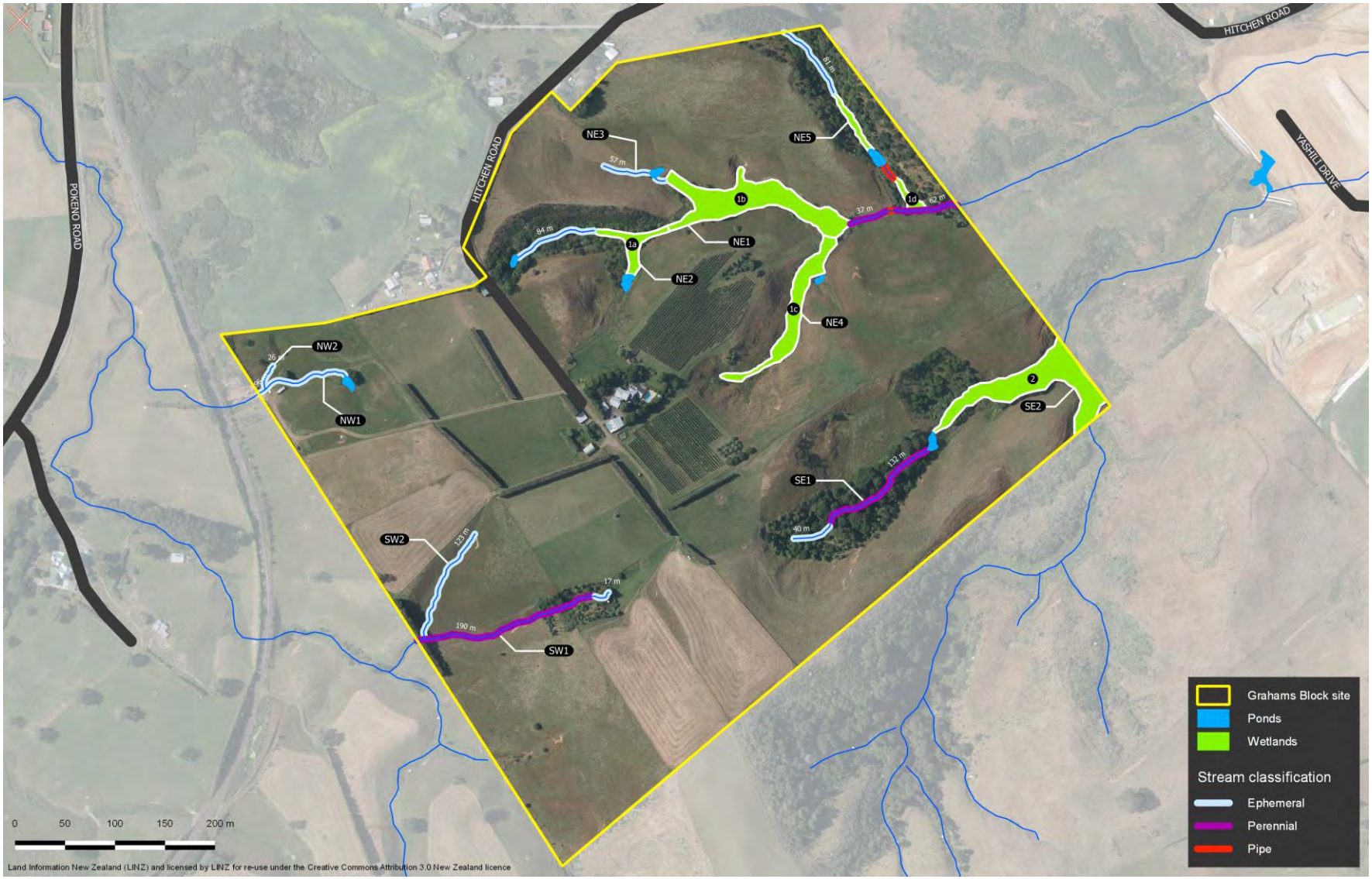

Figure 30: Classification of streams and wetlands within the Graham Block site.

Table 2: Classification and lengths of watercourses within the Graham Block site.

Stream	Status	Length (m)	Comment
NE1	Ephemeral	84	Uppermost reach extending downstream from the artificial pond at the top of the catchment; lacked defined channel, no surface water
NE1	Perennial	37	Deeply incised and channelised reach downstream of the lower extent of Wetland 1; holds surface water year-round
NE1	Pipe	12	Short culvert (stream crossing)
NE1	Perennial	62	Downstream of culvert and extends downstream to the eastern site boundary; defined channel and extensive surface water
NE3	Ephemeral	47	Upper section within a pasture grazed V-shaped gully, lacks surface water and channel
NE3	Ephemeral	10	Short section downstream of pond and upstream of Wetland 3; poorly defined channel; terrestrial grass/weeds in channel
NE5	Ephemeral	81	Intermittent defined and poorly defined channel sections; no surface water; abundant leaf litter in channel indicating rare flow
NE5	Pipe	16	Section downstream of artificial pond
NW1	Ephemeral	96	Poorly defined section extending downstream of pond; no surface water; terrestrial grass/weeds in flow path
NW2	Ephemeral	26	Shallow depression; lined with grazed pasture; no evidence of flowing water
SE1	Ephemeral	40	Headwater section draining steep gully; poorly defined channel; no surface water or aquatic habitat; well shaded; abundant leaf litter and woody debris
SE1	Perennial	132	Defined channel; surface water year-round; well-shaded; drains native bush
SW1	Ephemeral	17	Short section draining steep gully; poor channel definition; no water
SW1	Perennial	190	Defined and poorly defined channel sections; grazing affected (mid-lower); surface water present at all times
SW2	Ephemeral	123	Shallow gully; grass lined; grazed; no evidence of surface water or habitat

