

Central Interceptor Project

Assessment of Ecological Effects Associated with the Central Interceptor Project

Prepared for

Watercare

by

Boffa Miskell Limited

July 2012



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CENTRAL INTERCEPTOR PROJECT
ASSESSMENT OF ECOLOGICAL EFFECTS

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1.0 INTRODUCTION

1.1 Background

Watercare Services Ltd (Watercare) is planning to construct a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them across the Manukau Harbour to the Mangere Wastewater Treatment Plant (MWWTP). The Central Interceptor Project (the Project) arose out of the Three Waters Plan (2008) which identified the need to provide trunk sewer capacity to central Auckland to reduce wet weather wastewater overflows and provide capacity for growth. The project extends across the Auckland isthmus from Western Springs in the north to the Mangere WWTP in the south.

1.2 Proposed Works

The overall concept proposed for the Central Interceptor is a gravity tunnel from the Western Springs area to the Mangere WWTP with various link sewers and connecting pipelines connecting the existing network to the main tunnel at key locations along this route.

The key elements of the project include:

- An approximately 13 km long 4.5 m diameter main tunnel from Western Springs to Mangere WWTP, up to 110 m below ground.
- Four link sewers connecting the main tunnel to the existing sewerage network.
- Associated connections to existing sewers.
- Associated structures at key sites along the route and at connections. At each site facilities include access shafts, drop shafts and flow control structures. Grit traps, air intakes, air vents or air treatment facilities are also proposed at some sites.
- A limited number of overflow structures in nearby watercourses to enable the safe discharge of occasional overflows from the tunnel.
- A pump station located at the Mangere WWTP.
- Other associated works at and in the vicinity of the Mangere WWTP, including a rising main to connect to the WWTP and an emergency pressure relief structure to enable the safe discharge of flows in the event of pump station failure.

The main tunnel, link sewers, connection pipes and many of the associated structures will be underground. The tunnel and link sewers will be constructed by tunnelling methods, with access provided from around 19 surface construction sites. These surface construction sites include:

- Three primary construction sites (at Western Springs, May Road and Mangere WWTP);
- 16 secondary construction sites to provide connections to the main tunnel and link sewers.

The primary construction sites will be used for launching or retrieving the tunnel boring machine, and materials for tunnel construction will be stored at these sites and permanent facilities will be constructed at each. Activities at the secondary sites along the main tunnel will include shaft sinking and the construction of surface facilities, and works associated with the link sewer sites will include launching or retrieving of the microtunnel boring machine.

Other construction activities include removal of vegetation; service relocations; establishment of construction yards, lay down areas and site accessways; traffic management; earthworks; and site reinstatement. In addition, works within and adjacent to the Coastal Marine Area (CMA) are required alongside the existing Watercare Pump Station 23 at Hillsborough Bay on the northern side of the Manukau Harbour. The works will involve a temporary construction platform of approximately 1,200m², excavations, removal of the existing pump station, and construction of an access shaft, dropshaft, Air Treatment Facility (ATF) and air vent.

The duration of construction will range from around 5 to 6 years at the primary sites, and 6 to 18 months at the secondary sites. However, due to the nature of construction at the secondary sites their actual period of occupation will be longer than this (ranging between 2 and 5 years), with periods of time during which there will be no active construction works occurring within them.

The project has been developed to a concept design stage. It is likely that some details may change as the project moves through the detailed design process. Detailed construction methods will be determined following appointment of a construction contractor.

1.3 Project Area Context

The Project Area is located within metropolitan Auckland. Most of the sites are located in public open space, including Western Springs Park, Rawalpindi Reserve, Miranda Reserve, Dundale Avenue, Mt Albert War Memorial Reserve, Roy Clements Treeway, Walmsley Park and Kiwi Esplanade/Ambury Park. In addition sites are proposed at the bottom of the Plant and Food Research facility in Mt Albert, at an existing Watercare pumping station at Hillsborough Bay, in a road reserve, at an industrial site in Mt Roskill and on some residential properties.

The intertidal area adjacent to the Pump Station 23 site (AS6) is located within an Area of Significant Conservation Value (ASCV), namely the Manukau Harbour. In addition, a small Coastal Protection Area (CPA) 2 is identified in the Auckland Regional Plan: Coastal to the west of the site (White Bluff), which is recognised as regionally important due to the complex deformed Waitemata Group rocks showing faults and folds both below MHWS and in the cliffs above.

1.4 Scope of This Report

This report describes the current values of the terrestrial (vegetation, avifauna and herpetofauna), stream and marine environments of the Project Area, and assesses the potential effects of the Project on these values based upon the construction footprints as defined in the drawing set labelled "Construction Works Plans" prepared for the AEE (dated June 2012). In identifying these potential ecological effects a conservative approach has been adopted, whereby the loss of all vegetation occurring within each of the construction yards (including all associated construction access corridors to pipelines and overflows) has been assumed. This report then identifies how any unavoidable adverse ecological effects may be minimised or alternatively mitigated.

It is noted that at the time of the preparation of this report two alternative options were being evaluated by Watercare in relation to the specific location of AS7, with one option being located adjacent to the toilet block in Kiwi Esplanade (AS7[a]) and the other being located in Ambury Park (AS7[b]). Both of these alternative options are assessed in this report.

2.0 METHODOLOGY

2.1 Vegetation

A literature review was undertaken to ascertain whether any of the vegetated sites within the Project Area had been formally identified as Significant Natural Areas in the Auckland City Plan : Isthmus Section or in any Auckland Regional Council planning documents. Following this a preliminary desktop assessment of vegetation communities was undertaken using high resolution aerial imagery of the Project Area. Vegetated sites for subsequent survey were identified from this analysis (see Table 1), and all sites were surveyed on June 21st 2011 by way of either walk-through transects or, in the case of some private properties, by viewing from a neighbouring vantage point.

2.2 Herpetofauna

2.2.1 *Herpetofaunal Database Search*

The Department of Conservation's (DOC) Herpetofaunal Database was searched for all records of terrestrial herpetofauna within an approximately 10 km radius of the project site. Because native lizards are difficult to locate, search results from the database provide additional information regarding which species may be present in the area.

2.2.2 *Lizard Habitat Quality*

Habitat quality was assessed for terrestrial and arboreal lizards at all sites listed in Table 1. Key determinants for terrestrial lizards (i.e. predominantly skinks) were the availability of suitable refugia (e.g. pieces of deadwood, human-made debris, thick ground-tier vegetation) and the degree of openness (more open areas provide greater opportunities for thermoregulation). Key determinants for arboreal lizards (i.e. predominantly geckos) were the presence of native trees and shrubs, especially kanuka, manuka and totara. Survey work was only undertaken in those sites with potential lizard habitat.

2.2.3 *Artificial Cover Object (ACO) Survey*

Artificial Cover Objects (ACO's) were used in those areas where there was an abundance of good habitat (in terms of both food and shelter resources) – being Mt Albert War Memorial Reserve (AS1) [in the planted flax clumps], Lyon Avenue (AS2), Pump Station 23 (AS6), Pump Station 25 (L3S1) and May Road (WS2) – see Table 1. Approximately 40 ACO's were distributed at each site, with each ACO being a 50 cm x 50 cm sheet of Onduline roofing tile. In relation to the four former sites listed above (i.e. AS1, AS2, AS6 and L3S1), the ACOs were laid on 21st June 2011 and checked for lizard occupancy 4 weeks later on 22nd July 2011. In relation to the latter site (i.e. (May Road [WS2])), the ACO's were laid on April 26th 2012 and checked again on May 24th 2012.

2.2.4 *Refuge Search*

Searches were performed opportunistically whenever suitable refugia was encountered. The types of refugia checked included deadwood, clumps of pampas (dead and alive) and various artificial debris such as sheets of scrap metal, dumped rubbish and discarded real-estate signs.

2.2.5 *Night-time Spotlight Search*

There was a general lack of suitable gecko habitat within the Project Area, as a result of the paucity of native bush and, in the few instances where there was native bush, a general absence of suitable native trees (especially manuka and kanuka) within it. Additionally, the majority of the native bush within the construction footprints appears to be largely the result of historic plantings, and it is not known whether these areas ever supported populations of lizards. Notwithstanding this however, night-time spotlight searches were undertaken in those areas of woody vegetation that were connected to larger areas considered potentially capable of supporting gecko populations. These were restricted to Lyon Avenue (AS2), Pump Station 23 (AS6), Motions Road (L1S1), Pump Station 25 (L3S1) and within the manuka plantings at the Dundale Avenue (L3S4) site – see Table 1. These were all surveyed on the night of 22nd July 2011.

2.3 Avifauna

Avifauna was sampled at all of the proposed works sites (Table 1). The sampling took the form of 5-minute point counts, with all species heard or seen within the 5-minute period being noted (including those seen flying overhead). Any noteworthy observations obtained while traversing the sites were also recorded. Potential shore bird roosting sites at Kiwi Esplanade (AS7[a]), Ambury Park (AS7[b]) and Mangere Pump Station (WS3) were also visited at high tide on several occasions.

The nature of the available habitat at each site was also characterised to determine the site's overall habitat quality and to gauge the likelihood of the area supporting other bird species. Habitat quality was judged on the basis of factors such as food availability, presence of suitable nest sites, habitat linkages with nearby areas and vegetation matrix (e.g. dense or open).

2.4 Freshwater

Stream works associated with the Project will be of small scale, localised and temporary, and would include such things as temporary bridge crossings of waterways and provision of overflow structures at some sites. Given the restricted and low key nature of these stream works, the freshwater investigations were restricted to a collation of existing information in relation to the three waterways that flow through the general Project Area, being Oakley Creek, Meola Creek and a tributary of the Whau Creek (see Appendix 1 for a list of the information sources).

2.5 Estuarine

Field investigations were undertaken in the estuarine environment at Pump Station 23 (AS6) where a temporary construction platform is proposed to be built in the CMA. Minor additional works are also proposed at one other location in the CMA, being the construction of the outlet of an Emergency Pressure Relief Pipeline, including a headwall and scour protection, at Mangere Pump Station (WS3).

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Table 1 : Sites Surveyed

Site	Name	Habitat Type Within the Construction Footprint	Vegetation Survey	Avifauna Survey	Herpetofauna Survey	Marine Survey
WS1	Western Springs	Grass with a few exotic trees	yes	yes	no	n/a
AS1	Mt Albert War Memorial Reserve	Grass with mature flax clump plantings	yes	yes	ACO only	n/a
AS2	Lyon Avenue	Mainly native bush (mature plantings)	yes	yes	ACO & night	n/a
AS3	Haverstock Road	Grass with cabbage tree mass plantings	yes	yes	no	n/a
AS4	Walmsley Park	Grass with a few exotic trees & shrubs + low plantings	yes	yes	no	n/a
WS2	May Road	Overgrown weedfield + a few exotic trees	yes	yes	ACO only	n/a
AS5	Keith Hay Park	Homestead, grass + ornamental trees	yes	yes	no	n/a
AS6	Pump Station 23	Planted shrubland, coastal forest + coastal mudflats/ reef	yes	yes	ACO & night	yes (quantitative)
AS7[a]	Kiwi Esplanade	Grass + planted pohutukawa + coastal edge	yes	yes	no	n/a
AS7[b]	Ambury Park	Grass with adjacent planted native trees & shrubs	yes	yes	no	n/a
WS3	Mangere Pump Station	Grass+ 2 gums + planted shrublands + coastal edge	yes	yes	no	yes (qualitative)
L1S1	Motions Road	Grass + native shrub plantings	yes	yes	night only	n/a
L1S2	Western Springs Depot	Yard with some pines	yes	yes	no	n/a
L2S1	Rawalpindi Reserve	Grass with some flax and exotic trees	yes	yes	no	n/a
L2S2	Norgrove Avenue	Pavement + grass + plantings + exotic treeland	yes	yes	no	n/a
L3S1	Pump Station 25	Weedy native bush + plantings + grass	yes	yes	ACO & night	n/a
L3S2	Miranda Reserve	Grass + children's playground	n/a	n/a	no	n/a
L3S3	Whitney Street	Grassed road-side verge	yes	yes	no	n/a
L3S4	Dundale Avenue	Grass + native plantings + adjacent manuka shrublands	yes	yes	night only	n/a
L3S5	Haycock Avenue	Homestead + mature exotic tree	yes	yes	no	n/a

The 2 sites listed under AS7 (i.e. Kiwi Esplanade and Ambury Park) are alternative options being considered in this Project.

In relation to the Mangere Pump Station (WS3) site, while a qualitative survey was conducted here no quantitative investigations were undertaken. This was in recognition that the particular habitat type was ubiquitous in the wider area (being soft mudflats dominated by mud snails) and has only recently been rehabilitated from its previous use as part of the Mangere WWTP oxidation ponds, and that the proposed works here are small in size, involve minimal intrusion into the intertidal area, will be carried out at low tide and will include appropriate sediment control devices.

Quantitative field studies were carried out in relation to the intertidal area adjacent to Pump Station 23 (AS6). These are discussed next. The intertidal sampling was carried out at this site along three transects (western, central and eastern) at low tide on 15th June 2011 (see Appendix 2).

