Northern Corridor Improvements

Assessment of Freshwater Ecological Effects

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Executive summary

Purpose of report

This report assesses the potential effects of the Northern Corridor Improvements Project on freshwater ecological values within the Project area and the significance of those effects.

Assessments Undertaken

The aquatic ecological values within the Project area were assessed according to the quality of freshwater habitats and the presence freshwater flora and fauna. The assessments were undertaken over the entire Project area and included desktop and database reviews, site visits and formal surveys.

Results of Assessments

The freshwater habitats within the Project area comprise Lucas Creek, Alexandra Stream, Oteha Stream, tributaries of Lucas Creek, Oteha Stream and Alexandra Stream, various stormwater drainage channels, and ten stormwater ponds. The watercourses all flow north and west to Lucas Creek to discharge into the Upper Waitemata Harbour near Albany Village.

The aquatic ecological values within the Project area are considered to have a range of values from very low to moderate. Without mitigation, the potential adverse effects associated with the Project range from less than minor to moderate and include sedimentation, loss of habitat, effects from stormwater discharges, effects on fish passage and injury or mortality to native fish. The Project design has avoided aquatic habitats where possible and no works are being carried out in natural streams.

Suggested Approach for Effects Identified/Recommendations

The Project design has been modified to avoid sensitive aquatic habitats where possible. Where the Project impacts freshwater habitats, any potential adverse effects can be appropriately mitigated to a less than minor effect with the following mitigation measures in place:

- The erosion and sediment controls set out in the Assessment of Construction Water Management;
- The stormwater management measures outlined in the Assessment of Stormwater Management
- A native fish recovery and relocation programme; and
- Riparian planting.

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Glossary of Abbreviations

Item	Description
ACRP:ALW	Auckland Council: Air, Land and Water Plan
AEE	Assessment of Environmental Effects
AUP	Auckland Unitary Plan Operative in Part (15 November 2016)
BPO	Best Practicable Option
CD	Corinthian Drive
CSA	Construction Support Area
EPT	Ephemeroptera, Plecoptera and Trichoptera (Three orders of insects)
ESC	Erosion and Sediment Control
HUR	High Use Road
IBI	Index of Biotic Integrity
MCI	Macroinvertebrate Community Index
NDC	Network Discharge Consent
PAUP	Auckland Council: Proposed Auckland Unitary Plan decisions version (19 August 2016)
RWWTP	Rosedale Wastewater Treatment Plant
SEA	Significant Ecological Area
SEV	Stream Ecological Valuation
SHx	State Highway (number)
SQMCI	Semi-quantitative Macroinvertebrate Community Index
SUP	Shared Use Path
SWP	Stormwater Pond Site
UHH	Upper Harbour Highway
Watercare	Watercare Services Limited
YSI	Yellow Spring Instruments

Terms and Definitions

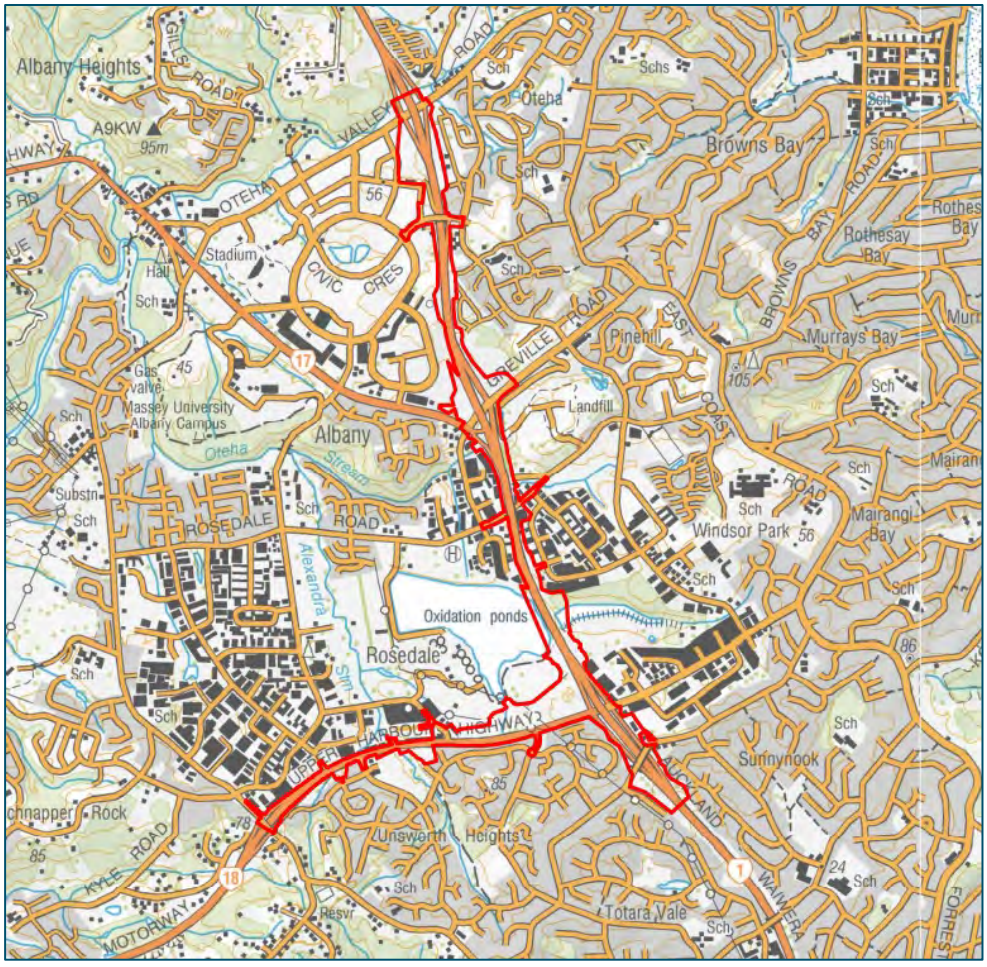
Item	Description
Alpurt	Albany to Puhoi Realignment (of the Auckland Northern Motorway).
Alpurt A1	Sector A1 of Alpurt, the southern 7km of the 1990's extension of the Auckland Northern Motorway between Greville Road and Silverdale.
Auckland Council	The unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations.
NZ Transport Agency	The New Zealand Transport Agency
Project	Refers to the Northern Corridor Improvements Project including the extension to the Northern Busway and proposed Shared Use Pathway.
Project area	The area within the proposed designation(s) corridor for the Project and that abutting this corridor
Project corridor	The area within the proposed designation(s) corridor for the Project
Project works	All proposed activities associated with the Project
Terrestrial Ecology Report	The Assessment of Terrestrial Ecological Effects (NCI-3PRE-2ENV-RPT-0030)

1 Description of Project

1.1 Project Background

The Northern Corridor Improvements Project (the Project) is an accelerated project. The Project area covers the area of SH18 between Albany Highway and Constellation Drive, and SH1 between Upper Harbour Highway (UHH) interchange to just beyond the Oteha Valley Road Interchange as indicated on **Figure 1** below and confirmed in the suite of plans provided in **Volume 5**.

Figure 1 Extent of Project Area



Source: Base Map from LINZ

The Project proposes to upgrade the existing State highways within the Project area. In summary, the key elements of the Project are as follows:

- North and West Motorway Interchange connections – SH1/SH18;
- State highway capacity and safety improvements;
- Northern Busway extension from Constellation Bus Station and connection to Albany Bus Station;
- Reconfiguration of Constellation Bus Station converting it from a terminus station to a dual direction station;

- Shared Use Path (SUP) provision along existing SH1 and SH18 routes for the full extent of the Project corridor:
  - Constellation Bus Station to Oteha Valley Road;
  - Constellation Drive to Albany Highway; and
  - Intermediate linkages to local network.

A full description of the Project, including its components and construction, is contained in Section 5 of the Assessment of Environmental Effects (AEE) (**Volume 2**).

1.2 Purpose of this Report

This report is one of a suite of technical reports that has been prepared to inform the AEE for the Project.

The particular focus of this report is assessment of the effects of the Project on freshwater ecosystems. A separate report, Assessment of Terrestrial Ecological Effects (**Technical Assessment 13**) addresses the effects on terrestrial ecosystems. Additional Project reports consulted in the assessment of effects on freshwater ecosystems are the Assessment of Stormwater Management (**Technical Assessment 11**) and the Assessment of Construction Water Management (**Technical Assessment 4**).

2 Assessment Methodology

2.1 Freshwater Assessment Methodology

A site inspection and walkover of the Project area was undertaken on 2 May 2016. Field notes, measurements and photographs were taken of the freshwater habitats. Sites were identified on which to carry out more detailed assessments and representative sites were selected along permanent watercourses with lengths over 50m, within the Project area, on which to carry out Stream Ecological Valuation (SEV) assessments.

The SEV (spreadsheet version 2.2 July 2012) methodology (*Storey et al.,* 2011) enables the overall function of the stream to be assessed and compared to the quality of other streams in the Auckland Region. The SEV procedure involves the collection of habitat data (e.g. stream depth, substrate type, riparian cover), and sampling of fish communities and macroinvertebrates (e.g. insect larvae, snails), the latter being recognised indicators of habitat quality.

The SEV protocol is a robust, repeatable methodology, developed and extensively utilised by Auckland Council. The SEV methodology, which is based on 14 important ecological functions of a stream, returns an average over the 14 ecological functions that ranges between 1 and 0. For all functions, a stream in a natural (unmodified) condition will always score close to 1 and a lower score indicates a departure from this natural condition, i.e. a pristine site might have a SEV score of 0.95 and a severely modified site a score of 0.25.

The results of the SEV assessment are presented in the stream assessment discussion and are summarised in **Appendix A.**

Macroinvertebrates were sampled from four permanent instream habitats to obtain semi-quantitative data in accordance with the Ministry for the Environment's current "Protocols for Sampling Macroinvertebrates in Wadeable Streams" (Stark *et al*., 2001). Sampling was undertaken along each SEV reach, using protocol 'C1: hard-bottomed, semi-quantitative' and 'C2: soft-bottomed, semi-quantitative' dependent upon whether the stream was predominantly hard or soft bottomed. The macroinvertebrate sample was preserved in 70% ethyl alcohol (ethanol), returned to the laboratory and sorted (using protocol 'P3: full count with sub-sampling option' (Stark *et al*., 2001)). Macroinvertebrates were then identified to the lowest practicable level and counted to enable biotic indices to be calculated.

Three biotic indices were calculated, n*amely the number of taxa, the percentage of Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera* (caddisflies) recorded in a sample (%EPT) and the Macroinvertebrate Community Index (MCI). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment, but exclude *Oxyethira* and *Paroxyethira* as these taxa are not sensitive and can proliferate in degraded habitats. The MCI is based on the average sensitivity score for individual taxa recorded within a sample. Sensitivity scores for taxa in soft-bottomed (sb) streams (Stark & Maxted, 2007a) are used where the substrate is silt and mud-dominated, such as the majority of the sites within the Project designation. MCI and MCI-sb scores of:

- >120 are indicative of excellent habitat quality;
- 100 – 119 are indicative of good habitat quality;
- 80 – 99 are indicative of fair habitat quality; and

- < 80 are indicative of poor habitat quality

  (Stark & Maxted, 2007b).

Semi-Quantitative Macroinvertebrate Community Index (SQMCI) scores were also used and take into account the relative abundance of each scoring taxon. The raw macroinvertebrate data are presented in **Appendix B.**

To sample fish communities within the SEV reaches, electric fishing was carried out using an EFM300 electric fishing machine. The electric fishing machine temporarily stuns the fish, allowing them to be captured. All fish captured were identified, their size estimated and counted before being returned to their habitats.

To sample fish communities within the stormwater ponds, up to four fyke nets and eight Gee minnow traps were deployed overnight in each pond, dependent upon the size and depth of the pond. Nets were removed the following morning with minimal disturbance and all captured fish were identified, measured for length or size estimated and counted before being returned to their habitats. Electric fishing within the stormwater ponds was not carried out, as it was assessed to be unsafe and/or could only be carried out safely in a very limited area because of slope, depth of sediment and cover of macrophytes and algae.

Freshwater fish database forms were completed for each site and are presented in **Appendix C.** An Index of Biotic Integrity (IBI) was calculated for each SEV site based on fish species present, altitude and distance inland (Joy & Henderson, 2004).

In situ spot measurements of basic water quality parameters (temperature, dissolved oxygen and conductivity) were undertaken in each of the permanent streams where a SEV was carried out and in each of the stormwater ponds, to ensure there was sufficient oxygen to enable the nets to be set without fish mortality from low concentrations of oxygen. Measurements were undertaken using a Yellow Springs Instruments (YSI) Professional Series combined dissolved oxygen/temperature/conductivity meter. The majority of the water quality measurements were collected in May and reflect the cooler conditions of late autumn.

Ecological values are described in this report as being high, moderate, low or very low and the corresponding assessment of effects are described as less than minor, minor, moderate or high. **Table 1** provides generalised ecological descriptions with corresponding simplified value descriptors.

Table 1 Generalised Ecological Descriptors and Corresponding Valuation and Assessment

Habitat Description	Ecological Value Descriptor
Aquatic habitats have a combination of very low levels of: shading, hydrologic heterogeneity, aquatic habitat diversity, and riparian integrity. As well as potentially high levels of anaerobic processes.	Very Low
Aquatic habitats have a combination of low levels of: shading, hydrologic heterogeneity, aquatic habitat diversity, and riparian integrity. As well as potentially moderate to high levels of anaerobic processes.	Low
Aquatic habitats have a combination of moderate levels of: shading, hydrologic heterogeneity, aquatic habitat diversity, and riparian integrity. As well as potentially moderate to low levels of anaerobic processes.	Moderate
Aquatic habitats have high levels of shading, low levels of suspended sediments and high hydrologic heterogeneity, such as pools, riffles, runs,	High

Habitat Description	Ecological Value Descriptor
chutes and cascades. Aquatic habitats likely to support (or has records for) a high diversity of fish species, including Nationally 'At Risk' species.	

3 Existing Environment

3.1 Introduction

The freshwater habitats within the Project area comprise Lucas Creek, Alexandra Stream, Oteha Stream, tributaries of Lucas Creek, tributaries of Oteha Stream, tributaries of Alexandra Stream, various stormwater drainage channels and stormwater ponds (**Figure 2**). The watercourses flow north and west, to Lucas Creek, to discharge into the Upper Waitemata Harbour near Albany Village. The catchments for the watercourses are dominantly urban (housing, roading, motorways) and open space (sports fields, undeveloped land, Rosedale Wastewater Treatment Ponds (RWWTP)), with some light industrial use.

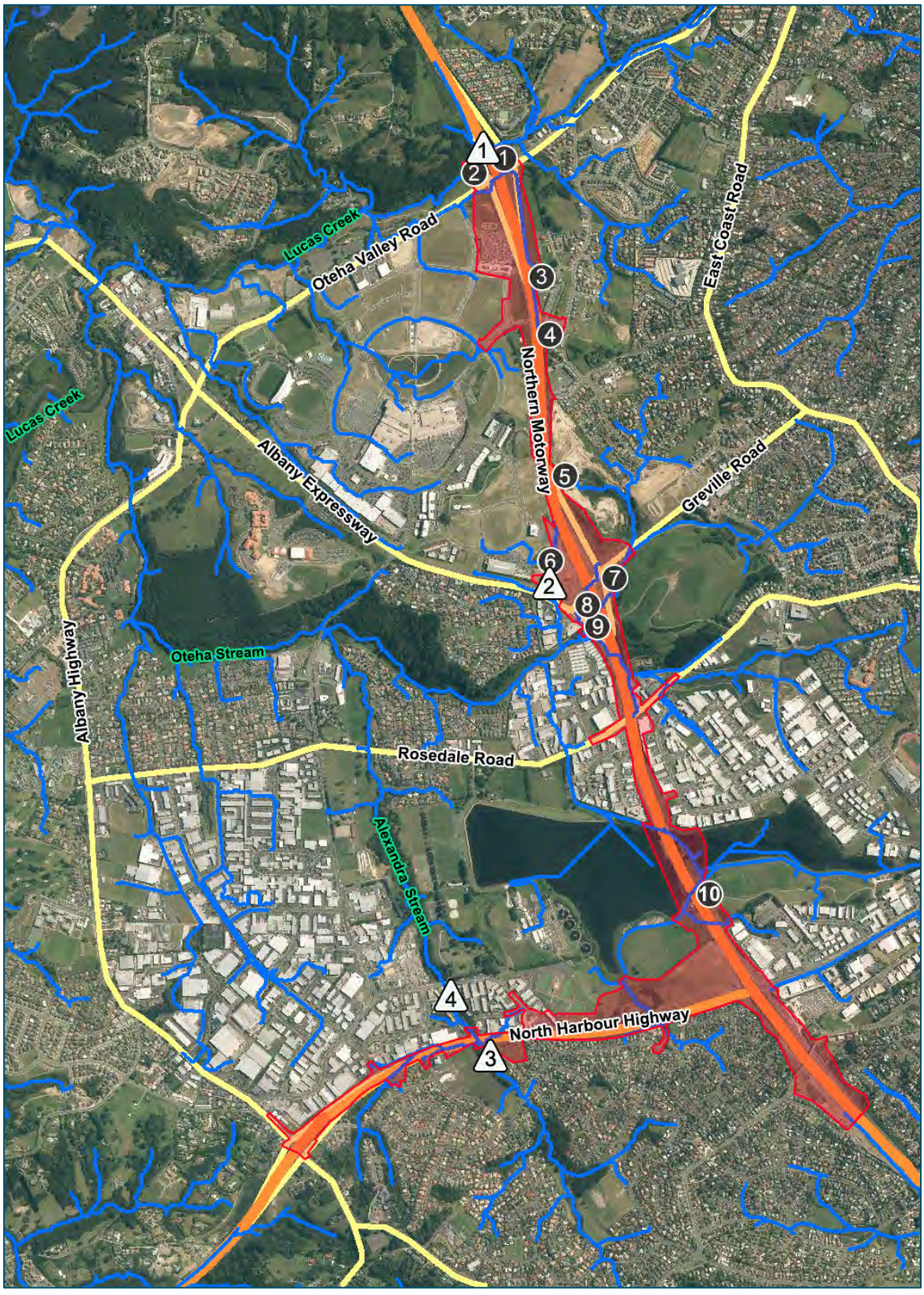
The results of the freshwater surveys are presented in the following sectors:

- Oteha Valley Road to McClymonts Road;
- McClymonts Road to Rosedale Road;
- Rosedale Road to Constellation Drive; and
- UHH from SH1 to Albany Highway.

