REPORT

Watercare Services Limited

Northern Interceptor - Phase 1
Ecological Assessment

Prepared for:

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List of Terms

Term	Definition
Benthic community	Plants and animals inhabiting the sediments of marine or freshwater ecosystems.
Horizontal Directional Drilling	A steerable trenchless method of installing underground pipes in a shallow arc along a prescribed bore path using a surface launched drilling rig.
Northern Interceptor	New wastewater interceptor to convey wastewater flows from the Northern Strategic Growth Area (NorSGA) and South Rodney (Kumeu/Huapai/Riverhead) via the upgraded existing pumping station at Hobsonville to the Rosedale Wastewater Treatment Plant (WWTP).
Tamaki Ecological District	An Ecological District is a particular geographical region that has a characteristic landscape and range of biological communities, as defined by the Department of Conservation (McEwen, 1987). The Tamaki Ecological District is one of 285 Ecological Districts, and includes all of the proposed Northern Interceptor footprint.
The Project	To be completed in 2020, the Project transfers the existing Hobsonville Pump Station flows to Rosedale WWTP through a 750mm ID rising main crossing the Upper Harbour, and through Greenhithe, The North Shore Memorial Park, the North Shore Golf Club and Rosedale Industrial areas. The majority of the construction will be open trenched.

List of Abbreviations

Abbreviation	Definition
AEE	Assessment of Effects on the Environment
ARP:ALW	Auckland Council Regional Plan: Air, Land and Water
ACRPS	Auckland Council Regional Policy Statement
ARDS	Amphibian and Reptile Database System
ARP:C	Auckland Council Regional Plan: Coastal
CMA	Coastal Marine Area
CMCA	Common Marine Coastal Area (PAUP)
CMP	Construction Management Plan
Council	Auckland Council
CPA	Coastal Protection Area
DN	Nominal Diameter
DoC	Department of Conservation
ESCP	Erosion and Sediment Control Plan
FFDB	Freshwater Fish Database
HDD	Horizontal Directional Drilling
GBWD & Causeway	Greenhithe Bridge Watermain Duplication and Causeway Project
NI	Northern Interceptor
NSGC	North Shore Golf Club
NSMA	Natural Stream Management Area
NSMP	North Shore Memorial Park and Cemeteries
NZCPS	New Zealand Coastal Policy Statement (2010)
PAUP	Proposed Auckland Unitary Plan (Notified 30 September 2013)
PE	Polyethylene
PS	Pump Station
PSD	Particle Size Distribution
RMA	Resource Management Act 1991
SEA	Significant Ecological Area
SEV	Stream Ecological Valuation
SH16	State Highway 16

Abbreviation	Definition
SH18	State Highway 18
SSWI	Site of Special Wildlife Interest
UWH	Upper Waitemata Harbour
Watercare	Watercare Services Limited
WWTP	Wastewater Treatment Plant

Executive summary

Watercare Services Limited ("Watercare") is proposing to build new wastewater pipelines and associated infrastructure to convey wastewater from north-western parts of Auckland to the Rosedale Wastewater Treatment Plant ("WWTP") in Albany. This project is known as the "Northern Interceptor".

This technical report provides specialist input for the *Northern Interceptor Phase 1 – Assessment of Effects on the Environment* report prepared by MWH New Zealand Limited, which supports the resource consent applications for construction of Phase 1 of the Northern Interceptor.

Desktop analyses and field/site visits were used to characterise the ecological values along the Northern Interceptor alignment, assess the ecological significance of those values, determine the potential effects of the project on these values and develop recommendations to avoid, remedy or mitigate potential adverse effects.

The proposed alignment of the Northern Interceptor primarily runs through urban and industrial environments. However, parts of the alignment will require construction through and within terrestrial, freshwater and marine ecosystems, some of which have significant ecological values. This includes several patches of indigenous-dominated forest habitats, several freshwater streams and two coastal marine areas in the upper Waitemata Harbour, and a section of Te Wharau Creek.

The proposed alignment will require the removal of terrestrial vegetation at seven sites, including two areas designated as Significant Ecological Areas (SEAs) under the Proposed Auckland Regional Plan. The total area of vegetation removal is approximately 4,000 m^2 (0.40 ha), including 1,600 m^2 (0.16 ha) of vegetation located within two SEAs. Vegetation clearance will result in small-scale loss of habitat and resources for native birds, lizards and invertebrates, including some "At Risk" (and legally protected) lizards.

The proposed open trenching across two streams will result in the temporary disturbance of the streams. This disturbance could lead to short term increases in sedimentation and reductions in water quality. Indirect effects on several streams may also occur through the loss of shade and detrital input due to vegetation clearance activities in proximity to the streams.

Effects on coastal marine environments will depend on the construction method selected. Horizontal Directional Drilling (HDD) will have negligible effect on coastal environments. HDD is proposed for the Te Wharau Creek estuary, and is being considered as an option for the upper Waitemata Harbour Crossing. The other option being considered for the upper Waitemata Harbour crossing is marine trenching. Trenching will result in the direct but temporary disturbance of benthic communities inhabiting the seabed within the footprint of the trench, and within intertidal areas that may be used for sidecasting.

In conclusion, the effects assessment illustrates that the proposed Northern Interceptor will have actual or potential adverse effects on several areas along/adjacent to the alignment, with some effects likely to be more than minor, in the absence of efforts to avoid, remedy or mitigate potential adverse effects.

Recommendations to avoid, remedy or mitigate these effects are set out in this report and will help ensure that ecological effects associated with Phase 1 of the proposed Northern Interceptor Project are no more than minor.

1 Introduction

1.1 Background

Watercare Services Limited ("Watercare") is proposing to build new wastewater pipelines and associated infrastructure to convey wastewater from north-western parts of Auckland to the Rosedale Wastewater Treatment Plant ("WWTP") in Albany. This project is known as the "Northern Interceptor". Construction of the Northern Interceptor is intended to be staged, with the timing of various stages depending on the rate of population growth.

Tonkin & Taylor Ltd (T&T) has been commissioned by Watercare to assess the potential ecological effects related to the construction of the proposed Northern Interceptor Phase 1 (the Project)[1].

The proposed work requires various resource consents under the Resource Management Act 1991 ("RMA"). This technical report provides specialist input for the *Northern Interceptor Phase 1 – Assessment of Effects on the Environment* report ("the main AEE") prepared by MWH New Zealand Limited, which supports the resource consent application.

This report provides the following:

- A brief overview of the proposed works;
- An overview of the methods used to assess the ecological characteristics/values and significance of areas potentially affected by the Project;
- A description of ecological characteristics and values of areas within the Project footprint and immediate surrounds;
- An assessment of ecological significance of the Project footprint and immediate surrounds, based on assessing the ecological characteristics and values of the Project area against:
  - The New Zealand Coastal Policy Statement 2010;
  - significance criteria in the Auckland Council Regional Policy Statement; and
  - based on the presence of designated Significant Ecological Areas (SEAs) and Natural Stream Management Areas (NSMAs) in the Proposed Auckland Unitary Plan (PAUP) and Auckland Council District Plan (North Shore City and Waitakere City Sections) and Coastal Protection Areas (CPAs) in the Auckland Council Regional Policy: Coastal (ARP:C);
- An assessment of the magnitude and type of potential effects associated with the Project's construction and operational activities, including potential habitat loss and degradation, and direct mortality or injury of indigenous fauna; and
- Recommendations to avoid, remedy, mitigate or compensate for potential adverse effects.

1.2 Overview of proposed works

The proposed Northern Interceptor Phase 1 will transfer existing flows from the Hobsonville Pump Station (PS) to the Rosedale WWTP. The proposed route is from the existing Hobsonville PS, under the State Highway 18 (SH18) motorway, along the northern side of the motorway causeway, and then under the upper Waitemata Harbour, through Greenhithe and then the commercial area of Rosedale.

Key elements of the project include:

- Upgrading of the existing Hobsonville PS

[1] In accordance with Tonkin & Taylor's letter of engagement dated 12 August 2014, as amended by subsequent instructions.

- Installation of a pipe under SH18
- Installation of pipelines in a widened section of the existing motorway causeway
- Installation of dual pipelines across the Upper Waitemata Harbour to Greenhithe via marine trenching or horizontal directional drilling (HDD)
- Installation of dual pipelines under Te Wharau Creek via HDD
- Construction of a pipe bridge between Witton Place and North Shore Golf Course
- Installation of dual pipelines under Alexandra Stream via HDD
- Trenched construction for pipeline installation in roads, open space and other land; and
- Installation of associated infrastructure.

With the exception noted below, the proposed works are described in detail in the main AEE. Key drawings showing the proposed works and construction methodology are copied in Appendix A of this report. The works described in the main AEE and shown on the appended drawings are assessed in this report.

Watercare is proposing some widening along the existing SH18 causeway near Hobsonville to provide for proposed water and wastewater infrastructure, including a section of the Northern Interceptor Phase 1 pipeline. That work forms part of Watercare's proposed Greenhithe Bridge Watermain Duplication and Causeway project. That project is part of a separate resource consent package, and is described in a report titled *Greenhithe Bridge Watermain Duplication and Causeway – Assessment of Effects on the Environment*, prepared by AECOM New Zealand.

2 Methods

Desktop analyses and field/site visits were used to determine the ecological characteristics/ values of terrestrial, freshwater and marine areas along the Project alignment as well as the significance of those values. This section of the report describes the methods used for desktop, field investigation locations, and the methods used at each.

2.1 Desktop assessment

A desktop assessment of the project alignment and surrounding area was undertaken to identify sites assessed as potentially having ecological values as well as sites already designated as being ecologically significant based on a review of the North Shore City Ecological Survey (2002), Auckland Council Regional Policy Statement (ACRPS), Auckland Council District Plan (North Shore City Section and Waitakere City Section), Proposed Auckland Unitary Plan (PAUP) and Auckland Council Regional Plan: Coastal. These resources were also used, where available, to provide insight as to the reasons why areas are significant, and the ecological values/characteristics they comprise. Areas with ecological values that were not identified and/ or designated as ecologically significant in the various reviewed documents were assessed against the significance criteria of the ACRPS.

The New Zealand Freshwater Fish Database (FFDB) was also used to gather information on fish present within the streams that the Project alignment bisects. The Department of Conservation's Amphibian and Reptile Database System (ARDS) was accessed to gather information on reptile species that have been recorded in proximity to the Project alignment.

2.2 Field assessment

Several site visits were undertaken in November 2014 to March 2015 to assess the variety of ecosystems, and the ecological values/ characteristics present, along the Project alignment. Ecological areas assessed included all areas with ecological values that occurred within 50 m either side of the Project Footprint, including:

- Areas designated as Significant Ecological Areas (SEAs) in the PAUP (refer to green hatched areas in Appendix A, Figures 2–5); and
- "Areas of Ecological Interest" that were not designated as SEAs in the PAUP but that may meet ecological significance criteria set out in the PAUP (refer to blue hatched areas in Appendix A, Figures 2–5).

2.2.1 Terrestrial ecosystems

Forest and terrestrial ecosystems were assessed over two days on 26-27 November 2014, and with subsequent brief field visits to confirm specific details as the pipeline route was finalised. The assessment included identifying the dominant vegetation types and the main plant species present.

Habitats of nationally "Threatened", "At Risk" or legally protected flora, invertebrates, lizards, and birds were assessed to determine the likelihood of ecologically significant species being present. Native and exotic birds observed and/or heard during the site visits were recorded. A search was undertaken for skinks and key ground invertebrates within habitat normally occupied by such species; by lifting over logs, turning leaf litter and checking round the bases of clump forming vegetation.

2.2.2 Freshwater and wetland ecosystems

All streams and wetlands, which the Project alignment crosses, were assessed over two days on 27 November and 9 December 2014. Stream Ecological Valuations (SEVs) were conducted on two streams which the Project alignment proposes to cross via open cut construction methods or through the construction of an overhead pipe bridge. These are shown on attached Figures 4 and 5.