2.5.1 Pump Station 23 (AS6) Invertebrates

2.5.1.1 Infauna

Two infaunal invertebrate samples were collected along each of the three transects; at 10 m and 20 m along the western transect, and at 15 m and 35 m along the central and eastern transects. The extent of the western transect was constrained by a small stream channel that discharges to the coast at the north-west corner of the site. To assess infaunal abundance and diversity, sediment cores were collected using a 13 cm diameter and 15 cm deep PVC tube and a garden trowel. The PVC tube has a tapered edge at one end and a metal handle on the opposite end to facilitate penetration. The PVC tube was manually driven into the sediment and then lifted up with the aid of the trowel, with its contents intact. The tube contents were then bagged and labelled according to sampling site number. Samples were processed on site by washing the contents of each sample through a 0.5 mm sieve. All material retained on the sieve was then carefully removed and placed into a labelled plastic container, preserved in 70% ethanol (with 2% glyoxal) and sent to Cawthron Institute for sorting, identification and enumeration of macroinvertebrates.

2.5.1.2 Epifauna

A 0.25 m² quadrat was placed at five metre intervals along each of the transect lines in order to sample epifauna and surface macroalgae. Quadrats were also photographed for reference. To provide information on epifaunal abundance and macroalgal cover, each quadrat was inspected for epifauna and macroalgae.

2.5.2 Pump Station 23 (AS6) Sediment Quality

2.5.2.1 Contaminants

A composite surface sediment sample was collected adjacent to the two infaunal invertebrate sampling locations along each transect. A garden trowel was used to scrape the top 2-3 cm of the sediment. Samples were held on ice and then sent to Hill Laboratories for the analysis of total copper, lead, zinc, high molecular weight polycyclic aromatic hydrocarbons (HMW PAHs) and total organic carbon (TOC). The concentration of PAHs was subsequently normalised to TOC.

2.5.2.2 Grain Size

A surface sediment sample was collected at each transect for grain size analyses using an identical collection methodology as that for the contaminant analyses.

3.0 RESULTS

3.1 Vegetation

The results of the review of the Auckland City Plan : Isthmus Section and Auckland Regional Council plans confirmed that none of the sites potentially affected by the Project had been identified and/or scheduled as Significant Natural Areas. Vegetation surveys were undertaken at all sites either by walk-through transects (where access was available) or (in the case of some privately owned properties) by way of visual assessment from neighbouring vantage points.

Within the construction footprint, the overall vegetation types fit into a number of categories, as described below.

3.1.1 *Predominantly Managed (Mown) Grass*

The following sites fit this category

- WS1 Western Springs (managed grass + a few exotic trees);
- WS3 Mangere Pump Station (managed grass + 2 gum trees + narrow band of native shrublands [planted] + coastal edge);
- L3S2 Miranda Reserve (managed grass + children's playground).

In both of the first two examples there are a few mature exotic trees that lie within the construction footprints, and WS3 includes a small area of planted shrublands along its coastal edge. The latter site (L3S2) has no trees or shrubs but does include a children's playground.

3.1.2 *Managed (Mown) Grass with Plantings and/or Some Trees*

The following sites fit this category:

- AS1 Mt Albert War Memorial Reserve (grass + multiple flax clumps);
- AS3 Haverstock Road (grass + cabbage tree plantation);
- AS4 Walmsley Park (grass, a few trees and shrubs [pohutukawa, magnolia, cassarina, acmena] and edge plantings of oioi, *Carex* spp. and toetoe);
- AS7[a] Kiwi Esplanade (grass + a few pohutukawa trees [planted] + coastal edge);
- AS7[b] Ambury Park (grass with adjacent native trees and shrubs [planted]);
- L1S1 Motions Road (grass + native shrubs [planted]);
- L2S1 Rawalpindi Reserve (grass, flax clumps, willows and 1 large Norfolk Island pine);
- L2S2 Norgrove Avenue (grass, semi-mature native plantings and willows/exotic trees);
- L3S3 Whitney Street (road-side grass verge);
- L3S4 Dundale Avenue (grass + 3 titoki, 2 kowhai & 5 puriri) – adjacent to manuka shrubland plantings.

3.1.3 *Unmanaged Grass and Weed Fields*

The following site fits this category:

- WS2 May Road.

This site supports mainly kikuyu, along with blackberry, pampas and various herbaceous weeds (in particular hoary mustard).

3.1.4 *Homestead / Council Yards*

The following sites fit this category:

- L1S2 Western Springs Depot (car park, yard and pine trees);
- AS5 Keith Hay Park (homestead with grass and exotic trees);
- L3S5 Haycock Avenue (homestead with garden).

The Haycock Avenue site (L3S5) includes a large liquid amber tree, the Western Springs Depot site (L1S2) includes several large pines and Keith Hay Park (AS5) includes mature exotic trees.

3.1.5 *Bush and Shrubland*

- AS2 Lyon Avenue (predominantly mature native plantings, with some exotics);
- AS6 Pump Station 23 (planted shrublands, coastal forest + coastal mudflats / reef);
- L3S1 Pump Station 25 (natural native bush and shrublands + native plantings).

These three sites (AS2, AS6 and L3S1) all appear to be a mix of historic (now mature) plantings together with possible vestiges of naturally occurring native bush. The most developed of these is at Lyon Avenue (AS2) which supports a large number of good sized lemonwood, with lesser amounts of totara, karo, ngaio, kohuhu, karaka, kanuka and puriri. A planted kawaka is also present, as are several good sized eucalypts, tree privet and cassarina. The understorey is dense in the more open areas of canopy, in particular in the lower lying (wet) areas where *Cortaderia fulvida* (a native toetoe) is dominant. Other species in this tier include mahoe, mamaku, cabbage tree, nikau, akeake, tanguru, kowhai, *Coprosma rhamnoides* and kumarahou. Flax is also locally common, and there is ample evidence of quite recent plantings in the form of hebes, *Coprosma* hybrids, *Pseudopanax* hybrids and poroporo.

At Pump Station 23 (AS6) there is a small narrow band of native shrubland plantings that grade into (and are well connected with) the mature coastal forest of Hillsborough Bay. The largest trees are on the coast and include pohutukawa up to 8-10m in height. Young kohekohe, mahoe, taupata, houpara, puriri and kawakawa are also found along the coastal edge here, growing under a canopy of tree privet. These are all considered to be the result of natural regeneration processes. The planted shrublands line the driveway leading into the site from the road – they are characterised by much agapanthus along the site boundaries and the edges of the plantings, together with karamu, ponga, flax, mahoe, karo and cabbage tree. Young (apparently naturally regenerating) specimens of totara and karaka are also present. Weeds are plentiful, and include pampas, wattle, tree privet, Japanese spindle tree, jasmine, Japanese honeysuckle and asparagus fern.

At Pump Station 25 (L3S1) the area of bush within the construction footprint is a mix of maturing historic plantings (predominant) together with what appears to be a small remnant of native bush and shrublands growing along the riparian margins of a Whau Creek tributary. The canopy is somewhat broken and patchy, but where it is coherent it is characterised by ngaio (planted) kohuhu (probably planted), mapou (abundant throughout), mahoe, ponga, pigeonwood and exotic trees (i.e. woolly nightshade, Chinese privet, Sydney golden wattle and brush wattle). Other species appearing in the understorey include much mapou, together with mahoe, akeake, kumarahou, hangehange, karaka, flax and bracken. Weeds are plentiful in the mid and ground tiers, and include pampas, wandering jew, blackberry, smilax, inkweed, Chinese privet, montbretia, bindweed, thistle, Arum lily, asparagus fern, tree privet and nasturtium.

3.1.6 Discussion

There is no vegetation within the Project's construction footprints that is considered to be significant in terms of s.6(c) of the RMA. Only three sites support native bush, and in the case of Lyon Avenue (AS2) the majority of that bush appears to have been planted (although those plantings were obviously a considerable time ago and they are presently all mature). These three sites alone (i.e. Lyon Avenue [AS2], Pump Station 23 [AS6] and Pump Station 25 [L3S1]) are the only ones that are of any botanical interest, and these are all compromised to some degree by their generally weedy nature.

While of some botanical interest in its own right, the bush at Pump Station 25 (L3S1) also has ecological value by virtue of its contribution to riparian benefits (for the local stream) and also its contribution to local wildlife corridors. Vegetated riparian strips play an important role in a number of ways – they act as biological filters or buffer zones between streams and their surrounding lands, intercepting much of the nutrients that would otherwise end up in waterways. Where sediments and nutrients enter streams unchecked (i.e. where there is no riparian strip) then turbidity and eutrophication reduce water quality and degrade in-stream habitat opportunities.

Stream-side vegetation also provides shade, which regulates stream temperatures and therefore contributes to water quality. Shaded streams have lower temperatures than unshaded streams and as a consequence have higher dissolved oxygen levels. At elevated (unshaded) temperatures the ability of streams to assimilate organic wastes (without depleting oxygen to dangerously low levels for aquatic fauna) is reduced. This is particularly the case with regard to small streams.

Riparian vegetation and the humus it provides also store rainwater, thereby reducing the amount of water that immediately enters streams during storm events. Instead the water is released over a longer period of time. By this mechanism run-off flows are more controlled, and as a result flood volumes are reduced and the potential for stream-bank erosion attenuated.

In addition, riparian vegetation helps maintain stable natural habitats rich in organic detritus, which are crucial to the survival of many freshwater organisms which are themselves important in aquatic food webs.

To a lesser extent the bush at Lyon Avenue (AS2) would provide similar benefits to the reach of Meola Creek that flows between it and Mt Albert Grammar School, and likewise the bush and plantings associated with Rawalpindi Reserve (L2S1) and Norgrove Avenue (L2S2) would also provide such benefits to lower reaches of Meola Creek.

3.2 Avifauna

3.2.1 5-minute Point Counts, High Tide Roosts and Habitat Assessment

Surveying for avifauna was undertaken at the same time as the vegetation and herpetofauna surveys were being conducted, as well as on several additional occasions in March – May 2012 when potential shore bird high tide roosts at Kiwi Esplanade Reserve (AS7[a]), Ambury Park (AS7[b]) and Mangere Pump Station (WS3) were surveyed. The results are presented in Table 2.

The great majority of the birds recorded were introduced species. Of these the most commonly recorded species were blackbird and sparrow. Song thrush, starling, myna, chaffinch and goldfinch were also relatively common, with a few observations also of magpie, rock pigeon and mallard.

Among native species, the only numerous counts were at Pump Station 23 (AS6) (on the open mudflats adjacent to the site) and at Kiwi Esplanade (AS7[a]) (on the open mown grassland areas of this reserve). At Pump Station 23 (AS6) New Zealand pied oystercatcher numbered a few score, along with lesser numbers of red billed gull, pied stilt and black-backed gull. A few variable oystercatcher and white-faced heron were also present here. Notwithstanding the above, it is emphasised that these birds were following the moving tide line at the time of survey, and none were actually observed to be physically present within the footprint of the temporary construction platform. Nevertheless, it is likely that at some periods of the tidal cycle the area within the footprint of the temporary construction platform would be used to some extent by some of these same species.

The area of Kiwi Esplanade in the immediate vicinity of site AS7[a] is a well-utilised high tide roost for shore birds, especially NZ pied oystercatcher. On most (but not all) of the surveys this species numbered in the few hundreds here, being normally present on the open field to the immediate west of the construction footprint. Notwithstanding this, the open fields further to the east (i.e. on the other side of the toilet block access road) appear to be a more important high tide roost, with many hundreds of NZ pied oystercatcher being observed at these fields on all surveys of Kiwi Esplanade (AS7[a]). In addition to the above, both black-backed gull and red-billed gull were also seen at Kiwi Esplanade (AS7[a]), and on one occasion a score of little black shag were also observed feeding in the sea adjacent to the site. These and other species of shag may utilise other coastal sites within the Project Area (i.e. Pump Station 23 (AS6) and possibly also Motions Road (L1S1)).

Away from the coast, the most commonly observed native birds were fantail and silvereye – these were present at all sites with a bush cover. However, overall the majority of the terrestrial sites are characterised by a lack of suitable habitat for native avifauna, with the exception of the bush present at Pump Station 23 (AS6), Lyon Avenue (AS2) and Pump Station 25 (L3S1).

The Threatened and At Risk species observed to be present were red-billed gull (Nationally Vulnerable), NZ pied stilt (Declining), NZ pied oystercatcher (Declining), little black shag (Naturally Uncommon) and variable oystercatcher (Recovering). These were observed only at two locations, being on opposite sides of the Manukau Harbour (being Pump Station 23 (AS6) and Kiwi Esplanade Reserve (AS7[a])). It is very likely that both sites are used routinely by all of these species for feeding and/or roosting purposes. Given this it will be important that disturbance is kept to a minimum during the construction works at these two locations, and that the temporary construction platform is reinstated back to its previous state and condition at the end of the works here.