All permanent and intermittent streams, as well as the eleven stormwater ponds within the Project area were assessed for the quality and extent of freshwater habitats. In addition, SEV assessments were carried out on four streams or tributary sections within the Project area that met the SEV criteria for permanent water and length, Assessments for the presence of native fish were carried out within the stormwater ponds.

The location, description, site characteristics and assessment results for the SEV sites and stormwater ponds are presented in **Table 2** and **Table 3.**

Figure 2 **Northern Corridor SEV (∆) and Stormwater Pond Site Locations (●)**



Source: Base Map from Auckland Council GIS Viewer

Table 2 Northern Corridor SEV and Stormwater Pond Site Locations

SEV Site	Location	Map Reference NZTM
1. Lucas Creek	Lucas Creek, under the SH1 Northern on and off-ramps	E 1752880 N 2935089
2. Oteha Stream Tributary	Northern tributary to Oteha Stream between Albany Expressway and Greville Road	E 1747737 N 5971241
3. Alexandra Stream - South	Alexandra Stream south of UHH – Rook Reserve	E 1747637 N 5971333
4. Alexandra Stream – North	Alexandra Stream north of UHH – Omega Reserve.	E 1747784 N 5971309
Stormwater Pond Site (SWP)	**Location**	**Map Reference NZTM**
SWP 1 – A1 29	Oteha East – Oteha Valley Road east of SH1, adjacent to northern off-ramp. Alpurt A1 Pond 29	E1752972 N 5935070
SWP 2 – A1 30	Oteha West – Oteha Valley Road west of SH1, adjacent to northern on-ramp. Alpurt A1 Pond 30	E 1752856 N 5935010
SWP 3 – A1 31	Masons Road – Stormwater pond between Masons Road and SH1 southbound lane. Alpurt A1 Pond 31	E 1753113 N 5934551
SWP 4 – A1 32	McClymonts Road – Stormwater pond near McClymonts Road, adjacent to the Busway on-ramp. Alpurt A1 Pond 32	E 1753156 N 5934276
SWP 5 – A1 33	Colliston Rise – Stormwater pond between Colliston Rise and SH1 south. Alpurt A1 Pond 33	E 1753218 N 5933663
SWP 6 – Corinthian Drive	Corinthian Drive – Stormwater pond at 39 Corinthian Drive.	E 1753143 N5933267
SWP 7 – Rosedale Landfill	Rosedale Landfill – Stormwater pond in north-west corner of Rosedale Closed Landfill.	E 1753451 N5933161
SWP 8 – A1 34	Greville Road – Stormwater pond within round-a-bout formed by Greville Road on-ramp north. Alpurt A1 Pond 34	E1753321 N 5933066
SWP 9 – A1 35	Greville Road South – Stormwater pond between Greville Road on-ramp north and SH1 north. Alpurt A1 Pond 35.	E 1753383 N 5932993
SWP 10 – ARC Refuse Pond	ARC Refuse Pond – Stormwater pond on RWWTP site adjacent to UHH off-ramp	E 1753933 N 5931719

Table 3 Summary of Stream Characteristics

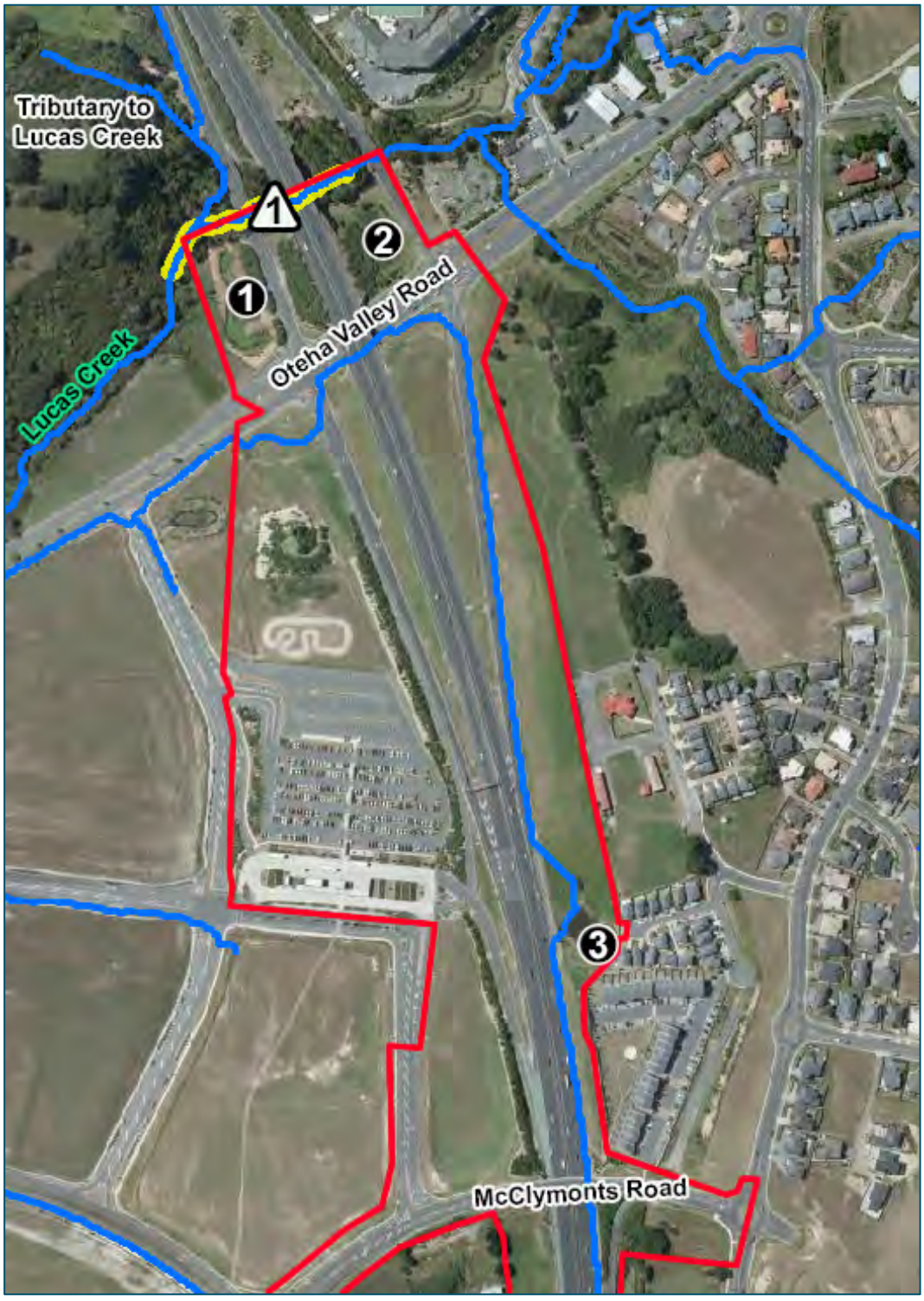
	Site 1 Lucas Creek	Site 2 Oteha Stream Tributary	Site 3 Alexandra Stream Rook Reserve	Site 4 Alexandra Stream Omega Reserve
Habitat Features				
Average width (m)	3.5	0.05	2.1	1.9
Average depth (m)	0.3	0.1	0.3	0.3
Dominant substrate	Bedrock	Bedrock	Mud	Mud
Macrophyte abundance	Rare	None	Common	Abundant
Dominant macrophyte species	Oxygen weed	-	Willow weed, water celery, purslane, watercress	Willow weed, water celery, purslane, watercress
Riparian vegetation	Native regenerating forest	Pine, native & exotic scrub	Native restoration planting	Native restoration planting
Water Quality				
Time NZST (Hours)	10:30	10:00	10:00	11:30
Temperature (°C)	14.9	14.1	17.4	16.0
Oxygen saturation (%)	89.3	94.7	75.8	85.3
Dissolved oxygen (g/m^3)	9.0	9.6	7.2	8.4
Conductivity (μS/cm)	190	89	122	235
Clarity (m)	>1	0.75	0.64	0.54
Macroinvertebrates				
Sampling protocol	HB	SB	SB	SB
No. of taxa	10	14	12	18
Dominant taxon	*Potamopygrus* Freshwater snail	*Chironomids* Midges	*Potamopygrus* Freshwater snail	*Potamopygrus* Freshwater snail
No. of EPT taxa	2	0	0	1
%EPT*	2.8	0	0	6
MCI	96 'Fair'	66 'Poor'	48 'Poor'	51 'Poor'
SQMCI	3.88 'Poor'	3.52 'Poor'	1.98 'Poor'	1.87 'Poor'
Fish				
Species recorded	Shortfin eel Crans bully Mosquito fish	Shortfin eel	Shortfin eel Crans bully Mosquito fish	Longfin eel Shortfin eel Crans bully
Number of native fish	12	9	34	84
Fish IBI Score	22	14	22	30
Rating	Poor	Very Poor	Poor	Fair
Stream Ecological Value				
SEV Score	0.53	0.58	0.52	0.51

* excluding *Oxyethira* and *Paroxyethira*
HB = Hard bottom sampling protocol.
SB = Soft bottom sampling protocol.

3.2 Oteha Valley Road to McClymonts Road

Provided in **Figure 3** below is an overview of the freshwater habitats within the Project area between Oteha Valley Road and McClymonts Road.

Figure 3 Freshwater Habitats – Oteha Valley Road to McClymonts Road - SEV (△) and Stormwater Pond Locations (●)



Source: Base Map from Auckland Council GIS Viewer

3.2.1 Lucas Creek (SEV1)

A section of Lucas Creek, either side of the northern motorway, lies within the Project area. The Project area includes approximately 300m from 157 Oteha Valley Road to the western boundary of the stormwater pond reserve to the west of the motorway.

At the time of the site visit Lucas Creek was flowing and there was sufficient length of stream to carry out a SEV. A representative 200m reach of the stream was assessed and the SEV was carried out on 4 May 2016.

The stream formed a highly shaded, natural channel with steeply (**Figure 4**). There was a wide variety of favourable aquatic habitats present including woody debris, riffles, undercut banks, root mats and other stable habitats. The hydrology of the stream was variable with deep pools, runs and occasional riffles and chutes (**Figure 5**). The creek averaged 3.5m wide (maximum 8.3m) and 0.3m deep (maximum 0.81m). The substrate was dominantly bedrock with some large gravel and cobble. No aquatic macrophytes were observed in the downstream cross sections of the SEV but oxygen weed (*Egeria densa*) and Canadian pondweed (*Elodea canadensis*) were recorded in the upstream reaches of the stream.

The riparian vegetation adjacent to Lucas Creek comprised a mix of native trees, amenity planting and exotic weeds (refer to the Assessment of Terrestrial Ecological Effects).

An *in situ* measurement of basic water quality parameters was taken in the middle portion of the SEV reach. The water temperature was 14.9˚C, indicative of autumn conditions and within the temperature range of 'excellent', which is considered to be suitable for most invertebrates and periphyton (Biggs *et al*., 2002). Conductivity was moderate to low (190µS/cm), indicative of good stream health with low enrichment. Dissolved oxygen concentration and saturation were good, at 9.0 mg/L and 89% respectively, a level where no stress is expected on aquatic organisms. The clarity of the water, at >1m, was excellent.

Macroinvertebrates were dominated by the freshwater snail, *Potamopyrgus antipodarum* and the sandfly larvae, *Austrosimulium*. Snails and sandfly larvae comprised 89% of the individuals present at the site, which was reflected in the moderately low MCI rank of 'fair' and low SQMCI rank of 'poor'. Only two EPT taxa were recorded at the site, which comprised less than 3% of the individuals. No sensitive taxa (with individual MCI scores ≥ 8) were recorded at this site.

Crans bully (*Gobiomorphus breviceps*) and shortfin eel (*Anguilla australis*) were the only native fish recorded from the Lucas Creek SEV reach. These were relatively common in the SEV reach, with five eels (size range 150 – 600mm) and seven bullies (ranging from 31mm to 40mm long). Freshwater crayfish, koura (*Paranephrops planifrons*) were common in the creek. The exotic mosquito fish (*Gambusia affinis*) was also present. The Fish IBI score was 22, indicative of 'poor' species diversity in comparison to other Auckland streams, given the altitude and distance from the sea (Joy & Henderson, 2004).

A search of the New Zealand freshwater fish database for Lucas Creek returned fish records for four additional native fish, longfin eel (*Anguilla dieffenbachii*), banded kokopu (*Galaxias fasciatus*), common bully (*Gobiomorphus cotidianus*), redfin bully (*Gobiomorphus huttoni*); and for the freshwater mussel (*Hyridella menziesi*). Both longfin eel and redfin bully are listed as 'At Risk; Declining' on the national threatened species list (Goodman *et al*., 2014; Hitchmough *et al*., 2007).

The quality of native galaxiidae spawning habitat was poor. Although the shading was high, the banks were near vertical and there was no nearly-flat stream bank with low growing vegetation necessary for spawning.

The SEV score of the Lucas Creek site was moderate (0.53), indicating that the stream retains some ecological values despite land use changes (i.e. urbanisation of large parts of the catchment,

culverting many of the tributaries and bridging of the watercourse and retention works for SH1). This section of the stream scored well for its water quality, namely the high amount of shading maintaining good temperature control, and retention of particles and organic matter, but poorly for biodiversity (fish and macroinvertebrates) and access to the floodplain.

Figure 4 Lucas Creek

Note: Variation in width and high banks

Figure 5 Lucas Creek

3.2.2 SWP 1 Alpurt A1 Pond 29 (Oteha Valley East) and SWP 2 Alpurt A1 Pond 30 (Oteha Valley West)

Two existing stormwater ponds are located within the Project area north of Oteha Valley Road. The stormwater ponds are east (SWP 1, A1 Pond 29) and west (SWP 2, A1 Pond 30) of the northern motorway. Both stormwater ponds are divided into two, with a central bund and are surrounded by a narrow band of native and exotic shrubs, dominated by flax (*Phormium tenax*), cabbage trees (*Cordyline australis*) and long grasses. SWP 1 (**Figure 7**). The stormwater ponds are both Alpurt ponds, which primarily collect water from the motorway system and discharge to Lucas Creek.

Two fyke nets and four Gee minnow traps were placed in each pond overnight to determine the presence of native fish. Shortfin eel were the only native fish recorded from the ponds with one eel caught in SWP 1 and two in SWP 2.

An *in situ* measurement of basic water quality parameters was taken at each of the stormwater ponds. The water temperature was 22^{o}C in SWP 1 (east) and 19.2˚C in SWP 2 (west), and within the temperature range of 'fair' and 'good' respectively, which are at levels which start to become stressful for some invertebrates and fish (Biggs *et al*., 2002). Conductivity was high in SWP 1 OE (417 µs/cm) in the range of 'very poor', indicative of enriched waters. Conductivity was moderate in SWP 1 (223 µS/cm), indicative of 'fair' health with slightly enriched waters. Dissolved oxygen concentration and saturation were good in SWP 1, at 7.3 mg/L and 84%, a level where no stress is expected on aquatic organisms, but very poor in SWP 1 (4.1 mg/L and 44%) and at a level which significant persistent stress would be caused to a range of aquatic organisms (Davies-Colley *et al*., 2013).

The aquatic ecological values of the stormwater ponds were low.

Figure 6 SWP 1 (A1 39) Oteha East

Figure 7 SWP2 (A1 30) Oteha West

3.2.3 SWP 3 Alpurt A1 Pond 31 Stormwater Pond between Masons Road and SH1 Southbound

SWP 3, Alpurt A1 stormwater pond 31, is located adjacent to the SH1 southbound below Masons Road and Lavender Garden Lane (**Figure 8**). The stormwater pond is approximately 30m by 18m and discharges over a weir to a small artificial drainage channel (**Figure 9**) that drains via a culvert under the motorway towards Lucas Creek. The stormwater pond and stormwater drainage channel are open, poorly shaded and surrounded by short grass with occasional small areas of amenity plants (flax and cabbage trees).

Figure 8 SWP 3 (A1 31) near Masons Road

Figure 9 Watercourse downstream of SWP 3

Two fyke nets and three Gee minnow traps were placed in the pond overnight to determine the presence of native fish. A fourth Gee minnow trap was placed in a small pool at the top of the drainage channel. One shortfin eel (920mm) was caught in the pond and an adult banded kokopu (130mm) was caught in the stormwater pond drainage channel.