At the stream crossing site shown on Figure 4, the pipeline will surface in the private right of way north of Witton Place and will be carried across the gully into 84 Laurel Oak Drive on a pipe bridge. The pipeline will then continue north to NSGC in an open trench through 84 Laurel Oak Drive. At the site shown on Figure 5, the pipeline will pass under Alexandra Stream using HDD.

A more general assessment of wetlands and the remaining streams (where HDD will be implemented) was undertaken, which comprised of a site visit and recording key ecological features.

SEV assessments were undertaken along 100 m sections at each of the two sites indicated in Figures 1-5 (Appendix A). SEV assessments were carried out using the methods set out in Storey *et al.* (2011). SEV scores for assessment sites were calculated using the SEV Data Analysis Spreadsheet Version 2.2 (July 2012).

A single macroinvertebrate sample was collected at each site in accordance with either Protocol C1 or C2 from the Protocols for Sampling Macroinvertebrates in Wadeable Streams (Stark *et al.*, 2001) depending on the stream. All samples were preserved in approximately 80 % ethanol solution for later sorting and identification. The macroinvertebrate samples were identified and counted by Environmental Impact Assessments Ltd, in accordance with Protocol P1 (coded abundance). The samples were used in the SEV calculations.

SEV assessment sites were surveyed for fish species present by a single pass with an EFM300 electric fishing machine. The New Zealand FFDB was also checked to establish records of fish populations in the catchment.

Spot measurements of dissolved oxygen, pH, temperature and conductivity were collected at all SEV sites using a calibrated YSI Pro ODO dissolved oxygen / temperature meter, and a Eutech pH/conductivity/temperature meter.

2.2.3 Coastal marine ecosystems

Benthic samples

Divers were used to sample the marine benthic fauna along the proposed alignment from the Greenhithe Bridge, across the upper Waitemata Harbour to where the alignment joins the coastal fringe near Rahui Road. A total of nineteen samples were collected at 100 m intervals over the approximately 1000 m crossing of the upper Waitemata Harbour. The samples were collected on two separate sampling occasions: 3 December 2014 and 25 March 2015.

Samples were collected using a 0.013 m^2 corer pushed into the top 10 cm of surface sediment (where sediment depths allowed) and the material put into a sieve bag before being placed into a sample container. All samples were preserved in approximately 80 % ethanol solution for later sorting and identification. Samples were sent Biolive Invertebrate Identification Services (Nelson) where they were processed and all organisms present identified. The Shannon-Weiner Diversity Index value for each sample was also calculated.

Two sediment samples were collected during the 25 March 2015 sampling from Site 10 and Site 13 for the purpose of testing for heavy metals and polyaromatic hydrocarbons. The locations of these sampling sites are shown in Figure 2. The testing of the samples was done by RJ Hill

Laboratories. To assess the ecological sediment quality status of the site, the results were compared to the Auckland Council Environmental Response Criteria (ERC) (ARC, 2004).

Coastal birds

We undertook a qualitative assessment of coastal bird characteristics and values in close proximity to the Project footprint on 26 and 27 November 2014. A survey was undertaken to identify nest sites for pied, black and little black shags along the coastal point of Rahui Rd, where the proposed dual pipelines under the harbour will make landfall on the North Shore. Assessments were made by walking along the coastal margin in the inter-tidal zone searching for guano and/or the physical presence of roosting/nesting shags in coastal trees or of their characteristic nesting sign (dead or guano streaked branches or rocks). Where mangrove habitat was present within or immediately surrounding the project, it was assessed for its suitability as banded rail foraging habitat. Inter-tidal sand/mudflat habitats within the project footprint and immediate surrounds were visually inspected to assess the importance of these areas as foraging habitat for coastal bird species.

3 Ecological characteristics and values

3.1 Ecological context

The proposed alignment of the Northern Interceptor primarily runs through urban and industrial environments, however part of the alignment will involve construction through and within terrestrial, freshwater and marine ecosystems, some of which are designated as Ecological Significant.

The entire length of the new pipeline and associated facilities lies within the Tamaki Ecological District, as has been defined by the Department of Conservation (McEwen, 1987). Indigenous ecosystems within the Tamaki Ecological District have been largely modified, with much of the area now under urban development. Indigenous habitat types are now restricted to coastal areas and steep gully sides. However, many of these areas have ecologically significant coastal marine, terrestrial and freshwater habitat types including:

- Inter-tidal habitats (present within the NI footprint);
- Large estuaries (present within the NI footprint);
- Freshwater streams (present within the NI footprint);

as well as the following habitat types, which are present within the wider study area but not within the works footprint:

- Remnants of kauri forest;
- Broadleaved-podocarp forest;
- Gumland scrub associations;
- Regenerating kanuka forests;
- Large forested coastal escarpments;
- Volcanic forest remnants; and
- Coastal forest including remnants of pohutukawa forest.

These habitat types support indigenous biodiversity values, and in some cases, support, nationally "Threatened", "At Risk" or legally protected species. Many of these environments also act as corridors and stepping stones for native wildlife between large habitat areas such as the Waitakere and Hunua Ranges, and offshore islands.

3.2 Ecological characteristics overview

The proposed alignment of the Northern Interceptor primarily crosses urban and industrial environments, however part of the alignment will involve construction within terrestrial, freshwater and marine ecosystems that contain a variety of ecological values and characteristics.

Terrestrial ecosystems mostly consist of grazed paddocks and parks dominated by exotic pasture grassland and treelands of low ecological value, however there are segments of urban forest and bush areas located along the alignment. Forest and bush areas range from small, early succession scrub sites to relatively larger, more natural forest habitats that have higher biodiversity values.

Freshwater ecosystems consist of several streams within the Lucas Creek catchment. The streams vary in size and include small (unnamed) and large (such as Te Wharau Creek) tributaries of Lucas Creek, as well as an upper headwaters of the Oteha sub-catchment in Rosedale (Alexandra Stream). There is only one small freshwater wetland near the Project alignment.

The proposed alignment crosses two coastal marine areas including the upper Waitemata Harbour, from Hobsonville to Greenhithe, and a section of Te Wharau Creek, between Wainoni

Park and the North Shore Cemetery. The coastal marine areas in the vicinity of the footprint include mangrove habitat and creek channels.

3.3 Habitat/vegetation characteristics

3.3.1 Hobsonville Pump Station

Immediately east and west of the Hobsonville PS is a small area of bush, approximately 1.9 ha in size (Appendix A, Figure 2). The bush area comprises mainly exotic vegetation with 10-15 m high wattle trees (*Acacia* sp.) forming a patchy canopy with emergent pine trees (*Pinus* sp.). Low stature exotic vegetation such as pampas (*Cortaderia* sp.), green goddess (*Zantedeschia aethiopica*), Chinese privet (*Ligustrum sinense*), gorse (*Ulex europaeus*) and a variety of pasture grasses/weeds associated with urban scrub areas have colonised more open areas.

A small pond is present within the bush area towards SH18, with common early succession native plantings, approximately 4-5 years of age, surrounding the pond and the SH18 batters. The only natural native vegetation present includes sporadic karamu (*Coprosma robusta*) shrubs and clusters of tree ferns (*Cyathea dealbata*).

Scrub, variable in height, is also present north of the Hobsonville PS, on the opposite side of SH18, adjacent to the coast. Plant species present include a mixture of native and exotic species, such as pampas, Chinese privet, gorse (exotic), broadleaf (*Griselinia littoralis*), mapou (*Myrsine australis*), karamu, kanuka (*Kunzea ericoides*) (native) and a variety of other common native planting species. Occasional large pine trees are present over top. The scrub gives way to mangrove (*Avicennia marina*) habitat over the mud flats.

3.3.2 State Highway 18 crossing

The footprint of the works beneath SH18 has no intrinsic ecological values.

3.3.3 SH18 to Causeway widening

The vegetation growing on the rocky substrate adjacent to the western end of Greenhithe Bridge consists of sporadic small trees and shrubs including small pohutukawa trees (*Metrosideros excelsa*), flax (*Phormium* spp.) pohuehue (*Muehlenbeckia* spp.), all of which are native, along with gorse and pampas (exotic).

Running parallel with the SH18 causeway on its southern side is an intertidal mangrove area and good quality riparian margins. At the south western point of the mangroves is an extensive fringe of salt marsh vegetation dominated by twig rush (*Machaerina juncea*), oioi (*Apodasmia similis)*, Salt marsh ribbon wood (*Plagianthus divaricatus*) and sea rush (*Juncus kraussii var. australiensis*). Terrestrial vegetation in this area includes; manuka, flax, mahoe (*Melicytus ramiflorus*), mapou, karamu, tree ferns (native) and Chinese privet (exotic). There are open grass areas surrounding a stream which seems to have been managed and planted, possibly in relation with construction happening on adjacent land. There is a second area of sparse salt marsh vegetation at the south eastern point of the intertidal zone, predominant species were tussock swamp twig rush, oioi, sea rush and forest sedge (*Carex sp*.).

3.3.4 Upper Waitemata Harbour crossing

The results of the samples collected at sampling sites along the proposed NI alignment and shown on Figure 3.1 are presented in Appendix B.

The habitat types of the Waitemata Harbour are mapped in Auckland Regional Council (1999). A majority of the habitat affected by the Northern Interceptor footprint is soft gloopy mud, a small area of mangrove habitat is also affected at the Northern point of the footprint crossing of the

Waitemata Harbour (Auckland Regional Council, 1999). Detailed sediment Particle Size Distribution (PSD) data are presented in the accompanying Coastal Processes report (Tonkin & Taylor Ltd, 2015). However, in summary, the sediments of the intertidal flats comprise fine sands (mean particle size in the range 0.15-0.20 mm), whereas coarser gravels are present in the low tide channel.

Suspended sediment data were not collected as part of the present study, however a number of previous studies have looked at suspended sediment concentrations in the upper Waitemata Harbour (summarised in Tonkin & Taylor, 2015). Ambient concentrations during calm conditions are typically in the 10-30 mg/L range, but they can reach levels in excess of 1,300 mg/L.

The number of benthic taxa present and the Shannon-Weiner diversity index values for each site are presented in Figure 3.1 below.

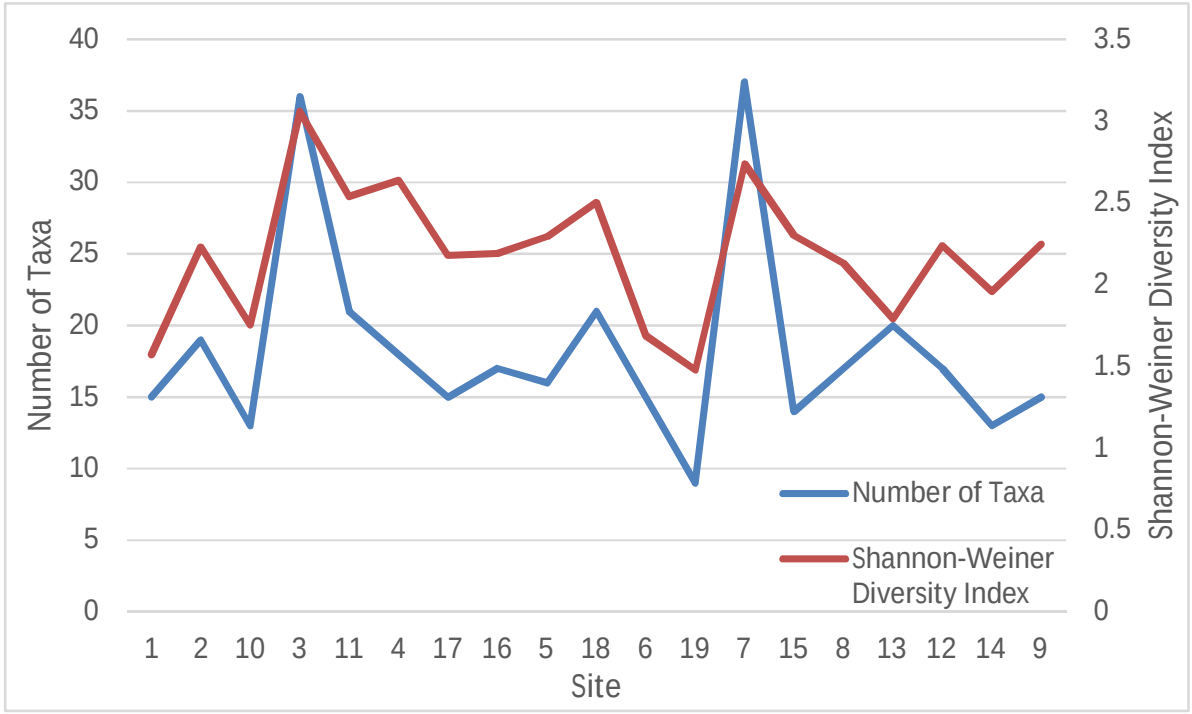

Figure 3.1: Number of taxa and Shannon-Weiner diversity index values for marine sites. Sites are presented based on their relative position across the Upper Waitemata Harbour as shown in Figures 2 and 3.