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Table 2: Avifauna Results

Site	Name	Native Species	Introduced Species
WS1	Western Springs	Paradise shelduck, spur-wing plover, kingfisher, swallow	Blackbird, myna, sparrow, starling, mallard, chaffinch
AS1	Mt Albert Reserve	Silvereye	Blackbird, sparrow, song thrush, starling, myna
AS2	Lyon Avenue	Fantail, silvereye	Blackbird, sparrow, song thrush
AS3	Haverstock Road	Nil	Blackbird, sparrow
AS4	Walmsley Park	Nil	Blackbird, starling, rock pigeon, dove
WS2	May Road	Nil	Blackbird, sparrow, song thrush
AS5	Keith Hay Park	Nil	Blackbird, sparrow
AS6	Pump Station 23	NZ pied oystercatcher, variable oystercatcher, black-backed gull, red billed gull, pied stilt, white faced heron, kingfisher, swallow, fantail, silvereye	Blackbird, sparrow, mallard
AS7[a]	Kiwi Esplanade	Red billed gull, black backed gull, NZ pied oystercatcher, pied stilt, variable oystercatcher, little black shag, pukeko	Blackbird, sparrow, starling, song thrush
AS7[b]	Ambury Park	Pukeko	Starling, blackbird, thrush, rock pigeon, mallard
WS3	Mangere Pump Station	Pukeko, paradise shelduck, spur-winged plover, kingfisher	Blackbird, starling, song thrush, starling
L1S1	Motions Road	Silvereye	Blackbird, rock pigeon
L1S2	Western Springs Depot	Nil	Blackbird, sparrow
L2S1	Rawalpindi Reserve	Nil	Blackbird, sparrow, magpie
L2S2	Norgrove Avenue	Shining cuckoo, grey warbler	Blackbird, sparrow
L3S1	Pump Station 25	Fantail, silvereye, grey warbler, kingfisher	Blackbird, sparrow, chaffinch, myna
L3S2	Miranda Reserve	Nil	Blackbird
L3S3	Whitney Street	Nil	Nil
L3S4	Dundale Avenue	Nil	Blackbird, mallard
L3S5	Haycock Avenue	Nil	Nil

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While not observed to be present over the course of this survey, it is also likely that tui are regular visitors to some of the sites, especially those which support flax (and in particular when that flax is in flower). These sites would include Mt Albert War Memorial Reserve (AS1) and Rawalpindi Reserve (L2S1). Tui are also likely to at least occasionally frequent the three bush sites (i.e. Lyon Avenue [AS2], Pump Station 23 [AS6] and Pump Station 25 [L3S1]). Morepork may also be resident in the wider bush areas associated with Pump Station 26 (AS6) and Pump Station 25 (L3S1), and may possibly frequent Lyon Avenue (AS2). Additionally, while grey warbler were only observed at Pump Station 25 (L3S1) and Norgrove Avenue (L2S2), it is likely that they are regularly present at Pump Station 23 (AS6) and may also visit Lyon Avenue (AS2).

3.3 Herpetofauna

3.3.1 Herpetofaunal Database Search

According to the DOC herpetofauna database, five lizard species have been recorded within 10 km of the Project Area (Table 3): two native skink (one of which is threatened), two native gecko (one of which is threatened) and one introduced skink species. The most commonly recorded species was copper skink with three records, whereas all other species were recorded only once. Copper skink was also the species recorded closest to the Project Area (within 2 km).

Table 3. Herpetofauna Recorded Within 10km of the Project in DOC's Database.

Major taxon	Common name	Scientific name	Conservation status ^{1,2}	No. records ≤10km
Turtles	Red-eared slider	<i>Trachemys scripta elegans</i>	Introduced	3
Frogs	Golden bell frog	<i>Litoria raniformis</i>	Introduced	5
	Green tree frog	<i>Litoria aurea</i>	Introduced	3
	Unidentified frog	<i>Litoria sp.</i>	Introduced	3
	Whistling tree frog	<i>Litoria ewingii</i>	Introduced	3
Geckos	Auckland green gecko	<i>Naultinus elegans elegans</i>	At Risk (Declining)	9
	Common gecko	<i>Woodworthia maculatus</i>	Protected, not threatened	1
	Forest gecko	<i>Mokopirirakau granulatus</i>	Protected, not threatened	19
	Pacific gecko	<i>Dactylocnemis pacificus</i>	At Risk (Relict) ^{CD,PD}	4
Skinks	Copper skink	<i>Oligosoma aeneum</i>	Protected, not threatened	29
	Moko skink	<i>Oligosoma moco</i>	At Risk (Relict) ^{CD,PD}	1
	Ornate skink	<i>Oligosoma ornatum</i>	At Risk (Declining) ^{CD,PD}	14
	Rainbow skink	<i>Lamproholis delicata</i>	Introduced	21
	Shore skink	<i>Oligosoma smithi</i>	Protected, not threatened	2
	Unidentified skink	<i>Oligosoma sp.</i>	Protected, may also be threatened	1
	Unidentified skink	<i>Unknown</i>	Unknown	1
Total no. native species				8
Total no. introduced species				5

Shaded rows denote introduced species

¹From Hitchmough, R.A., Hoare, J.M., Jamieson, H., Newman, D., Tocher, M.D., Anderson, P.J., Lettink, M., and Whitaker, A.H. 2010. Conservation status of New Zealand reptiles, 2009. New Zealand Journal of Zoology 37:3. P203-224.

²CD = conservation dependent, PD = partial decline.

3.3.2 *Habitat Assessment*

Terrestrial lizards

Habitat quality for terrestrial lizards was generally low due to the predominance of mown grass at most of the sites. However, small areas of good quality habitat were found scattered across the Project Area in the form of the following:

- Rank grassland at park boundaries with private properties, around hedgerows, under fence-lines and bordering bush patches;
- Isolated pieces of deadwood (only found in the bush patches at Lyon Avenue [AS2] and Pump Station 25 [L3S1]);
- Dense thickets of planted flax (such as at Mt Albert War Memorial Reserve [AS1]) or naturally colonised pampas (including dead pampas – e.g. at Pump Station 23 [AS6]);
- Boulder fields (found only at Lyon Avenue [AS2]), but in abundance here);
- Dumped rubble and construction debris (only found at Pump Station 23 [AS6]);
- Extensive rank grasslands with clumps of pampas (only found at May Road [WS2]);
- Bush patches where leaf litter and/or suitably thick ground-tier vegetation were present (such as at Pump Station 23 [AS6] and Pump Station 25 [L3S1]).

Arboreal lizards

Habitat quality for arboreal lizards such as Auckland green gecko, forest gecko and Pacific gecko was generally low due to the scarcity of bush habitat within the construction footprints and the scarcity of suitable tree species (in particular kanuka) in those few areas that did support bush. The majority of the trees present within the construction footprints were unsuitable exotic species. Notwithstanding this however, nocturnal surveys for native geckos were undertaken in all sites with coherent bush present that was of a size and composition that could potentially support resident geckos.

3.3.3 *Active Searches: the ACO, Natural Refuge & Spotlight Surveys*

The ACO's were checked for lizard occupancy at Mt Albert Reserve (AS1), Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1) on 22nd July 2011, and at the May Road site (WS2) on 24th May 2012. Multiple natural (and man-made) refuges were checked for lizard occupancy during the refuge searches (at the time of ACO deployment and retrieval), and one night (22nd July) was spent conducting the spotlight searches, respectively.

No geckos were found to be present in any of the bush patches searched. Two native skinks were found sheltering beneath the ACO's that had been deployed, being one copper skink (at Pump Station 25 [L3S1] and one ornate skink (at Pump Station 23 [AS6]). These same two species were also captured (one individual each) at these same sites during the natural refuge searches (i.e. one ornate skink at Pump Station 23 [AS6] and one copper skink at Pump Station 25 [L3S1]). It is noted that the same individuals could have been involved in both captures at each site respectively. Copper skink is a common species that is widespread throughout the Auckland (and wider) region. It is protected under the Wildlife Act 1953, and is a Non-Threatened endemic species. Ornate skink is also protected under the Wildlife Act 1953 – it is an At Risk (Declining) endemic species.

In addition to these two native skinks, the introduced rainbow skink was also captured at three sites (i.e. Lyon Avenue [AS2], Mt Albert War Memorial Reserve [AS1] and May Road [WS2]). This is a widespread species that was accidentally introduced into New Zealand from Australia, and it has quickly become established within Auckland (and wider afield). It is locally abundant at both the Lyon Avenue (AS2) and May Road (WS2) sites.

3.4 Freshwater

The Oakley Creek is classified as a Permanent Stream with respect to stream flow under the Proposed Auckland Regional Plan: Air, Land and Water (ALWP). It is an Urban Stream Management Area under Section 3.5 of the ALWP. This provides for stream reaches to be classified, primarily by the percentage of impervious surface area and the percentage of artificial streambed material (such as concrete). The Oakley Creek is primarily Type 4 (Highly Disturbed Urban Stream), with some Type 5 (Artificial or Concrete Channelised Urban Stream) reaches in the upper catchment (e.g. Underwood Park and Keith Hay Park).

Oakley Creek is not listed in the Regional Policy Statement as an area of Significant Natural Heritage value, nor as an Area of High Ecological Value Vulnerable to Degradation, although its marine receiving environment is (being the Pollen Island/Motu Manawa Marine Reserve).

In terms of physical habitat, Oakley Creek is a large stream with a large volume of habitat, deep pools suitable for large eels and permanent flows. Downstream of New North Road it has a relatively low level of channel modification, although hydrological changes resulting from urbanisation have probably affected channel form in this area.

In terms of freshwater ecology, earlier surveys conducted at several sampling points along Oakley Creek identified taxonomic richness (i.e. species diversity) to range between 7 to 15 taxa, the number of insect taxa to range from 3 to 7, and the number of EPT taxa to range from 0 (most commonly) to 2. Aquatic snails and other pollution-tolerant taxa were the most abundant species present. The Macroinvertebrate Community Index (MCI) ranged from 50 to 70 and the Semi-Quantitative Macroinvertebrate Community Index (SQMCI) ranged from 2.1 to 3.2. These metrics are all indicative of degraded water quality and degraded habitat opportunities.

In addition to the aquatic macroinvertebrate metrics, earlier surveys conducted at several sampling points along Oakley Creek identified a marked distinction between the fish communities resident upstream of the 6m high waterfall at Waterview Glades and those resident downstream. The upstream communities were characterised by just 2 native species, being shortfin eel (in very high abundance) and (less commonly) longfin eel. The latter species is classified as “At Risk – Declining”. A single record of banded kokopu from just above the waterfall is considered to represent an artefact as opposed to a resident population here. In addition, mosquito fish (an introduced pest fish species) is relatively numerous above the waterfall.

Below the waterfall the fish community is far more diverse, with (over a period of several years of sampling) the following species having been recorded: longfin eel, shortfin eel, giant bully, redfin bully, common bully, inanga, torrentfish and a single record of yellow-eye mullet (normally a marine species but obviously using the salt (tidal) wedge in this lower section of the creek). In addition to longfin eel, three other of these species are also classified as being “At Risk – Declining”, being redfin bully, inanga and torrentfish.

Meola Creek is a Permanent Stream with respect to flow, and is also classed as a Type 4 (Highly Disturbed) Urban Stream due to the high percentage of impervious catchment (ALWP; ARC, 2008). The ALWP notes that these stream types typically have lower natural values. The creek is listed as a Degraded Urban Stream in the Auckland Regional Policy Statement (Map 5), and the stream mouth is identified as an area of localised sediment contamination. It is a moderately long stream (2.6km) with its headwaters entirely piped. The riparian zone upstream of the SH16 motorway is generally open as it flows through Chamberlain Park golf course, but below the motorway it consists of tall shading exotic vegetation (primarily willows) with an understory of weed species.

Thick growths of the introduced macrophyte *Vallisneria gigantean*, interspersed with oxygen weed, fill all but the swiftest flowing areas of the creek immediately downstream of the existing SH16 culvert. It is noteworthy that the Nationally Endangered aquatic moss *Fissidens berteroi* is present in Meola Creek in the vicinity of the Great North Road culvert.

The most recent bio-metric records for Meola Creek are from 1998, from a single survey immediately downstream of the SH16 motorway crossing. A total of 10 taxa were found, being dominated by snails (predominantly *Potamopyrgus* but also *Physa*) and amphipods. No sensitive macroinvertebrates (such as EPT) were present, with the only caddisfly present being *Oxyethira* (a pollution-tolerant taxa). The creek was considered to be typical of an urban stream with a relatively high degree of habitat modification and low water quality.

A total of seven species of fish have been recorded from Meola Creek, although two of these are marine wanderers found only at the creek's mouth (being yellow-eye mullet and cockabully). The other fish recorded from the creek are shortfin eel, common bully, banded kokopu, inanga and torrentfish. The latter two species are classified as "At Risk – Declining" species.