Table 3: Wetlands within the Graham Block site.

Stream	Wetland	Area (m^2)	Comment
NE1/NE2	Wetland Area 1a	862	*Carex* sedge dominated wetland. Mixed native/ exotic regenerating buffer. Fenced. Pugged and sodden bed with areas of pooled surface water.
NE1/NE3	Wetland Area 1b	5,581	Unfenced grazing damaged / degraded wetland comprised of predominantly exotic species. Pools, channels and slow moving water common.
NE4	Wetland Area 1c	2,269	Wetland area extending along entire length of watercourse NE4. Predominantly native species especially where permanently wet. Unfenced.
NE5	Wetland Area 1d	729	*Carex* sedge dominated wetland. Mixed native/ exotic regenerating buffer. Fenced. Pugged and sodden bed, with few areas of surface water.
	Wetland 1 (Total)	9,441	
SE1	Wetland 2	4,363	Reed sweet grass and willow dominated wetland. Unfenced moderate sized pools with slow flowing channels and surface water.

There was between 0.0–7.6 mm of rainfall at the Pukekohe station (National Climate Database) over the one week period prior to each of the site visits on 4 November 2016, 7 December 2016, 15 February 2017 and 27 February 2017.

There is approximately 524 m of ephemeral stream habitat within the site. Ephemeral flow paths within the site typically originate as headwater reaches (e.g., NE1, NE3, NE5, NW1, SW1) or are short reaches that originate within shallow gullies (e.g., NW2, SW2). As outlined earlier it is probable that in its natural state and prior to land clearance that more of what is now wetland would have been stream habitat.

There is approximately 421 m of perennial stream habitat within the site. There are three main perennial stream sections within the site and include the lower section of watercourse NE1 (below Wetland 1), the upper section of SE1 that drains an area of indigenous vegetation and most of SW1.

There is approximately 934 m length of wetland habitat comprising a combined area of 13,803 m^2 (refer to Section 5.0 for wetland descriptions).

6.2 General Habitat Characteristics

Ephemeral Flow Paths

Ephemeral stream sections were characterised by features including an absence of surface water, grazing damaged, poorly defined channels, lacking streambed sorting processes or terrestrial grass/weed growth across the channel (Figure 31 and Figure 32). Ephemeral flow paths provided very limited habitat but may provide temporary habitat during wetter periods of the year. These stream sections, although providing marginal aquatic habitat or temporary aquatic habitat, do have functional value through the conveyance of surface water and organic material (e.g., leaf litter) during wetter periods of the year.

Figure 31: Ephemeral flow paths in upper reaches of watercourse SW1.

Figure 32: Ephemeral flow paths in upper reaches of NE5 (top) and NE3 (below).

Perennial Stream Sections

The perennial section in the lower reaches of watercourse NE1 had a well-defined, moderately wide (0.5–3.5 m) and deep (0.2 –0.6 m) channel that has been channelised and excavated for drainage purposes (Figure 33). The streambed was made up by weathered clay (40%) and silt (60%). Woody debris and leaf litter was rare. Habitat was moderate-poorly shaded by exotic trees/shrubs and overhanging terrestrial grasses and sedges (Figure 33). Flow velocities were sluggish and habitat comprised uniform run habitat that provided moderate-poor aquatic habitat for invertebrates but good habitat for shortfin eels. Aquatic plants recorded included willow weed (<10%), watercress (30%) and water celery (5%) and filamentous green algae was common. The WRC habitat score for NE1 was 65 (out of 180) and indicates poor aquatic and riparian habitat quality.

Figure 33: Perennial stream habitat in lower section of watercourse NE1.

The perennial section in the headwaters of watercourse SE1 represents aquatic habitat of highest quality within the Graham Block site. The channel is narrow (0.2–1.3 m wide) and shallow (0.01–0.2 m deep) and drains slight-moderate gradient topography within a steep V-shaped gully. The channel is poorly defined in the upper reaches with habitat limited to shallow runs/pools whilst the mid-lower section within the bush becomes more well-defined and incised as channel gradient increases (Figure 34). Aquatic habitat is dominated by runs (90%) with occasional deeper pools (8%) and chutes (2%) formed over large tree roots. The channel is well shaded (90%) by indigenous vegetation with woody debris common and leaf litter abundant. Although the channel is well shaded, watercress was noted in low cover (<1%). The WRC habitat score for SE1 was 128 (out of 180) and indicates moderate-good aquatic and riparian habitat quality.