The results show that benthic communities varied depending on the location of sample in terms of where they were collected across the upper Waitemata Harbour. Samples collected from along the middle of the channel (Sites 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19 generally had different community structures to samples collected at Sites 1–2 and 8–9), with some samples from the middle of the channel containing encrusting species such as sponges and sea squirts. Cockles (*Austrovenus stutchburyi*), an important kaimoana species, were found in the Site 8 and Site 9 samples, at the Rahui Road end of the proposed route.

Sites from within the channel also generally had higher Shannon-Weiner diversity index values compared with the other sites. Sites S3 and S7 had the highest Shannon-Weiner diversity index values due to these sites having more than double the species found at some of the other sites (36 and 37 species respectively, compared to 9–21). The Shannon-Weiner evenness scores were generally close to 1.00, indicating that at most sites no particular species was dominant. Site 1 and Site 6 had lower evenness scores due to the high numbers of the polychaete worm family

Paraonidae found within both samples. Site 10 had a lower evenness score due to high numbers of brittle stars (Ophiuroidea) and Site 13 due to the polychaete worm *Sphaerosyllis* sp.

The species found in the Northern Interceptor alignment are similar to those found in other samples collected for other projects in the Greenhithe area Connell Wagner, 2001; Auckland Council 2008).

No threatened species were identified within the samples (Freeman *et al*., 2013).

The marine sediment quality analyses for Sites 10 and 13 are presented in Appendix C, as are the full laboratory transcripts. Overall, the sediment quality results show that the majority of copper, lead zinc levels were within the ARC "green" zone indicating that contaminant concentrations present a low risk to the biology of the site (ARC, TP 168). At Site 13 the zinc concentration fell within the "amber" zone indicating that the biology of this site could possibly be impacted (ARC, TP 168). PAH results were below laboratory detection limits at all sites. Overall, sediments have relatively low contaminant levels and are similar to previous data that was collected for the Upper Harbour Highway Bridge upgrade (Connell Wagner, 2001).

3.3.5 Rahui Rd to Greenhithe Rd

Vegetation near Rahui Road, at the northern end of the Waitemata Harbour crossing, consists of mixed native and exotic coastal forest. To the north of where the proposed alignment comes ashore, large pohutukawa, kowhai (*Sophora sp*.) and mangrove trees form a 10-15 m patchy canopy. Between and beneath the large trees are mapou, karamu, karo (*Pittosporum crassifolium*), astelia (*Astelia banksii*), kawakawa (*Macropiper excelsum*) (native), tree privet (*Ligustrum lucidum*) and ginger (*Hedychium gardnerianum*) (exotic). This segment of coastal forest is approximately 100 m in length and varies in width from 10–25 m.

South of where the proposed pipeline lands on the North Shore is a larger area of coastal forest that follows the coast around to the Greenhithe Bridge, and varies in width from 30 m to almost 200 m in places. Immediately adjacent to the coast, the forest primarily features large pine trees, with various sized pohutukawa trees dotted in between. Other native and exotic trees and shrubs present include manuka (*Leptospermum scoparium*), karamu, akepiro (*Olearia furfuracea*), kumarahou (*Pomaderris kumeraho*) (native), wattle, boneseed (*Chrysanthemoides monilifera*), cotoneaster (*Cotoneaster coriaceus*), ginger, tree privet and brush wattle (*Paraserianthes lophantha*) (exotic).

More inland from the coast, kanuka, tanekaha (*Phyllocladus trichomanoides*), karo, mingimingi (*Leucopogon fasciculatus*), mahoe, mapou, silverfern, kawakawa, astelia, are also found beneath pine trees as well as the exotic species wandering jew (*Tradescantia fluminensis*), gorse, climbing asparagus (*Asparagus scandens*) and jasmine (*Jasminum polyanthum*) (exotic).

Further inland, a small area of bush, approximately 0.15 ha in size, exists on the northern side of the paper road, Traffic Road. The bush area features a mainly native 10–15 m kanuka canopy, with tanekaha, kamahi (*Weinmannia racemosa*) and cabbage trees (*Cordyline australis*). Other plant species present in the understory include silver fern, mapou, flax, mahoe (native), with exotic species ginger, agapanthus (*Agapanthus praecox*) and montbretia (*Crocosmia x crocosmiiflora*) also present.

3.3.6 Greenhithe Road to Wainoni Park

The proposed alignment crosses over a stream on Greenhithe Road, near Sunnyview Road. At the crossing point, this permanent stream (which is an un-named tributary of Lucas Creek) runs north under Greenhithe Road through a culvert approximately 25 m in length and with a diameter of 1.8 m. At the time of the site visit, a shortfin eel (*Anguilla australis*) and whitebait were observed

swimming in the stream. There is a man-made fish barrier (a weir-like structure) immediately upstream of the culvert on the southern side of Greenhithe Road.

On the downstream side of Greenhithe Road, the stream contains a forested riparian zone consisting of a native and exotic 10–15 m canopy, which varies in width from 30 – 50 m. Canopy tree species include tanekaha, puriri (*Vitex lucens*) (native), and cherry tree (*Prunus* sp.) with emergent pines above. The developed and dense understory includes tree ferns, flax, hangehange (*Geniostoma ligustrifolium*), mapou, karo, mahoe, kawakawa (native), wattle, woolly nightshade (*Solanum mauritianum*), blackberry (*Rubus fruticosus*), green goddess (exotic) and common ornamental garden plants. The upstream side is more open and consists of several large canopy trees including a single rimu tree (*Dacrydium cuppressinum*), ribbonwood (*Hoheria populnea*), kanuka (native), eucalyptus tree (*Eucalyptus* sp.) and magnolia tree (*Magnolia* sp.) (exotic). Vegetation in understory is sparse but does include karo, hangehange, maupo (native) and common ivy (*Hedera helix*) (exotic).

3.3.7 Wainoni Park South & North

At the southern end of Wainoni Park, the proposed alignment crosses over the headwaters of a permanent stream which is also an unnamed tributary of Lucas Creek. Within Wainoni Park, this headwater stream flows into the same tributary that was crossed near Sunnyview Road (Section 3.3.6). The stream runs under Greenhithe Road through a culvert approximately 22 m in length and with a diameter of 0.9 m.

On the Wainoni Park side of Greenhithe Road (outside the works footprint), the stream contains an early succession forested riparian zone with a 10–15 m high dense canopy and developed understory. The riparian zone varies in width from 15–80 m. The canopy consists of kanuka (native), wattle and tree privet (exotic) with emergent pines overtop. Other species present in the canopy and understory includes native totara (*Podocarpus totara*), mapou, karamu, hangehange, tree ferns, kawakawa, forest sedges (*Carex* spp.), small ferns, and exotic species including wandering jew, Chinese privet, honeysuckle (*Lonicera japonica*) and fatsia (*Fatsia japonica*).

At the northern end of Wainoni Park, the proposed alignment crosses over an unnamed permanent stream that flows north east towards Te Wharau Creek (which itself is a tributary of Lucas Creek). The stream is soft-bottomed and varies in width from 0.25–2.5 m wide with a maximum depth of approximately 0.2 m during dry weather. A 5 m long culvert has been installed near where the proposed alignment crosses the stream, while a dam structure is present approximately 10 m upstream of the culvert. The stream has received high sediment loads, and flows into a pond near the outlet at Te Wharau Creek.

The SEV method generates a score from 0.00 (no ecological value) to 1.00 (pristine) for the stream reach being studied. This is based on the average score for each of 16 parameters, falling into four categories: Hydraulic, Biogeochemical, Habitat Provisions and Biodiversity. The SEV assessment for the unnamed permanent stream at Wainoni Park North gave an overall SEV score of 0.43, with the biogeochemical category scoring the highest of the four categories. The biogeochemical category includes aspects such as water temperature control, dissolved oxygen levels maintained, organic matter input, instream particle retention and decontamination of pollutants. The overall SEV score falls within the range of other Auckland urban stream SEV scores of 0.25–0.81. Streams found within native bush areas typically have SEV scores of 0.90 or greater.

The stream contains an early succession forested riparian zone with a 10 m high dense canopy that varies in width from 15 to 30 m. Beneath the kanuka canopy, a dense understory consists of native plants tree ferns, maupo, karamu, and exotic plants gorse, pampas, privet and honeysuckle . Further upstream, the stream flows through Wainoni Park with a mix of stream, wetland and more open areas.

3.3.8 Te Wharau Creek crossing

The proposed alignment will pass beneath Te Wharau Creek (a tributary of Lucas Creek) by HDD from the northern end of Wainoni Park, before rising up in North Shore Memorial Park. The section of creek that the alignment crosses is saline and approximately 400 m wide, a high proportion of which has been colonised by mangroves.

Early succession forest is adjacent to Te Wharau Creek on the North Shore Memorial Park side and runs alongside the coastal edge. The forest has a 5–15 m kanuka canopy that also comprises tree ferns, mahoe, mapou, manuka (native) and gorse (exotic). The understory is developed in most places and consists of hangehange, forest sedges, *Coprosma* spp., mingimingi, totara, astelia (native), honey suckle and Chinese privet (exotic). A small stream network flows through the forested area and out into Te Wharau Creek.

3.3.9 North Shore Memorial Park

The alignment crosses over the top of a culverted section of stream, that flows north through North Shore Memorial Park before running adjacent to an early succession forest approximately 4.7 ha in area. The culvert is approximately 25 m in length. The forest consists of a 10–15 m dense kanuka canopy with emergent pine trees overtop. The developed understory contains tree ferns, hangehange, karamu, mapou, karo, tanekaha, mingimingi, toropapa (*Alseuosmia* sp.) (native) and gorse (exotic). Plant diversity is greater in the riparian zones and further includes *Coprosma* spp., mahoe, lemonwood, totara, kawakawa, titoki, kahikatea and karaka (native).

3.3.10 North Shore Memorial Park to North Shore Golf Club

South of the North Shore Golf Club, the proposed alignment will cross another unnamed permanent stream and associated gully via a pipe bridge. The stream is hard-bottomed, and flows west towards the main stem of Lucas Creek. It varies in width from 0.65–2.3 m, with a maximum depth of almost 1 m during dry weather.

The SEV generated a score of 0.64[2], with the biogeochemical category again scoring the highest of the four categories, which includes aspects such as water temperature control, dissolved oxygen levels maintained, organic matter input, instream particle retention and decontamination of pollutants. The SEV score falls within the range of other Auckland urban stream SEVs scores of between 0.25–0.81. Streams found within native bush areas typically score over 0.90.

The stream contains an early succession forested riparian zone with a 10–15 m high dense kanuka canopy with emergent pines overtop. The riparian zone varies in width from 40 m to over 100 m. Beneath the kanuka canopy, a mainly native and dense understory consists of tree ferns, karamu, mapou, tanekaha, mahoe, five-finger (*Pseudopanax arboreus*) (native) and Chinese privet (exotic). Native plantings have also been planted adjacent to nearby houses.