3.5 Estuarine

3.5.1 Pump Station 23 (AS6)

3.5.1.1 Invertebrates

Quantitative sampling was undertaken in the intertidal area at Pump Station 23 (AS6). Benthic sediment differed between the three survey sites (see Appendix 3): the Western Transect (Transect W) was characterised by gravel and cobbles which altered abruptly at approximately 18.5 m to a fine sand substrate; the Central Transect (Transect C) consisted of gravel and sand which then changed to a sandstone reef from approximately 20 m onwards; and the Eastern Transect (Transect E) was characterised by fine mud approximately 2 to 4 cm deep over sandstone. The shallow nature of the sediment caused some difficulty in gathering sufficient core samples.

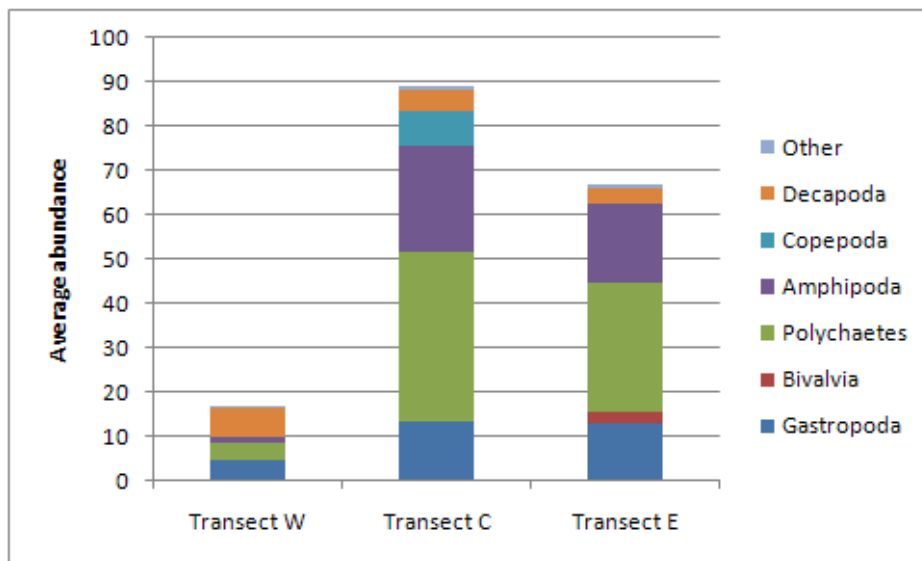
Core sediment samples collected for intertidal infaunal invertebrate analyses revealed the community within the survey area was dominated by polychaetes, amphipods, gastropods and decapods (Figure 1). The invertebrate community comprised both tolerant and sensitive organisms, but no rare or threatened species were detected

The central transect (Transect C) had the highest average abundance of taxa with a strong representation of polychaetes (mainly the polychaete worm *Scolecopides benhami* and juvenile *Nereidae*) (Figure 1). No bivalvia species were recorded within this transect.

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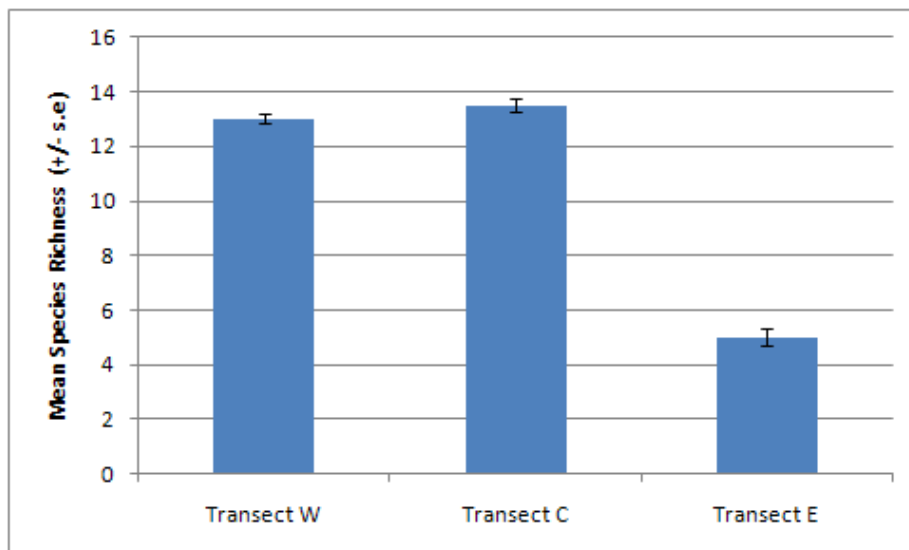
The western transect (Transect W) comprised mainly of decapoda (the tunnelling mud crab, *Helice crassa*), polychaetes (*Scolecopides benhami* and juvenile *Nereidae*) and gastropoda (*Potamopyrgus estuarinus*). No bivalves or copepods were recorded within this transect (Figure 1). Transect W had the lowest average abundance of infaunal taxa (Figure 1). Polychaetes, amphipoda and gastropoda were the dominant taxa in Transect E (eastern transect) (Figure 1). *Potamopyrgus estuarinus* was the dominant taxon of gastropod, the freshwater amphipod *Paracorophium* sp. was revealed in high numbers and *Scolecopides benhami* and juvenile *Nereidae* were the dominant polychaetes.

Figure 1: Average Abundance of Dominant Intertidal Taxa.



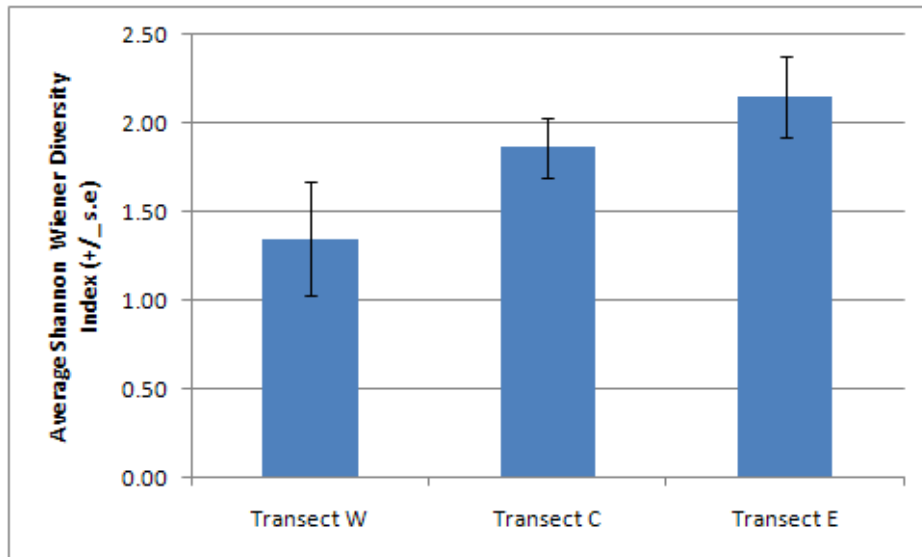
Of the six core samples that were collected during surveying, species richness ranged from 3 to 17. Mean species richness was greatest at Transect C (13.5) and lowest at Transect E (5) (Figure 2).

Figure 2: Mean Species Richness of Intertidal Infauna.



The Shannon-Wiener Diversity Index ranged from 1.35 to 2.15, indicating a low to moderate level of species evenness and richness (Figure 3). The Shannon-Wiener Diversity Index was lowest at the Transect W site and highest at the Transect E site.

Figure 3: Mean Intertidal Infauna Species Diversity per Site.



Dominant epifauna taxa noted in the survey quadrats were *Zeacumanthus lutulentus* and *Potamopyrgus estuarinus*. *Z. lutulentus* was very abundant within the crevices and holes provided by the sandstone reef. There was a noted absence of *Cominella glandiformis*, a common mud whelk. Crab holes were noted in several of the quadrats but were largely absent where the substrate was comprised of sandstone overlain by mud.

3.5.1.2 Sediment Quality

3.5.1.2.1 *Contaminants*

The results of the sediment quality analyses are given in Appendix 4. The concentration of common stormwater contaminants (copper, lead, zinc and HMW PAHs) were compared against the former Auckland Regional Council (ARC) Environmental Response Criteria (ERC) and the Australian and New Zealand Environment and Conservation Council (ANZECC) Interim Sediment Quality Guidelines (ISQG).

The metal contaminants of copper, lead and zinc were detected at concentrations below the low effects threshold concentrations (Table 4). However, elevated levels of the HMW PAHs in the Western and Central transects were detected. Concentrations were within the ARC ERC Amber threshold range, but below the ISQG Low threshold (Table 4).

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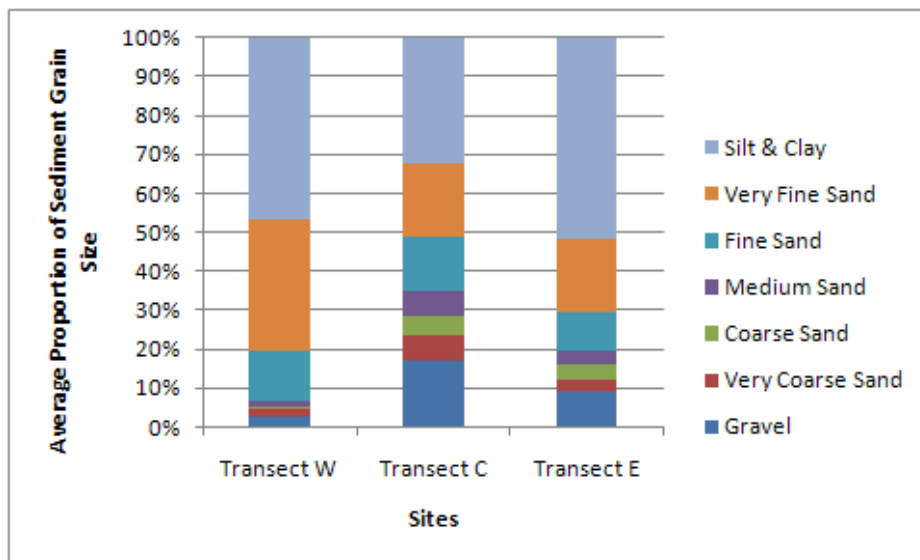
Table 4: Intertidal Sediment Quality Data.

	Transect W	Transect C	Transect E	ARC ERC Green	ARC ERC Amber	ISQG Low
Copper (mg/kg dry wt)	9.8	12	9.7	<19	19-34	65
Lead (mg/kg dry wt)	10.2	19.3	14.1	<30	30-50	50
Zinc (mg/kg dry wt)	50	70	72	<124	124-150	200
HMW PAHs (mg/kg dry wt)	0.757	1.349	0.157	<0.66	0.66-1.7	1.7
Total PAHs (mg/kg dry wt)	1.21	2.28	0.27	n/a	n/a	4

3.5.1.2.2 *Sediment Grain Size*

The results of the grain size analyses are given in Appendix 5. Composite samples analysed for sediment grain size showed a variety of size classes present across all transects. The average proportion of sediment grain size was comprised mostly of smaller sizes (fine sand to silt and clay (250µm - <63µm)). The average proportion of surface sediment grain size was dominated across all sites by silt and clay (Figure 4 and Table 5). Transect W revealed the highest proportions of fine sand through to silt and clay with < 10% consisting of coarse sand through to gravel. Transect C contained the highest proportion of gravel (17.2 %) and the lowest proportion of silt and clay (32.1%). Transect E revealed the highest proportion of silt and clay (51.6%).

Figure 4: Intertidal Surface Sediment Grain Size Composition.



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Table 5: Mean Intertidal Surface Sediment Grain Size.

	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt & Clay
	>2mm	<2mm & >1mm	<1mm & >500µm	<500µm & >250µm	<250µm & >125µm	<125µm & >63µm	<63µm
Transect W	2.9	1.7	0.8	1.2	12.8	34.1	46.5
Transect C	17.2	6.4	4.8	6.5	14.1	18.9	32.1
Transect E	8.9	3.3	3.8	3.4	10.3	18.8	51.6

3.5.1.3 Summary of Marine Ecological Value at Pump Station 23 (AS6)

The marine habitat at Pump Station 23 (AS6) is considered to have moderate to high ecological value based on the criteria / characteristics of Table 6 below (developed by Boffa Miskell). The following characteristics were considered to be relevant:

- Benthic invertebrate community typically highly diverse with high species richness.
- Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present.
- Marine sediments typically comprise <50% silt and clay grain sizes.
- Contaminant concentrations in sediment rarely exceed low effects threshold concentrations.
- Habitat modification limited.

Table 6: Characteristics of Estuarine Site with Low, Moderate and High Ecological Values.

ECOLOGICAL VALUE	CHARACTERISTICS
LOW	<ul style="list-style-type: none"> • Benthic invertebrate community degraded with low species richness and diversity. • Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with few/no sensitive taxa present. • Marine sediments dominated by silt and clay grain sizes. • Elevated contaminant concentrations in surface sediment, above ISQG-high or ARC-red effects threshold concentrations¹. • Invasive, opportunistic and disturbance tolerant species dominant. • Habitat highly modified.

¹ ANZECC (2000) Interim Sediment Quality Guideline (ISQG) High contaminant threshold concentrations or Auckland Regional Council's Environmental Response Criteria Red contaminant threshold concentrations (ARC, 2004).