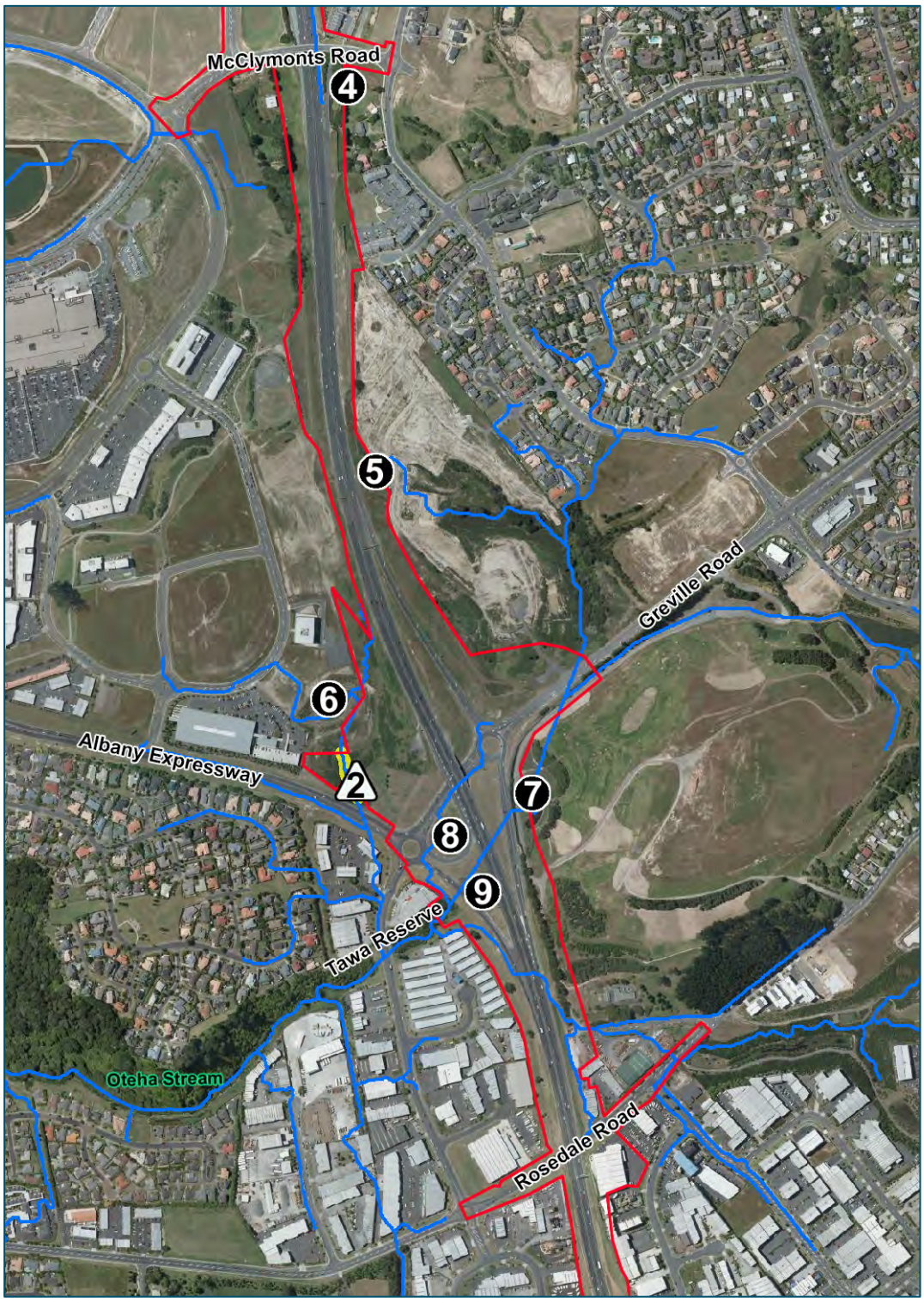
The water temperature of the pond was 18˚C, indicative of autumn conditions and within the temperature range of 'good', which is considered to be suitable for most invertebrates and periphyton (Biggs *et al*., 2002). Conductivity was low (130 µS/cm), indicative of low enrichment and dissolved oxygen concentration and saturation were good, at 9.3 mg/L and 98%, a level where no stress is expected on aquatic organisms.

The aquatic ecological values of the stormwater pond were low. The aquatic ecological values of the artificial stormwater drainage channel between the outlet of the stormwater pond and the SH1 culvert were moderate, based on the natural character of the stormwater drainage channel and the refuge habitat the watercourse has provided for native fish.

3.3 McClymonts Road to Rosedale Road

Figure 10 provides an overview of the freshwater habitat located between McClymonts Road and Rosedale Road within the Project area.

Figure 10 Freshwater Habitats – McClymonts Road to Rosedale Road - SEV (Δ) and Stormwater Pond Locations (●)



Source: Base Map from Auckland Council GIS Viewer

3.3.1 Oteha Stream tributary (SEV 2)

The Corinthian Drive stormwater pond (SWP 6) discharges via culverts to an upper northern tributary of Oteha Stream (SEV Site 2). As there was continuous water flow in the tributary, the watercourse was classified as permanent according to the stream classification criteria in both the Auckland Council Regional Plan: Air, Land and Water (ACRP:ALW) and the notified version of the Proposed Auckland Unitary Plan (notified PAUP). A SEV assessment was carried out on the tributary on 10 May 2016.

The northern tributary of Oteha Stream within the Project area flows from north to south for approximately 90m, from an upstream culvert to a second culvert running under the Albany Expressway to discharge to Oteha Stream. A SEV assessment (SEV Site 2, **Figure 10**) was carried out over 70m of stream length.

The stream formed a natural channel with steeply incised, near vertical banks with no connection with the floodplain (**Figure 11**). There was a moderate variety of favourable aquatic habitats present including woody debris, undercut banks and other stable habitats. The stream formed a run with occasional shallow pools and riffles (**Figure 12**). The stream averaged 0.63m wide (maximum 0.9m) and 0.1m deep (maximum 0.23m). The substrate was dominantly bedrock with occasion areas with large cobbles and gravel. No aquatic macrophytes were recorded.

The riparian vegetation adjacent to the Oteha Stream tributary comprised native and exotic scrub with tall pines.

An *in situ* measurement of basic water quality parameters was taken in the middle portion of the SEV reach. The water temperature was 14.1˚C, within the temperature range of 'excellent', which is considered to be suitable for most invertebrates and periphyton (Biggs *et al*., 2002). Conductivity was low (89 µS/cm), indicative of good stream health with no or low enrichment. Dissolved oxygen concentration and saturation were good, at 9.6 mg/L and 95% respectively, a level where no stress is expected on aquatic organisms. The clarity of the water, at 0.75m was excellent.

Only low numbers of macroinvertebrates were found in Oteha Stream tributary. The macroinvertebrates were dominated by midges (Chironomidae) followed by freshwater snails and springtails (Collembola). These groups comprised 77% of the individuals present at the site which was reflected in the low MCI and SQMCI ranks of 'poor'. No EPT taxa were recorded at the site and no sensitive taxa (with individual MCI scores ≥ 8) were recorded from the site.

Shortfin eel was the only native fish recorded from the Oteha Stream tributary SEV reach. These were relatively common in the SEV reach, with 9 eels recorded within the 90m length fished. The eels were all juveniles and ranged in size from 50mm (elver) to 120mm. The Fish IBI score was 14, indicative of 'very poor' species diversity in comparison to other Auckland streams, given the altitude and distance from the sea (Joy & Henderson, 2004).

The quality of native galaxiidae spawning habitat was poor because of the steep high banks and lack of low growing bankside vegetation.

The SEV score for Oteha Stream tributary, was moderate (0.58), indicating that the stream retained some ecological values despite land use changes to a dominantly urban environment. This section of the stream scored well for water temperature control, provided by the high amount of shading, and organic matter input from the restoration planting, but poorly for biodiversity (fish and macroinvertebrates) and access to the floodplain.

Figure 11 Oteha Stream Tributary

Note: Steep banks

Figure 12 Oteha Stream Tributary

Note: Pools and riffles

3.3.2 Tawa Reserve

A short reach of the upper most open section of Oteha Stream in Tawa Reserve lies within the Project area (**Figure 12**). Stormwater from the three ponds near the Greville Road intersection and upper Greville Road catchment (SWP 7, 8 and 9) drain into the Oteha Stream, via a large (3000mm diameter) stormwater culvert. The water discharges to the stream over a culvert apron to bedrock **Figure 13**).

At the time of the survey there was continuous flow from the culvert which measured 0.9m wide (wetted area) and 0.03m deep. There was a fine layer of iron floc covering the wetted area of the culvert and the upper reaches of the stream, giving the watercourse an orange appearance. The upper reaches of the stream were located in a steep gully. The banks had been stabilised with large rocks and were covered in a mix of weed species, including woolly nightshade (*Solanum mauritianum*), gorse (*Ulex europaeus*), wandering Jew (*Tradescantia fluminensis*) and rank grass, and native shrubs (karamu, flax, ponga, manuka).

The stream bed was exposed bedrock without macrophytes, with little cover for fish or substrate suitable for macroinvertebrates (**Figure 14**). Below the culvert and the Project area, the stream developed a more natural profile and the riparian zone provided shading, cover and inputs to the stream.

Upper Oteha Stream within Tawa Reserve formed a stabilised steep sided watercourse. The short area of the watercourse within the Project area included the culvert, culvert apron, the scour pool and stream immediately below the pool. The aquatic ecological values of the watercourse within the Project area were low.

Figure 13 Upper Oteha Stream

Note: Culvert apron on right and discharge pool

Figure 14 Upper Oteha Stream

Note: Iron floc

3.3.3 SWP 4 Alpurt A1 Pond 32 Stormwater Pond Adjacent to McClymonts Road.

A narrow stormwater pond is present within the Project area, adjacent to the on-ramp accessible from McClymonts Road (Alpurt A1 Pond 32, SWP 4). The pond is approximately 34m long by 8m wide, bounded by a tall retaining wall to the east and the retaining wall for the dedicated bus way on-ramp to the west. The pond is surrounded by band of amenity planting dominated by flax, cabbage trees, karamu (*Coprosma robusta*) and manuka (*Leptospermum scoparium*). Sediment from the adjacent development to the west had entered the stormwater pond reducing the clarity (**Figure 15**). One fyke net and two Gee minnow traps were placed in the pond overnight. No fish were caught.

This pond was one of two stormwater ponds that were investigated later in the year (in September) once the Project stormwater maps were made available. The temperature of the pond in September was 12^{o}C, within the range of "excellent" which is considered to be suitable for most stream life (Biggs *et al*., 2002) and conductivity was low (125 µS/cm), indicative of low enrichment. Dissolved oxygen concentration and saturation were low, at 6.1mg/L and 56% respectively, a level where moderate stress would be caused to aquatic organisms (Davis-Colley *et al*, 2014) and at a level where the nets and traps were required to be placed in a position to ensure an air pocket was available for fish.

The aquatic ecological values of the stormwater pond were low.

Figure 15 SWP 4 (A1 32) McClymonts Road

3.3.4 SWP 5 Alpurt A1 Pond 33 Stormwater Pond near Colliston Rise

A small, shallow stormwater pond is present within the Project area, adjacent to the SH1 southbound lane, north of Greville Road and accessible from Colliston Rise (SWP 5). The pond is approximately 20m long by 16m wide and on average 0.15m deep. The pond was bounded by pasture grasses, with the occasional amenity plant (dominated by flax) and there was no shading on the water (**Figure 16**). The water was clear. The water was too shallow for the deployment of fyke nets. Two Gee minnow traps were placed in the pond overnight. No fish were caught.

This pond was one of two ponds that were investigated later in the year (September 2016) after the Project stormwater maps were made available. The temperature of the pond was 13.6°C, within the range of "excellent" which is considered to be suitable for most stream life (Biggs *et al*., 2002) and conductivity was low (86 µS/cm), indicative of low enrichment. Dissolved oxygen concentration and saturation were excellent, at 9.95mg/L and 95% respectively, a level where no stress would be caused to aquatic organisms (Davis-Colley *et al*, 2014).

The aquatic ecological values of the stormwater pond were low.

Figure 16 SWP 5 (A1 33) Colliston Rise

3.3.5 SWP 6 CD Stormwater Pond at 35 Corinthian Drive

A large stormwater pond is present adjacent to the Project area, accessible from 35 Corinthian Drive (CD), draining via culverts to an upper tributary of Oteha Stream. This stormwater pond is an Auckland Council asset and serves part of the urban catchment.

The pond is approximately 72m by 29m, fenced and surrounded by amenity planting including manuka, karamu, flax, cabbage trees, Hebe species and wildling pines (**Figure 17**).

Four fyke nets and eight Gee minnow traps were placed the pond overnight. One juvenile shortfin eel (320mm) was caught in the pond and numerous late stage tadpoles.

The water temperature of the pond was 17.7˚C, indicative of autumn conditions and within the temperature range of "good", which is considered to be suitable for most invertebrates (Biggs *et al*., 2002). Conductivity was low (114 µS/cm), indicative of low enrichment. Dissolved oxygen concentration and saturation were very high, at 11.91 mg/L and 126% respectively, a level where supersaturation was occurring and a level potentially dangerous to fish and invertebrates[1]. The supersaturation of the pond was likely a result of photosynthetic aquatic oxygen producers such as macrophytes and algae (**Figure 18**), and is known to occur on occasions in stagnant waters, such as stormwater ponds.

The aquatic ecological values of the stormwater pond were low.

Figure 17 SWP 6, 35 Corinthian Drive

Figure 18 Macrophytes and Algae in SWP 6

3.3.6 SWP 7 RL Stormwater Pond at North-Western Corner of Rosedale Closed Landfill

A large stormwater pond, approximately 86m by 30m, is located in the Rosedale Closed Landfill adjacent to Greville Road and the Greville Road on-ramp southbound (**Figure 19**). The stormwater pond is unshaded, surrounded by short grasses, and discharges to a culvert under the motorway that drains to Oteha Stream.

Two fyke nets and six Gee minnow traps were placed the pond overnight to determine the presence of native fish. Two introduced green and golden bell frogs (*Litoria aurea*) were caught in the nets but no fish were caught. The water temperature of the pond was 18.4˚C, indicative of autumn conditions and within the temperature range of 'good', which is considered to be suitable for most invertebrates and periphyton (Biggs *et al*., 2002). Conductivity was high (444 µS/cm), indicative of enrichment and dissolved oxygen concentration and saturation were very poor, 4.03 mg/L and 43% respectively, at a level where significant persistent stress would be cause to aquatic organisms living in the pond.

[1] Supersaturated water can cause gas bubble disease in fish and invertebrates and significant death rates also occur when dissolved oxygen remains above 115% -120% air saturation for a period of time. Fondriest Environmental, Inc. "Dissolved Oxygen." Fundamentals of Environmental Measurements. 19 Nov. 2013. Web. < http://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/ >

The aquatic ecological values of the stormwater pond were very low.

Figure 19 SWP 7 Rosedale Closed Landfill

3.3.7 SWP 8 Alpurt A1 Pond 34 and SWP 9 Alpurt A1 Pond 35 Greville Road Motorway Intersection Stormwater Ponds

Two Alpurt stormwater ponds are present in the Greville Road, Tawa Drive, Albany Expressway, SH1 intersection (Alpurt A1 Ponds 34 and 35). A stormwater pond is located within the round-a-bout formed by the Greville Road on-ramp north (**Figure 20**) and a second stormwater pond is located immediately south of the on-ramp north (**Figure 21**). Both stormwater ponds contained wetland plants (Carex species, *Baumea articulatata*) are mostly unshaded, surrounded by grasses with occasional patches of amenity plants (flax, cabbage tree, manuka). Both stormwater ponds drain to Oteha Stream via a 3000mm diameter culvert.

The northern pond, bounded by the on-ramp round-a-bout, measured approximately 24m by 37m while the southern pond measured approximately 51m by 10m. One fyke net and two Gee minnow traps were placed in each pond overnight. No fish were caught in the nets and traps and no fish were observed in these ponds.

The water temperature of the ponds was 18˚C and the conductivity was moderate (278 µS/cm in the northern pond and 173 µS/cm in the southern pond). Dissolved oxygen concentrations and saturations were moderate, 6.4 mg/L and 65% in the northern pond and 7.7 mg/L and 78% in the southern pond.

No native fish were recorded from SWP 8 (north) or SWP 9 (south) and swimming and climbing native fish would not be expected to negotiate the barriers provided by the roading, culverting and vertical manhole (topped with the scruffy dome) to migrate into the ponds.

The aquatic ecological values of the stormwater ponds were very low.

Figure 20 SWP 8 (A1 34) Greville Road northern on-ramp

Figure 21 SWP 9 (A1 35) Greville Road south

3.4 Rosedale Road to Constellation Drive

Figure 22 Freshwater Habitats – Rosedale Road to Constellation Drive - Stormwater Pond Location (●)

Source: Base Map from Auckland Council GIS Viewer

3.4.1 South of Arrenway Reserve - Stormwater Drain (Moro Pond)

South of Arrenway Reserve, within Watercare's RWWTP, an open section of the watercourse and stormwater system (Moro Pond) collects water from the from the catchment to the south and drains north to a large culvert that discharges west (under SH1) and north to Oteha Stream (**Figure 22**). The Moro Pond is an Auckland Council asset serving the wider catchment and not the motorway. The artificial watercourse in the Moro Pond is lined with concrete and is approximately 40m long and 0.9m wide (**Figure 23**). The watercourse has low shading with the riparian zone dominated by grasses with occasional shrubs and larger trees. One shortfin eel, approximately 520mm long, was observed in the watercourse.

The aquatic ecological values of the stormwater drain were very low.

Figure 23 Moro Pond and Stormwater Drain South of Arrenway Reserve

3.4.2 Stormwater System South of RWWTP Pond 2

The stormwater system east of the motorway and south of RWWTP Pond 2 was constrained to a narrow, open concrete lined channel (**Figure 24**) draining generally east to west adjacent to the southern banks of Pond 2, then draining via culverts (**Figure 25**) and open drains north and west to Oteha Stream. The concrete channel was uniform, 0.8m wide and 0.2 - 0.3m deep. The riparian vegetation was limited to short pasture grass and there was no effective shading on the drain and no quality habitat for aquatic fauna.

The aquatic ecological values of the stormwater drain were very low.

Figure 24 Stormwater Drain South of Pond 2

Figure 25 Stormwater Drain Discharge Point Through Vertical Culvert

3.4.3 RWWTP Pond 1 and 2 Adjacent to SH1

The aquatic ecological values of the RWWTP ponds adjacent to the SH1 are low. The ponds are constructed for the treatment of sewage effluent prior to discharge offshore. Grass carp were released into the ponds in April 2008 to control weed growth and anecdotal information indicates the residential grass carp are successfully controlling the aquatic weeds and maintaining a healthy population.