3.3.11 North Shore Golf Club

The proposed alignment runs adjacent to and crosses over a stream and gully system at the southern end of the North Shore Golf Club, passing above an existing culvert on the access road to the golf club. In this area is a small pond, wetland, temporary stream system, which in combination with surrounding vegetation is approximately 1.1 ha in area. The system has undergone extensive modification with a man-made pond and wetland as well as a network of culverts.

The terrestrial vegetation of the gully is comprised of native and exotic plant species with an approximately 30 m high pine tree canopy. Understory plants include karamu, hangehange, tree

[2] Background information on the SEV scoring system is provided in Section 3.3.7.

ferns, kanuka, mapou, mahoe (native), agapanthus, pampas and ornamental garden plants such as roses (exotic). The pond and wetland area is dominated by raupo and *Carex* spp.

3.3.12 Albany Highway to William Pickering Drive

South of John Glen Ave (approximately 80 m from the proposed pipeline route, and unlikely to be affected) is a small planted forest area approximately 0.1 ha in area and 8–10 m in height. The plant species present are common early succession native species and includes manuka, mapou, flax, mahoe and karamu.

3.3.13 Piermark Road to Bush Road

In this section, a small pond is located near the pipeline alignment, but is unlikely to be affected. There are no other notable ecological features.

3.3.14 Rosedale Park to Rosedale WWTP

Within Rosedale Park, the proposed alignment will pass beneath a stream and gully system via HDD. This soft-bottomed permanent stream is part of the headwaters of Lucas Creek, flowing north through the park. The stream section varies in size from 1.8–4.6 m and has a maximum depth of over 2 m in dry weather.

The stream contains a forested riparian zone with a 10–15 m high dense willow (*Salix* spp.) canopy with emergent pine overtop. Beneath the canopy, native and exotic species are present throughout the understory and include tree ferns, mahoe, mapou, *Coprosma* spp., mapou, karo, cabbage trees (native), wattle and privet (exotic).

Further east towards the Rosedale WWTP the route crosses a small intermittent tributary ("Jack Hinton Drive tributary"), which drains into the main stem of the permanent stream. A large portion of this tributary has been modified through the addition of a pond and an extensive network of culverts. Pipeline construction at this location is proposed to be carried out by open cut. Riparian vegetation is similar to the main stem, with large emergent pines over a mixture of native and exotic species. The proposed alignment crosses the tributary over an area with culverts and a native hedge row comprising 10 m high karaka, ngaio (*Myoporum laetum*) karo and puriri.

3.4 Fauna

The terrestrial, freshwater and marine ecosystems provide valuable habitats for indigenous fauna including birds, skinks, geckos and fish.

3.4.1 Birds

Land birds

Birds observed or heard during the visits to the forest patches and stream sites were common native and exotic species typical of urban forested habitats. Table 3.1 provides an overview of the native and exotic species present. No threatened birds were seen or observed during any of the site visits and are unlikely to use any of the described habitats.

Table 3.1: Native and exotic land bird species observed during the site visits

Native birds		Exotic birds	
Common name	Species name	Common name	Species name
Tui	*Prosthemadera novaeseelandiae*	Thrush	*Turdus philomelos*
Fantail	*Rhipidura fuliginosa*	Blackbird	*Turdus merula*
Greywarbler	*Gerygone igata*	Sparrow	*Passer domesticus*
Silvereye	*Zosterops lateralis*	Mallard duck	*Anas platyrhynchos*
New Zealand pigeon	*Hemiphaga novaeseelandiae*	Brown quail	*Coturnix ypsilophora*
Pukeko	*Porphyrio melanotus*	Yellowhammer	*Emberiza citrinella*
Kingfisher	*Todiramphus sanctus*	Common starling	*Sturnus vulgaris*
Spur-winged plover	*Vanellus miles*	Common myna	*Acridotheres tristis*
Welcome swallow	*Hirundo neoxena*	Chaffinch	*Fringilla coelebs*

Coastal Birds

Shags

Coastal cliffs from Rahui Road to Austin Road support mature pine and pohutukawa trees which could potentially provide colony or single roosting habitat for several shag species, some of which are Nationally "Threatened" or "At Risk". No shag nesting colonies were detected and no shag species where present, however small amounts of guano suggest trees may be used as individual roost sites.

Banded rail

A large area of mangroves is present within Te Wharau Creek, above where pipes are proposed to be installed under the channel using HDD. Given the large extent of these mangroves and the known presence of banded rail in the area, it is expected that this area of mangroves supports the "At Risk" (Declining) banded rail.

Other coastal birds

Other coastal bird species (including Threatened species) are known to use intertidal areas in the vicinity of the work, particularly adjacent to the SH18 causeway, for foraging. These are described in detail in the ecological report for the GBWD & Causeway project.

3.4.2 Herpetofauna

The North Shore is known to provide habitats for six native species of skinks and geckos. Species include forest gecko (*Hoplodactylus granulatus*), pacific gecko (*H. pacificus* – At risk: Relict), Auckland green gecko (*Naultinus elegans* – At risk: Declining), copper skink (*Oligosoma aeneum*), ornate skink (*O. ornatum* – At risk: Declining) and moko skink (*O. moco* – At risk: Relict).

Skink habitat was variable, in terms of quality, at the array of sites. The best quality habitat comprised large areas of forest at Te Wharau Creek and Rosedale Park, where a thick leaf litter had developed and a variety of large woody debris was present. Table 3.2 provides an overview of the habitat quality, in relation to native skinks, present over the proposed alignment. While no native skinks were observed, it is likely that copper skink will be present within the moderate to

high quality habitat. It is also possible that ornate skink are present in the moderate to high quality habitat.

Gecko habitat was of low quality over the majority of the proposed alignment. The best quality habitat is in large contiguous bush areas at Te Wharau Creek, which comprise well developed forest structure, with animal pest control and linkages to other ecological areas and corridors. Table 3.2 also provides an overview of the habitat quality in relation to native geckos, present over the proposed alignment. While no geckos were searched for or observed, it is possible that Auckland green gecko, Pacific gecko and forest gecko are present within the moderate to high quality habitat types within the Project footprint and immediate surrounds.

Table 3.2: Overview of the native lizard habitat quality present along the proposed alignment.

Assessed ecological areas	Native skink habitat	Native gecko habitat
Hobsonville PS	Moderate	Low
SH18 crossing	None	None
State Highway 18 to causeway widening	Low	Low
Upper Waitemata Harbour crossing	None	None
Rahui Road to Greenhithe Road	Moderate	Low
Greenhithe Road to Wainoni Park	Moderate	Low
Wainoni Park South & North	Moderate	Low
Te Wharau Creek crossing	High	Moderate
North Shore Memorial Park	Moderate	Low
North Shore Memorial Park to North Shore Golf Club	Moderate	Low
North Shore Golf Club	Moderate	Low
Albany Highway to William Pickering Drive	Low	Low
Piermark Road to Bush Road	Low	Low
Rosedale Park to Rosedale WWTP	High	Low

All native lizards in New Zealand are protected under the Wildlife Act 1953 and permission is required from the Department of Conservation to disturb habitat or impact on populations, and a Department of Conservation (DoC)-permitted herpetologist must oversee vegetation clearance and lizard relocation works. Exotic rainbow skinks (*Lampropholis delicata*) are likely to be present throughout the alignment, but this species is not protected under the Wildlife Act 1953.

3.4.3 Marine benthic invertebrates

Benthic communities are described in Section 3.3.4 above. As previously stated, these communities contain no threatened species.

3.4.4 Fish

Three native freshwater fish species were identified in the streams potentially affected by the Northern Interceptor alignment. Of these species, the longfin eel is listed as a threatened species (At Risk: declining). The other two species (shortfin eel and banded kokopu) are not listed as

threatened (Goodman *et al.* 2013). Table 3.3 provides an overview of the fish species caught/observed within the streams along the proposed alignment.

Table 3.4 presents the species that have been previously recorded in the streams potentially affected by the Northern Interceptor alignment. At most sites the same species were found during the current survey compared to those held within FFDB records.

Table 3.3: Overview of all fish species caught/observed within the streams along the proposed alignment

Assessed stream site	Method	Common name	Species name	Threat status
Wainoni Park North	Electric fishing	Shortfin eel	*Anguilla australis*	Not threatened
Witton Place	Electric fishing	Shortfin eel	*Anguilla australis*	Not threatened
	Electric fishing	Longfin eel	*Anguilla dieffenbachii*	At Risk: declining
	Electric fishing	Banded kokopu	*Galaxias fasciatus*	Not threatened

Table 3.4: Fish species recorded within streams along the proposed alignment in the Freshwater Fish Database

Site	Stream name on FFDB	Common name	Scientific name
Witton Place	Lucas Creek Tributary	Banded kokopu	*Galaxias fasciatus*
		Longfin eel	*Anguilla dieffenbachii*
		Shortfin eel	*Anguilla australis*
		Unidentified eel	*Anguilla* sp.
		Koura	*Paranephrops* sp.

No survey for marine fish was carried out as part of this investigation. However, the diversity of marine fish species frequenting the project area during high water are likely to be similar to that recorded in the upper Waitemata Harbour (Auckland Regional Authority, 1983).

Fish species probably present in the Project area include the Australian anchovy (*Engraulis australis*), the yellow-eye mullet (*Aldrichetta forsteri*), the striped mullet (*Mugil cephalus*), the yellow belly flounder (*Rhombosolea leporina*), the New Zealand flounder (*Rhombosolea plebeia*), snapper (*Pagrus auratus*), kahawai (*Arripus trutta*), the spiny dogfish (*Mustelus lenticulatus*), spotties (*Notolabrus celidotus*), parore (*Girella tricuspidata*), jack mackerel (*Trachurus novazelandiae*) and school sharks (*Galeorhinus galeus*).

4 Assessment of significance

The Project footprint and immediate surrounds includes a diversity of ecological characteristics and values. Sites have been assessed under different statutory contexts including the NZ Coastal Policy Statement 2010 (NZCPS), the PAUP, North Shore Ecological Survey, the Auckland Council District Plan (North Shore City and Waitakere City Sections), the operative ACRP:C and the significance criteria in the ACRPS. Where available, stated reasons for a site's significance is provided. The ecological significance of all sites designated as ecologically significant in the various policies and plans listed below is supported by our desktop review and field assessment.

4.1 New Zealand Coastal Policy Statement

NZCPS Policy 11 (Indigenous biological diversity) is relevant to the project, as the project footprint and wider study area contains indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification system lists. These taxa comprise:

- Banded rail within the project footprint (western end of SH18 causeway, Te Wharau Creek);
- (Potentially) shags roosting or nesting in coastal trees near Rahui Road;
- Other coastal birds using intertidal foraging areas adjacent to the project footprint.

4.2 Auckland Council Regional Policy Statement significance criteria

Of the ecological sites investigated, and which are not classified as ecologically significant under the Proposed Auckland Unitary Plan, two further sites are considered significant under the Auckland Council Regional Policy Statement significance criteria.

The first of these is the stream and gully system near Sunnyview Road, which provides an ecological corridor for native fauna from the coastal area of Lucas Creek to Significant Ecological Areas in Wainoni Park and further South.

The second is the mangrove and salt marsh area located at the western end of the Greenhithe Bridge causeway which is inhabited by banded rail which are a Regionally Threatened species (Sawyer & Forbes 2013) and therefore trigger the ACRPS significance criteria[3]. To provide some context, banded rail inhabit areas with salt marsh and mangrove habitats and are known to be present but uncommon elsewhere within the upper Waitemata Harbour. Banded rail are expected to be present in the salt marsh and mangrove habitat (SEA _T_4791), on the southern side of the causeway between the motorway and Buckley Ave. The mangrove areas on the western side of Monterey Park, fringing the Waiarohia Inlet and around Herald Island may also be inhabited by banded rail.