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ECOLOGICAL VALUE	CHARACTERISTICS
MODERATE	<ul style="list-style-type: none"> • Benthic invertebrate community typically has moderate species richness and diversity. • Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present. • Marine sediments typically comprise approximately 50-70% silt and clay grain sizes. • Contaminant concentrations in surface sediment generally below ISQG-high or ARC-red effects threshold concentrations. • Few invasive opportunistic and disturbance tolerant species present. • Habitat modification limited.
HIGH	<ul style="list-style-type: none"> • Benthic invertebrate community typically highly diverse with high species richness. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud. • Marine sediments typically comprise <50% silt and clay grain sizes. • Contaminant concentrations in surface sediment rarely exceed low effects threshold concentrations. • Habitat largely unmodified.

3.5.2 Mangere Pump Station (WS3)

In relation to the Mangere Pump Station (WS3) site, as noted earlier the footprint at this site includes the construction of an Emergency Pressure Relief Pipeline, which will have its outlet just below the line of MHWS. This outlet will include a headwall and scour protection, with a total footprint in the order of 150m².

No quantitative investigations were undertaken at this site. This was in recognition that the proposed works here are very small in size, involve minimal intrusion into the intertidal area, will be carried out at low tide, will include appropriate sediment control devices and involve an area that has only recently been rehabilitated from its previous use as part of the Mangere WWTP oxidation ponds.

Notwithstanding the above, a qualitative survey was undertaken, with the site being visited and the general habitat visually inspected. The findings demonstrated that the area within the outlet footprint was entirely typical of the surrounding intertidal mudflats, being characterised by an abundance of mud snails together with numerous mud crab burrows.

3.6 Summary of Ecological Values

A summary of the ecological values within the construction footprints is given in Table 7.

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Table 7 : Summary of Ecological Values at Each Construction Site

Site	Name	Habitat Within Construction Footprint	Veg Values	Bird Values	Lizard Values	Marine Values	Overall Values
WS1	Western Springs	Grass with a few exotic trees	Nil	Low	Low	n/a	Low
AS1	Mt Albert Reserve	Grass with mature flax clump plantings	Low	Moderate-Low	Low*	n/a	Moderate-Low
AS2	Lyon Avenue	Mainly native bush (mature plantings)	Moderate	Moderate	Low*	n/a	Moderate
AS3	Haverstock Road	Grass with cabbage tree mass plantings	Low	Low	Low	n/a	Low
AS4	Walmsley Park	Grass with a few exotic trees & shrubs + low plantings	Low	Low	Low	n/a	Low
WS2	May Road	Overgrown weedfield + a few exotic trees	Low	Low	Low*	n/a	Low
AS5	Keith Hay Park	Homestead, grass + ornamental trees	Low	Low	Low	n/a	Low
AS6	Pump Station 23	Planted shrubland, coastal forest + coastal mudflats/reef	Moderate	Moderate-High	High	Moderate-High	Moderate-High
AS7[a]	Kiwi Esplanade	Grass + planted pohutukawa + coastal edge	Low	Moderate-High ²	Low	n/a	Moderate-High
AS7[b]	Ambury Park	Grass with adjacent planted trees & shrubs	Low	Low	Low	n/a	Low
WS3	Mangere Pump Station	Grass + a few gums + planted shrublands + coastal edge	Low	Low	Low	Low	Low
L1S1	Motions Road	Grass + native shrub plantings	Low	Low	Low*	n/a	Low
L1S2	Western Springs Depot	Yard with some pines	Low	Low	Low	n/a	Low
L2S1	Rawalpindi Reserve	Grass with some flax and exotic trees	Low	Low	Low	n/a	Low
L2S2	Norgrove Avenue	Pavement + grass + plantings + exotic treeland	Low	Low	Low	n/a	Low
L3S1	Pump Station 25	Weedy native bush + plantings + grass	Moderate	Moderate	Moderate-High	n/a	Moderate-High
L3S2	Miranda Reserve	Grass + children's playground	Nil	Nil	Nil	n/a	Nil
L3S3*	Whitney Street	Grassed road-side verge	Low	Low	Low	n/a	Low
L3S4	Dundale Avenue	Grass + native plantings + adjacent manuka shrublands	Low	Low	Low	n/a	Low
L3S5*	Haycock Avenue	Homestead + mature exotic tree	Low	Low	Low	n/a	Low

* - These sites scored Low based on the results of the field investigations, but they are nevertheless still considered to be potential lizard habitats based upon their apparently suitable habitat features

² NZ Pied Oystercatcher split their time each year between the North and South Islands (where they breed). From late December until July the open fields of Kiwi Esplanade in the vicinity of site AS7 are an important high tide roost for this species, along with adjacent areas of Kiwi Esplanade to the immediate east and west – the ranking given applies to this period of each year only.

4.0 ASSESSMENT OF ECOLOGICAL EFFECTS

4.1 Terrestrial Effects

4.1.1 Clearance of Vegetation

The removal of indigenous vegetation may result in direct adverse ecological effects in a number of ways. Firstly, it may result in the removal of particularly representative vegetation types. Secondly, it reduces the overall size of a habitat, and if large enough this may affect the carrying capacity and functionality of that habitat. However, there are two important factors to consider when addressing the issue of vegetation clearance in relation to the magnitude of adverse effects, being:

- (i) the type of vegetation to be cleared (i.e. what is its conservation value);
- (ii) the extent of the clearance (i.e. how much is going to be removed); and
- (iii) the context of the vegetation (i.e. whether the clearance affects a buffer or a corridor).

In relation to the construction footprints associated with the Project, a large proportion of the land is located within public reserves that are dominated by a cover of mown grass (e.g. Western Springs [WS1]). Such areas have no botanical conservation value.

In a few instances the mown grass cover within the construction footprints is complemented by planted strips of low growing vegetation and/or specimen native trees and/or ornamental or naturally established exotic trees. Planted strips include the sizeable flax beds present at Mt Albert War Memorial Reserve (AS1). Flax is also present as isolated clumps at Rawalpindi Reserve (L2S1), and mature willows and a Norfolk Island pine are also within the construction access corridor at this site. Mown grass with semi-mature native plantings, mature willows and other exotic trees are present at Norgrove Avenue (L2S2). Mown grass together with several semi-mature planted pohutukawa are present at Kiwi Esplanade (AS6), mown grass with adjacent planted native trees and shrubs are located at Ambury Park (AS7[b]), mown grass and a few young native trees are present at Dundale Avenue (L3S4), mown grass and a children's playground are found at Miranda Reserve (L3S2) and a homestead with mown grass and garden trees (predominantly exotic) are found at Keith Hay Park (AS5). Mown grass, a few gums and a coastal strip of planted native shrublands are present at Mangere Pump Station (WS3), mown grass and a few cassarina and acmena (together with young planted native trees) and a planted strip of carex sedges, oioi and toetoe are found at Walmsley Park (AS4), and a homestead garden with a mature liquid amber tree is present at Haycock Avenue (L4S1). Additionally, a "plantation" of cabbage trees is present along with mown grass within the construction footprint at Haverstock Road (AS3). May Road (WS2) supports a cover of kikuyu grass and rank overgrown weedfields, and Whitney Street (L3S3) is a grassed road-side verge.

It is considered that the loss of any vegetation within the construction footprints at those sites listed above would constitute either minor or less than minor adverse effects on vegetation and botanical conservation values. Only 3 sites support a cover (or at least partial cover) of bush, with these being Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1). As discussed earlier, some of this bush appears to be the result of historic (now mature or semi-mature) plantings of (mainly) native tree species (in particular at Lyon Avenue [AS2]).

The extent of vegetation within the construction footprint at Lyon Avenue (AS2) is relatively large, measuring in the order of 4,500m² (although this is not entirely comprised of canopy trees but includes open areas supporting ground cover only, together with a small amount of existing pavement). The site is part of a larger vegetated riparian area of Meola Creek running alongside Mt Albert Grammar School and the St Luke's Mega Centre. However, the creek is piped both upstream and downstream of this site, and the riparian vegetation ceases at the mouths of those pipes.

While the Lyon Avenue (AS2) construction footprint is confined to the eastern side of the creek (leaving the mature trees on the western bank intact), it occupies a relatively sizeable portion of the wider area of vegetation here, being in the rough order of 10%. In the worst-case (and unlikely) scenario that all vegetation within the construction yard fence was to be cleared, this would constitute an adverse effect on vegetation of a greater than minor nature which would need to be mitigated. Indeed, the clearance of vegetation from even part of the construction footprint at this locality would need to be mitigated.

The shrublands growing along the eastern margins of the access road down to Pump Station 23 (AS6) are relatively mature. While quite weedy, they nevertheless retain some coherency and are well connected to the coastal forest of Hillsborough Bay. Notwithstanding this however, while these shrublands are included within the boundary of the construction yard here, given that the vegetation occupies a steep bank and that an access road already exists down to the pump station, it is considered unlikely that the vegetation will be greatly affected by any works here, with the exception of the proposed water treatment plant and the air treatment facility (which have their footprint in the middle of the shrublands). Any effects associated with this area are more likely to be associated with the intertidal zone (via the temporary construction platform), although some of the more mature shrubs/trees at the coastal edge may also be affected by the proposed access shaft. Notwithstanding the above, damage or loss of vegetation at this site is likely to constitute an adverse effect of a greater than minor nature (depending on the extent of any loss or damage) and would need to be mitigated.

The construction yard at Pump Station 25 (L3S1) includes both mown grass and mature (and semi-mature) bush. The quality of this bush is not particularly high, with the canopy being somewhat patchy, and with a high degree of weed infestation in the understorey and ground tier. There are a few large native trees within the construction footprint, with the largest being ngaio and kohuhu (all planted) together with a few mahoe and mamaku. The extent of vegetation within the construction footprint is in the order of 1,500m², although the amount of bush within the Watercare designation here is around double that. Notwithstanding the weed issues that confront this bush area, the loss of vegetation here as a result of the Project is considered to be an adverse effect of a greater than minor nature. Other considerations in relation to this bush area (such as its contribution to ecological corridors) are considered separately below.

4.1.2 Loss of Significant ('Threatened' and 'At Risk') Species of Flora

While it is generally more important to focus assessments of ecological effects on habitats, communities and wider ecosystems rather than on individual specimens, in some circumstances individuals may be worthy of attention. This would be the case in particular where they were locally rare or nationally 'threatened' or 'at risk' species, or particularly notable specimen native trees. In relation to the Project Area however, no 'threatened' or 'at risk' species of flora, nor particularly notable specimen native trees, were observed to be present.

4.1.3 Increase in the Extent of Edge Effects

Edge effects occur where vegetation clearance creates new edges. They refer to the differences in micro-climatic conditions as well as vegetation composition that exist between forest margins and forest interior. These micro-climatic variables are generally those associated with air temperature, solar radiation, relative humidity and wind. Modifications to these variables can dramatically alter the natural processes and species composition of habitat-interiors.

Modifications to existing edges may be important when edge effects reduce the extent of habitat-interior conditions, but is not such a significant issue where the areas to be affected are already characterised by edge processes. In this regard it is known from scientific studies that edge effects can penetrate up to 50m into Northland forest habitats, on all sides (Young & Mitchell, 1994; Davies-Colley *et al.*, 2000). Hence, habitats that are less than 100m in width are generally dominated by edge effects and processes, and contain little if any habitat “interior” conditions.

In relation to the Project Area, all of the vegetation is already compromised by edge effects (including the 3 stands of coherent bush – Lyon Avenue [AS2], Pump Station 23 [AS6] and Pump Station 25 [L3S1]). Indeed, edge effects presently exert an influence within all of the larger vegetated blocks that these three sites are a part of (i.e. edge effects are not simply confined solely to those portions of these wider forested areas that are located within the construction footprints). Given this, it is considered that the creation of new edges and their attendant adverse effects will not be a significant issue in relation to the Project.

4.1.4 Habitat Fragmentation and Loss of Ecological Corridors

Vegetation clearance may also result in the fragmentation of habitats, which creates a physical barrier that reduces existing flows of species, individuals, genes, nutrients or energy. Habitat fragmentation is an important effect for nature conservation if it leads to reductions in the long-term survival of some of the species present on either side of the barrier, or to their ability to respond to changing conditions. Overall, with fragmentation the resilience of the ecosystem and populations is reduced.

In relation to the Project Area, an obvious existing ecological corridor is that which is associated with Pump Station 25 (L3S1). This bush is part of a far larger corridor that stretches from the Whau River in the west through to the Maungakiekie Golf Course in the east³. While the width and coherency of this ecological corridor decreases in an easterly direction, at Miranda Reserve (where Pump Station 25 (L3S1) is located) it is generally at its widest, being in the order of 40m (and being present on both sides of the stream). The construction footprint for Pump Station 25 (L3S1), at its widest point, intrudes some 25m into this bush and comes in close proximity to the stream here. While this level of disturbance diminishes to some degree in the operational phase of the Project there will nevertheless be permanent structures that would continue to occupy space here, resulting in a permanent (albeit small) reduction in corridor width. It is considered that both the temporary effects and permanent effects of the Project works at this site constitute adverse effects on the corridor that are greater than minor, and these effects need to be mitigated.