Figure 34: Perennial stream habitat in upper reaches of watercourse SE1.

The perennial section of watercourse SW1 originates within an area of fenced off vegetation as a narrow (<0.2 m wide) and shallow (<0.1 m deep) channel that drains a flat area of grass/herbs surrounded by trees/shrubs that provide moderate shade (Figure 35). Although perennial, the channel is small and aquatic habitat is limited due to the shallow nature and silt streambed. Downstream of the upper vegetated area, the stream flows into an unfenced and grazed V-shaped gully in its mid-lower reaches. The mid-lower reaches are heavily grazed and the channel damaged resulting in poor channel definition and poor habitat quality in its current state (Figure 35). Filamentous green algae was rare (<5% cover) and macrophytes recorded included moderate cover of water pepper (30%), *Ludwigia palustris* (5%), watercress (1%) and *Isolepis prolifer* (1%). The WRC habitat score for NE1 was 46 (out of 180) and indicates very poor aquatic and riparian habitat quality.

Figure 35: Perennial stream habitat along watercourse SW1 within the upper vegetated area (top) and grazed pasture mid-lower reaches (below).

6.3 Artificial Ponds

There are at least seven ponds within the site with the locations shown on Figure 30. All ponds within the site are artificial features and provide modified aquatic habitat of low quality and ecological value (Figure 36). Most of the ponds have been constructed in the headwaters or in the mid-upper reaches of streams and intersect groundwater or intercept seepage flows. Some of the ponds were dry during the site visits (pond at head of NE1), low and choked with macrophytes (pond on NE3) or had water on all occasions (ponds on NE2, NE5, SE1, NW2).

Figure 36: Examples of artificial ponds within the site.

6.4 Water Physicochemistry

Water temperatures measured at three sites on perennial stream (refer Figure 3 for sampling locations) during warm summer conditions ranged between 16.2 and 18.4°C and were within the satisfactory range according to WRC guidelines (Table 4). Dissolved oxygen concentrations were moderate-low and ranged between 3.6–7.9 g/m^3 (38–80%) and were within the satisfactory to unsatisfactory range. Dissolved oxygen measured in SE1 within the indigenous vegetated area (80% and 7.9 g/m^3) was high relative to other streams within the site and reflects greater shade and cooler temperatures. Stream conductivity and pH were only measured in SW1 and were 7.1 (excellent) and 133 µS/cm (moderate) respectively.

Water temperatures were within the range measured in small tributaries of the Tanitewhiora Stream by Coffey (2008) (17.9–20.2°C) but lower than the temperature (21.5°C) measured by Freshwater Solutions (2016b) in a highly degraded and poorly shaded tributary in the lower reaches of the mainstem that watercourses NW1 and SW1 drain into (Table 4). Dissolved oxygen measured in SE1 (80%; 7.9 g/m^3) was higher than recorded in other tributaries in the Pokeno area during summer conditions (range: 6–49%, 0.5–4.3 g/m^3) whilst levels measured in the poorer shaded NE12 and SW1 were similar and within the range of other similar tributaries. Stream pH and conductivity recorded in SW1 was within the range of similar tributaries nearby and in the wider Tanitewhiora Stream catchment (Coffey 2008; Freshwater Solutions 2016a).

6.5 Macroinvertebrate Communities

A total of 24 taxa were recorded across three sites (M1, M2, M3) on perennial sections of NE1, SE1 and SW1 within the Graham Block. Taxa richness ranged between 6 taxa (SE1) and 20 taxa (NE1). This compares with between 11–15 taxa recorded from three streams draining grazed pasture on an adjacent site to the north of Graham Block in 2016 (Hitchen Stage 3; Freshwater Solutions 2016b), 11 taxa recorded from a highly-modified tributary draining grazed pasture in the lower catchment of SW1 in 2016 (Pokeno Sports Park; Freshwater Solutions 2016a), between 13–22 taxa recorded from zero order streams around Pokeno (Storey et al. 2009) and between 2–15 taxa from tributaries and the Tanitewhiora Stream in 2006 and 2008 (Coffey 2008).

The community recorded from the open channelised section in the lower reaches of NE1 was the most diverse (20 taxa) and was dominated by Crustacea. The community was characterised by very high numbers of *Paracalliope* (amphipod) and moderate numbers of *Polyplectropus* (caddisfly), dipterans (*Paradixa* and Tanypodinae), Acari (water mites) and worms. Two water and habitat sensitive caddisfly taxa were recorded (*Polyplectropus* and *Psilochorema*). The MCI-sb score for NE1 was 87 and indicative of 'fair' stream health.