4.3 Auckland Council Regional Plan: Coastal

Under the Auckland Council Regional Plan: Coastal, the section of Waitemata Harbour that the proposed alignment crosses from the Greenhithe Bridge to Rahui Road is categorised as a General Management Area as well as a Mooring Management Area. General Management Area refers to coastal and marine areas which are not within one of the specific management areas but still have

[3] The New Zealand Threat Classification System was developed by the Department of Conservation and is used to assign native New Zealand taxa with a standardised threat status. The Criteria for categorising a species is outlined in the New Zealand Threat Classification Manual (Townsend *et al*., 2008). An audit of all New Zealand bird taxa that have been categorised using this criteria and further details on the bird species listed above can be found in Robertson *et al.* (2013).

restrictions and rules relating to the management. Mooring Management Areas are marked to encourage high concentration of moorings for management purposes.

Further along the proposed alignment, the Te Wharau Creek crossing area is classified as a Coastal Protection Area 1 due to the area containing:

- The best example of the muddy, mangrove lined inlets of the Waitemata Harbour;
- A high productivity and diversity of flora and fauna;
- An important pathway for migration and habitat for threatened species; and
- Gradations between the marine environment and natural freshwater and/or terrestrial systems.

4.4 Auckland Council District Plan (North Shore City Section) and North Shore Ecological Survey

Under the operative North Shore City Council District Plan and North Shore Ecological Survey, the following assessed sites along the proposed alignment are considered significant;

Rahui Road

South of where the proposed alignment comes ashore, sections of the large tract of coastal forest is considered significant due to;

- Containing significant examples of pohutukawa-broadleaved forest and coastal kanuka forest associations;
- Contains areas with exotic species in the canopy which provides important ecological linkages and buffering to coastal forest;
- Provides riparian protection to a small coastal stream;
- Coastal vegetation provides protection to cliffs; and
- There is a small area of mangrove saltmarsh with ecotonal sequences to terrestrial coastal forest.

Under the District Plan, the entire coastal stretch is also considered a coastal conservation area, with segments also categorised as a proposed reserve.

Te Wharau Creek crossing

The coastal inlet at the mouth of Te Wharau Creek and the surrounding vegetation is considered significant due to:

- Containing excellent examples of a range of eco-unit types, including saline wetlands and terrestrial and stream habitat.
- Isolated patches of saline scrubland species (e.g. Stipa, saltmarsh ribbonwood) scattered throughout the wetland. The site is an integral part of the wetland ecosystem and part of the eco-tone sequence.

Under the District Plan, the land adjacent to Te Wharau Creek on both sides of the crossing is considered a coastal conservation area, with segments also categorised as a proposed reserve. Lucas Creek, including Te Wharau Creek, is categorised as a Site of Special Wildlife Interest (SSWI).

Linkage areas

The stream and riparian area near Sunnyview Road is classified as linkage area and a coastal conservation area. The Witton Place gully system is also considered a linkage area.

4.5 Auckland Council District Plan (Waitakere City Section)

The planning maps in the Auckland Council District Plan (Waitakere City Section) show a number of annotations in the vicinity of, and partially within, the footprint of the proposed works, at the Hobsonville end, as follows:

- 20 m coastal edge, around the original coastline, i.e. not including the current coastline along the northern side of the SH18 causeway;
- Coastal Natural Area, around the original coastline, i.e. not including the current coastline along the northern side of the SH18 causeway;
- Approximately 2 ha of Open Space, to the east of and surrounding the Hobsonville PS; and
- Managed Natural Area: a small triangular area approximately 100 m long x 20 m wide, at the western end of the SH18 causeway. This area would largely fall within the footprint of the GBWD & Causeway project; and thus would be significantly modified before the NI project commences.

4.6 Proposed Auckland Unitary Plan

Under the PAUP, the following assessed sites along the proposed alignment are considered significant by Auckland Council for the reasons listed. These reasons are the qualifying criteria upon which Council's listing of these is based;

Greenhithe Bridge causeway

Both the thin strip of rocky vegetation (SEA_T_4791) adjacent to the northern side of the SH18 causeway and the much larger estuarine and coastal area (SEA_T_3409) on the southern side of the causeway. Both sites are significant due to;

- *Threat status and rarity;* and
- *Stepping stones, migration pathways and buffers.*

Although the NI pipelines will partially occupy the footprint of SEA_T_4791, effects on this SEA will arise in the first instance from the causeway extension that is described and assessed in the AEE for the Greenhithe Bridge Watermain Duplication and Causeway project.

Rahui Road

The small strip of coastal vegetation (SEA_T_8433) to the north of where the proposed alignment comes ashore is considered significant due to;

- *Stepping stones, migration pathways and buffers.*

South of where the proposed alignment comes ashore, the large tract of coastal forest (SEA_T_8319) is considered significant due to;

- *Diversity*; and
- *Stepping stones, migration pathways and buffers.*

Wainoni Park North

The vegetation and stream system (SEA_T_8406) in the north of Wainoni Park is considered significant due to;

- *Threat status and rarity;* and
- *Stepping stones, migration pathways and buffers*.

Te Wharau Creek crossing

The coastal inlet at the mouth of Te Wharau Creek (a tributary of Lucas Creek) (SEA_M2_57b) is considered significant as it is the best example of the muddy, mangrove-lines inlets of the inner Waitemata Harbour, with a high diversity of flora and fauna including shellfish, birds and fish. It is also an important pathway for migration and habitat for threatened species. The site's significance is further increased as it abuts terrestrial vegetation, and hence provides for important ecological linkages between ecosystems, buffering and improved resilience of both systems.

The vegetation adjacent to Lucas Creek (SEA_T_8045, SEA_T_8351 and SEA_T_3433) on the northern side is considered significant due to;

- *Threat status and rarity*; and
- *Stepping stones, migration pathways and buffers.*

Memorial Park

The large forested area in Memorial Park (SEA_T_8045, SEA_T_8351 and SEA_T_3433), immediately south of the proposed alignment, is considered significant due to;

- *Threat status and rarity*; and
- *Stepping stones, migration pathways and buffers*.

Witton Place

The forested gully and stream system (SEA_T_8047) located west of the North Shore Golf Club is considered significant due to;

- *Threat status and rarity*; and
- *Stepping stone, migration pathways and buffers*.

Rosedale Park

The forested gully and stream system (SEA_T_8084 and SEA_T_8082) located west of the Rosedale WWTP is considered significant due to;

- *Threat status and rarity*.

5 Assessment of effects

An assessment of the environmental effects of the NI project is presented below. These effects are summarised in Table 5.2. We have assessed Project effects on ecological values within sites identified as:

- An SEA;
- A CPA; or
- being ecologically significant under the Auckland Council District Plan: North Shore City and Waitakere City Sections.

5.1 Vegetation removal

The proposed alignment will require the removal of vegetation at six of the fourteen assessed sites (see Appendix A, Figures 2–5), including two SEAs (green hatched areas in Appendix A, Figures 2–5) and four areas of ecological interest that comprise non-significant vegetation (blue hatched areas in Appendix A, Figures 2–5). The total amount of vegetation required for removal is approximately 4,000 m^2 (0.40 ha) including 1,600 m^2 (0.16 ha) of vegetation located within two SEAs (Table 5.2). Specifically, vegetation removal is required at:

- SEAs (green hatched areas in Appendix A, Figures 2–5):
  - SEA-T-8406 in Wainoni Park North (1,000 m²)
  - SEA-T-8047 Witton Place (600 m²)
- Areas of ecological interest (blue hatched areas in Appendix A, Figures 2–5) that comprise non-significant vegetation:
  - Vegetation at Hobsonville PS (1,000 m²)
  - Vegetation at close to Rahui Road (300 m²)
  - Vegetation adjacent to and immediately North of SEA-T-8047 (400 m²)
  - Vegetation in Rosedale Park immediately East of SEA-T-8082/8084 (700 m²)

Forest and scrub areas to be cleared are unlikely to include any nationally "Threatened" or "At Risk" plants and comprises native species common throughout the early succession forested areas within the North Shore area and the wider Auckland Region.

Clearance of vegetation may also introduce forest edge conditions, including increased light and wind and reduced humidity. However as many of the sites will require vegetation removal along the edge of the forest or riparian areas, this is likely to have a minimal effect on the remaining vegetation. At sites (such as the pipe bridge) where vegetation removal is required through the middle of the forest or riparian zones, it is assumed that approximately 10 m width of vegetation will be cleared. Again, edge effects are likely to be negligible.

Vegetation clearance will result in small-scale loss of habitat and resources for native birds, lizards and invertebrates, while also having an indirect effect on stream habitat through the loss of shade and detrital input. Native plant species mentioned in the previous sections of this report also provide food resources in the form of berries/nectar to the native birds and lizards present in the area.

The effects of habitat loss resulting from vegetation clearance could potentially be more than minor if native species, some of which are nationally "Threatened", "At Risk", or legally protected are harmed during the track construction or operational activities. Precautions discussed in the following section of this report will minimise the likelihood of potentially causing harm to native species.

Other potential effects resulting from vegetation removal include the introduction and establishment of pest plant species from machinery. Precautions discussed in the following section will minimise the risk of the introduction of exotic pest plants.

5.2 Freshwater stream effects

The project footprint traverses streams or creeks between Hobsonville and Rosedale, as follows.

Table 5.1: Stream crossings

Location	Description of crossing
Sunnyview Road	Crosses above existing culvert, no streamworks.
Wainoni Park South	Crosses below existing culvert, no streamworks.
Wainoni Park North	Open trench with overpumping of stream.
Te Wharau Creek	HDD below tidal section.
North Shore Memorial Park	Crosses above existing culvert, no streamworks.
Witton Place/Laurel Oak Drive	Pipe bridge – vegetation clearance but no streamworks.
North Shore Golf Club access road	Crosses above existing culvert, no streamworks.
Alexandra Stream (Rosedale Park)	HDD under stream
Jack Hinton Drive tributary (Rosedale Park)	Open trench (intermittent stream)

The proposed open trenching across two streams will result in the temporary disturbance of the streams. This disturbance could lead to short term increases in sedimentation and reductions in water quality. The streams at sites where vegetation clearance will take place will also be affected by the reduction in channel shading and input of organic detritus. However, it is expected that these effects will be no more than minor due to the short-term nature of the proposed works assuming standard TP90 erosion and sediment control plans are put in place.

During HDD under watercourses, there is risk of drilling fluid escaping into watercourses. The risk of this occurring and/or adversely affecting the ecological quality of watercourses can be managed by development and implementation of an appropriate drilling fluid management plan.

We understand that it is not proposed to permanently modify any sections of stream by construction of new culverts.

5.3 Coastal/marine effects

Effects on coastal marine environments will depend greatly on the construction method selected. Horizontal Directional Drilling will have negligible effect on coastal environments. HDD is proposed for the Te Wharau Creek estuary, and is being considered as an option for the upper Waitemata Harbour Crossing.

The other option being considered for the upper Waitemata Harbour crossing is marine trenching. In the intertidal section where the pipeline makes landfall on the North Shore (Rahui Road) (see Figure 2), marine trenching would be carried out by traditional sidecasting methods, with excavated material being placed adjacent to the trench before the pipeline is laid. A temporary causeway will be required for access: this will require temporary occupation of the CMA, which will be reinstated after completion of construction. The core of the causeway will be constructed of rock or gravel, overlying a geotextile mat, which will assist with identification and removal of the material.

At its Hobsonville end, the pipeline will be laid within the (widened and lengthened) Greenhithe Bridge Causeway, and no direct effects on intertidal areas of the CMA are expected.

In subtidal sections, deep trenching would be carried out by other methods such as jet trenching or mass flow excavation. These methods are described in more detail in the accompanying Coastal Processes report (T&T, 2015).

At the two points where deep trenching abuts against intertidal areas, there will be a 'transition area' (see Figure 2). In these areas the pipe will be installed either using hydraulic excavators mounted on a barge to form the trench or mobile hydraulic jetting techniques to self-lower the pipe lain out on the existing seabed as described in T&T (2015). In the case of the hydraulic excavator method, excavated material will either be stockpiled in a barge for replacement within the dredged channel or located on the seabed adjacent to the trench for backfilling.

Typical cross sections of intertidal and deep trenching works areas are shown on MWH Drawing 2012102.004.