The riparian vegetation of the RWWTP in the Project area is limited to well-maintained short grasses with occasional amenity plants.

Monitoring of dissolved oxygen levels indicates that the ponds are well oxygenated containing an average of 9g/m^3 at the surface, and 7 g/m^3 at a depth of 4m (Bioresearches, 2011). Non-biting midges (Chironomidae) are present in the ponds and historic complaints have resulted in the use of methoprene, an insect growth regulator to prevent the midges maturing to flying adults. The ponds are subject to the AUP Natural Resource overlays: Significant Ecological Area (SEA); SEA_T_8364 at Pond 1 and SEA_T_8365 at Pond 2 for threat status and rarity; and diversity, stepping-stones, migration pathways and buffers.

3.4.4 SWP 10 ARC Refuse Pond – Stormwater Pond on RWWTP Site, Adjacent to UHH Off-Ramp

A stormwater pond approximately 73m by 25m, described as the ARC Refuse Pond, is located with the RWWTP site adjacent to the UHH off-ramp south, near Centurion Reserve (**Figure 26**). This stormwater pond is an Auckland Council asset and serves part of the urban catchment.

The riparian vegetation surrounding the stormwater pond comprised short pasture grass. The stormwater pond discharges via a culvert under the motorway to drain overland via a watercourse to the stormwater drain on the southern edge of RWWTP Pond 1.

Two fyke nets and four Gee minnow traps were placed the pond overnight to determine the presence of native fish. Twenty-three shortfin eel, ranging in size from 140mm to 630mm were caught in the pond and numerous mosquito fish.

The water temperature of the pond was 19.3^{o}C, conductivity was low to moderate (160 µS/cm), and dissolved oxygen concentration and saturation were moderate, 6.3 mg/L and 68% respectively.

The aquatic ecological values of the stormwater pond were low.

Figure 26 SWP 10 (ARC Refuse Pond) in RWWTP

3.5 UHH from SH1 to Albany Highway

Figure 27 Freshwater Habitats UHH from SH1 to Albany Highway - SEV (∆) and Stormwater Pond Locations (●)

Source: Base Map from Auckland Council GIS Viewer

3.5.1 RWWTP central watercourse – near UHH on-ramp north

SWP 10 (ARC Refuse Pond) near the corner of Constellation Drive and SH1 off-ramp drains via a culvert under SH1 to the centre of the RWWTP site (**Figure 27**, **Figure 28**). The outlet of the culvert discharge forms a watercourse running south to north for approximately 60m to drain to the open stormwater drain adjacent to the Pond 1 southern road (**Figure 29**). Stock have access to the watercourse and the banks and stream bottom have been pugged, forming a broken boggy area about 3m wide. The water depth in the central area was approximately 0.06m within pools. Rushes (*Juncus* species*)*, water pepper (*Persicaria hydropiper)* and buttercup (*Ranunculus* species) were present throughout the wetted area (**Figure 29**). The riparian vegetation was limited to short pasture grass. Mosquito fish were abundant in the pools.

The aquatic ecological values of the watercourse were low.

Figure 28 Upper watercourse draining SWP 10

Figure 29 Lower watercourse draining towards RWWTP Pond 1

3.5.2 RWWTP Watercourses South of Pond 1

Figure 30 Freshwater Habitats RWWTP Watercourses South of Pond 1

Source: Base Map from Auckland Council GIS Viewer

Within the RWWTP site, immediately north of UHH in line with Caribbean Drive, an area of modified watercourses and stormwater drains is present (**Figure 27** and **Figure 30**).

Stormwater from Caribbean Drive and the urban areas south of UHH drain north under the Highway via a 1350mm diameter culvert to the RWWTP site. The watercourse has been confined to a concrete lined open drain (Watercourse 2, **Figure 30**), 1m wide with 0.4m concrete block sides. This open drain was lined with iron floc and contained a continuous flow less than 0.01m deep (**Figure 31**). This watercourse is a modified element of a natural drainage system that existing prior to land modification (email from Matt Byrne, Auckland Council to Aurecon, 24 November 2016).

Immediately south-west of the stormwater drain, an anaerobic ditch was present, generally adjacent to the stormwater drain (Watercourse 3, **Figure 30**). The ditch varied between 0.2 and 0.5m wide, was anaerobic, with mud, slime, iron floc and maintained elongated very shallow pool areas, but no flow (**Figure 32**). The ditch was bisected by a culvert, forming a deeper header pool, approximately 0.5m deep, before widening and joining a similar ditch from the west (Watercourse 4, **Figure 30**) and draining east via a very incised ditch to the stormwater drain. A shortfin eel, approximately 480mm long, was present near the junction with the stormwater drain and mosquito fish were present throughout. The drains were unshaded with the riparian vegetation limited to short grasses.

A watercourse draining the central area east to west to the stormwater drain (Watercourse 1, **Figure 30**) was not investigated further than the fenceline, as the area was a treated effluent irrigation trial (Site 1 Field A) (**Figure 33** and **Figure 34**). The hydrology of this watercourse was not determined but is likely to be largely determined by the operation of RWWTP. The riparian vegetation of this watercourse comprised short grasses with amenity planting in the upper reaches (**Figure 33**).

West of the Caribbean Drive stormwater drain, during winter, water seeped out from under Upper Harbour drive to a narrow drainage channel which flowed north and north-east to a culvert under the farm access track, to join with the stormwater system draining Caribbean Drive (Watercourse 4, **Figure 30**). The drainage channel was not a natural watercourse and appeared to have been formed. In September the watercourse averaged 0.15m wide (**Figure 35**), widening to 2m immediately in front of the culvert. At this time (early spring) there was no flow in the watercourse and the culvert was completely dry. The watercourse did not meet the criteria under the Auckland Unitary Plan, Operative in Part (AUP) for an intermittent stream. The banks were firm and contoured, clear of shrubs and the riparian vegetation was dominantly pasture grass with buttercup and occasional amenity trees (**Figure 36**).

The stormwater drains and ditches all drained north via a culvert under the farm track to the open stormwater drain adjacent to the Pond 1 south road. An adult eel (>500mm) was present near the junction of the drains.

The stormwater from this site was constrained to an open concrete lined channel draining generally west to east adjacent to the southern banks of Pond 1, then draining via culverts under SH1 (to drain north and west to Oteha Stream). The riparian vegetation comprised short pasture grass. There was no effective shading on the drain and no quality habitat for aquatic fauna (**Figure 37** and **Figure 38**).

The freshwater aquatic values of this area were very low. The stormwater discharges were confined to a series of concrete lined drainage channels. The adjacent highly modified soft bottomed channels are currently being used for treated effluent trials or appear to be historically used for trials and many of these areas comprise very soft anaerobic sediment.

Figure 31 RWTTP stormwater drain from Caribbean Drive

Figure 32 RWWTP Drain parallel to the Stormwater Drain in Figure 3

Figure 33 RWWTP Effluent Trial Area

Figure 34 RWWTP Discharge from Trial Area

Figure 35 Narrow watercourse West of Drains

Figure 36 Watercourse West of Stormwater Drains

Figure 37 Stormwater Drain adjacent to Pond 1

Figure 38 Stormwater Drainage System adjacent to Pond 1

3.5.3 Alexandra Stream South – Rook Reserve (SEV3)

Alexandra Stream, either side of the UHH, lies within the Project area. The Project area includes just over 100m of the stream, south of the UHH, within Rook Reserve. Alexandra Stream was flowing at the time of the assessment and a SEV was carried out over a 100m reach of the stream. A SEV was carried out on 6 May 2016.

The stream drains south to north to a culvert under the UHH. The stream averaged 2m wide (maximum 3.1m) and 0.3m deep (maximum 0.84m) and formed a well shaded, natural channel with sloping banks (**Figure 39** and **Figure 40**). The stream formed a run with occasional deeper pools and riffles. There was a variety of favourable aquatic habitats present including woody debris, riffles, undercut banks, root mats and other stable habitats.

The substrate was dominated by silt with a good mix of gravel, cobble, bedrock and wood providing harder substrate. Aquatic macrophytes were present in low abundance throughout the SEV reach. The macrophytes included willow weed (*Persicaria maculosa*), starwort (*Callitriche stagnalis*), water celery (*Apium prostratum*), water purslane (*Ludwigia palustris*), watercress (*Nasturtium officinale*), curly pond weed (*Potamogeton crispus*) and swamp lilly (*Ottelia ovalifolia*). The riparian vegetation in Rook Reserve adjacent to Alexandra Creek comprised a mix of native restoration planting and exotic weeds (refer the Assessment of Terrestrial Ecological Effects).

An *in situ* measurement of basic water quality parameters was taken in the middle portion of the SEV reach. The water temperature was 17.4^{o}C, within the temperature range of 'good' (Biggs *et al*., 2002). Conductivity was moderate to low (122 µS/cm), indicative of good stream health with low enrichment. Dissolved oxygen concentration and saturation were good, at 7.3mg/L and 76% respectively, a level where no or little stress is expected on aquatic organisms. The clarity of the water at 0.64m, was good.

Macroinvertebrates were dominated by the freshwater snail, *Potamopyrgus antipodarum,* comprising 56% of the individuals present, and the dragonfly larvae *Xanthocnemis zelandica,* comprising 23%. No sensitive taxa (with individual MCI scores ≥ 8) or EPT taxa were recorded from the site which was reflected in the low MCI and SQMCI ranks of 'poor'.

Crans bully and shortfin eel were the only native fish recorded from the southern Alexandra Creek SEV reach. These species were common in the SEV reach, with 24 eels (size range 220 – 800mm) and ten bullies (ranging from 34mm to 67mm long) recorded. No koura or other larger invertebrates were found the creek, but the exotic mosquito fish was present. The Fish IBI score was 22, indicative of 'poor' species diversity in comparison to other Auckland streams, given the altitude and distance from the sea (Joy & Henderson, 2004).

A search of the New Zealand freshwater fish database for Alexandra Stream returned fish records for four additional native fish; longfin eel, banded kokopu, common bully, and redfin bully. The quality of native galaxiidae spawning habitat was low. Although the shading was moderate to high there were only small areas of near-flat slope.

The SEV score for Alexandra Stream south, was moderate (0.52), indicating that the stream retained some ecological values despite land use changes. This section of the stream scored well for water temperature control, provided by the high amount of shading, and organic matter input from the restoration planting, but poorly for biodiversity (fish and macroinvertebrates) and access to the floodplain.

Alexandra Stream south, within Omega Reserve and within the Project area, forms a narrow soft bottomed watercourse with the potential for moderate to high volume flows.

Figure 39 Alexandra Stream South, Rook Reserve – Downstream

Figure 40 Alexandra Stream South, Rook Reserve – Upstream

3.5.4 Alexandra Stream North – Omega Reserve (SEV4)

Alexandra Stream, north of the UHH, lies within Omega Reserve. The Project area includes just over 200m of the stream north of the Upper Harbour Highway to Paul Matthews Road. Alexandra Stream was flowing at the time of the assessment and a SEV was carried out over a 200m reach of the stream. A SEV was carried out on 5 May 2016.

The stream drains south to north, from a culvert under the UHH, to a culvert under Paul Matthews Drive. The stream averaged 1.9m wide (maximum 3.05m) and 0.3m deep (maximum 0.97m) and formed a well shaded, natural channel with sloping banks (**Figure 41**and **Figure 42**). The stream showed little hydrologic variation and formed a run with occasional pools. There was a good variety and abundance of favourable aquatic habitats present in the northern stream, including woody debris, undercut banks, root mats, rooted aquatic vegetation and other stable habitats.

The substrate was predominantly silt, with bedrock and small wood providing harder substrate. Aquatic macrophytes were present in most cross sections throughout the SEV reach. The macrophytes included willow weed, water celery, purslane, watercress, curly pond weed, swamp lilly, buttercup and forget-me-not. The riparian vegetation in Omega Reserve adjacent to Alexandra Creek comprised a mix of native restoration planting, exotic weeds and grass (refer to the Assessment of Terrestrial Ecological Effects).

An *in situ* measurement of basic water quality parameters showed the water temperature to be cool, 16.0^{o}C, within the temperature range of 'good' (Biggs *et al*., 2002). Conductivity was moderate (235 µS/cm), indicative of good stream health with low enrichment. Dissolved oxygen concentration and saturation were high, at 8.4mg/L and 85% respectively, a level where no stress is expected on aquatic organisms.

Macroinvertebrates were similar to the upstream site (Alexandra Stream south) and dominated by the freshwater snail and dragonfly larvae *Xanthocnemis zelandica,* comprising 76% and 13% of the individuals respectively. No sensitive taxa (with individual MCI scores ≥ 8) and only one EPT taxa were recorded from the site which was reflected in the low MCI and SQMCI ranks of 'poor'.

Longfin eel, shortfin eel and Crans bully were recorded from the northern Alexandra Stream SEV reach. These species were common in the SEV reach, with over 60 eels and fourteen bullies recorded. The shortfin eel ranged in size from elvers (10mm) to small adults (510mm) and the single longfin eel identified was 1100mm long. The bullies ranged in size from 36mm to 63mm. The Fish IBI score was 30, indicative of 'fair' species diversity in comparison to other Auckland streams and a

reflection of the presence of longfin eel. Longfin eel is listed as 'At Risk; Declining' on the national threatened species list (Goodman, *et al.*, 2014; Hitchmough *et al.*, 2007). Their presence elevates the value of this stream as habitat for aquatic biota.

The search of the New Zealand freshwater fish database for Alexandra Stream returned fish records for three additional native fish, banded kokopu, common bully, and redfin bully, as discussed above. There was no suitable habitat for native galaxiidae in the northern section of Alexandra Stream.

The SEV score for Alexandra Stream north was moderate (0.51) and very similar to Alexandra Stream south, indicating that the stream retained some ecological values despite land use changes. This section of the stream scored higher for fish fauna than the other SEV sites assessed and scored well for water temperature control.

Alexandra Stream within the Project area forms thickly vegetated watercourse with the potential for moderate to high volume flows, evident from flood debris on the bank and the size of the catchment (approximately 173ha).

Figure 41 **Alexandra Stream, Omega Reserve – Downstream**

Figure 42 **Alexandra Stream, Omega Reserve – Upstream**

4 Effect Assessment: Construction Activities

The principal activities associated with the construction of the Project that may affect freshwater habitats and aquatic organisms are:

- Earthworks and associated water treatment and discharge;
- Watercourse modification through filling, piping or culverting;
- Removal of stormwater ponds; and
- Works adjacent to or in watercourses such as construction of outfalls.

4.1 Earthworks

The Assessment of Construction Water Management (**Technical Assessment 4**) assesses the potential effects of the Project associated with construction water management and outlines the best practice for the construction to be undertaken. The Project is centred on widening the existing State highway carriageway and has minimal earthwork activities, the exception being the area of earthworks associated with the SH18 / SH1 tie in location.

The assessment of construction water management considers that the effects of construction activities and associated water management can be appropriately managed following implementation of the recommendations and associated conditions put forward in the Assessment of Construction Water Management.

The earthworks methodology has been designed in accordance with NZ Transport Agency Guidelines and TP90 and the erosion and sediment control principles that will apply to this Project are outlined in Section 5 of the Assessment of Construction Water Management, including the Design Guiding Criteria of:

- Overall Erosion and Sediment Control Approach (Section 5.2);
- Erosion Control Measures (Section 5.3);
- Sediment Control Measures (Section 5.4); and
- Sequencing of Erosion and Sediment Controls (Section 5.5).

These include ongoing, progressive and rapid stabilisation of disturbed areas utilising hardfill and the use of super silt fences in those areas of work adjacent to, or in the immediate vicinity of, any freshwater stream systems.

As part of the erosion and sediment control implementation, as outlined in the Assessment of Construction Water Management, ongoing site monitoring by a site based erosion and sediment control team (ESC Team) will occur to ensure that the proposed construction water management measures have been installed correctly, methodologies are being followed and are functioning effectively throughout the duration of the works. This will include visual inspections of any downstream freshwater receiving environments throughout the construction period.

Flocculation treatment of sediments will occur in all sediment retention ponds on the Project. The application of flocculants will be carried out in accordance with best practice principles, will be monitored and will be undertaken in accordance with Section 6.2.5 of the Assessment of Construction Water Management.

The Assessment of Surface Water Quality Effects (**Technical Assessment 12**) report concludes that the potential effects of discharges from earthworks on water quality are likely to be no more than

minor. Based on this assessment, in combination with the Assessment of Construction Water Management, the effects of the construction water discharges will be no more than minor.

4.2 Oteha Valley Road to McClymonts Road

4.2.1 Lucas Creek (SEV1)

Lucas Creek, within the Project area, forms a steep sided watercourse with the potential for high volume flows. The ecological values within this part of Lucas Creek have been assessed as being moderate.

A new stormwater outfall from the proposed Oteha Valley East Stormwater Wetland will be constructed at the edge of Lucas Creek.

Works this close to Lucas Creek have the potential to create sedimentation from disturbed soils. However, effective sediment management tools are available to ensure that sediment discharges do not occur from the construction area. The erosion and sediment controls that will be implemented are outlined in Section 5 of the Assessment of Construction Water Management. Provided stringent sediment control measures are implemented, for example super silt fencing and/or compost filled socks between the works area and the stream, and the open works area is minimised, well stabilised and re-vegetated prior to removal of the sediment control measures, then the effects on the stream from sedimentation as a result of the works will be less than minor.

4.2.2 SWP 1 Alpurt A1 Pond 29 (Oteha Valley East) and SWP 2 Alpurt A1 Pond 30 (Oteha Valley West)

SWP 1 (Oteha Valley East) and SWP 2 (Oteha Valley West) will be retained and no works are planned within these ponds.