³ It is recognised that this corridor is truncated by Boundary Road to the east and by both the North Auckland Rail Line and Great North Road to the west, so is not in a pristine and fully connected condition. Nevertheless it retains at least some functionality.

In addition to Pump Station 25 (L3S1), another ecological connection exists at Pump Station 23 (AS6), which includes bush that is part of the vegetated coastal cliffs that run below Seacliffe Road in Hillsborough Bay. This site is also loosely connected to a large local network of contiguous forested reserves located to the west. However, given the existing infrastructure that is already present at this site (i.e. an access road, turning area and a pump station) the Project works proposed for this site are unlikely to alter the existing situation here in relation to ecological corridors or connectivity.

4.1.5 Avifauna Effects

Another potential adverse effect is that of disturbance to avifauna, by way of both direct impacts (e.g. loss or degradation of habitat) and indirect impacts (e.g. effective loss of habitat as a result of noise). The magnitude of these adverse effects are proportional to the rarity of the species concerned as well as to the extent of habitat affected compared to that which remains unaffected.

In relation to the Project Area, the only “At Risk” birds were all restricted to the intertidal mudflats of Hillsborough Bay opposite Pump Station 23 (AS6), the shallow waters of the Manukau Harbour foreshore adjacent to Kiwi Esplanade (AS7[a]), and the open grasslands of that same reserve. The species concerned were red-billed gull, NZ pied oystercatcher, variable oystercatcher, little black shag and pied stilt. In relation to the Kiwi Esplanade (AS7[a]) site, it is noted that shore birds were not consistently utilising the area in the immediate vicinity of the construction footprint, and indeed on some of the surveys undertaken at that site the roosting flocks were found only on the open fields to the east of the toilet block access road. The fact that cars routinely utilise this road and associated car-park suggest that construction noise is unlikely to be an issue here. In addition, it is further noted that ample roosting habitat will continue to exist in the general area well outside of the construction footprint (including at the neighbouring Ambury Park), to the extent that the Project is very unlikely to result in adverse effects upon these roosting birds. Furthermore, in relation to works closest to the high tide roosts at Kiwi Esplanade (AS7[a]), the potentially most disruptive of these activities could probably be programmed to occur within the period when shore bird numbers present here are at their annual lowest (i.e. August through to early December).

In relation to the other (non-coastal) mown or grazed fields that comprise a sizeable portion of the construction footprints (e.g. Western Springs [WS1], Mt Albert War Memorial Reserve [AS1], Walmsley Park [AS4], Motions Road [L1S1] and Rawalpindi Reserve [L2S1]), while these may be utilised by birds for feeding purposes and, in some instances, as loafing areas (especially for waterfowl), there would remain ample similar habitat outside of the construction footprints at each location, and the loss of such land cover is considered to be an adverse avifauna effect of less than minor significance.

The only areas where vegetation loss may possibly have some noticeable adverse effects in relation to avifauna are at the three bush sites. However, it is noteworthy that the majority of the bird species utilising these areas are introduced passerines, and that (in general) numbers of all species observed here were low. Additionally, the extent of bush loss is relatively small, especially with regard to Pump Station 23 (AS6), at least within the context of the wider coastal forest of Hillsborough Bay which it is functionally connected to. The affected bush area is also relatively small at Pump Station 25 (L3S1), at least in the context of the vegetated corridor of which it is a part. It is considered that ample alternative bush habitat is available at both of these sites to the extent that the effects of the Project upon avifauna would be less than minor.

The effects on bush birds resident or utilising Lyon Avenue (AS2) have the potential to be somewhat more pronounced however. This is due to the smaller size of the wider bush area here (compared to that of the wider bush areas associated with Pump Station 23 [AS6] and Pump Station 25 [L3S1]), together with the fact that the construction footprint encompasses a sizeable portion of this wider bush area. Notwithstanding this however, the only native birds observed to be present here were fantail and silvereye, and these are quite common in urban landscapes. While some displacement of resident birds (including native) may occur at Lyon Avenue (AS2) as a result of the Project construction works here, it is likely that these effects would be minor.

While highly mobile when fledged, native bush bird chicks and eggs in nests are vulnerable to loss if their nest is within vegetation that is to be cleared. This effect can be avoided by restricting clearance outside of the main breeding seasons of native bush birds. Notwithstanding this however, it is noted that none of the native bush birds observed to be present within the construction footprints are “At Risk” (indeed, they are all very common species), and the effects associated with the loss of a few nests (at worst) would be less than minor.

In relation to the two options for the location of site AS7 (i.e. Kiwi Esplanade (AS7[a]) and Ambury Park (AS7[b])), it is considered that any potential adverse effects could be readily managed at the former site (i.e. AS7[a]), and that there would be few issues (if any at all) in relation to the latter site (i.e. AS7[b]). Hence, it is considered that the Kiwi Esplanade (AS7[a]) option is likely to result in only minor effects (at worst) while the Ambury Park (AS7[b]) option is likely to result in less than minor effects.

4.1.6 Herpetofauna Effects

Potential disturbance to lizards would be by way of both direct impacts (eg. loss or degradation of habitat) and indirect impacts (e.g. effective loss of habitat as a result of noise).

No geckos were observed to be present within the Project Area, despite intensive searches in all areas of likely habitat within the five construction footprints that were searched. Two species of skink were found, being copper skink (at 1 site [Pump Station 25 - L3S1] in low numbers) and ornate skink (at 1 site [Pump Station 23 - AS6] and in low numbers). An introduced (and pest) lizard species was also observed to be present, being Rainbow skink (seen at 3 places (being May Road [WS2], Lyon Avenue [AS2] and Mt Albert War Memorial reserve [AS1], and being present in abundance at the former two sites).

Given that all species of native lizard are protected pursuant to the Wildlife Act 1953, and that ornate skink is an “At Risk – Declining” species, the potential effects on the individuals resident within the construction footprints and their wider environs poses something of an issue, and one that requires an appropriate form of mitigation in response. It is considered that the appropriate response would be to undertake a “salvage” (or rescue) operation immediately prior to any vegetation clearance at the sites where their presence has been confirmed. This is discussed in more detail in Section 5 (Mitigation). It would also be advisable to extend such a salvage operation to include other areas that were specifically surveyed for skinks via ACO’s (due to their apparent potential habitat suitability) but where no skinks were found, given that an absence in survey results is not always a guarantee of actual absence from a site. These sites are Mt Albert War Memorial Reserve (AS1), Lyon Avenue (AS2), May Road (WS2) and Motions Road (L1S1).

The general absence of particularly suitable habitat for arboreal geckos within the construction footprints (and the absence of any observations of these species over the course of the survey work) suggests that this group of herpetofauna are not likely to be actually present at most of the sites – as a result salvage operations are recommended only at those sites where nocturnal surveys were conducted (due to their apparent potential habitat suitability). These sites are restricted to Lyon Avenue (AS2), Pump Station 23 (AS6), Motions Road (L1S1) and Pump Station 25 (L3S1). While a nocturnal survey was undertaken at Dundale Avenue it is noted that the construction footprint here is away from the planted tea-tree that was searched, and consequently no salvage operation is necessary at this site.

Provided that comprehensive and well managed salvage operations (in line with the recommended methods in Section 5.2) are implemented then it is concluded that any adverse effects on native lizards as a result of the Project are unlikely to be more than minor.

4.2 Freshwater Effects

The Project has a construction phase requirement for earthworks. While the majority of this work will be underground in bored tunnels, surface earthworks will occur within each of the construction footprints. Additionally, at three sites there will be spoil storage areas (i.e. Western Springs [WS1], May Road [WS2] and Mangere Pump Station [WS3]). Earthworks have attendant risks in relation to the potential for elevated levels of sediment entering streams and water courses.

While four of the construction footprints are well away from natural watercourses or stormwater overland flow paths (i.e. Western Springs [WS1], Mt Albert War Memorial Reserve [AS1], Whitney Street [L3S3] and Haycock Avenue [L4S1]), the remainder are all in relatively close proximity to either streams or the coast. Given this, should accidents involving sediment occur then that sediment is likely to end up in streams or coastal waters.

Notwithstanding the above, it is noted that the degree of earthworks within each construction footprint is relatively small and contained, and the three spoil storage areas are likewise all relatively small. Additionally, almost without exception the terrain involved is flat, and there is ample space available for the installation of appropriate sediment control measures. Provided that the appropriate erosion and sediment controls are implemented (such as compliance with the ARC TP90), it is considered unlikely that any significant spills involving sediment will occur.

4.3 Estuarine Effects

As noted earlier in section 2.5, quantitative field investigations were undertaken in the estuarine environment at Pump Station 23 (AS6) where a temporary construction platform is proposed to be built within the CMA. The works in the CMA associated with Pump Station 23 (AS6) involve construction of a temporary construction platform and disturbance of an area of approximately 1,200m² in order to excavate and support a 28 m deep and 7 m diameter access shaft and a 18 m deep and 5 m diameter dropshaft, to excavate other areas for underground permanent works, to connect pipes and tunnels, to construct an Air Treatment Facility and to construct an above ground air vent. An area of CMA will also be occupied at significant depth by connecting pipes and tunnels, but given that marine organisms typically do not inhabit a depth greater than 0.5 m, this is not considered to be an adverse effect.

4.3.1 Pump Station 23 (AS6)

4.3.1.1 Invertebrates

The temporary construction platform and site disturbance will result in the mortality of invertebrates (none of which are rare or threatened) within an area of approximately 1,200m². While the temporary construction platform will smother all organisms and create anoxic sediment characteristics, once it is removed it is considered that in the long term the area will be recolonised by common intertidal invertebrates, and the sediment will become more oxygenated through bioturbation and other natural biological and chemical processes.

It is considered that the temporary habitat loss associated with the temporary construction platform comprises a moderate (and temporary only) adverse effect. Provided appropriate erosion and sediment control measures are established on site and spoil is not placed within the CMA (outside of the area of the temporary construction platform) disturbance and habitat loss should be restricted to the areas stated above.

4.3.1.2 Sediment

As noted above, the marine sediment beneath the temporary construction platform will become anoxic, but is expected to recover in the long term once the structure is removed. The concentration of common stormwater metals in the sediment was low, but HMW PAHs were detected above low effect threshold concentrations. Even though the PAHs were only marginally elevated, it remains important that robust erosion and sediment control measures are put in place to prevent the remobilisation of sediment. In addition, any spoil excavated to facilitate the temporary construction platform should be disposed of to land at an approved facility.

In order to encourage the recolonisation of the area affected by the temporary construction platform it may be necessary to reinstate the site with clean marine sediment of an appropriate grain size (i.e. fine to very fine sand).

It is considered that the adverse effects of the Project on marine sediment are moderate but temporary.

4.3.2 Mangere Pump Station (WS3)

At the only other area where works in the CMA are proposed (i.e. at Mangere Pump Station (WS3) where the outlet of an Emergency Pressure Relief Pipeline is proposed, including a headwall and scour protection), qualitative investigations (rather than quantitative surveys) were undertaken. The investigations identified that the affected area was very typical of the surrounding mudflats and was characterised by mud snails together with some mud crab burrow.

It was concluded that adverse ecological effects at this location as a result of the proposed works would be less than minor (or minor at worst), given the type of habitat that would be affected as well as the fact that the proposed works are very small in size, involve minimal intrusion into the intertidal area, will be carried out predominantly at low tide, will include all appropriate sediment control devices and are restricted to an area that has only recently been rehabilitated from its previous use as part of the oxidation ponds associated with the Mangere WWTP.

4.4 Summary of Ecological Effects

Table 8 below summarises the effects assessment in relation to the loss of vegetation and habitat within the construction footprints. The proposed construction works will have a greater than minor ecological effect at only three sites, with their respective issues being as follows:

Lyon Avenue (AS2)

- Loss of indigenous vegetation (including riparian vegetation).

Pump Station 23 (AS6)

- Loss of indigenous vegetation;
- Loss of habitat for “At Risk” lizard species (ornate skink);
- Loss of intertidal habitat (both soft-bottom and rocky reef);
- Loss of intertidal feeding habitat for shorebirds, including “At Risk” species.

Pump Station 25 (L3S1)

- Loss of indigenous vegetation (including riparian vegetation);
- Impacts on existing ecological corridor;
- Loss of habitat for native lizard species (copper skink).

5.0 MITIGATION

As summarised in the preceding section, it is considered that the proposed construction works will have a greater than minor ecological effect at only three sites, being Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1). These effects have been predicted to be of moderate significance, and as such they can be appropriately mitigated. The proposed mitigation is described below.

5.1 Loss of Indigenous Vegetation and Impacts on Existing Ecological Corridors

The most appropriate means of mitigation for the effects of loss of indigenous vegetation are to minimise the extent that is cleared and to replace that which must be cleared. Minimising the extent of clearance would involve keeping the actual construction footprints as small as practicable, retaining all woody vegetation that lies within the construction footprints but is not in the way of any of the proposed site facilities, and configuring the access roads and site facilities in such a way as to avoid (as far as practicable) large trees and other significant woody vegetation.