The community recorded from the small headwater stream SE1 draining indigenous vegetation was dominated by Mollusca and Crustacea. The community was made up by very high numbers of *Potamopyrgus* (snail) and *Paraleptamphopus* (amphipod) with the mayfly *Zephlebia* and water mites recorded in moderate-low abundance. The only other taxa recorded from SE1 were very low numbers of Sphaeriidae (bivalve) and Oligochaeta (worms). Low taxa richness (6 taxa) reflects the intermittent and shallow nature of pools along the upper headwater reaches of this stream. The MCI-sb score for SE1 was 94 and indicative of 'fair' stream health.

The narrow and shallow upper reaches of SW1 within the area mixed exotic and indigenous vegetation supported 15 taxa and a community dominated by Oligochaeta, Diptera (true-flies) and Mollusca. The most abundant taxa were worms, *Potamopyrgus* snails, *Paradixa* (dixid midge) and Orthocladiinae (chironomid).

Table 4: Water physico-chemistry measured at sites M1, M2 and M3 within the Graham Block site.

Location / project	Site	Stream	Date	Time	Temperature (°C)	Dissolved oxygen		pH	Conductivity (µS/cm)
						%	(g/m^3)		
Graham Block	M1	NE1	7/12/16	2:30 p.m.	17.6	56	5.3	-	-
Graham Block	M2	SE1	7/12/16	3:45 p.m.	16.2	80	7.9	-	-
Graham Block	M3	SW1	17/2/17	12:30 p.m.	18.4	38	3.6	7.1	133
Hitchen Stage 3 (FSL 2016b)	-	A1	21/7/16	12.40 p.m.	13.5	91	8.5	7.3	114
Hitchen Stage 3 (FSL 2016b)	-	A2	21/7/16	1.30 p.m.	14.2	92	9.5	6.5	109
Hitchen Stage 3 (FSL 2016b)	-	B	21/7/16	3.00 p.m.	12.2	92	9.9	6.5	90
Pokeno Sports Park (FSL 2016a)	-	Trib	3/3/16	12.30 p.m.	21.5	49	4.3	6.0	150
Coffey (2008)	Range (n=2)	Tributaries	5/2/07	a.m. / p.m.	17.9–20.2	6–43	0.5–3.8	6.6–7.5	270–310
Coffey (2008)	Range (n=5)	Tanitewhiora	5/2/07	a.m. / p.m.	17.5–19.6	33–100	3.1–8.9	6.8–8.0	190–280

Note: Waikato Regional Council guidelines: Temperature (Oct-Apr) ⇒ excellent <16°C, satisfactory 16–20°C, unsatisfactory >20°C. Dissolved oxygen (%) ⇒ excellent >90%, satisfactory 80–90%, unsatisfactory <80. pH ⇒ excellent 7–8, satisfactory 6.5–7.0 or 8–9, unsatisfactory <6.5 or >9.0.

Two water and habitat sensitive caddisfly taxa were recorded from the upper reaches (Oeconesidae and *Polyplectropus*). The MCI-sb score for NE1 was 93 and indicative of 'fair' stream health. The high highly modified and grazing damaged mid-lower reaches of SW1 was not sampled but is likely to support a community dominated by water and habitat tolerant taxa due to livestock grazing damage and pugging of the channel.

Invertebrate communities recorded from perennial streams within the Graham Block were of higher quality than those recorded from three streams on the adjacent Hitchen Road property (Hitchen - Stage 3; Freshwater Solutions 2016b) where MCI-sb scores ranged between 66 and 71 due to the presence of low scoring taxa (e.g., *Oxyethira*, *Xanthocnemis*, *Austrosimulium*, *Gyraulus*, *Physa*, flat worms, nematodes) that were not recorded within Graham Block. MCI-sb scores for the communities recorded at three sites (P2, P3 and P6) by Coffey (2008) downstream of Graham Block ranged between 57 and 83 and were lower than the MCI-sb in the present study. Coffey (2008) did not record water and habitat sensitive EPT taxa from sites P2 and P3 (downstream of SW) or Site P6 (downstream of NE) whilst caddisflies were recorded from NE and SE in the present study.

In summary, streams within Graham Block supported invertebrate communities of moderate-low quality that were numerically dominated by water and habitat tolerant Crustacea, Mollusca, Diptera or Oligochaeta taxa but also including low diversity and abundance of water and habitat sensitive mayflies and caddisflies.

6.6 Fish Fauna

The only fish recorded from within the site were eight shortfin eels from the wetland (Wetland 1) and perennial sections of NE1 and three shortfin eels in the lower wetland area (Wetland 7–8) of SE1 and SE2. No electric fishing was carried out within the north-west gully (NW1), south-west gully (SW1) or upper bush section of the south-east gully (SE1) due to a lack of adequate surface water. Shortfin eels recorded were of moderate size (300–600 mm length) and in healthy condition. Survey results indicate perennial stream sections (NE1 and SE1) and associated wetlands support moderate numbers of shortfin eels. It is likely shortfin eels would also be present in ponds within the site.