4.2.3 SWP 3 Alpurt A1 Pond 31 Stormwater pond between Masons Road and SH1 southbound

SWP 3 is to be removed and replaced with a new larger stormwater wetland constructed downstream adjacent to Oteha Valley Road (Oteha Valley East Wetland).

Removal of the existing stormwater pond will result in the loss of very low quality aquatic habitat. Loss of the stormwater pond discharge outlet watercourse will result in the loss of approximately 30m of moderate to low value aquatic habitat. In addition, works within this area have the potential to release sediment into Lucas Creek.

Both the pond and the discharge outlet watercourse contain native freshwater fish (eel in the pond and banded kokopu in the pond outlet watercourse). To mitigate the effects on native fish of the removal of the pond and outlet watercourse, native fish recovery and relocation should occur prior to any works being undertaken and a suitably qualified freshwater ecologist should be onsite during dewatering to rescue and relocate native fish present.

The site will be progressively stabilised and sequenced to minimise the discharge of sediment into the downstream watercourse (Lucas Creek). Sections 9.1 and 9.6 of the Assessment of Construction Water Management set out the procedures to dewater the ponds and the prevention and stabilisation measures that will be implemented to ensure sediment is captured before it enters the downstream culverts. These sediment control measures will be retained until the site is fully stabilised. With these measures in place, the potential effects of the works near the stream will be negligible.

4.3 McClymonts Road to Rosedale Road

4.3.1 Oteha Stream Tributary (SEV2)

The part of Oteha Stream tributary within the Project area forms a steep-sided incised watercourse.

The Project will involve use of the site surrounding the watercourse as a construction support area (CSA). The CSA has been reduced in size from the original proposal to avoid effects on the existing trees and watercourse.

The CSA will be well stabilised and sedimentation from the CSA will be minimised with the methodologies outlined in Section 9.1 of the Assessment of Construction Water Management report. Water will be diverted around the boundary of the site to a sediment retention pond in the south-western corner of the CSA, discharging to the downstream end of Oteha Stream Tributary (refer to Sheet 3, Appendix D of the Assessment of Construction Water Management). The sediment retention pond is designed for the capacity of the 1.43ha CSA. Provided the best practice methodologies outlined in the Assessment of Construction Water Management for sedimentation are utilised, the effects of the Project on the watercourse will be less than minor.

4.3.2 Tawa Reserve

Upper Oteha Stream, within Tawa Reserve, forms a stabilised steep sided watercourse. The short area of the watercourse within the Project area includes several culverts, culvert apron, the scour pool and stream immediately below the pool. Potential adverse effects of works in the watercourse and on the banks in the vicinity of the creek include bank failure, sedimentation and loss of a small section of low quality aquatic habitat.

Project works in or near the upper watercourse will involve the placement of two new rip-rap aprons for stormwater outfalls (OF 8 and OF 10, refer to the Assessment of Stormwater Management and the Stormwater Layout Plan Drawing 1404).

The areas the rip-rap aprons are to be placed have been previously stabilised with large rocks and provided sedimentation is minimised and the site stabilised (refer to **Section 4.2.1** above), there should be no adverse effects on the watercourse. The rip-rap aprons will provide energy dissipation of stormwater and reduce potential scour of the watercourse.

No changes are proposed to the existing stormwater outlets or outfalls in the upper Oteha Stream (OF 9 and OF 11).

4.3.3 SWP 4 Alpurt A1 Pond 32 Stormwater pond adjacent to McClymonts Road.

The Project proposes to remove SWP 4 (Alpurt A1 32) at McClymonts Road. The existing cut off drains will discharge to a new extended culvert under SH1 to the new McClymonts Road wetland on the western side of SH1.

The removal of SWP 4 will result in loss of very low quality aquatic habitat and potential sedimentation effects within the downstream ponds near Westgate, Albany. These effects would be minor and can be mitigated to less than minor by the use of a sediment control plan designed to prevent sediment discharge into the existing stormwater system.

Sections 9.1 and 9.6 of the Assessment of Construction Water Management set out the procedures to dewater the ponds and the prevention and stabilisation measures that will be implemented to ensure sediment is captured before it enters the downstream culverts. The site will be progressively stabilised and sequenced to minimise the discharge of sediment into the downstream receiving environment and

the proposed new McClymonts Road wetland with be utilised as a sediment retention device during construction. These measures will be retained until the site is fully stabilised. With these measures in place, the potential effects of the works near the stream will be negligible.

Although no native fish were recorded from the stormwater pond it is likely that eels are present. To mitigate the potential effects of the removal of the pond, native fish recovery and relocation should occur prior to the works commencing and a suitably qualified freshwater ecologist should be onsite during dewatering to rescue and relocate native fish present. With this proposed mitigation in place, the potential adverse effects associated with the removal of the Alpurt A1 Pond 32 will be less than minor.

4.3.4 SWP 5 Alpurt A1 Pond 33 Stormwater pond near Colliston Rise

The Project proposes to remove SWP 5 (Alpurt A1 Pond 33) east of SH1 near Colliston Rise with the stormwater diverting under SH1 to the new Greville Road wetland on the western side of SH1.

Sections 9.1 and 9.6 of the Assessment of Construction Water Management set out the procedures to dewater the ponds, and prevention and stabilisation measures that will be implemented to ensure sediment is captured before it enters the downstream culverts. The site will be progressively stabilised and sequenced to minimise the discharge of sediment into the downstream watercourse (tributary to Oteha Creek) via the stormwater system. With these measures in place, the potential effects of the works near the stream will be negligible.

Although no native fish were recorded from the stormwater pond it is possible that eels are present. To mitigate the potential effects of the removal of the pond, native fish recovery and relocation should occur prior to the works commencing and a suitably qualified freshwater ecologist should be onsite during dewatering to rescue and relocate any native fish present. With this proposed mitigation in place, the potential adverse effects associated with the removal of the Alpurt A1 Pond 33 will be less than minor.

4.3.5 SWP 6 CD Stormwater pond at 35 Corinthian Drive

SWP 6 CD is outside of the Project area. Although no works are proposed in the stormwater wetland, the proposed Greville Road Wetland and the proposed western Greville Road CSA abut the stormwater wetland and sedimentation from the works areas has the potential to adversely affect the existing wetland. Works involving the construction of the new Greville Road Wetland and the CSA will be quickly stabilised, water from the works areas will be separated from SWP 6 and maintained onsite by boundary diversion to a sediment retention pond. Stormwater from the upper site will be captured by the proposed new wetland which will be utilised as an interim construction stormwater retention pond (refer to Section 9.1 and Sheet 3, Appendix D of the Assessment of Construction Water Management). With these measures in place, the effects of the construction on SWP 6 will be negligible.

4.3.6 SWP 7 RL Stormwater pond at north-western corner of Rosedale closed landfill

Although part of SWP 7 lies within the Project area, no works are proposed in the pond and the stormwater pond will be retained. The use of cut and cover methodology for construction of the shared use path that will about the pond (Section 5.2 of the Assessment of Construction Water Management) will have negligible effects on the ecology of the pond.

4.3.7 SWP 8 Alpurt A1 Pond 34 and SWP 9 Alpurt A1 Pond 35 Greville Road motorway intersection stormwater ponds

The existing outlets for both SWP 8 (Alpurt A1 Pond 34) and SWP 9 (Alpurt A1 Pond 35) will be raised and a silt fence will be utilised on the western side of the pond, adjacent to Greville Road.

As no major works are proposed in SWP 8 (north) and SWP 9 (south) and the stormwater wetlands are to be retained, the Project will have no effect on the aquatic ecology of these ponds.

4.4 Rosedale Road to Constellation Drive

4.4.1 South of Arrenway Reserve Stormwater Drain (Moro Pond)

Within this area, the existing drain will be piped to enable construction of an adjacent new stormwater wetland. This work will result in the loss of very low quality aquatic habitat. However, since native eels are located within the existing drain, it is recommended that these are relocated prior to commencement of construction.

Potential adverse effects of works in the stormwater drain, and within the vicinity of the drain include sediment discharge into the existing stormwater system. All culvert inlet and outlets will be protected by a super silt fence as outlined in the Assessment of Construction Water Management (Sheet 5, Appendix D), which mitigate the potential adverse effects to less than minor.

4.4.2 Stormwater system south of RWWTP Pond 2

With the exception of relocating the existing bell mouth intake structure (Stormwater Layout Plan Drawing 1405) within the concrete lined stormwater drain, no works are planned in the stormwater system south of Pond 2. The aquatic ecological effects of relocating the intake will be less than minor.

4.4.3 RWWTP Pond 1 and 2 adjacent to SH1

Section 9.7 of the Assessment of Construction Water Management sets out the proposed measures to prevent sedimentation from the works into the ponds, including the use of a cofferdam. These measures will ensure that the discharges from Pond 2 meet the water quality requirements set out in Watercare's discharge consents.

4.4.4 SWP 10 ARC Refuse Pond – Stormwater pond on RWWTP site, adjacent to UHH off-ramp

The ARC Refuse Pond will be removed as part of the Project. This work will result in the loss of very low quality aquatic habitat.

The stormwater pond contains a small population of native freshwater fish (shortfin eel). To mitigate the potential effects of the removal of the pond, native fish recovery and relocation should occur prior to the works commencing and a suitably qualified freshwater ecologist should be onsite during dewatering to rescue and relocate native fish present. With this proposed mitigation in place, the potential adverse effects associated with the removal of the ARC Refuse Pond will be no more than minor.

In accordance with the Erosion and Sediment Control Plans within Appendix D of the Assessment of Construction Water Management, the site will be progressively stabilised and sequenced to minimise the discharge of sediment into the downstream watercourses adjacent to Ponds 1 and 2, and all culvert inlets and outlets will be protected by super silt fence.

4.5 Upper Harbour Highway from SH1 to Albany Highway

4.5.1 RWWTP central watercourse – near Upper Harbour Highway on-ramp north

The Project proposes to extend the existing culvert from under SH1 to a new stormwater pond (proposed ARC Refuse Pond) downstream near RWWTP Pond 1 (Refer to the Assessment of Stormwater Management and Stormwater Layout Plan Drawing 1405). The quality of the habitat within this watercourse is low. This site was not fished for native freshwater fish, but considering the moderate number of eels in the upstream stormwater pond and the presence of an occasional eel downstream, eels are assumed to be present in the discharge watercourse.

On this basis, native fish recovery and relocation is recommended for the works within this location. The works area should be isolated, the water flow temporarily diverted and work should be staged to allow the upper watercourse to de-water naturally, allowing fish to move into the lower channel prior to any major stream works. Native fish recovery and relocation should then be carried out at the site to ensure any stranded native fish are relocated.

4.5.2 RWWTP Watercourses South of Pond 1

With the exception of the immediate vicinity of SH1, involving the widening of the SH1 causeway, no works are planned within the stormwater drain following the shoreline of Pond 1.

New ramps linking SH18 and SH1 will be constructed between UHH and Pond 1 of the RWWTP. Works will include cut and fill, the construction of roading and on and off-ramps, culverting of the existing stormwater drain and construction of two new stormwater retention devices, one wetland and one dry pond. The extent of the earthworks, location of the new culverts and modification of stormwater drains into stormwater culverts or wetlands are shown in the Stormwater Layout Plan Drawing 1408 and will result in the culverting of approximately 130m of concrete lined stormwater drain, classified under the AUP as a permanent stream, and the loss of up to 430m highly modified extremely poor quality aquatic habitat.

Shortfin eel were observed in the lower stormwater drain. Native fish recovery and relocation should occur prior to the works commencing.

Section 5 and 9.1 of the Assessment of Construction Water Management set out the prevention and stabilisation measures that will be implemented to ensure sediment is captured before it enters the downstream stormwater system. These measures will be retained until the site is fully stabilised. With these measures in place, the potential effects of the works on the downstream stormwater system and ultimately to the Oteha Stream receiving environment will be less than minor.

4.5.3 Alexandra Stream South – Rook Reserve (SEV3)

Alexandra Stream south, within Rook Reserve and within the Project area, forms a narrow soft bottomed watercourse with the potential for moderate to high volume flows.

No stream works are planned in Alexandra Stream within this part of the Project area. A new outfall (OF 16) from the proposed Rook Wetland, south of UHH and east of Alexandra Stream, is proposed near the existing culvert (refer to the Assessment of Stormwater Management and Stormwater Layout Plan Drawing 1409).

The greatest potential adverse effect on Alexandra Stream from construction of the outfall would be sedimentation from disturbed soils. Provided the sediment control measures are in accordance with the sediment control design criteria utilised in Section 5 of the Assessment of Construction Water

Management, the effects on the stream from sedimentation as a result of the works will be less than minor.

4.5.4 Alexandra Stream North – Omega Reserve (SEV4)

Alexandra Stream north, within the Project area, forms a thickly vegetated watercourse with the potential for moderate to high volume flows.

No stream works are planned in Alexandra Stream near Omega Reserve. A new outfall (OF18) is proposed near the existing culvert.

The greatest potential adverse effect on Alexandra Stream from construction of the outfall would be sedimentation from disturbed soils. Provided the sediment control measures are in accordance with the sediment control design criteria utilised in Section 5 of the Assessment of Construction Water Management, the effects on the stream from sedimentation as a result of the works will be less than minor

4.6 Conclusion

Overall, it is considered that the construction effects on the freshwater ecology within the Project area will be no more than minor.

5 Effect Assessment: Operation of Project

The principal activities associated with the operation of the Project that may affect freshwater habitats and aquatic organisms relate to:

- Stormwater discharges - elevated concentrations of contaminants in the streams downstream of stormwater discharges, temperature increases in discharge water and changes in water volume and flow;
- Changes to stormwater wetlands; and
- Culverting and filling of watercourses.

5.1 Stormwater discharges

There is a potential for adverse water quality effects arising from stormwater runoff from roads, including hydrocarbons and trace metals.

The Assessment of Stormwater Management provides a detailed explanation of the design and capacity of the stormwater treatment for the operation of the Project. **Figure 43** (as sourced from the Assessment of Stormwater Management), illustrates the proposed stormwater devices and outfall locations.

In summary, the potential water quality effects of the stormwater and increased impervious surfaces from the Project on freshwater aquatic habitats will be mitigated by the:

- Seven new wetlands and one new pond, which will provide treatment, detention and attenuation of stormwater runoff from existing and new impervious areas;
- Three Alpurt stormwater ponds and one Auckland Council stormwater pond to be replaced by stormwater wetlands, providing a higher level treatment, detention and attenuation of stormwater, and an increase in ecological habitat and function;
- Three dry detention ponds;
- Two swales, which are proposed for treatment where there is limited space for wetlands, and also for informal pre-treatment prior to discharge to wetlands where practical; and
- Proprietary devices at Greville Road (discharging to Alpurt A1 Pond 35) and potentially at the proposed Rook Wetland.

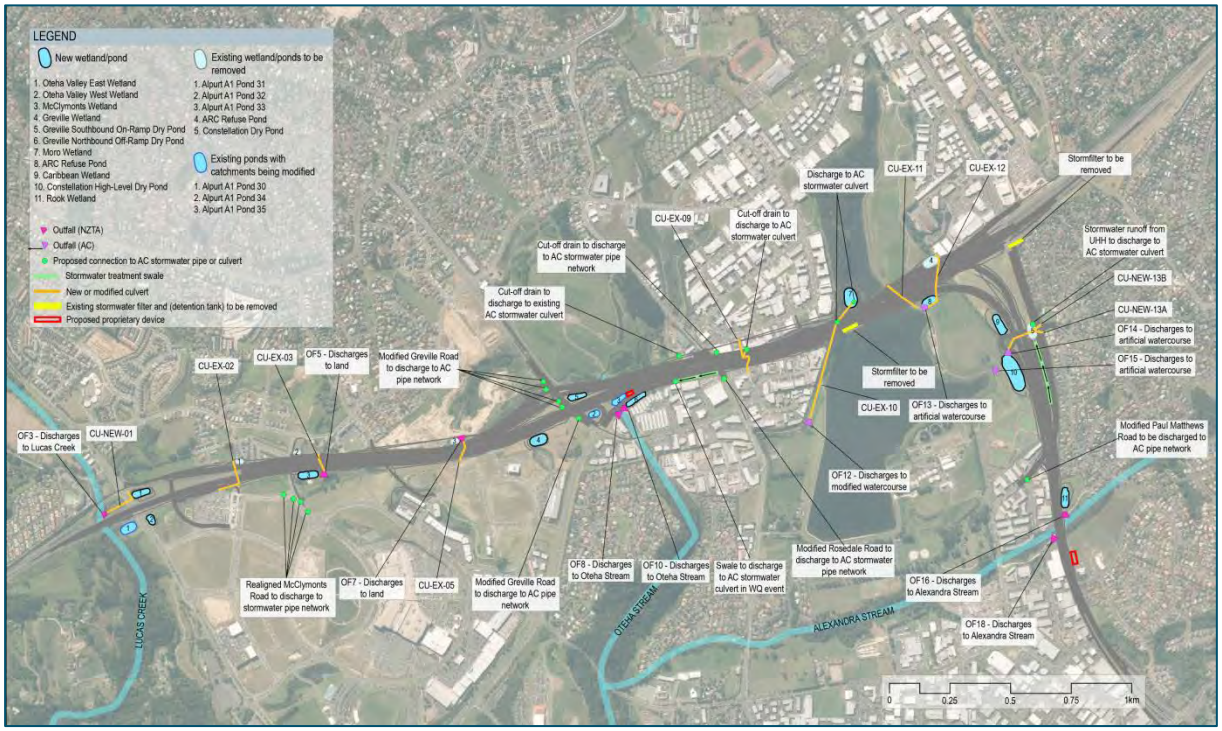
Treatment of 75% total suspended solids removal on a long-term average basis will be achieved for all new high use road (HUR) areas (Refer Tables 18, 19, 20 and 21 of the Assessment of Stormwater Management).