Trenching across the upper Waitemata Harbour will result in the direct disturbance of benthic communities inhabiting the seabed within the footprint of the trench, and within intertidal areas that are used for sidecasting. These effects will be significant for marine life in the works footprint and immediate environs, but will be short-term in nature and should not result in any long-term negative impacts to the environment. Previous work involving benthic community disturbances and recovery has shown that recovery occurs rapidly, with few signs of the impact observable 12 months after the disturbance (Gardner & Wear, 2006). While these effects will potentially be significant in the short term, we consider that residual medium to long-term effects will be no more than minor.

In addition there will be increased suspended sediment and potentially some deposition of fine sediment at locations outside the works footprint. The HDR study which is summarised in the accompanying coastal processes report (T&T, 2015) found that suspended solids concentrations increased massively in the vicinity of hydraulic jetting works, but that these levels reduced within a few hours. One advantage of the hydraulic jetting method is the speed with which it can be carried out, and thus the acute effects on water quality during implementation are only short-lived.

Although less information on the effects of mass flow excavation is available in the literature, the physical effects are expected to be similar to those for hydraulic jetting (T&T, 2015).

In the immediate area of the works (tens of metres from the pipeline) there will be some deposition which will affect benthic communities in the short-term, although (as for the effects within the works footprint) recovery is expected to be rapid. Mobile species such as finfish will move away to avoid areas with elevated suspended sediment levels. Overall, given the relatively high natural suspended sediment levels and depositional nature of the upper Waitemata Harbour, as well as the short duration of the works, the effects of the project are expected to be no more than minor (greater than 1 year post-construction).

A small area of intertidal coastal area will be temporarily affected by the trenching of the NI pipeline and the temporary causeway at Rahui Road. However, in relation to the remaining available habitat for foraging and the temporary nature of the disturbance it is considered that the effects on coastal birds will be no more than minor.

Banded rail, a key threatened bird species, which is likely to be present within mangrove habitats in Te Wharau Creek, will not be adversely affected by the Project given that horizontal drilling will be undertaken under Te Wharau Creek.

Table 5.2: Summary of adverse ecological effects and scale of effect.

Location	Activity/potential ecological effect	Scale of effect without mitigation*	Basis
Hobsonville PS (Figure 2)	Vegetation/habitat removal.	Potentially more than minor.	Vegetation removal will total approximately 1,000 m^2 of early succession native and exotic forest that supports native birds, is likely to support the legally protected copper skink and possibly supports several "At Risk" lizards. No effect on banded rail (threatened birds) is anticipated as part of this project.
Upper Waitemata Harbour crossing (Figure 2)	Temporary loss of foraging habitat for coastal birds.	No more than minor.	This would depend on the method of laying pipes; HDD or marine trenching and the area of disturbance for the latter. The area being trenched is mostly deep channel water and not the optimal foraging habitat in the local area. Effects of the causeway widening are addressed in the AEE for the GBWD & Causeway project.
	Disturbance of benthic communities from marine trenching	Significant, temporary.	Significant mortality of benthic organisms in trench footprint and sidecasting areas, recovering over 1-2 years. Temporary avoidance of works area by mobile species such as finfish.
Rahui Road area of ecological interest (Figure 3)	Vegetation/ habitat removal.	No more than minor.	Vegetation removal will total approximately 300 m^2 of early succession native and exotic forest with minimal ecological value. Low quality habitat to native birds, lizards and skinks. No effect on threatened shag species is anticipated.
Sunnyview Road area of ecological interest (Figure 3)	Works near a permanent stream	Negligible	The proposed alignment crosses a stream over the top of a culvert and runs adjacent to the forested area. Effects will be negligible assuming sediment control measures are implemented.
Wainoni Park South (Figure 3)	Works near a permanent stream	Negligible	The proposed alignment crosses a stream over the top of an existing culvert and runs adjacent to the forested area. Effects will be negligible assuming sediment control measures are implemented.
Wainoni Park North (Figure 3)	Works near an ephemeral stream	Negligible	The proposed alignment runs near an ephemeral stream. Effects will be negligible assuming sediment control measures are implemented.
	Vegetation removal/ habitat removal within an SEA.	More than minor.	This site is an SEA (SEA-T-8406). Vegetation removal associated with the project is approximately 1000 m^2. Affected vegetation includes early succession native and exotic forest that supports native birds. It is also likely to support the legally protected copper skinks and possibly supports several "At Risk" lizards.

Location	Activity/potential ecological effect	Scale of effect without mitigation*	Basis
	Temporary alterations to permanent stream.	Minor	Assuming no permanent stream is lost, disturbance of stream is short-term and sediment control measures are implemented.
Te Wharau Creek crossing (Figure 4)	Negligible	Negligible	This site is SEA-T-8045/ 8351/8433. HDD will be undertaken in this segment, which (provided appropriate measures are in place to manage drilling fluids) will have no effect on the ecosystems present. No effect on banded rail (threatened birds) is anticipated.
Memorial Park (Figure 4)	Stream crossing	Negligible	The proposed alignment crosses a stream over the top of an existing culvert and runs adjacent to the forested area.
Witton Place/ Laurel Oak Drive (Figure 4)	Vegetation removal/ habitat removal within an SEA.	More than minor.	The site is an SEA (SEA-T-8047). Vegetation removal will total approximately 600 m^2 of early succession and predominantly native forest that supports native birds, is likely to support the legally protected copper skinks and possibly supports several "At Risk" lizards.
	Vegetation removal/ habitat removal outside an SEA.	No more than minor	The site is not an SEA though it is adjacent to SEA-T-8047. Approximately 400 m^2 of vegetation will be removed. Vegetation is early successional mixed native/exotic forest of relatively low quality. It is however likely to support the legally protected copper skinks and possibly supports several "At Risk" lizards.
	Stream crossing (pipe bridge)	No more than minor.	Assuming no permanent stream is lost, disturbance of stream is short-term and sediment control measures are implemented.
North Shore Golf Club (Figure 5)	Stream crossing	Negligible	The proposed alignment crosses a stream over the top of a culvert and runs adjacent to the forested area.
Rosedale Park (Figure 5)	Stream crossing using HDD	Negligible	SEA (8082/8084). Horizontal directional drilling will be undertaken in this segment which will have no effect on the ecosystems present.
	Vegetation removal/ habitat removal.	Minor	The site is not an SEA. Vegetation removal will total approximately 700 m^2 of early succession and predominantly native forest that supports native birds. It is likely to support the legally protected copper skinks and possibly supports several "At Risk" lizards.

*Note: recommended measures to avoid, remedy or mitigate adverse effects, and residual effects post-mitigation are discussed in Section 6 of this report.

6 Summary of recommendations to avoid, remedy or mitigate adverse effects

The effects assessment in Section 5 illustrates that the proposed northern interceptor will have actual or potential adverse effects on several areas along/adjacent to the alignment, with some effects likely to be more than minor, in the absence of efforts to avoid, remedy or mitigate potential adverse effects.

Consequentially, recommendations to avoid, remedy or mitigate these effects are set out below.

6.1 Terrestrial ecosystems

Terrestrial effects will include the removal of approximately 4,000 m^2 (0.40 ha) of vegetation and potential habitat for native species, at Hobsonville PS, Rahui Road, Wainoni Park North, Witton Place and Rosedale Park. This includes the loss of 1,600 m^2 (0.16 ha) of vegetation within SEAs and 2,400 m^2 (0.24 ha) of clearance of vegetation which provides habitat to native birds and may support "At Risk" lizards and the legally protected copper skink. Without appropriate mitigation, the effect of vegetation/habitat loss is considered to be more than minor.

To avoid, remedy or mitigate for habitat/vegetation loss, we recommend the following:

- Where practical, vegetation removal is undertaken outside of peak bird breeding season, particularly when fledglings will be present (November–March);
- Cut vegetation is to remain onsite for 3 days to provide affected lizards an opportunity to disperse into remaining vegetation;
- Native skinks are salvaged prior to and during vegetation clearance associated with construction activities, under the supervision of a DoC-permitted herpetologist;
- Machinery is checked before coming on site for any seeds or fragments of exotic pest plants;
- Other than for riparian vegetation immediately adjacent to permanent streams, a 2 (replacement): 1 (loss) ratio of native revegetation is undertaken within or in close proximity to affected areas for the purposes of replacing lost vegetation and habitats for native species;
- Recognising that stream crossings such as the pipe bridge will have a permanent footprint which may pose constraints for replanting at 2:1 ratio alongside permanent streams, that the removal of riparian vegetation from permanent streams is minimised, where practicable. If 2:1 replanting is not practicable (e.g. due to height restrictions around pipe bridges), then stream banks are replanted with lower-stature vegetation, to minimise loss of shading, detrital inputs and food resources for birds and lizards.

6.2 Fresh water ecosystems

Based on the supplied specifications, direct effects in the freshwater environment are likely to be limited to pipe trenching across two streams (one permanent, one intermittent). Trenching will have short terms effects on the stream including stream bed disturbance, possible increases in sedimentation and a decrease in water quality. These effects can be mitigated via installing temporary dams and overpumping the stream while trenching is being undertaken. This would also help minimise any sedimentation or water quality effects.

Fish salvage works would also be required to relocate native fish species out of the affected stream area, if works are likely to directly affect them (e.g. over-pumping of sections of stream, so that instream works can be carried out 'in the dry').

Upon completion of works, the stream bed and banks should be restored to achieve as near a natural state as possible, including gradient of stream bed and banks, substrate, and riparian vegetation.

In locations such as the Witton Place pipe bridge, where vegetation removal is required to carry out the proposed works, the effects can be mitigated by replanting to the greatest extent possible upon completion of works.

The risk of drilling fluids being released to watercourses during HDD should be managed by development and implementation of an appropriate management plan.

6.3 Coastal marine ecosystems

Based on the supplied specifications, the effects on the coastal marine environment are likely to be limited to the trenching or HDD across the upper Waitemata Harbour and the horizontal drilling under Te Wharau Creek.

The trenching across the upper Waitemata Harbour will result in the direct disturbance of benthic communities inhabiting the seabed within the footprint of the trench, and within intertidal areas that are used for sidecasting and the temporary causeway. In addition there will be increased suspended sediment and potentially some deposition of fine sediment at locations outside the works footprint. The most appropriate means of managing these effects are to minimise the works footprint and the duration of works. These objectives have been central to the development of the construction method.

More specifically, the effects of sidecasting and the temporary causeway can be mitigated by the use of geotextile mats before placement of material, which will assist with removal of the material upon completion of works, while minimising effects on the underlying substrate.

Effects of the project on coastal birds are expected to be negligible. Therefore no mitigation for coastal birds is considered to be necessary.

Short-term, construction related effects may be managed by standard construction management techniques, such as sediment control, drilling fluid management, appropriate storage of environmentally hazardous substances so that they do not find their way into coastal environments, and selection of tracking routes to, through and around the active construction site, which avoid the areas of highest ecological value as identified in this report.

6.4 Post-mitigation effects

If the above recommendations are implemented to avoid, remedy and mitigate for the adverse ecological effects associated with the project, it is likely that the net residual effects of the Northern Interceptor (Phase 1) Project will be no more than minor.