Fish recorded from the Tanitewhiora Stream catchment upstream of the Mangatawhiri River confluence based on NZFFD records, various Freshwater Solutions ecological surveys and fish relocations, and in Coffey (2008) are shown on Figure 37.

Fish species recorded from the wider Tanitewhiora Stream catchment in the vicinity of Pokeno include the native species shortfin eel, longfin eel, giant kōkopu, banded kōkopu and Cran's bully and the exotic species goldfish and *Gambusia*. A substantial waterfall (~4 m high) is located in the lower reaches of Tanitewhiora Stream near its confluence with Helenslee Stream and is a significant barrier to upstream fish passage. The waterfall is likely to restrict the upstream migration of diadromous fish that are poor climbers (e.g., īnanga and common bully). Species recorded downstream of the waterfall include the native species īnanga, common smelt and grey mullet and exotic species catfish and koi carp which do not have the ability to negotiate the waterfall.

The most widespread and abundant species within the Tanitewhiora Stream catchment in the vicinity of Pokeno are shortfin eels. Longfin eel, giant kōkopu, banded kōkopu and Cran's bully have been recorded within the sub-catchment that the Graham Block site is located but in the mid-lower reaches. Based on habitat conditions and habitat availability in the streams within the Graham Block site it is unlikely any other native fish except shortfin eels will be recorded. Giant kōkopu prefer deep pools with good overhead cover and is a habitat type that does not occur within the Graham Block site. Longfin eels migrate into the headwaters of catchments but also prefer deep pool habitat so are unlikely to occur.

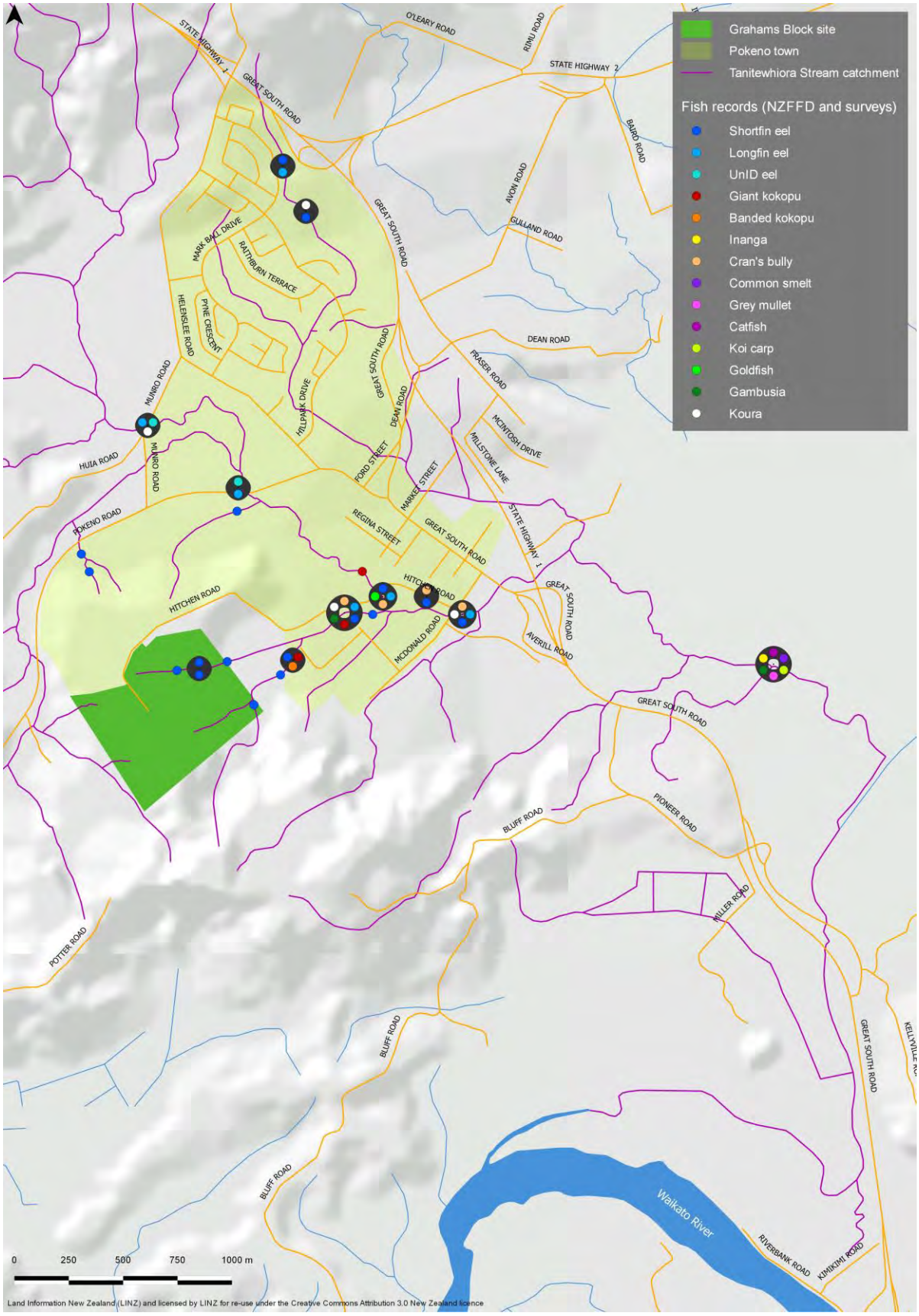

Figure 37: Records of fish within the Tanitewhiora Stream catchment.