Section 9.3 of the Assessment of Stormwater Management concludes that during the operational phase, the effects of contaminants in stormwater from the Project on the downstream receiving environment will be mitigated by treatment devices designated in accordance with the AUP requirements, Auckland Council's Technical Publication 10 and Technical Report 2013/035. A thorough best practicable option (BPO) analysis has been undertaken to determine the best option for ensuring that any water quality effects are appropriately managed and that overall the proposed constructed wetlands, swales and proprietary devices are appropriate for managing the stormwater runoff from the Project.

The higher degree of stormwater treatment by the Project, over and above the existing level of treatment, will have a beneficial effect on stormwater quality and ultimately the aquatic ecological values of the receiving environments.

The effects of the Project on water quality are assessed in the Assessment of Surface Water Quality Effects.

Figure 43 Proposed Stormwater Devices and Outfall Locations



Source: Assessment of Stormwater Management (Figure 9).

Although increased flows from impervious areas have the potential to increase stream erosion, the wetlands and dry ponds proposed as part of the Project will also provide detention. These detention devices are important as the Project is within Stormwater Management Area Flow 1 and 2 controls in the AUP (Section 6.4 of the Assessment of Stormwater Management).

5.2 Outfalls

Stormwater discharges have the potential to increase the velocity of the water and cause erosion at the stormwater outlet. This will be mitigated with rip-rap apron and rip-rap basin protection at the stormwater outfalls, which have been designed to dissipate the energy of the water flow and avoid scour and erosion (refer to Section 7.3 and Appendix O of the Assessment of Stormwater Management).

Five new outfalls or combined outfalls to streams are proposed, one to Lucas Creek and two each to Oteha Stream and Alexander Stream respectively (as shown in **Figure 43** and on Stormwater Layout Plan Drawings 1401, 1404 and 1409 in the Assessment of Stormwater Management).

The new Lucas Creek outfall will be a combined outfall for Oteha Valley Wetlands and cut-off drain. Siting of the outfall will be crucial to avoid erosion of the banks of Lucas Creek. The outfall has been located to avoid discharging over the steep vertical banks of Lucas Creek and is situated where the bank profile is at a low point to the stream.

The two new Oteha Stream outfalls are outfalls for treated stormwater from the proposed Greville Wetland (OF8) and detained stormwater from the proposed Greville Northbound Off-ramp Dry Pond (OF10). The two new Alexandra Stream outfalls are for treated stormwater from the proposed Rook Wetland (OF16) and a new combined outfall for proposed cut-off drains and Paul Matthews to Albany Highway sub-catchment.

The new outfalls in Oteha Stream and Alexandra Stream are all located in the vicinity of the existing culverts and all the outfalls and have been designed in accordance Hydraulic Engineering Circular 14, as referenced in Auckland Council Technical Publication 10 (TP10). Appendix M of the Assessment of Stormwater Management provides details of the proposed culvert outfalls and rip-rap. The outfalls will be designed with large rip-rap aprons to reduce the velocity effects of the discharges of stormwater on the streams and prevent erosion or scour of the bank. The effects of the discharges will be less than minor.

The Project will result in an increase capacity of stormwater retention, and effective velocity and energy dissipation at all new outfalls. These measures will result in a reduction in the volume and velocity of the stormwater entering the receiving environment during a rain event, decreasing the risk of scour and erosion effects in the downstream aquatic habitats.

5.3 Stormwater Wetlands

Stormwater ponds have the potential to increase the temperature of the stormwater discharges to streams. The stormwater wetlands designed for the Project will be designed in accordance with TR2013/035 (Auckland Council, 2013) and are discussed in detail in Section 6.4 of the Assessment of Stormwater Management. In addition appropriate planting specifically on the northern boundary of the wetlands, will mitigate potential temperature effects. There is not expected to be an increase in temperature above those currently experienced in the stormwater pond discharges.

Treatment, detention and attenuation functions of existing ponds that are proposed to be removed will be replaced by proposed wetlands. The proposed stormwater wetlands will provide treatment of new HUR areas and also existing impervious areas where practical. This will result in a higher percentage of the motorway stormwater being treated.

The RWWTP watercourses south of Pond 1 are highly degraded, open and exposed, and the main watercourses are diverted concrete lined stormwater drains. Given the watercourses are to be converted into a new wetland with wetland plants, a variety of depths and habitat types, there will be an increase in biodiversity and an increase in aquatic ecological values. Additional riparian planting around the wetland, specifically on the northern side, is recommended as the riparian planting will increase the shading and substrate to the wetland, increase water temperature control and provide bankside shelter and habitat to birds utilising the wetland.

5.4 Modification of Watercourses

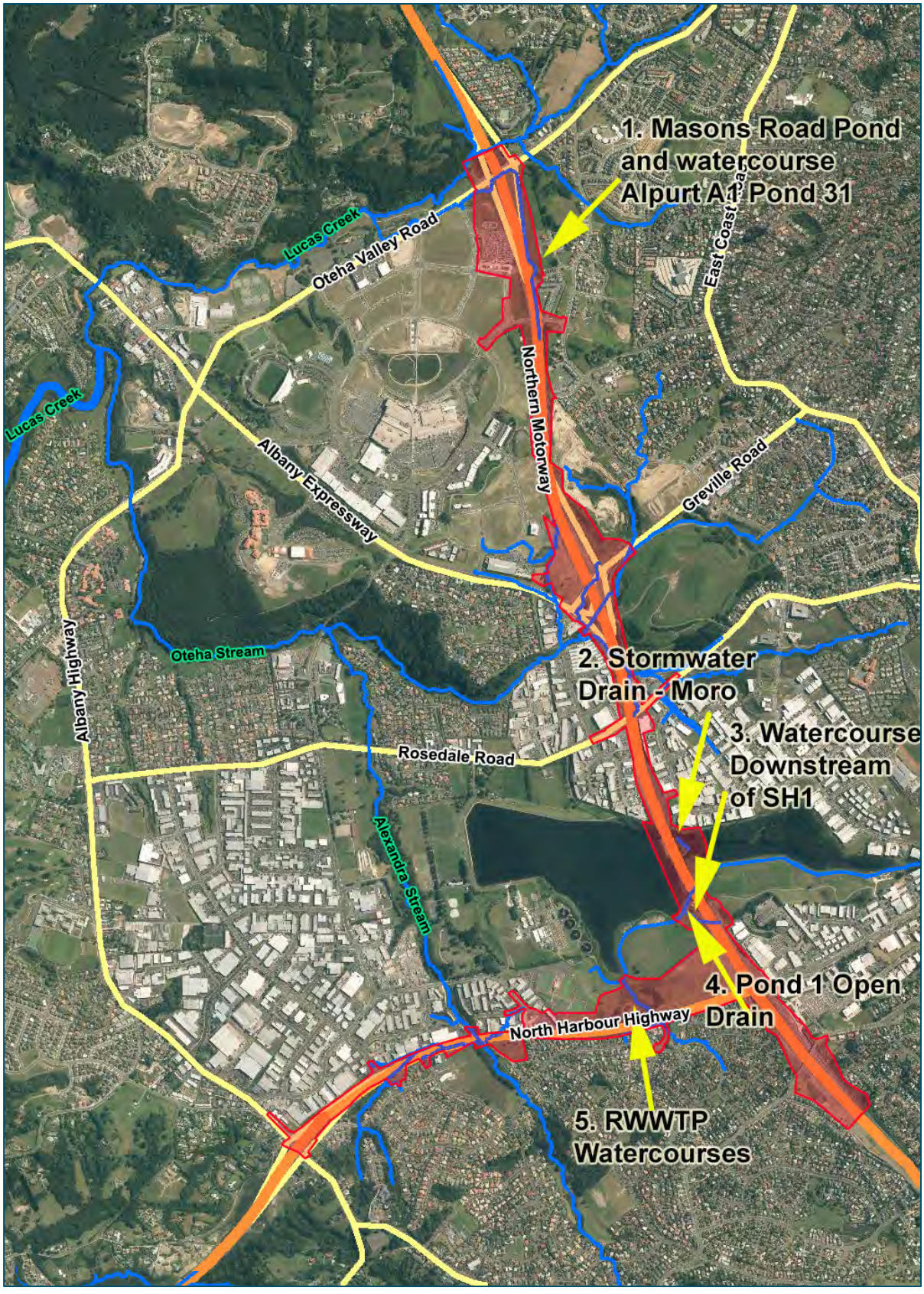
Modification of watercourses to form stormwater wetlands and/or culverting of permanent watercourses within the Project area has the potential to form barriers to fish passage and alter the current habitat and hydrology of the watercourses.

There are various watercourses that are affected by the Project as shown in **Figure 44**:

- Downstream of SWP 3 (Alpurt A1 31) near Masons Road, within the stormwater discharge channel;
- The open concrete lined stormwater drain (Moro Pond) south of Arrenway Reserve, adjacent to Pond 2;

- Downstream of the SH 1 UHH on-ramp north;
- The open concrete lined stormwater drain adjacent to Pond 1 and 2; and
- The area of Caribbean Drive concrete lined stormwater drains and intermittent watercourses on RWWTP grounds between UHH and Pond 1.

Figure 44 Sites of Proposed Culverts or Modification of Current Aquatic Habitat



Source: Base Map from Auckland Council GIS Viewer

Chapter E3 of the AUP sets out the rules relating to lakes, rivers and wetlands. Consideration has been given to whether the drainage channels affected by the Project fall within the definition of 'stream' in the AUP. 'Streams' are covered by the rules in Section E3 but artificial watercourses are not.

The term 'stream' is defined to exclude 'ephemeral streams' and 'artificial watercourses' (and therefore Chapter E3 does not apply to these types of watercourses). The term 'artificial watercourses' is defined as follows:

> *Constructed watercourses that contain no natural portions from their confluence with a river or stream to their headwaters.*
>
> *Includes:*
>
> - *canals that supply water to electricity power generation plants;*
> - *farm drainage canals;*
> - *irrigation canals; and*
> - *water supply races.*
>
> *Excludes:*
>
> - *naturally occurring watercourses.*

Each of the watercourses shown in **Figure 44** has been assessed to determine whether they fall under the definition of 'stream', 'ephemeral stream' or 'artificial watercourse' and what the potential effects of works in these areas are.

5.4.1 SWP 3 Alpurt A1 Pond 31 Stormwater Pond between Masons Road and SH1 Southbound

As outlined above, this short stormwater drainage channel was constructed by the NZ Transport Agency in 2004 and transports treated motorway stormwater from the stormwater pond to a culvert under SH1. This ephemeral watercourse is an 'artificial watercourse' that appears to have been constructed specifically for carrying stormwater flows from Alpurt Pond 31 to the culvert under the motorway. A review of aerial photographs of the area taken in 1959 provided no evidence of a watercourse in this location.

Removal of the stormwater pond discharge outlet drain will result in the loss of approximately 30m of stormwater drainage channel. Although this artificial watercourse receives the discharge from the Alpurt stormwater pond, it has provided a refuge habitat for native freshwater fish at the limit of their access upstream in the catchment. With the mitigation measures outlined in **Section 6** of this report, the effects of the loss of this stormwater channel will be less than minor.

5.4.2 South of Arrenway Reserve - Stormwater Drain (Moro Pond)

This concrete lined stormwater channel carries water from a catchment to the south and conveys it to a large culvert running under SH1 and north to Oteha Stream. The stormwater is discharged under Auckland Council's network discharge consent (NDC). This watercourse is an 'artificial watercourse' that appears to have been constructed specifically for carrying stormwater flows from the stormwater drains adjacent to the southern boundary of RWWTP Ponds 1 and 2. A review of aerial photographs of the area taken in 1959 provided no evidence of a natural watercourse in this location. With the mitigation measures outlined in **Section 6** of this report, the effects of the loss of this lined stormwater channel will be less than minor.

5.4.3 Downstream of the SH 1 Upper Harbour Highway On-ramp North

This watercourse conveys water from the ARC Refuse Pond, near Constellation Drive to the stormwater drains adjacent to RWWTP Pond 1. This ephemeral watercourse appears to have been constructed specifically for conveying stormwater from the ARC Refuse Pond. There is no evidence of this watercourse in the 1959 aerial photographs. Accordingly, this ephemeral stormwater drain is an 'artificial watercourse'.

Extension of the culvert and relocation of the ARC Refuse stormwater pond into the stormwater pond discharge watercourse, downstream of the existing ARC Refuse Pond (draining west under SH1 towards RWWTP Pond 1), will result in the modification of approximately 70m of low quality aquatic habitat. This ephemeral channel links the stormwater culvert under SH1 and the stormwater drains adjacent to Pond 1 and currently forms an open channel, pugged and fully accessed by cattle.

5.4.4 Pond 1 Open Drain

The concrete lined channel following the boundary of Pond 1 is an artificial watercourse. There were no natural watercourses in this location evident in the 1959 aerial photographs. The short length of concrete lined channel that is to be culverted when widening SH1 causeway, is part of the RWWTP conveyance system to ensure additional water does not enter the treatment ponds.

5.4.5 RWWTP watercourses south of Pond 1

New culverts and stormwater pipes, under the proposed intersection of SH1 and SH18, between UHH and RWWTP Pond 1, the proposed stormwater wetland (Caribbean Wetland) and dry pond (Constellation Pond) will result in the loss or modification of up to 560m of very poor quality aquatic habitat. Details of the proposed pipes, culverts, ponds and outfalls are provided in the Stormwater Layout Plan Drawing 1408 in the Assessment of Stormwater Management. Fish passage does not need to be considered, as there is no upstream native fish habitat (the catchment is fully urbanised and culverted); there are significant barriers downstream, including vertical manholes; and there is currently only very poor quality habitat for native fish (exposed, concrete drains) with no undercuts or shade for protection, and no woody debris or cobble for macroinvertebrates.

The majority of the stormwater from this area is proposed to be discharged via pipes into the proposed Caribbean Wetland and proposed Constellation Pond, ultimately discharging to the existing stormwater drainage system adjacent to Pond 1. There will be a small amount of stormwater over the proposed SH18 to SH1 ramps from this area that will discharge to the wetland near Alexandra Stream. The stormwater wetlands will provide an improved quality of the existing stormwater over the existing discharges, as these wetlands will provide retention, attenuation and natural treatment, where there is currently no retention or attenuation outside of the concrete drains.

5.5 RWWTP Ponds

Works on the causeway into RWWTP Pond 1 and Pond 2 and a link between the wastewater ponds is proposed. The ponds support very low quality aquatic habitat. The amount of habitat lost will be small in the context of the overall size of the ponds. The effect of this loss of aquatic habitat will be negligible.

5.6 Conclusion

In summary, the operational effects of culverting sections of the concrete lined stormwater drains will be less than minor on the very low value aquatic habitats. All the sections of stormwater drains that will be filled are highly modified aquatic habitats designed for the movement of stormwater between

existing stormwater culverts. They are open, relatively smooth sided, and unshaded, with poor aquatic ecological values.

Overall, it is considered that the operational effects on the freshwater ecology within the Project area will be no more than minor.

6 Mitigation Measures and Offset Mitigation

6.1 Introduction

The Project has been designed, as far as practicable, to avoid impacting on the aquatic habitats within the Project area. Where adverse impacts on aquatic habitats have not able to be avoided, then the Project has been designed to minimise or mitigate these effects.

The proposed mitigation measures for the Project have been outlined in the sections above and are, in summary, as follows:

- Recovery and relocation of native fish where populations are affected by construction works;
- Design of outfalls to prevent erosion and scour;
- Planting of riparian vegetation;
- Implementation of the erosion and sediment controls outlined in the Assessment of Construction Water Management; and
- Implementation of the stormwater management system outlined in the Assessment of Stormwater Management.

As outlined in this report, various stormwater wetlands and stormwater drainage channels will be lost as a result of the construction of the Project. Chapter E3 of the AUP sets out the rules relating to lakes, rivers and wetlands. Section E3.1 states that for the purpose of Chapter E3, the term 'wetland' does not include stormwater wetlands. Therefore, no consent is required to remove the existing stormwater treatment wetlands. In addition, 'artificial watercourses' and 'ephemeral streams' are not covered by Chapter E3.

Of the four watercourses that will be affected by the proposed SH1/SH18 interchange immediately south of Pond 1 (**Figure 30**), only the central concrete lined watercourse (Watercourse 2) conveying stormwater from the Caribbean Drive catchment is considered a 'stream' under the AUP. Culverting of a permanent or intermittent stream (greater than 30m) is a non-complying activity under the AUP and Objective E3.2 requires that *significant residual adverse effects* on streams that cannot be avoided, remedied or mitigated to be offset. The aquatic habitat of the open concrete lined stormwater drain is of very poor quality and culverting the drain will not result in a significant residual adverse effect. There will also be a significant biodiversity gain with the establishment of the stormwater wetland. In addition to the significant stormwater treatment advantages the proposed Caribbean Wetland has over the current drain, the stormwater wetland will contain a variety of aquatic flora and fauna, much greater than that of the current stormwater drain, provide habitat for birdlife and result in an increase in biodiversity values. Therefore, no off-setting is required.

7 Summary and Conclusions

The majority of the aquatic ecological values within the Project area are low. The Project has been designed to avoid aquatic habitats where possible, improve stormwater inputs to aquatic habitats by increasing the number of stormwater retention devices, increasing the capacity and retention of the stormwater system, replacing most stormwater ponds that are required to be relocated with stormwater wetlands, thereby increasing the quality of stormwater entering the streams; and where impacts on aquatic systems are unavoidable mitigate any adverse effects.

Native fish recovery and relocation should be carried out in all existing ponds where construction works are being carried out and in other aquatic environments, with native fish, affected by construction works.