Replacing the vegetation that will be lost would entail revegetating the construction footprints at the cessation of the construction period, less that land which will be occupied by any permanent (operational phase) structures and facilities. While this approach is standard “best practice”, it is noted that it does not result in the replacement of “like with like”, principally due to the fact that the vegetation lost would be more mature (and contributing a greater degree of ecosystem services) than the vegetation that would be planted in its place (at least in the first instance).

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ASSESSMENT OF ECOLOGICAL EFFECTS

Table 8 : Summary of Ecological Values and Effects

Site	Name	Habitat Type Within the Construction Footprint	Ecological Values	Overall Ecological Effects
WS1	Western Springs	Grass with a few exotic trees	Low	Less than minor
AS1	Mt Albert Reserve	Grass with mature flax clump plantings	Moderate-Low	Minor
AS2	Lyon Avenue	Mainly native bush (mature plantings)	Moderate	Greater than minor (needing mitigation)
AS3	Haverstock Road	Grass with cabbage tree mass plantings	Low	Less than minor
AS4	Walmsley Park	Grass with a few exotic trees & shrubs + low plantings	Low	Less than minor
WS2	May Road	Overgrown weedfield + a few trees	Low	Less than minor
AS5	Keith Hay Park	Homestead, grass + ornamental trees	Low	Less than minor
AS6	Pump Station 23	Planted shrubland, coastal forest + coastal mudflats/reef	Moderate-High	Greater than minor (needing mitigation)
AS7[a]	Kiwi Esplanade	Grass + planted pohutukawa + coastal edge	Moderate-High	Minor ⁴
AS7[b]	Ambury Park	Grass with adjacent planted trees & shrubs	Low	Less than Minor
WS3	Mangere Pump Station	Grass + a few gums + planted shrublands + coastal edge	Low	Less than minor
L1S1	Motions Road	Grass + native shrub plantings	Low	Less than minor
L1S2	Western Springs Depot	Yard with some pines	Low	Less than minor
L2S1	Rawalpindi Reserve	Grass with some flax and exotic trees	Low	Less than minor
L2S2	Norgrove Avenue	Pavement + grass + plantings + exotic treeland	Low	Less than minor
L3S1	Pump Station 25	Weedy native bush + plantings + grass	Moderate-High	Greater than minor (needing mitigation)
L3S2	Miranda Reserve	Grass + children's playground	Nil	Nil
L3S3	Whitney Street	Grassed road-side verge	Low	Less than minor
L3S4	Dundale Avenue	Grass + native plantings + adjacent manuka shrublands	Low	Less than minor
L3S5	Haycock Avenue	Homestead + mature exotic tree	Low	Less than minor

⁴ Between December and July each year large numbers of shore birds roost at high tide in Kiwi Esplanade Reserve in close proximity to the proposed works at AS7 (especially NZ Pied Oystercatcher). However, the main roosting site is located to the east of the toilet block car park, which will not be directly affected by the Project works. Furthermore, undertaking the potentially most disruptive works outside of the peak shore bird season is likely to reduce any potential adverse effects on shore birds here to minor levels only.

Notwithstanding this, it is possible to include additional measures which would, at least in part, off-set this difference. These measures would include foremost the planting of a larger area than that which is cleared – in this regard however, it is noted that there exists no established tool or mechanism for calculating a ratio for area of clearance versus area of replacement planting, and hence the only “rule of thumb” is that the area of planting needs to be well in excess of the area of clearance. On this point however, it needs to be recognised that the permission of the landowner would be required in relation to the extent of any new plantings (being Auckland Council in relation to Pump Station 25 [L3S1] and the Crown in relation to Lyon Avenue [AS2]), and that in the case of Pump Station 25 (L3S1) the construction site is located within a reserve where there is likely to be at least equal demand for public open space. Conversely, the ownership of Pump Station 23 (AS6) is with Watercare and hence the extent of any replacement plantings here is not reliant on any third party.

The most likely way forward in this regard is to enter into discussions with the relevant landowners (i.e. Council and the Crown) and attempt to reach agreement on the exact extent of replacement plantings that would be appropriate to be undertaken at each of the two sites that they control.

Another option in relation to off-setting the absence of a “like for like” vegetation replacement would be to undertake enhancement works in the three areas of bush surrounding the construction sites at Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1). The enhancement works should focus on two primary things, being firstly weed control and secondly in-fill planting. Weed control should focus on the wider area concerned as far as is practicable, given that any weeds that are left will simply encroach in again over time.

In-fill planting refers to targeting areas within existing stands of bush that are presently sparse in terms of either their canopy, mid-tier or ground cover, and then planting directly into these areas. The species planted would depend on the objectives of the in-fill planting, but would need to be “fit-for-purpose” (i.e. be hardy, normally occupy the tier they are being used to bolster, be at an appropriate size and be planted at an appropriate density).

Another possible form of mitigation would be the implementation of a pest control operation (in collaboration with any programmes already being undertaken by the landowner). This may in fact be necessary if rabbits (for instance) are present in any of the sites in question (since they would simply eat the young planted material). In such an instance a period of time involving multiple pest control operations may be necessary, to allow the plantings to reach a size where they would be reasonably safe from rabbits – this could be for up to 2 or more years, depending on the size of the plants when they are first planted. Additional pests that could also be targeted could potentially include predators such as rats and mustelids (i.e. stoats and weasels). However, this would be unlikely to benefit the existing vegetation (although it is noted rats do eat seeds), but may provide a respite for the local native wildlife, especially lizards and birds. This is discussed further in section 5.2 below.

It is recommended that a condition of the Central Interceptor designation require the preparation of a Site Reinstatement Plan for the three sites in question (i.e. Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1)). This Plan should include detail on the extent of the area that is to be revegetated, the extent of the area that is to be in-fill planted, the mix of species to be used, the size and density of these plants, and the extent of the area to be subject to weed and pest / predator control.

5.2 Loss of Habitat for Native Lizard Species

Effective management of lizard populations would involve salvaging the resident populations before vegetation clearance occurs at sites where skinks have been detected (or where their presence is considered to be potentially likely despite no records), as well as implementing appropriate relocation strategies prior to their release (primarily habitat enhancement and pest management). The sites in question are Pump Station 23 (AS6) and Pump Station 25 (L3S1) (where skinks were found), as well as Mt Albert War Memorial Reserve (AS1), Lyon Avenue (AS2), May Road (WS2) and Motions Road (L1S1) (where, despite no observations, habitat appears to be suitable). Salvage operations for native arboreal geckos should be undertaken at Lyon Avenue (AS2), Pump Station 23 (AS6), Motions Road (L1S1) and Pump Station 25 (L3S1) (due to their apparent potential habitat suitability).

The recommended approach is described below. Rainbow skinks encountered would be left onsite at all skink salvage sites, as they are considered to be a potential pest species by DOC.

5.2.1 *Salvage Site Management*

5.2.1.1 Installation of Silt Fences

Vegetation clearance contractors would be responsible for installing silt-fences that demarcate the construction footprint boundaries at the sites where skinks were recorded (or are potentially likely to be present). These fences will prevent salvaged lizards returning to the construction zones when released into the adjacent habitat. Contractors working in those areas should be advised that the silt-fencing demarcates works boundaries that should not be breached.

5.2.1.2 Pre-clearance Trapping

Following the installation of silt-fences, a pre-clearance trapping (salvage) operation would be undertaken prior to any other works commencing. This would incorporate intensive trapping of skinks (using ACO's), together with searches of selected vegetation patches providing suitable habitat for skinks (e.g. rank grass, pampas, bracken thickets etc) as well as searches of suitable shelter structures (such as dead wood and debris) by DOC permitted herpetologists. In relation to the salvage of geckos potentially within the fenced off areas, nocturnal searches using powerful torches to scan the shrubs and trees there-in should be undertaken on at least 2 occasions.

Salvaged lizards would be placed immediately into temporary containment boxes, with secure meshed lids to allow adequate ventilation. The boxes would need to be furnished with soil and leaf litter to provide cover during containment. Salvaged lizards would not be contained for more than 24 hours. The skinks should not be released into areas of herbicide spraying within 24 hours of spraying.

5.2.1.3 Vegetation Clearance

Controlled vegetation clearance by approved contractors would need to commence under the guidance of DOC permitted herpetologists. The vegetation clearance would involve the removal of all remaining vegetation within the works footprints via chainsaws for trees and machinery (e.g. tractor-mounted mulching heads) for lower shrub vegetation in a way that would facilitate herpetologists in salvaging any remaining lizards on site.

5.2.2 Release Sites

5.2.2.1 Adjacent Habitat

In all instances where suitable habitat for native lizards remains directly adjacent to the construction site, the salvaged lizards should be released immediately following capture into these undisturbed sites (i.e. outside of the construction footprint area contained within the silt fences).

5.2.2.2 Lizard Habitat Enhancement - Revegetation

In some instances it would be prudent to enhance the release-site habitats. While this can be effectively achieved by way of in-fill planting, it will take a while for any plantings to provide suitable lizard cover and resources (unless they are mass planted as large specimens at a very high density – which is an expensive option). A related issue in relation to plantings is that the use of mulch and woodchips (as a weed mat ground cover) is not appropriate in lizard habitats, as it does not provide appropriate or suitable habitat for them - it maintains open spaces between plants, and disrupts invertebrate food communities. Hence, while it may be appropriate to use woodchips or mulch surrounding the immediate base of newly planted vegetation, its widespread (“blanket”) application across in-fill planting areas is not appropriate.

5.2.2.3 Lizard Habitat Enhancement – Additional Refuges

An alternative and equally successful strategy to enhance lizard receptor sites would be to supply additional (new) lizard refuges. Additional refuges such as log piles, rocks, and log discs should be placed strategically throughout the lizard habitat to provide salvaged lizards refuge from predators.

5.2.2.4 Lizard Habitat Enhancement - Animal Pest Control

Another highly successful (and necessary) form of lizard habitat enhancement is the implementation of predator control within the release areas, to ensure that relocated lizards can successfully re-establish there. The chances of such re-establishment are greatly enhanced in the absence of predator pressure. Predator control operations would involve the installation of rodent bait stations within the lizard release sites, at least one month prior to their release there.

Predator control should be maintained on a monthly basis by refreshing the bait blocks in the bait stations. It is recommended that predator control continue at least until such time as the rescued lizards have become established within their new environment. This timeframe is estimated to be in the order of one year, after which time predator control may be terminated.

Predator control operations should be implemented and managed by a registered predator control provider.

5.3 Avifauna Effects

In relation to shore birds, programming the most disruptive works proposed at Kiwi Esplanade (AS7[a]) to take place outside of the peak shore bird season (i.e. undertake these works between August and early December) should reduce any potential adverse effects on those birds to minor levels (at worst).

Notwithstanding this however, it is emphasised that there is ample suitable alternative roosting habitat available in adjacent parts of Kiwi Esplanade to the east and west of the construction site here, as well as at coastal areas of the neighbouring Ambury Park. These areas would provide shore birds with an alternative place to roost at high tide should they be disturbed during construction activities at the Kiwi Esplanade (AS7[a]) site.

While highly mobile when fledged, native bush bird chicks and eggs in nests are vulnerable to loss if their nest is within vegetation that is to be cleared. This effect can be avoided by restricting clearance outside of the main breeding seasons of native bush birds, or alternatively by verifying (via field survey) that no nests of native birds are present prior to bush clearance. Notwithstanding this however, it is noted that none of the native bush birds observed to be present within the construction footprints are “At Risk” (indeed, they are all common species), and any inadvertent mortalities would constitute only a minor adverse effect (at worst).

5.4 Temporary Occupation of the CMA

In order to encourage the recolonisation of the intertidal area affected by the temporary construction platform it may be necessary to reinstate this area of CMA with clean marine sediment of an appropriate grain size (i.e. fine to very fine sand). The grain size distribution used is important, as more damage can be done to a habitat through the placement of inappropriate sized sediment. However, whether this would be necessary is best determined immediately following removal of the temporary construction platform, and would depend on the condition and state of the uncovered intertidal material.

6.0 CONCLUSIONS

As described earlier in Table 8, the proposed works within the Project’s construction footprints will have a greater than minor ecological effect at only three sites, being Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1). Depending upon the specific site, the ecological effects associated with these areas include the loss of indigenous vegetation (including riparian vegetation); impacts on existing ecological corridors; loss of habitat for native lizard species (including “At Risk” species); loss of intertidal habitat (both soft-bottom and rocky reef); and loss of intertidal feeding habitat for shorebirds, including “At Risk” species. Notwithstanding this, while it is considered that these effects are likely to be more than minor, they are not likely to be greater than moderate in terms of their gravity or significance. Given this it is considered that these effects can all be appropriately and sufficiently mitigated.

The principle form of mitigation recommended in relation to vegetation loss is revegetation (at a greater ratio to that which is lost) and/or enhancement of the three existing bush areas associated with Lyon Avenue (AS2), Pump Station 23 (AS6) and Pump Station 25 (L3S1).