7.0 Assessment of Effects

7.1 Introduction

The Graham Block is located within the Waikato River catchment and is typical of highly modified, moderately steep gradient agricultural land in the Waikato. The current ecological values of the site are variable, and are generally associated with freshwater habitat (streams and wetlands). The plan change from agricultural to residential land use provides an opportunity to protect and enhance the ecological values of the site in a manner that is consistent with meeting the objective of improving water and habitat quality within the wider Waikato River catchment. The opportunities to protect and enhance the existing ecological values centre on:

- Reducing the impact of pests and weeds.
- Creating greater buffering of sensitive areas (e.g., wetland habitat).
- Improving hydrology.
- Removing fish barriers.
- Improving connectivity of currently fragmented habitat.
- Improving access and community involvement in protection and enhancement initiatives.

7.2 Terrestrial Environment

The terrestrial ecological values of the site are currently limited to riparian vegetation and include:

- The bush block in upper SE1, which meets the Franklin District Plan significance criteria.
- The bush block at the head of SW1, which would be unlikely considered significant within the Framework of the Franklin District Plan, but retains some native character and remnant vegetation.
- All other areas of mixed native/ exotic riparian vegetation associated with wetlands and streams that would not be considered significant within the framework of the Franklin District plan, but form important buffers, protecting watercourses and improving aquatic habitat and water quality.

As part of the plan change process, protection of terrestrial ecological values within the site will include the retention of the bush block in upper SE1 and the retention of the bush block in upper SW1. Wherever possible native riparian buffer vegetation will be retained. However, where this is not viable, restoration efforts will be employed as to ensure an overall net ecological gain in terrestrial habitat within the site.

Restoration methods may include, but not be limited to:

- Planting pioneer species such as mānuka, kānuka, karamū and NZ flax around the outer edges of SE1 Bush block, to help reduce light penetration.
- Adding woody debris (wood rounds) within the outer edges of bush areas to supplement lizard habitat.

- Animal pest control to enhance the presence of native birds and lizards.
- Plant pest control to ensure the integrity and perpetuity of native vegetation.
- Restoration or infill planting of native species in degraded areas using species that are attractive to lizards and birds.
- Removal of exotic amenity species and replacement with native species.
- Planting areas of pasture between the north east and south east gullies to link areas of higher quality vegetation and improve connectivity and habitat integrity.
- Extending the width of buffer areas where appropriate.

7.3 Wetland Areas

The most significant ecological values within the Graham Block are associated with Wetland 1 and Wetland 2. Wetland 1 and 2 are assessed as significant due to the severe reduction of wetlands as a habitat type both Nationally and within the Meremere Ecological District. The severely degraded, highly modified, and poor quality of both Wetlands 1 and 2 and the very high external pressures which are contributing to their ongoing degradation mean that retention of the wetlands in their current state would do little to protect indigenous biodiversity or maintain ecosystem function.

As part of the plan change process and development of the site, wetland values will be protected and enhanced through the retention, enhancement, and protection of most of the wetland areas. Any loss of habitat will not exceed 20% of its total area, and will be limited to the upper extent, where hydrology is more limited and values to aquatic fauna such as fish is low. To mitigate or offset any loss, restoration of the remaining portions of the wetlands will be undertaken to ensure an overall net ecological gain in wetland habitat within the site (and off site if required). Given the current ecological value of both Wetland 1 and 2 is very low, restoration efforts are expected result in an overall net ecological gain in wetland ecological values within the site.

Restoration methods may include, but not be limited to:

- Pest plant control to ensure the integrity and perpetuity of native vegetation.
- Animal pest control to enhance the presence of native fauna.
- Enhancement and restoration planting with native species.
- Assess opportunities to create habitat for giant kōkopu.
- Improving connectivity by removing fish migration barriers such as culverts and ponds.
- Improving buffer connectivity by planting areas between the gullies.
- Removal of livestock.
- Protection from sediment inflow.
- Restoration and extension of wetland buffer vegetation as per Section 7.2.