Although no works are being carried out within what would normally be considered 'natural streams', construction of the SH1/SH18 interchange will involve filling a concrete lined stormwater drain, which technically falls within the definition of a 'stream' within the AUP, and therefore this work is a non-complying activity. Consideration has been given as to whether offset mitigation is required in order to address any significant residual effects. Given the stormwater drain contains only very poor quality habitat and there will be significant biodiversity gain from the establishment of the new stormwater wetland no offsetting is necessary.

All works near streams will include sediment control measures as outlined in the Assessment of Construction Water Management. It is considered that the effects of construction activities and associated water management on the freshwater ecosystems can be appropriately managed to a less than minor level following implementation of the recommendations and associated conditions put forward in the Assessment of Construction Water Management.

Table 4 Summary of Aquatic Ecological Values, Effects and Recommended Mitigation for the Project

Receiving environment		Ecological Value	Potential adverse effects without mitigation	Proposed mitigation	Potential adverse effects with mitigation
	Lucas Creek	Moderate	Moderate	Avoid. Sediment controls for works close to the creek or where the creek is the receiving environment. Rip-rap energy dissipation device at proposed outfall.	Less Than Minor
	SWP 1 Oteha Valley East & SWP 2 Oteha Valley West	Low	Minor	Avoid.	Less Than Minor
	SWP 3 (Alpurt A1 Pond 31)	Low	Moderate	Native fish recovery and relocation. Sediment controls.	Less Than Minor
McClymonts Road to Rosedale Road	Oteha Stream Tributary	Moderate	Moderate	Avoid. Sediment controls for adjacent CSA and sediment retention pond. Replacement planting for any loss of riparian planting.	Less Than Minor
	Tawa Reserve	Low	Minor	Avoid. Sediment controls. Rip-rap energy dissipation device at proposed outfalls.	Less Than Minor
	SWP 4 (Alpurt A1 Pond 32)	Low	Minor	Native fish recovery and relocation. Sediment controls.	Less Than Minor
	SWP 5 (Alpurt A1 (Pond 33)	Low	Less than minor	Native fish recovery and relocation. Sediment controls.	Less Than Minor
	SWP 6 35 Corinthian Drive.	Low	Moderate	Avoid. Sediment controls for adjacent works.	Less Than Minor
	SWP 7 Rosedale Landfill	Very Low	Less Than Minor	Avoid. Sediment controls for adjacent works.	Less Than Minor
	SWP 8 & SWP 9 Greville Road motorway intersection	Very Low	Less Than Minor	Sediment controls. Compensation for any loss of wetland or riparian planting.	Less Than Minor
Rosedale Road to Constellation Drive	Arrenway Reserve South Stormwater Drain (Moro Pond)	Very Low	Less Than Minor	Sediment controls. Native fish recovery and relocation.	Less Than Minor
	Stormwater system south of RWWTP Pond 2	Very Low	Less Than Minor	Sediment controls.	Less Than Minor
	SWP 10 ARC Refuse Pond	Low	Moderate	Native fish recovery and relocation. Sediment controls.	Less Than Minor
Upper Harbour Highway from SH1 to Albany Highway	RWWTP central watercourse	Low	Minor	Sediment controls. Native fish recovery and relocation. Compensation for any loss of riparian planting. Riparian planting on northern side of proposed stormwater pond.	Less Than Minor
	RWWTP watercourses south of Pond 1	Very Low	Less Than Minor	Sediment controls. Compensation for any loss of riparian planting. Instatement of a wetland. Planting of wetland with wetland vegetation. Riparian planting on northern side of proposed stormwater wetland.	Less Than Minor

Receiving environment		Ecological Value	Potential adverse effects without mitigation	Proposed mitigation	Potential adverse effects with mitigation
	Alexandra Stream Rook Reserve	Moderate	Moderate	Avoid. Sediment controls. Rip-rap energy dissipation device at proposed outfall.	Less Than Minor
	Alexandra Stream Omega Reserve	Moderate	Moderate	Avoid. Sediment controls. Rip-rap energy dissipation device at proposed outfall.	Less Than Minor

Note: Sedimentation during and after works has high potential to adversely affect aquatic habitats. This is covered in detail in the Assessment of Construction Water Management. Downstream receiving environments will also potentially be affected by sediment and storm water discharges. These need to be addressed to a very high standard to ensure the effects both at the works site and downstream of the works area are less than minor. Sediment control is provided for in the Assessment of Construction Water Management and stormwater discharges are discussed in the Assessment of Stormwater Management.

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Appendices

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Appendix A
SEV Summary Table

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Ecological Functions				
	SEV 1	**SEV 2**	**SEV 3**	**SEV 4**
	Lucas Creek	**Oteha Stream Tributary**	**Rook Reserve**	**Omega Reserve**
Hydraulic				
1. Natural flow regime	0.19	0.61	0.18	0.17
2. Floodplain effectiveness	0.00	0.00	0.08	0.18
3. Connectivity for migrations	1.00	1.00	1.00	1.00
4. Connectivity to groundwater	0.85	0.87	0.73	0.77
Biogeochemical				
5. Water temperature control	0.94	1.00	0.80	0.70
6. Dissolved oxygen maintained	0.50	1.00	0.60	0.40
7. Organic matter input	0.80	0.70	0.80	1.00
8. Instream particle retention	0.74	0.68	0.79	0.56
9. Decontamination of pollutants	0.47	0.60	0.50	0.48
Habitat Provision				
10. Fish spawning habitat	0.4	0.40	0.50	0.40
11. Habitat for aquatic fauna	0.65	0.55	0.55	0.52
Biodiversity				
12. Fish fauna intact	0.37	0.23	0.37	0.50
13. Invertebrate fauna intact	0.34	0.13	0.06	0.17
14. Riparian vegetation intact	0.14	0.38	0.33	0.3
Overall mean value (SEV)	**0.53**	**0.58**	**0.52**	**0.51**

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Appendix B
Raw Macroinvertebrate Data

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PHYLUM	CLASS: Order	Family	Taxa	Taxa MCI hb	Taxa MCI sb	Lucas Creek	Oteha Stream Tributary	Rook Reserve	Omega Reserve
ANNELIDA	OLIGOCHAETA		Oligochaeta	1	3.8		4	1	2
	HIRUDINEA		*Glossiphonia* sp.	3	1.2		2	10	25
PLATYHELMINTHES			Platyhelminthes	3	0.9		1	1	2
MOLLUSCA	GASTROPODA	Hydrobiidae	*Potamopyrgus antipodarum*	4	2.1	785	29	114	830
		Physidae	*Physella fontinalis*	3	0.1	60		6	45
		Lymneaidae	*Lymnaea columella*	3	1.2		1		20
ARTHROPODA	ARACHNIDA: Acari (mites)		Acari	5	5.2		1		
	Araneae		*Dolomedes* sp.	5	6.2		3		1
	CRUSTACEA: Ostracoda		Ostracoda	3	1.9		1	2	
	Amphipoda		*Paracalliope fluviatilis*	5	5.5	27	2		
	Decapoda		*Paranephrops planifrons*	5	8.4	2			
	Decapoda		*Paratya curvirostris*	5	3.6				1
	INSECTA: Megaloptera	Corydalidae	*Archichauliodes diversus*	7	7.3	2			
	Odonata	Zygoptera	*Xanthocnemis zealandica*	5	1.2		14	46	143
		Anisoptera	*Aeshna brevistyla*	5	1.4				1
			Hemicordulia australiae	5	0.4				1
	Trichoptera	Hydropsychidae	*Aoteapsyche colonica*	4	6	32			
		Hydroptilidae	*Oxyethira albiceps*	2	1.2				2
		Leptoceridae	*Triplectides obsoleta*	5	5.7	4			
	Hemiptera	Veliidae	*Microvelia* sp.	5	4.6		3	2	2
		Corixidae	*Sigara* sp.	5	2.4			2	8
			Anisops sp.	5	2.2			12	1
	Coleoptera	Elmidae	Elmidae	6	7.2	10			
	Diptera	Diptera	Diptera (larve)	3	2.9			2	
		Simuliidae	Austrosimulium	3	3.9	308		1	1
		Chironomidae	Chironomidae	2	3.8		46	5	2
	Collembola	Collembola .	Collembola	6	5.3	1	29		1
		TOTALS:	NO. TAXA			10	13	13	18
			NO. EPT TAXA			2	0	0	1
			NO. INDIVIDUALS			1231	136	204	1088

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Appendix C
Freshwater Fish Database Forms

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FRESHWATER FISH DATABASE FORM

SEV1

Date	**4/5/2016**	River/Lake system **Lucas Creek**						Catchment number	**078.030**		
Time	**1030**	Sampling locality **Lucas Creek**									
Observer	**md**	Access						Altitude (m)	**31.8**		
Organisation	**bior**	NZMS 260 Map no.	**R10**	Coord. **2663287**	**6496763**			Distance inland (km)	**4**		
Fishing method	**efp**	Area fished (m2) or no. nets used		Number of electric fishing passes	**1**			Tidal water	**n**		

HABITAT DATA

Water	Colour				**u**	Clarity			**m**	Temp.	**14.9**	pH	
	Average width (m)	**3.5**	Average depth (m)		**0.3**	Maximum depth (m)			**1.5**	Conductivity			**19**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool **40**	Run	**40**	Riffle	**15**	Rapid	**0**	Casc.	**5**
Substrate type (%)	Mud	**5**	Sand	**0**	Fine gravel **5**	Coarse gravel	**20**	Cobble	**5**	Boulder	**5**	Bed-rock	**60**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**y**	Undercut bank **y**	Bank veg.	**n**						
Catchment vegetation (%)	Native forest	**5**	Exotic forest	**0**	Farm **0**	Urban zone	**90**	Scrub	**5**	Swamp land	**0**	Other	**0**
Riparian vegetation (%)	Native forest	**70**	Exotic forest	**0**	Grass tussock **15**	Exposed bed	**5**	Scrub willow	**10**	Raupo flax	**0**	Other	**0**

Type of river/stream/lake **ftrssn**

Water level	**n**	Downstream barrier	**u**	Pollution	**l**		
Large invertebrate fauna	Koura	**c**	Paratya	**r**	Freshwater mussel	**u**	
Bottom fauna abundance	**m**	Predominant species group	**s**	Permanent water	**y**		

FISH DATA

Species		Abundance		Length	Habitat/Comments
Paranephrops	**Koura**	**20**	**(c)**	**b**	**gen**
Anguilla	**Unidentified eel**	**3**	**(o)**	**80-600**	**gen**
Gambusia affinis	**Gambusia**	**3**	**(o)**	**14-30**	**gen**
Gobiomorphus basalis	**Crans bully**	**3**	**(o)**	**26-40**	**gen**
Anguilla australis	**Shortfin eel**	**2**	**(o)**	**150-300**	**gen**

Comments **15168 DO 89.3%**

FRESHWATER FISH DATABASE FORM

SEV2

Date	**10/5/2016**	River/Lake system **Oteha Stream**						Catchment number	**078.036**		
Time	**0930**	Sampling locality **Oteha Stream**									
Observer	**mcl**	Access						Altitude (m)	**41.4**		
Organisation	**bior**	NZMS 260 Map no.	**R10**	Coord. **2663638 6494884**				Distance inland (km)	**5.6**		
Fishing method	**efp**	Area fished (m2) or no. nets used		Number of electric fishing passes	**1**			Tidal water	**n**		

HABITAT DATA

Water	Colour				**u**	Clarity		**d**	Temp. **14.1**		pH
	Average width (m)	**0.5**	Average depth (m)		**0.1**	Maximum depth (m)		**0.3**	Conductivity		**9**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool **20**	Run	**70**	Riffle **10**	Rapid	**0**	Casc. **0**
Substrate type (%)	Mud	**20**	Sand	**0**	Fine gravel **0**	Coarse gravel	**0**	Cobble **10**	Boulder	**0**	Bed-rock **70**
Fish cover (y/n)	Macrophyte	**n**	Instream debris	**y**	Undercut bank **n**	Bank veg.	**n**				
Catchment vegetation (%)	Native forest	**0**	Exotic forest	**0**	Farm **0**	Urban zone	**80**	Scrub **10**	Swamp land	**0**	Other **10**
Riparian vegetation (%)	Native forest	**0**	Exotic forest	**10**	Grass tussock **0**	Exposed bed	**0**	Scrub willow **90**	Raupo flax	**0**	Other **0**

Type of river/stream/lake **ftrssn**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**		
Large invertebrate fauna	Koura	**n**	Paratya	**n**	Freshwater mussel	**n**	
Bottom fauna abundance	**l**	Predominant species group	**k**	Permanent water	**y**		

FISH DATA

Species		Abundance	Length	Habitat/Comments
Anguilla	**Unidentified eel**	**9 (c)**	**50-120**	**gen**

Comments **15168 DO 94.7%**

FRESHWATER FISH DATABASE FORM

SEV3

Date	**6/5/2016**	River/Lake system **Alexandra Stream**						Catchment number	**078.036**		
Time	**1000**	Sampling locality **Rook Reserve**									
Observer	**md**	Access						Altitude (m)	**39.3**		
Organisation	**bior**	NZMS 260 Map no.	**R10**	Coord. **2663384 6492791**				Distance inland (km)	**6.2**		
Fishing method	**efp**	Area fished (m2) or no. nets used		Number of electric fishing passes	**1**			Tidal water	**n**		

HABITAT DATA

Water	Colour				**t**	Clarity			**m**	Temp. **17.4**	pH	
	Average width (m)	**2.1**	Average depth (m)	**0.3**		Maximum depth (m)			**0.9**	Conductivity		**12**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool **30**	Run	**65**	Riffle	**5**	Rapid **0**	Casc.	**0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel **0**	Coarse gravel	**0**	Cobble	**0**	Boulder **0**	Bed-rock	**0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**y**	Undercut bank **y**	Bank veg.	**y**					
Catchment vegetation (%)	Native forest	**0**	Exotic forest	**0**	Farm **0**	Urban zone	**100**	Scrub	**0**	Swamp land **0**	Other	**0**
Riparian vegetation (%)	Native forest	**0**	Exotic forest	**0**	Grass tussock **0**	Exposed bed	**0**	Scrub willow	**100**	Raupo flax **0**	Other	**0**

Type of river/stream/lake **ftrssn**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**		
Large invertebrate fauna	Koura	**n**	Paratya	**n**	Freshwater mussel	**n**	
Bottom fauna abundance	**m**	Predominant species group	**s**	Permanent water	**y**		

FISH DATA

Species		Abundance		Length	Habitat/Comments
Anguilla	**Unidentified eel**	**15**	**(a)**	**90-900**	**gen**
Anguilla australis	**Shortfin eel**	**9**	**(a)**	**220-800**	**gen**
Gobiomorphus basalis	**Crans bully**	**7**	**(c)**	**34-67**	**gen**
Gambusia affinis	**Gambusia**	**4**	**(o)**	**14-30**	**gen**

Comments **15168 DO 75.8%**

FRESHWATER FISH DATABASE FORM

SEV4

Date	**5/5/2016**	River/Lake system **Alexandra Stream**		Catchment number	**078.036**
Time	**1000**	Sampling locality **Omega Reserve**			
Observer	**md**	Access		Altitude (m)	**39.3**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663217 6492982**	Distance inland (km)	**6.1**
Fishing method	**efp**	Area fished (m2) or no. nets used	Number of electric fishing passes **1**	Tidal water	**n**

HABITAT DATA

Water	Colour				**t**	Clarity			**m**	Temp. **16**	pH	
	Average width (m)	**1.9**	Average depth (m)		**0.3**	Maximum depth (m)			**1.0**	Conductivity		**23**
Habitat type (%)	Still **0**	Back-water **0**	Pool **30**			Run **70**	Riffle **0**			Rapid **0**	Casc. **0**	
Substrate type (%)	Mud **90**	Sand **0**	Fine gravel **10**			Coarse gravel **0**	Cobble **0**			Boulder **0**	Bed-rock **0**	
Fish cover (y/n)	Macrophyte **y**	Instream debris **y**	Undercut bank **y**			Bank veg. **y**						
Catchment vegetation (%)	Native forest **0**	Exotic forest **0**	Farm **0**			Urban zone **100**	Scrub **0**			Swamp land **0**	Other **0**	
Riparian vegetation (%)	Native forest **0**	Exotic forest **0**	Grass tussock **0**			Exposed bed **0**	Scrub willow **100**			Raupo flax **0**	Other **0**	

Type of river/stream/lake **ftrssn**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**		
Large invertebrate fauna	Koura **n**	Paratya **r**	Freshwater mussel **n**				
Bottom fauna abundance	**l**	Predominant species group	**s**	Permanent water	**y**		

FISH DATA

Species		Abundance		Length	Habitat/Comments
Anguilla	**Unidentified eel**	**57**	**(a)**	**60-800**	**gen**
Anguilla dieffenbachii	**Longfin eel**	**1**	**(r)**	**1100**	**gen**
Anguilla australis	**Shortfin eel**	**7**	**(a)**	**200-510**	**gen**
Gobiomorphus basalis	**Crans bully**	**14**	**(c)**	**36-68**	**gen**

Comments **15168 DO 85.3%**

FRESHWATER FISH DATABASE FORM

SW1

Date	**6/5/2016**	River/Lake system **Lucas Creek**						Catchment number	**078.030**		
Time	**1240**	Sampling locality **Oteha Valley Stormwater Pond East**									
Observer	**md**	Access						Altitude (m)	**34**		
Organisation	**bior**	NZMS 260 Map no.	**R10**	Coord. **2663432 6496774**				Distance inland (km)	**4.1**		
Fishing method	**fyn**	Area fished (m2) or no. nets used	**2**	Number of electric fishing passes				Tidal water	**n**		