The principle form of mitigation in relation to herpetofauna is to undertake a salvage and relocation operation in those areas where lizards were either directly observed to be present (i.e. Pump Station 23 [AS6] and Pump Station 25 [L3S1]) or where they are otherwise potentially likely to be present (i.e. even in those locations where the ACO and nocturnal surveys failed to find them – specifically Mt Albert War Memorial Reserve [AS1], Lyon Avenue [AS2], May Road [WS2] and Motions Road [L1S1]).

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Native bush bird chicks and eggs are vulnerable to loss if their nest is within vegetation that is to be cleared. This effect can be avoided by restricting clearance outside of the main breeding seasons of native birds. However, Watercare has advised that it may not be possible to time the proposed works to avoid this effect, so an alternative approach could entail verifying (via field survey) that no nests of native birds are present prior to bush clearance. Notwithstanding this however, it is noted that none of the native bush birds observed to be present within the construction footprints are “At Risk” (indeed, they are all very common species), and the effects associated with the loss of a few nests (at worst) would be less than minor.

In relation to shore birds, programming the most disruptive works proposed at Kiwi Esplanade (AS7[a]) to take place outside of the peak shore bird season (i.e. undertake these works between August and early December) should reduce any potential adverse effects on those birds to minor levels (at worst). Additionally, there is ample suitable alternative roosting habitat available in adjacent parts of Kiwi Esplanade to the east and west of the construction site here, as well as at coastal areas of the neighbouring Ambury Park, which would provide these birds with an alternative place to roost at high tide should they be disturbed during construction activities at the Kiwi Esplanade (AS7[a]) site.

Finally, if necessary, reinstatement of the temporary construction platform might require the importation and spreading of clean marine sediment of an appropriate grain size (i.e. fine to very fine sand). This would depend on the condition and state of the uncovered intertidal material.

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APPENDICES

CENTRAL INTERCEPTOR PROJECT
ASSESSMENT OF ECOLOGICAL EFFECTS

APPENDIX 1. FRESHWATER INFORMATION SOURCES

Oakley Creek Information Sources

Section	Habitat	Fish	Invertebrates	SEV	Water Quality	Sediment Quality
Great North Road - waterfall	BML 2001, 2003, 2008a; Suren 2001, 2005	BML 2001, 2003, 2008a; Suren 2001	BML 2001, 2003, 2008a; Suren 2001	BML (2010)	ARC 2010; Suren 2001, 2005	Suren 2005
Waterfall - New North Road	BML 2001, 2003, 2008a; Suren 2001, 2005; Bioresarches 1998, 1999	BML 2001, 2003, 2008a; Suren 2001; Bioresarches 1998, 1999	BML 2001, 2003, 2008a; Bioresarches 1998, 1999		Suren 2001, 2005; Bioresarches 1998	Suren 2005
New North Road - Richardson Road	BML 2001, 2003, 2008a; Suren 2001, 2005; Bioresarches 1998, 1999	BML 2001, 2003, 2008a; Allibone et al 2001; Suren 2001; Bioresarches 1998, 1999	BML 2001, 2003, 2008a; Allibone et al 2001; Bioresarches 1998, 1999	BML, 2009b	Suren 2001, 2005; Beca (unpub); Bioresarches 1998, 1999	Suren 2005; Beca (unpub)
Richardson Road - May Road	Suren 2001, 2005	Suren 2001	Suren 2001	-	Suren 2001, 2005	Suren 2005
May Road - Keith Hay Park	BML 2001, 2003, 2008a; Suren 2001, 2005	BML 2001, 2002, 2003, 2005, 2006, 2007, 2008a, 2009a; Suren 2001	BML 2001, 2002, 2003, 2005, 2006, 2007, 2008a, 2009a; Suren 2001		Suren 2001, 2005	Suren 2005
Headwater tributaries	BML 2001, 2003, 2008a; Suren 2001, 2005	BML 2001, 2002, 2003, 2005, 2006, 2007, 2008a, 2009a; Suren 2001	BML 2001, 2002, 2003, 2005, 2006, 2007, 2008a, 2009a; Suren 2001		Suren 2001, 2005	Suren 2005

Table 3 Meola Creek Information Sources

	Habitat	Fish	Invertebrates	SEV	Water Quality
Meola Creek	Bioresarches 1998; Suren 2001	Bioresarches 1998; Allibone et al 2001; FFDB records	Bioresarches 1998; Allibone et al 2001	-	Bioresarches 1998; Suren 2001

Table 4 Avondale/Whau Creek Information Sources

	Habitat	Fish	Invertebrates	SEV	Water Quality
Avondale/Whau Creek	BML 2010; BML 2011	BML 2010; BML 2011	BML 2010; BML 2011	BML 2010; BML 2011	

APPENDIX 2. INTERTIDAL SAMPLING LOCATIONS



APPENDIX 3. PHOTOGRAPHS OF ESTUARINE SAMPLING LOCATIONS



Plate 1: View of Hillsborough Bay from top of shore.



Plate 1: Site location looking east out into the estuary.



Plate 2: Site location looking back to shore.

CENTRAL INTERCEPTOR PROJECT
ASSESSMENT OF ECOLOGICAL EFFECTS



Plate 3: Seaward end of Western transect looking back to shore.



Plate 4: Intertidal benthic sediment – Western transect.



Plate 5: Seaward end of Central transect looking back to shore.



Plate 6: Intertidal benthic sediment along Central transect.

CENTRAL INTERCEPTOR PROJECT
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Plate 7: Seaward end of Eastern transect looking back to shore.

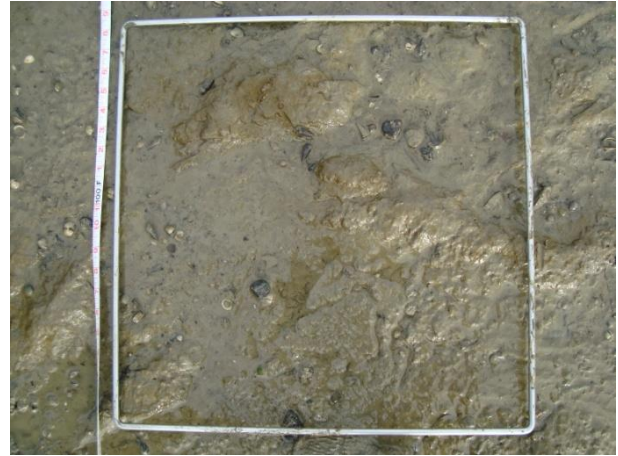


Plate 8: Intertidal benthic sediment along Eastern transect.



Plate 9: Small sandstone reef.



Plate 10: Close-up of sandstone reef showing *Zeacumanthus lutulentus* and green algae.

CENTRAL INTERCEPTOR PROJECT
ASSESSMENT OF ECOLOGICAL EFFECTS



Plate 11: Stormwater outlet leading out to estuary area.



Plate 12: Channel from stormwater outlet leading into the estuary.

APPENDIX 4. SEDIMENT QUALITY DATA



ANALYSIS REPORT

Client:	Boffa Miskell Limited	Lab No:	906574	SPV1
Contact:	S De Luca C/- Boffa Miskell Limited PO Box 13373 TAURANGA 3141	Date Registered:	17-Jun-2011	
		Date Reported:	01-Jul-2011	
		Quote No:		
		Order No:		
		Client Reference:	A08103B	
		Submitted By:	S De Luca	

Sample Type: Sediment

	Sample Name:	E 15-Jun-2011	W 15-Jun-2011	C 15-Jun-2011		
	Lab Number:	906574.1	906574.2	906574.3		
Individual Tests						
Dry Matter	g/100g as rcvd	72	75	73	-	-
Total Recoverable Copper	mg/kg dry wt	9.7	9.8	12.0	-	-
Total Recoverable Lead	mg/kg dry wt	14.1	10.2	19.3	-	-
Total Recoverable Zinc	mg/kg dry wt	72	50	70	-	-
Total Organic Carbon	g/100g dry wt	0.56	0.42	0.59	-	-
Polycyclic Aromatic Hydrocarbons Trace in Soil						
Acenaphthene	mg/kg dry wt	< 0.002	< 0.002	0.004	-	-
Acenaphthylene	mg/kg dry wt	< 0.002	< 0.002	0.003	-	-
Anthracene	mg/kg dry wt	< 0.002	0.004	0.014	-	-
Benzo[a]anthracene	mg/kg dry wt	0.013	0.052	0.132	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.013	0.047	0.137	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.018	0.064	0.181	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.013	0.040	0.112	-	-
Benzo[k]fluoranthene	mg/kg dry wt	0.008	0.029	0.075	-	-
Chrysene	mg/kg dry wt	0.011	0.040	0.102	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	0.003	0.010	0.030	-	-
Fluoranthene	mg/kg dry wt	0.023	0.087	0.195	-	-
Fluorene	mg/kg dry wt	< 0.002	< 0.002	0.003	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.010	0.036	0.100	-	-
Naphthalene	mg/kg dry wt	< 0.010	< 0.010	< 0.010	-	-
Phenanthrene	mg/kg dry wt	0.006	0.011	0.053	-	-
Pyrene	mg/kg dry wt	0.025	0.082	0.20	-	-

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Samples
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3
Polycyclic Aromatic Hydrocarbons Trace in Soil	Sonication extraction, SPE cleanup, GC-MS SIM analysis US EPA 8270C. Tested on as received sample	-	1-3
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550.	0.10 g/100g as rcvd	1-3
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.2 mg/kg dry wt	1-3



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Sediment			
Test	Method Description	Default Detection Limit	Samples
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.04 mg/kg dry wt	1-3
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.4 mg/kg dry wt	1-3
Total Organic Carbon	Acid pretreatment to remove carbonates if present, Elementar Combustion Analyser.	0.05 g/100g dry wt	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Martin Cowell - BSc (Chem)
Client Services Manager - Environmental Division

APPENDIX 5. SEDIMENT GRAIN SIZE DATA



CAWTHRON

Laboratory Report

Certificate of Analysis: Final

Cawthron Contract Number: 13182

Project Number: S71241

Boffa Miskell Ltd
PO Box 13373
Level 2, Gartshore House
116 Cameron Road
TAURANGA 3030

Attention: Dr Sharon DeLuca - Abbott

Customer Order No: A08103B
Email Recipients: Dr Sharon DeLuca - Abbott

Sample Details

Laboratory ID: S71241-1 **Sample Type:** Sediment **Date Sampled:** 15/06/2011 14:00
Description: Marine Sed **Date Received:** 18/06/2011 09:00
Customer ID: E

Analysis	Result	Units	Method
Gravel (>2mm)*	8.9	% w/w	In House Method
Very Coarse Sand (<2mm & >1mm)*	3.3	% w/w	In House Method
Coarse Sand (<1mm & >500µm)*	3.8	% w/w	In House Method
Medium Sand (<500µm & >250µm)*	3.4	% w/w	In House Method
Fine Sand (<250µm & >125µm)*	10.3	% w/w	In House Method
Very Fine Sand (<125µm & >63µm)*	18.8	% w/w	In House Method
Silt & Clay (<63µm)*	51.6	% w/w	In House Method

Sample Details

Laboratory ID: S71241-2 **Sample Type:** Sediment **Date Sampled:** 15/06/2011 14:00
Description: Marine Sed **Date Received:** 18/06/2011 09:00
Customer ID: W

Analysis	Result	Units	Method
Gravel (>2mm)*	2.9	% w/w	In House Method
Very Coarse Sand (<2mm & >1mm)*	1.7	% w/w	In House Method
Coarse Sand (<1mm & >500µm)*	0.8	% w/w	In House Method
Medium Sand (<500µm & >250µm)*	1.2	% w/w	In House Method
Fine Sand (<250µm & >125µm)*	12.8	% w/w	In House Method
Very Fine Sand (<125µm & >63µm)*	34.1	% w/w	In House Method
Silt & Clay (<63µm)*	46.5	% w/w	In House Method

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Report Number: 393332
Project Number: S71241
V16.03



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Grovettown Park SH 1, Private Bag 1007, Blenheim, New Zealand. Ph. +64 3 579 2270, Fax +64 3 579 2210.

Sample Details

Laboratory ID: S71241-3
Description: Marine Sed
Customer ID: C

Sample Type: Sediment

Date Sampled: 15/06/2011 14:00
Date Received: 18/06/2011 09:00

Analysis	Result	Units	Method
Gravel (>2mm)*	17.2	% w/w	In House Method
Very Coarse Sand (<2mm & >1mm)*	6.4	% w/w	In House Method
Coarse Sand (<1mm & >500µm)*	4.8	% w/w	In House Method
Medium Sand (<500µm & >250µm)*	6.5	% w/w	In House Method
Fine Sand (<250µm & >125µm)*	14.1	% w/w	In House Method
Very Fine Sand (<125µm & >63µm)*	18.9	% w/w	In House Method
Silt & Clay (<63µm)*	32.1	% w/w	In House Method

Results apply to samples as received

Our routine detection limits for chemical testing relate to samples with a clean matrix.
Reported detection limits may be higher for individual samples if there is insufficient sample or the matrix is complex.

< means less than, > means greater than

Date Generated: 28/6/11

Authorised by: Toni Deas (LAS)

Position: Senior Technician, Environmental Lab

Signature:



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