Stormwater

The most significant factor that limits the success of wetland restoration projects is inadequate hydrological regimes (Peters et al. 2010). While both Wetland 1 and 2 have sufficient hydrological capacity to operate as swamps year-round (especially within lower areas), the development of the site will ultimately lead to alterations in surface run off from the upper catchment. Natural wetlands require water tables that fluctuate seasonally and in response to pulses of water inputs (e.g., from rainfall, tides, flooding rivers) – but not too much fluctuation, or too little (Peters et al. 2010). Artificial water control structures often result in unnaturally stable or high water tables. On the other hand, extreme water table lowering caused by artificial drainage, or drought will challenge the survival of some wetland plants and animals, and may allow dryland weeds to invade (Peters et al. 2010).

Development of the catchment upstream of the Wetlands 1 and 2 and stormwater has the potential to influence water flow and quality within the wetlands. Water quality within the wetlands is currently compromised by the agricultural land use of the catchment. With appropriate stormwater treatment and management adverse effects from stormwater on the wetlands are not expected.

To protect the water quality of the wetlands, Freshwater Solutions understands discharge road runoff is intended to flow through four pre-treatment forebays (three located within the Graham Block site) which will be constructed in the reserve at the head of the gullies of Wetland 1 (see Civil Plan 2017). The forebays will be vegetated with appropriate wetland plant species and designed to maintain the long-term water level of the wetlands (i.e., be fitted with low flow pipes). The installation of these forebays will result in a small loss of natural wetland habitat in headwater reaches but will also function to remove coarse particulates from stormwater preventing transport downstream.

Freshwater Solutions understands the residential lots will require on-lot re-use and detention tanks which will be sized based on the lot area and allowing for impervious areas as per District Plan Rule 26.6.12. Water from the reticulated networks servicing lots will bypass the pre-treatment forebays, connecting directly to outlet structures into the wetlands, and ultimately Treatment Pond J (Civil Plan 2017).

7.4 Stream and Pond Environments

The stream and pond habitat within the Graham Block site is highly modified. Ephemeral streams and artificial ponds are located in gully heads throughout the property. Removing these ponds should have a positive effect on water quality downstream, while removing sections of ephemeral stream will not adversely affect aquatic communities given these reaches do not provide habitat for aquatic organisms.

The opportunities to protect and enhance the permanent stream habitat centre on enhancing the riparian buffer areas along the streams and around the wetland areas (see Sections 7.2 and 7.3) as well as measures to reduce erosion and sediment inputs (see Lander Geotechnical 2017).

Specific recommendations for protecting and enhancing instream ecological values with the Graham Block include:

- Undertaking the restoration initiatives for protecting and enhancing riparian vegetation.
- Reducing sediment inputs through erosion control measures.
- Removing artificial ponds.

- Removing culverts.

Where losses of permanent stream habitat cannot be avoided it is recommended that offset restoration be undertaken along other stream sections within or outside of the Graham Block site to ensure a net overall improvement in aquatic habitat quality.

7.5 Summary

The current terrestrial and aquatic ecological values of the Graham Block site reflect the highly-modified nature of the environment. The proposed plan change provides the opportunity to restore, protect and enhance the current ecological values. Implementing the recommendations set out in Sections 7.1 to 7.4 of this report will significantly enhance ecological values within the property and will meet the broader objective of improving water and aquatic habitat quality in the wider Waikato River catchment.

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Report Signature Page

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APPENDIX A

Plant Species Encountered

Species (* denotes indicates exotic)	Common Name
Dicot herbs	
*Apium nodiflorum**	water celery
*Cichorium intybus**	chicory
*Cirsium arvense**	Californian thistle
*C. vulgare**	Scotch thistle
*Crepis capillaris**	hawksbeard
*Conyza bonariensis**	wavy-leaved fleabane
*Daucus carota**	carrot weed
*Epilobium ciliatum**	willow herb
*Galium aparine**	cleavers
*Galium divaricatum**	slender bedstraw
*Gallium palustre**	marsh bedstraw
*Hypochoeris intybus**	catsear
*Lemna disperma **	duckweed
*Leontodon taraxacoides**	hawkbit
*Leucanthemum vulgare**	oxeye daisy
*Lotus pedunculatus**	lotus
*Ludwigia palustris**	water purslane
*Lythrum hyssopifolia**	hyssop loosestrife
*Mentha pulegium**	penny royal
*Nasturtium officinale**	watercress
*Oenanthe pimpinelloides**	parsley dropwort
*Persicaria maculosa**	willow weed
*Persicaria strigosa**	-
*P. hydropiper**	water pepper
*Phytolacca octandra**	inkweed
*Plantago lanceolata**	narrow-leaved plantain
*Prunella vulgaris**	self heal
*Ranunculus flammula**	spearwort
*R. repens**	creeping buttercup
*Rumex obtusifolius**	broad-leaved dock
*Solanum nigrum**	black nightshade
*Taraxacum officinale**	dandelion
*Trifolium pratense**	red clover
*T. repens**	white clover
Monocot Herbs	
Phormium tenax	NZ Flax
Typha orientalis	raupō
*Zantedeschia aethiopica**	arum lily
Sedges, Rushes and Grasses	
*Agrostis capillaris**	browntop
*Anthoxanthum odoratum**	sweet vernal
Carex maorica	Maori sedge
C. secta	pūkio
C. geminata agg.	rautahi
*Cortaderia selloana**	pampas
Cyperus ustulatus ustulatus	giant umbrella sedge
*Dactylis glomerata**	cocksfoot
Eleocharis acuta	sharp spike sedge
*Glyceria maxima**	floating sweetgrass
*Holcus lanatus**	Yorkshire fog
Isachne globosa	swamp millet
Isolepis prolifera	-
*I. sepulcralis**	-
Juncus articulatus agg.*	jointed rush
*J. bulbosus**	bulbous rush
J. effusus var *effusus**	leafless rush
J. prismatocarpus	-
*Lolium perenne**	perennial rye grass
Machaerina rubiginosa	baumea
Oplismenus hirtellus subsp. imbecillis	-
*Paspalum distichum**	mercer grass
*P. dilatatum**	paspalum
*Poa annua**	annual poa
Climbers and Vines	
*Calystegia sepium roseata **	pink bindweed
*Lonicera japonica**	Japanese honeysuckle