HABITAT DATA

Water	Colour				**o**	Clarity		**d**	Temp. **22.2**		pH	
	Average width (m)	**13.0**	Average depth (m)			Maximum depth (m)			Conductivity		**42**	
Habitat type (%)	Still	**0**	Back-water	**0**	Pool **100**	Run	**0**	Riffle **0**	Rapid	**0**	Casc.	**0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel **0**	Coarse gravel	**0**	Cobble **0**	Boulder	**0**	Bed-rock	**0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank **n**	Bank veg.	**n**					
Catchment vegetation (%)	Native forest	**0**	Exotic forest	**0**	Farm **0**	Urban zone	**100**	Scrub **0**	Swamp land	**0**	Other	**0**
Riparian vegetation (%)	Native forest	**0**	Exotic forest	**0**	Grass tussock **30**	Exposed bed	**0**	Scrub willow **30**	Raupo flax	**0**	Other	**40**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**		
Large invertebrate fauna		Koura	**n**	Paratya	**n**	Freshwater mussel	**n**
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**		

FISH DATA

Species		Abundance	Length	Habitat/Comments
Anguilla australis	**Shortfin eel**	**1 (o)**	**760**	**poo**

Comments **15168 DO 83.6%, 2 x fyke, 4 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW2

Date	**6/5/2016**	River/Lake system **Lucas Creek**		Catchment number	**078.030**
Time	**1230**	Sampling locality **Oteha Valley Stormwater Pond West**			
Observer	**md**	Access		Altitude (m)	**31.9**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663325 6496715**	Distance inland (km)	**4**
Fishing method	**fyn**	Area fished (m2) or no. nets used **2**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour				**o**	Clarity		**d**	Temp. **19.2**		pH	
	Average width (m)	**12.0**	Average depth (m)			Maximum depth (m)			Conductivity			**22**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool **100**	Run	**0**	Riffle **0**	Rapid	**0**	Casc.	**0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel **0**	Coarse gravel	**0**	Cobble **0**	Boulder	**0**	Bed-rock	**0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank **n**	Bank veg.	**n**					
Catchment vegetation (%)	Native forest	**0**	Exotic forest	**0**	Farm **0**	Urban zone	**100**	Scrub **0**	Swamp land	**0**	Other	**0**
Riparian vegetation (%)	Native forest	**0**	Exotic forest	**0**	Grass tussock **50**	Exposed bed	**0**	Scrub willow **30**	Raupo flax	**0**	Other	**20**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**
Large invertebrate fauna		Koura **n**	Paratya **n**	Freshwater mussel	**n**
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**

FISH DATA

Species		Abundance	Length	Habitat/Comments
Anguilla australis	**Shortfin eel**	**2 (o)**	**550-910**	**poo**

Comments **15168 DO 44%, 2 x fyke, 4 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW3

Date	10/5/2016	River/Lake system	Lucas Creek					Catchment number	078.030		
Time	1140	Sampling locality	Masons Rd Stormwater Pond								
Observer	md	Access						Altitude (m)	31.8		
Organisation	bior	NZMS 260 Map no.	R10	Coord.	2663586 6496245			Distance inland (km)	4		
Fishing method	fyn	Area fished (m2) or no. nets used	2	Number of electric fishing passes				Tidal water	n		

HABITAT DATA

Water	Colour	o			Clarity	d		Temp.	18	pH	
	Average width (m)	18.0	Average depth (m)		Maximum depth (m)			Conductivity	10		
Habitat type (%)	Still	0	Back-water	0	Pool	100	Run	0	Riffle	0	Rapid	0	Casc.	0
Substrate type (%)	Mud	100	Sand	0	Fine gravel	0	Coarse gravel	0	Cobble	0	Boulder	0	Bed-rock	0
Fish cover (y/n)	Macrophyte	y	Instream debris	n	Undercut bank	n	Bank veg.	n						
Catchment vegetation (%)	Native forest	0	Exotic forest	0	Farm	0	Urban zone	100	Scrub	0	Swamp land	0	Other	0
Riparian vegetation (%)	Native forest	0	Exotic forest	0	Grass tussock	100	Exposed bed	0	Scrub willow	0	Raupo flax	0	Other	0

Type of river/stream/lake **scposm**

Water level	n	Downstream barrier	u	Pollution	m		
Large invertebrate fauna		Koura	n	Paratya	n	Freshwater mussel	n
Bottom fauna abundance	u	Predominant species group		Permanent water	y		

FISH DATA

Species		Abundance		Length	Habitat/Comments
Anguilla australis	**Shortfin eel**	**1**	**(o)**	**920**	**poo**
Galaxias fasciatus	**Banded kokopu**	**1**	**(r)**	**130**	**poo**

Comments **15168 DO 97.9%, 2 x fyke, 4 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW4

Date	**10/9/2016**	River/Lake system **Lucas Creek**		Catchment number	**078.030**
Time	**0830**	Sampling locality **McClymonts Rd stormwater pond**			
Observer	**tjb**	Access		Altitude (m)	**64**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663619 6495983**	Distance inland (km)	**4.3**
Fishing method	**ntc**	Area fished (m2) or no. nets used **3**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour				**o**	Clarity		**d**	Temp. **12.0**		pH	
	Average width (m)	**8.0**	Average depth (m)			Maximum depth (m)			Conductivity			**13**
Habitat type (%)	Still	**100**	Back-water	**0**	Pool **0**	Run	**0**	Riffle **0**	Rapid	**0**	Casc.	**0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel **0**	Coarse gravel	**0**	Cobble **0**	Boulder	**0**	Bed-rock	**0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank **n**	Bank veg.	**y**					
Catchment vegetation(%)	Native forest	**0**	Exotic forest	**0**	Farm **0**	Urban zone	**100**	Scrub **0**	Swamp land	**0**	Other	**0**
Riparian vegetation(%)	Native forest	**0**	Exotic forest	**0**	Grass tussock **0**	Exposed bed	**0**	Scrub willow **50**	Raupo flax	**0**	Other	**50**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**y**	Pollution	**m**
Large invertebrate fauna	Koura **n**	Paratya **n**	Freshwater mussel	**n**	
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**

FISH DATA

Species	Abundance	Length	Habitat/Comments
- **No species recorded**			

Comments **15168 DO56.3%, 6.12mg/L, 1 x fyke, 2 x Gee minnow**

FRESHWATER FISH DATABASE FORM										SW5
Date	10/9/2016	River/Lake system	Oteha Stream					Catchment number	078.036	
Time	0850	Sampling locality	Colliston Rise Stormwater Pond							
Observer	tjb	Access						Altitude (m)	62	
Organisation	bior	NZMS 260 Map no.	R10	Coord.	2663680 6495370			Distance inland (km)	6.4	
Fishing method	gmt	Area fished (m2) or no. nets used	2	Number of electric fishing passes				Tidal water	n	

HABITAT DATA

Water	Colour	u			Clarity	c			Temp.	13.6	pH	
	Average width (m)	16.0	Average depth (m)	0.1	Maximum depth (m)	0.1			Conductivity	9		
Habitat type (%)	Still	0	Back-water	0	Pool	100	Run	0	Riffle	0	Rapid	0	Casc.	0
Substrate type (%)	Mud	100	Sand	0	Fine gravel	0	Coarse gravel	0	Cobble	0	Boulder	0	Bed-rock	0
Fish cover (y/n)	Macrophyte	y	Instream debris	n	Undercut bank	n	Bank veg.	n						
Catchment vegetation(%)	Native forest	0	Exotic forest	0	Farm	0	Urban zone	100	Scrub	0	Swamp land	0	Other	0
Riparian vegetation(%)	Native forest	0	Exotic forest	0	Grass tussock	100	Exposed bed	0	Scrub willow	0	Raupo flax	0	Other	0

Type of river/stream/lake **scposm**

Water level	n	Downstream barrier	y	Pollution	l		
Large invertebrate fauna		Koura	n	Paratya	n	Freshwater mussel	n
Bottom fauna abundance	u	Predominant species group		Permanent water	y		

FISH DATA

Species	Abundance	Length	Habitat/Comments
- **No species recorded**			

Comments **15168 DO 95.2% 9.95 mg/L, 2 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW6

Date	**4/5/2016**	River/Lake system **Oteha Stream**		Catchment number	**078.036**
Time	**1430**	Sampling locality **Cornithian Drive Stormwater Pond**			
Observer	**md**	Access		Altitude (m)	**45.1**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663618 6494995**	Distance inland (km)	**5.6**
Fishing method	**ntc**	Area fished (m2) or no. nets used **12**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour **o**			Clarity **d**			Temp. **17.7**	pH		
	Average width (m) **29.0**	Average depth (m)		Maximum depth (m)			Conductivity **11**			
Habitat type (%)	Still **0**	Back-water **0**	Pool **100**	Run **0**	Riffle **0**		Rapid **0**	Casc. **0**		
Substrate type (%)	Mud **100**	Sand **0**	Fine gravel **0**	Coarse gravel **0**	Cobble **0**		Boulder **0**	Bed-rock **0**		
Fish cover (y/n)	Macrophyte **y**	Instream debris **n**	Undercut bank **n**	Bank veg. **y**						
Catchment vegetation(%)	Native forest **0**	Exotic forest **0**	Farm **0**	Urban zone **100**	Scrub **0**		Swamp land **0**	Other **0**		
Riparian vegetation(%)	Native forest **0**	Exotic forest **0**	Grass tussock **90**	Exposed bed **0**	Scrub willow **10**		Raupo flax **0**	Other **0**		

Type of river/stream/lake **scposm**

Water level **n**		Downstream barrier **u**			Pollution **m**					
Large invertebrate fauna	Koura **n**		Paratya **n**		Freshwater mussel **n**					
Bottom fauna abundance **u**		Predominant species group			Permanent water **y**					

FISH DATA

Species	Abundance	Length	Habitat/Comments
Anguilla australis **Shortfin eel**	**1 (o)**	**320**	**poo**

Comments **15168 DO 125.6%, 4 x fyke, 8 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW7

Date	**10/5/2016**	River/Lake system **Oteha Stream**		Catchment number	**078.036**
Time	**1445**	Sampling locality **Rosedale Landfill Stormwater Pond**			
Observer	**md**	Access		Altitude (m)	**30.9**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663933 6494864**	Distance inland (km)	**5.5**
Fishing method	**ntc**	Area fished (m2) or no. nets used **8**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour					**o**	Clarity		**d**	Temp. **18.4**	pH	
	Average width (m)	**30.0**	Average depth (m)				Maximum depth (m)			Conductivity		**44**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool	**100**	Run	**0**	Riffle **0**	Rapid **0**	Casc.	**0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel	**0**	Coarse gravel	**0**	Cobble **0**	Boulder **0**	Bed-rock	**0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank	**n**	Bank veg.	**n**				
Catchment vegetation(%)	Native forest	**0**	Exotic forest	**0**	Farm	**0**	Urban zone	**70**	Scrub **0**	Swamp land **0**	Other	**30**
Riparian vegetation(%)	Native forest	**0**	Exotic forest	**0**	Grass tussock	**70**	Exposed bed	**0**	Scrub willow **10**	Raupo flax **0**	Other	**20**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**
Large invertebrate fauna	Koura **n**	Paratya **n**	Freshwater mussel	**n**	
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**

FISH DATA

Species	Abundance	Length	Habitat/Comments
- **No species recorded**			

Comments **15168 DO 43.1% 2 x fyke, 6 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW8

Date	**11/5/2016**	River/Lake system **Oteha Stream**		Catchment number	**078.036**
Time	**1145**	Sampling locality **Greville Rd Roundabout Stormwater Pond**			
Observer	**md**	Access		Altitude (m)	**35.1**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663793 6494780**	Distance inland (km)	**5.5**
Fishing method	**ntc**	Area fished (m2) or no. nets used **3**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour					**o**	Clarity			**d**	Temp. **17.7**	pH
	Average width (m)	**37.0**	Average depth (m)				Maximum depth (m)				Conductivity	**28**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool	**100**	Run	**0**	Riffle	**0**	Rapid **0**	Casc. **0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel	**0**	Coarse gravel	**0**	Cobble	**0**	Boulder **0**	Bed-rock **0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank	**n**	Bank veg.	**y**				
Catchment vegetation(%)	Native forest	**0**	Exotic forest	**0**	Farm	**0**	Urban zone	**100**	Scrub	**0**	Swamp land **0**	Other **0**
Riparian vegetation(%)	Native forest	**0**	Exotic forest	**0**	Grass tussock	**50**	Exposed bed	**0**	Scrub willow	**10**	Raupo flax **0**	Other **40**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**		
Large invertebrate fauna		Koura	**n**	Paratya	**n**	Freshwater mussel	**n**
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**		

FISH DATA

Species	Abundance	Length	Habitat/Comments
- **No species recorded**			

Comments **15168 DO 65.2% 1 x fyke, 2 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW9

Date	**11/5/2016**	River/Lake system **Oteha Stream**		Catchment number	**078.036**
Time	**1130**	Sampling locality **Greville Rd South Stormwater Pond**			
Observer	**md**	Access		Altitude (m)	**27.9**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2663849 6494698**	Distance inland (km)	**5.4**
Fishing method	**ntc**	Area fished (m2) or no. nets used **3**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour					**o**	Clarity			**d**	Temp. **17.9**	pH
	Average width (m)	**10.0**	Average depth (m)				Maximum depth (m)				Conductivity	**17**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool	**100**	Run	**0**	Riffle	**0**	Rapid **0**	Casc. **0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel	**0**	Coarse gravel	**0**	Cobble	**0**	Boulder **0**	Bed-rock **0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank	**n**	Bank veg.	**y**				
Catchment vegetation(%)	Native forest	**0**	Exotic forest	**0**	Farm	**0**	Urban zone	**100**	Scrub	**0**	Swamp land **0**	Other **0**
Riparian vegetation(%)	Native forest	**0**	Exotic forest	**0**	Grass tussock	**80**	Exposed bed	**0**	Scrub willow	**0**	Raupo flax **0**	Other **20**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**
Large invertebrate fauna	Koura **n**	Paratya **n**	Freshwater mussel	**n**	
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**

FISH DATA

Species	Abundance	Length	Habitat/Comments
- **No species recorded**			

Comments **15168 DO 78%, 1 x fyke, 2 x Gee minnow**

FRESHWATER FISH DATABASE FORM

SW10

Date	**10/5/2016**	River/Lake system **Alexandra Stream**		Catchment number	**078.036**
Time	**1230**	Sampling locality **Rosedale WTTP Stormwater Pond**			
Observer	**md**	Access		Altitude (m)	**38.4**
Organisation	**bior**	NZMS 260 Map no. **R10**	Coord. **2664413 6493406**	Distance inland (km)	**6.5**
Fishing method	**ntc**	Area fished (m2) or no. nets used **6**	Number of electric fishing passes	Tidal water	**n**

HABITAT DATA

Water	Colour					**o**	Clarity			**d**	Temp. **19.3**	pH
	Average width (m)	**25.0**	Average depth (m)				Maximum depth (m)				Conductivity	**16**
Habitat type (%)	Still	**0**	Back-water	**0**	Pool	**100**	Run	**0**	Riffle	**0**	Rapid **0**	Casc. **0**
Substrate type (%)	Mud	**100**	Sand	**0**	Fine gravel	**0**	Coarse gravel	**0**	Cobble	**0**	Boulder **0**	Bed-rock **0**
Fish cover (y/n)	Macrophyte	**y**	Instream debris	**n**	Undercut bank	**n**	Bank veg.	**n**				
Catchment vegetation(%)	Native forest	**0**	Exotic forest	**0**	Farm	**50**	Urban zone	**50**	Scrub	**0**	Swamp land **0**	Other **0**
Riparian vegetation(%)	Native forest	**0**	Exotic forest	**0**	Grass tussock	**80**	Exposed bed	**0**	Scrub willow	**0**	Raupo flax **0**	Other **20**

Type of river/stream/lake **scposm**

Water level	**n**	Downstream barrier	**u**	Pollution	**m**
Large invertebrate fauna	Koura **n**	Paratya **n**	Freshwater mussel	**n**	
Bottom fauna abundance	**u**	Predominant species group		Permanent water	**y**

FISH DATA

Species		Abundance	Length	Habitat/Comments
Anguilla australis	**Shortfin eel**	**23 (a)**	**140-630**	**poo**
Gambusia affinis	**Gambusia**	**500 (a)**	**10-40**	**poo**

Comments **15168 DO 68%, 2 x fyke, 4 x Gee minnow**

Appendix D
Freshwater Fish Caught or Observed within the Project area

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Northern Corridor Permanent Streams and Tributaries – Observed Freshwater Fish			
Site	**Species**	**Abundance**	**Size Range (mm)**
Lucas Creek (SEV1)	Shortfin eel Crans bully Gambusia*	5 7 3	80 – 300 26 – 40 14 – 30
Oteha East (SWP1)	Shortfin eel	1	760
Oteha West (SWP2)	Shortfin eel	2	550 - 910
Masons Road (SWP3)	Shortfin eel Banded kokopu	1 1	920 130
Oteha Stream Tributary (SEV2)	Shortfin eel	9	50 - 120
McClymonts Road (SWP4)	No species	-	-
Colliston Rise (SWP5)	No species	-	-
Corinthian Drive (SWP6)	Shortfin eel	1	320
Rosedale Landfill (SWP7)	No species	-	-
Greville Road Roundabout (SWP8)	No species	-	-
Greville Road South (SWP9)	No species	-	-
Arrenway Reserve Stormwater Drain	Shortfin eel Gambusia*	1 >20	520 14 – 30
RWWTP (SWP10)	Shortfin eel Gambusia*	23 >500	140 – 630 10 – 40
RWWTP South Watercourses	Shortfin eel Gambusia*	1 >100	480 14 – 30
Alexandra Stream, Rook Reserve (SEV3)	Shortfin eel Crans bully Gambusia*	24 10 4	220 – 900 34 – 67 -
Alexandra Stream, Omega Reserve (SEV4)	Shortfin eel Longfin eel Crans bully	69 1 14	210 – 510 1100 36 - 68
Omega Reserve (SWP11)	Shortfin eel	8	150 – 750

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