7 References

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8 Applicability

This report has been prepared for the benefit of Watercare Services Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

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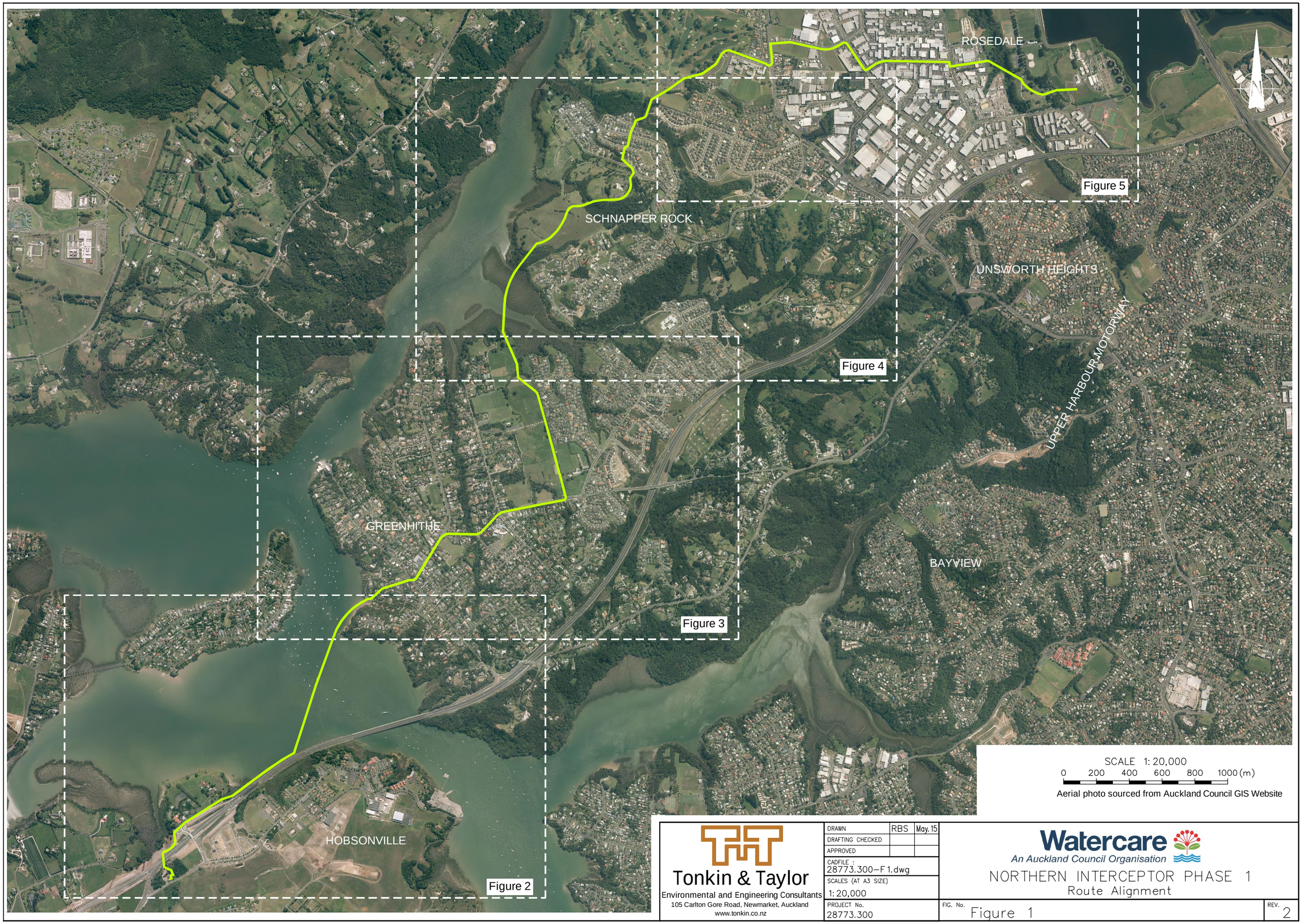
Appendix A: Figures



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NORTHERN INTERCEPTOR PHASE 1
Route Alignment

FIG. No. Figure 1 REV. 2

SCALE 1: 7500

0 100 200 300 400 500 (m)

Aerial photo sourced from Auckland Council GIS Website

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NORTHERN INTERCEPTOR PHASE 1
Hobsonville

FIG. No. Figure 2

REV. 2

SEA-M-576

Wainoni Park North

SEA-T-8406

SEA-T-8003

Wainoni Park South

GREENHITHE

UPPER HARBOUR MOTORWAY

Sunnyview Road

SEA-T-8433

INTERTIDAL TRENCHING

12

13

14

9

DEEP TRENCHING

TRANSITION AREA

8

15

7

HORIZONTAL DIRECTIONAL DRILLING

Rahui Road

SEA-T-8319

N

LEGEND

- Pipe route - open cut
- Pipe route - drilling
- Significant Ecological Area (SEA)-Terestrial as defined by Auckland Council
- Significant Ecological Area (SEA)-Marine as defined by Auckland Council
- Areas of ecological interest not classified as an SEA
- Benthic fauna core sample location
- SEV Reach

SCALE 1: 7500

0 100 200 300 400 500 (m)

Aerial photo sourced from Auckland Council GIS Website

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NORTHERN INTERCEPTOR PHASE 1
Greenhithe

FIG. No. Figure 3

REV. 2

North Shore Golf Club

Unity Drive South

SEA-T-8047

SEA-M-576

SCHNAPPER ROCK

Memorial Park

SEA-T-8045
SEA-T-8351
SEA-T-8433

SEA-T-8045
SEA-T-8351
SEA-T-8433

Te Wharau Creek Crossing

UPPER HARBOUR MOTORWAY

LEGEND

- Pipe route - open cut
- Pipe route - drilling
- Significant Ecological Area (SEA)-Terestrial as defined by Auckland Council
- Significant Ecological Area (SEA)-Marine as defined by Auckland Council
- Areas of ecological interest not classified as an SEA
- SEV Reach

SCALE 1: 7500

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NORTHERN INTERCEPTOR PHASE 1
Schnapper Rock

FIG. No. Figure 4

REV. 2

SCALE 1: 7500

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Aerial photo sourced from Auckland Council GIS Website

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NORTHERN INTERCEPTOR PHASE 1
Rosedale

FIG. No. Figure 5

REV. 2

Appendix B: Marine ecological data

			Northern Interceptor Sites																		
General Group	**Taxa**	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Anthozoa	Anthopleura												1	1			2	5		5	
Porifera	Sponge Unid Encrusting	Unidentifed encrusting sponge		1	1	3			3												
Porifera	*Ciocalypta* sp.	Sponge			3	5	1	1	1												
Porifera	*Sycon* sp.	Calcareous Sponges			10	12	1		5												
Hydrozoa	Hydroida (thecate)	Hydroid colony			5	2	10		2												
Anthozoa	*Edwardsia* sp.	Burrowing anemone									2										
Nemertea	Nemertea	Proboscis worms	1							1	1	1								2	
Nematoda	Nematoda (large)											1		1	2	4	2	3		5	
Sipuncula	*Aspidosiphon* sp.	Peanut worm				2		2													
Polyplacophora	*Leptochiton inquinatus*	Chiton					2														
Gastropoda	*Nassarius burchardi*	Dog whelk								2											
Gastropoda	*Potamopyrgus estuarinus*	Estuarine snail									1										
Gastropoda	*Sigapatella novaezelandiae*	Slipper limpet							7				1							2	
Gastropoda	*Zeacumantus lutulentus*	Spireshell									2										
Bivalvia	*Anomia trigonopsis*	Jingle shell												1	1	1					
Bivalvia	*Arthritica bifurca*	Small bivalve	2							2					2		2				
Bivalvia	*Austrovenus stutchburyi* (0-5mm)	Cockle (0-5mm)								6	5										
Bivalvia	*Austrovenus stutchburyi* (06-10mm)	Cockle (6-10mm)									14										
Bivalvia	*Austrovenus stutchburyi* (11-20mm)	Cockle (11-20mm)								6	15										
Bivalvia	*Austrovenus stutchburyi* (21-30mm)	Cockle (21-30mm)								1											
Bivalvia	*Felaniella zelandica*												2								
Bivalvia	*Limaria orientalis*	Oriental file shell											2					1			
Bivalvia	*Leptomya retiaria retiaria*	Bivalve			1								1								
Bivalvia	*Macomona liliana*	Wedge shell (Hanikura)									2										
Bivalvia	*Musculista senhousia*	Asian mussel										1	11	2	7	2	2	5	1	13	
Bivalvia	*Nucula hartvigiana*	Nut Shell								2											
Bivalvia	*Perna canaliculus* (spat)	Green Lipped Mussel juveniles							1												
Bivalvia	*Saccostrea glomerata*	Auckland rock oyster							7												
Bivalvia	*Crassostrea gigas*	Pacific Oyster														1					
Bivalvia	*Theora lubrica*	Window shell		10	3	1										1			4		8
Bivalvia	*Varinucula gallinacea*	Nut shell							2				6	2	3						
Bivalvia	Juvenile UNID												1								
Oligochaeta	Oligochaeta	Oligochaete worms	3	3					1						1			1		13	8
Polychaeta: Ampharaetidae	Ampharaetidae												1								
Polychaeta: Orbiniidae	*Phylo novazealandiae*	Polychaete worm	4	5	1																1
Polychaeta: Orbiniidae	*Scoloplos cylindrifer*	Polychaete worm									12										
Polychaeta: Paraonidae	Paraonidae	Polychaete worm	98	29	12	1	18	36		26	1	1	3	4		1	2	8	2		51
Polychaeta: Paraonidae	*Aricidea* sp.	Polychaete worm							1					1	1	1	4		2	22	2
Polychaeta: Cossuridae	*Cossura consimilis*	Polychaete worm	22	1	8				1					1		3	1		1	1	5
Polychaeta: Spionidae	*Boccardia* sp.	Polychaete worm	1		1				1	15		1						1			2
Polychaeta: Spionidae	*Prionospio aucklandica*	Polychaete worm								3	2										
Polychaeta: Spionidae	*Prionospio multicristata*	Polychaete worm			1					1											
Polychaeta: Capitellidae	*Barantolla lepte*	Polychaete worm									1										
Polychaeta: Capitellidae	*Heteromastus filiformis*	Polychaete worm	22	10	17		5	2		52	1	1	1	13	4	1	2	11	6	24	25
Polychaeta: Opheliidae	*Armandia maculata*	Polychaete worm						1					1		1						
Polychaeta: Polynoidae	Polynoidae	Scale worms		3					7										1		
Polychaeta: Hesionidae	Hesionidae	Polychaete Worm							1												
Polychaeta: Syllidae	Syllidae	Polychaete worm		1		2		1	2			1		2	27		1	2	1	10	
Polychaeta: Syllidae	*Sphaerosyllis* sp.	Polychaete worm			5		3	3	8	1		1	3	13	113	8	11	17	1	27	
Polychaeta: Nereidae	Nereidae (juvenile)	Rag worms	1							5	1										
Polychaeta: Glyceridae	Glyceridae	Polychaete worm				1				2	1										
Polychaeta: Goniadidae	*Goniada* sp.	Polychaete worm		1	1		2														1
Polychaeta: Eunicidae	Eunicidae	Polychaete worm				2		1					2								
Polychaeta: Lumbrineridae	Lumbrineridae	Polychaete worm		1			1	2					8							2	
Polychaeta: Dorvilleidae	Dorvilleidae	Polychaete worm				2							1	1	1			2		1	
Polychaeta: Cirratulidae	Cirratulidae	Polychaete worm	4		12		5			36				5	4	8		2	1	10	
Polychaeta: Terebellidae	Terebellidae	Polychaete worm	4	1	1	5			1							1			2		
Polychaeta: Sabellidae	*Branchiomma curtum*	Fan worm							13												
Polychaeta: Sabellidae	*Sabella spallanzanii*	Fan worm (introduced)			1				6												
Polychaeta: Sabellariidae	*Sabellaria kaiparaensis*	Polychaete worm		1																	
Crustacea	Euphausiacea	Krill			1																
Mysidacea	Mysidacea	Mysid shrimp	1																		
Cumacea	Cumacea	Cumaceans		1	3																
Tanaidacea	*Tanaid* sp.	Tanaid Shrimp			2	6	1	2	25	4					1				5		
Isopoda	Anthuridea	Isopod		3			1	1							3				1	1	
Isopoda	*Exosphaeroma waitemata*	Isopod									2										
Isopoda	*Munna schauinslandii*	Isopod							2												
Isopoda	*Plakathrium* sp.	Isopod							11												
Amphipoda	Ampeliscidae	Amphipod (family)											1								
Amphipoda	Caprellidae	Caprillid amphipod			1				1								1				
Amphipoda	Corophiidae	Amphipod (family)	1	15			1	1				1						2			
Amphipoda	Lysianassidae	Amphipod (family)	1		1	2			13												
Amphipoda	*Melita awa*	Melitidae (family)													1						
Amphipoda	Phoxocephalidae	Amphipod (family)	11	24	6	2	3	3				2						1	3		
Amphipoda	Oedicerotidae	Amphipod (family)			1																
Amphipoda	Amphipoda Unid.	Amphipod			2	5		1							2					1	
Decapoda	*Halicarcinus cookii*	Pill-box Crab							1												
Decapoda	*Helice crassa*	Tunnelling Mud Crab								3	1										
Decapoda	*Macrophthalmus hirtipes*	Stalk-eyed Mud Crab		1																	
Decapoda	*Notomithrax minor*	Crab							1												
Decapoda	*Palaemon affinis*	Estuarine Prawn							2												
Decapoda	*Petrolisthes elongatus*	Half crab							1												
Decapoda	*Petrolisthes novaezelandiae*	Red false crab							8												
Decapoda	*Pontophilus* sp.	Shrimp			2																
Decapoda	Decapoda (larvae Unid.)	Unidentified Crab Larvae			2				15												
Ostracoda	*Cymbicopia hispida*	Ostracod			1																
Ostracoda	*Cypridinoides reticulata*	Ostracod			1																
Ostracoda	Neonesidea	Ostracod							59					1							
Ostracoda	*Parasterope quadrata*													1							
Ostracoda	*Scleroconcha arcuata*	Ostracod			1																
Ostracoda	Ostracoda UNID												1				1	1			
Copepoda	Copepoda	Copepods			1																
Cirripedia	*Austrominius modestus*	Estuarine Barnacle							2	1											
Pycnogonida	Pycnogonid (unid.)	Sea spiders			1							2			2					1	
Bryozoa	Bryozoa (encrusting)	Bryozoan			1				3												
Bryozoa	Bryozoa (bushy)											1								1	
Hemichordata	Hemichordata	Acorn worm			1																
Ophiuroidea	Ophiuroidea	Brittle stars			2	6	2	3	62			18	17		21		2	3	5	21	
Ascidiacea	UNID solitary ascidian													19	43		1	33		34	
Ascidiacea	*Aplidium* sp.	Colonial sea squirts							1												
Ascidiacea	*Asterocarpa* sp.	Solitary sea squirt				2															
Ascidiacea	*Cnemidocarpa bicornuta*	Saddle squirt							6												
Ascidiacea	*Molgula* sp.	Solitary sea squirt		1	1		3														
Ascidiacea	*Pyura* sp.	Solitary sea squirt							2												
Opisthobranchia	*Philine* sp.															1					
Holothuroidea	*Trochodota dendyi*	Sea cucumber											2	3						2	
Mollusca: Polyplacophora	*Leptochiton inquinatus*	Chiton											4								
	Count: No of Individuals		**176**	**112**	**114**	**61**	**59**	**60**	**285**	**169**	**64**	**32**	**70**	**71**	**240**	**33**	**34**	**98**	**36**	**198**	**103**
	Count: No of Taxa		**15**	**19**	**36**	**18**	**16**	**15**	**37**	**19**	**17**	**13**	**21**	**17**	**20**	**13**	**14**	**17**	**15**	**21**	**9**
	SW_Diversity		**1.574**	**2.232**	**3.060**	**2.638**	**2.295**	**1.687**	**2.738**	**2.130**	**2.247**	**1.753**	**1.960**	**2.239**	**1.790**	**2.565**	**2.302**	**2.189**	**2.178**	**2.503**	**1.479**
	SW_Evenness		**0.581**	**0.758**	**0.854**	**0.913**	**0.828**	**0.623**	**0.758**	**0.723**	**0.793**	**0.684**	**0.824**	**0.790**	**0.598**	**0.764**	**0.872**	**0.773**	**0.804**	**0.822**	**0.673**