Muehlenbeckia australis	large-leaved muehlenbeckia
Ripogonum scandens	supplejack
Rubus fruticosis agg.*	blackberry

Woody shrubs and trees	
*Acer sp.**	-
*Aesculus sp.**	-
*Aesculus hippocastenum**	common horse chestnut
Agathis australis	kauri
Beilschmiedia tarairi	taraire
Beilschmiedia tawa	tawa
*Berberis glaucocarpa**	barberry
*Castanea sativa**	sweet chestnut
*Citrus spp.**	lemon, orange
Coprosma robusta	karamū
Cordyline australis	cabbage tree
Corynocarpus laevigatus	karaka
Dacrycarpus dacrydioides	kahikatea
Dacrydium cupressinum	rimu
Dodonaea viscosa	akeake
Entelea arborescens	whau
*Ficus carica**	fig
Hebe stricta var. stricta	koromiko
Hedycarya arborea	pigeonwood
Hoheria populnea	-
*Juglans sp.**	walnut
Knightia excelsa	rewarewa
Kunzea robusta	kānuka
Laurelia novae-zelandiae	pukatea
Leptospermum scoparium agg.	mānuka
Ligustrum lucidum	tree privet
*Ligustrum sinense**	Chinese privet
*Macadamia sp.**	macadamia
*Malus x domestica**	apple
Melicytus ramiflorus	māhoe
Metrosideros excelsa	pōhutukawa
Metrosideros perforata	-
Myrsine australis	māpou
*Persea americana**	avocado
Podocarpus totara	tōtara
*Populus deltoides**	necklace poplar
*Populus trichocarpa**	western balsam poplar
*Pinus radiata**	pine
Piper excelsum	kawakawa
Pittosporum crassifolium	karo
Pittosporum eugenioides	tarata
Pittosporum tenuifolium	kōhūhū
Prumnopitys taxifolia	matai
Pseudopanax crassifolius	lancewood
*Pseudotsuga sp.**	fir
Rhopalostylis sapida	nīkau
*Rhododendron spp.**	rhododendron
*Salix cinerea**	grey willow
Salix fragilis	crack willow
*Sequoia sempervirens**	redwood
*Solanum mauritianum**	woolly nightshade
Sophora microphylla	kōwhai
*Quercus canariensis**	Algerian oak
*Quercus palustris**	pin oak
*Quercus robur**	European oak
*Quercus suber**	cork oak
*Ulex europaeus**	gorse
*Ulmus sp.**	elm
Vitex lucens	pūriri

Ferns	
Blechnum chambersii	nini
Blechnum filiforme	-
Blechnum minus	swamp kiokio
Blechnum novae-zealandiae	kiokio
Cyathea dealbata	silver fern

C. medullaris	mamaku, black tree fern
C. smithii	soft tree fern, katote
Dicksonia fibrosa	whekī-ponga
Dicksonia squarrosa	whekī
Diplazium australe	-
Doodia media	rasp fern
Histiopteris incisa	water fern
Lastreopsis glabella	smooth shield fern
Microsorum pustulatum subsp. pustulatum	hounds tongue
Microsorum scandens	fragrant fern
Paesia scaberula	ring fern
Pteridium esculentum	bracken fern

APPENDIX B

Bird Species Encountered

Species (denotes* indicates exotic)	Common Name
*Alauda arvensis**	European skylark
Circus approximans	Australasian harrier
*Fringilla coelebs**	Chaffinch
*Gymnorhina tibicens**	Australian magpie
Rhipidura fuliginosa	Fantail, piwakawaka
*Phasianus colchicus**	Common pheasant
*Platycercus eximius**	Eastern rosella
Porphyrio porphyrio melanotus	Pūkeko
*Turdus merula**	European blackbird
*Vanellus miles novaehollandiae**	Spur-winged plover
Zosterops lateralis	Waxeye