Appendix C: Sediment quality data

Summary sediment quality results

	Relevant Guideline*	Site 10	Site 13
Copper (mg/kg)	< 19	15	6
Lead (mg/kg)	< 30	29	17.1
Zinc (mg/kg)	< 124	116	127
HMW PAH (mg/kg)	< 0.66	-	-

*Values are for the (former) Auckland Regional Council's "green" environmental response criteria for sediment contaminants (Auckland Regional Council, 2004).

Laboratory transcripts are included overleaf.

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BETTER TESTING BETTER RESULTS

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ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1409541	SPv1
Contact:	C Sjardin	**Date Registered:**	09-Apr-2015	
	C/- Tonkin & Taylor	**Date Reported:**	16-Apr-2015	
	PO Box 5271	**Quote No:**		
	AUCKLAND 1141	**Order No:**	28773.300	
		Client Reference:	28773.300	
		Submitted By:	C Sjardin	

Sample Type: Sediment

Sample Name:		Site 10 23-Mar-2015	Site 13 23-Mar-2015			
Lab Number:		1409541.1	1409541.2			
Individual Tests						
Dry Matter	g/100g as rcvd	29	60	-	-	-
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	19	20	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	-	-	-
Total Recoverable Chromium	mg/kg dry wt	18	12	-	-	-
Total Recoverable Copper	mg/kg dry wt	15	6	-	-	-
Total Recoverable Lead	mg/kg dry wt	29	17.1	-	-	-
Total Recoverable Nickel	mg/kg dry wt	8	8	-	-	-
Total Recoverable Zinc	mg/kg dry wt	116	127	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Anthracene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Chrysene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Fluoranthene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Fluorene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Naphthalene	mg/kg dry wt	< 0.4	< 0.18	-	-	-
Phenanthrene	mg/kg dry wt	< 0.08	< 0.04	-	-	-
Pyrene	mg/kg dry wt	< 0.08	< 0.04	-	-	-

SUMMARY OF METHODS

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

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-2

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1-2
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-2
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2

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

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

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division

Appendix D: Stream Ecological Valuation data

Northern Interceptor SEV Function Scores

Function category	Functions	Alexandra Stream	Wainoni Park North
Hydraulic			
1	Natural flow regime	0.80	0.69
2	Floodplain effectiveness	0.80	0.48
3	Connectivity for natural species migrations	0.30	0.00
4	Natural connectivity to groundwater	0.88	0.66
Biogeochemical			
5	Water temperature control	0.76	0.68
6	Dissolved oxygen levels maintained	1.00	0.23
7	Organic matter input	0.75	0.75
8	In-stream particle retention	0.86	0.52
9	Decontamination of pollutants	0.70	0.65
Habitat provisions			
10	Fish spawning habitat	0.05	0.16
11	Habitat for aquatic fauna	0.77	0.33
Biodiversity			
12	Fish fauna intact	0.57	0.23
13	Invertebrate fauna intact	0.26	0.31
14	Riparian vegetation intact	0.42	0.26
Overall mean ECR value (max value 1)		**0.637**	**0.425**

Stream Ecological Valuation (SEV) field sheets

Site description

Date		9/12/14
Stream name		
Site code		
Site location		Site 3 Wainoni park (~~South~~) (North)
GPS coordinates	Easting	
	Northing	

Current weather conditions (tick)	
Clear/sunny	
Overcast	✓
Rain	
Heavy rain in past week? (tick)	
Yes	
No	/

Biological sample information		
Invertebrate sampling protocol used (HB/SB?)	SB	
Dominant substrate type sampled (e.g. wood/macrophyte/ cobble?)	Silt	
Fish sampling protocol used?	EF	
Length of reach fished?	90	
	Captured in sample (& returned to stream)?	Observed in stream?
Crayfish:		
Live freshwater Mussles:		

Site sketch map

Time 12:50
Temp 16.3
DO % 50.5
DO mg/L 4.95
PH 6.1
Cond 189

Comments

Cross sectional measures

Record the substrate at 10 points across each cross section

Inorganic and wood categories should total 10 points for each cross section; organic categories can be between 0 and 10 dependent on the occurrence of organic material over the bed substrate

		Inorganic material categories								Wood categories			Organic material categories		
	Substrate category	Silt/ sand (SI/SA)	Small gravel (SG)	Small medium gravel (SMG)	Medium large gravel (MLG)	Large gravel (LG)	Small cobble (SC)	Large cobbles (LC)	Boulders (B)	Bedrock (BR)	Small (SW)	Medium (MW)	Large (LW)	Leaf litter	Periphyton, moss, submerged macrophyte	Roots, non-submerged macrophytes
	Substrate size (mm)	<2	2-8	8-16	16-32	32-64	64-128	128-256	>256	n/a	< 50	50 – 100	> 100			
2.5m	Cross section 1	𝍸 𝍸												𝍸		
1.6m	Cross section 2	𝍸 𝍸									1			𝍸		
0.8m	Cross section 3	𝍸 𝍸									1			𝍸 𝍸		
0.3	Cross section 4	𝍸 𝍸									1			𝍸 𝍸		
1.3	Cross section 5	𝍸 𝍸									11	1		𝍸		
1.0	Cross section 6	𝍸 𝍸									1			𝍸 𝍸		
0.25	Cross section 7	𝍸 𝍸	11											𝍸		
0.55	Cross section 8	1	𝍸	11	11						1			𝍸		
1.30	Cross section 9	𝍸 𝍸	1											𝍸		
0.26	Cross section 10	𝍸 𝍸			1									1		
	Example	///	//		/	/					/	//		//	/	

This assessment contributes to the Fish Spawning Habitat (Vsurf; FSH) and Decontamination of Pollutants (Vgobspawn; DOP) functions.

The aim is to determine the relative proportion of different particle sizes and organic materials within the test reach . This is achieved by recording the size of 10 particles across each of the 10 cross sections (100 particles in total). Woody debris is included with the inorganic categories for the purposes of this assessment. Refer to page 14 of the SEV User Guide for further information.

If organic matter overlies the inorganic or wood substrate record the type of organic material in the appropriate column under the "organic material categories". It is possible to record between 0 and 10 particles in the organic material columns for each cross section dependent on the occurrence of organic material over the dominant bed substrate

Cross sectional measures

Assess the following variables at each of your 10 cross sections

	V_{depth} (Page 14)					V_{macro} (Page 21)		V_{veloc} (Page 23)			V_{shade} (Page 17)	V_{decid} (Page 48)
	Record depth (in metres) at five equally spaced locations at each cross section					Assess proportional cover of macrophytes in a 1 m band at each cross section (0-1)		Estimate maximum current velocity at each cross section using the ruler method or floating particle method (if ruler d2-d1 = <2mm)			Assess shading at stream surface from vegetation and topography	Assess the permanence of vegetation shading at each cross section
	10%	30%	50%	70%	90%	Surface-reaching, emergent and bankside	Below surface macrophytes	Ruler method (d2 – d1) in mm	Floating particle method: Distance travelled (m)	Floating particle method: Time taken (s)	One category for each cross section (see shade category descriptors below)	Record proportion of canopy cover that is NOT deciduous (0-1)
Cross section 1	0.08	0.09	0.16	0.16	0.14	0.4	–		0.05	10	Low	1
Cross section 2	.03	0.04	0.04	0.04	0.01	–	–		0.10	8	Mod	1
Cross section 3	0.02	.03	.01	0.02	.05	–	–	2			Mod	1
Cross section 4	.01	.01	.04	0.04	.05	–	–	2			Low	1
Cross section 5	.01	.01	.04	.01	.01	–	–		0.3	8	Low	1
Cross section 6	.015	.02	0.015	.02	.01	–	–		0.3	4	Mod	1
Cross section 7	.005	.01	0.04	.02	.005	–	–	2	3		VHS	1
Cross section 8	.005	.015	0.025	.01	.01	–	–		0.3	4	High	1
Cross section 9	.09	.12	.13	.17	.13	–	–		0.3	10	VHS	1
Cross section 10	.005	0.01	0.01	0.02	0.005	–	–	3			VHS	1
Example	*0.32*	*0.24*	*0.46*	*0.31*	*0.15*	*0.2*	*0.1*	*12*	*n/a*	*n/a*	*moderate*	*0.8*

V_{shade} categories			
Very high shading	> 90%	Low shading	31 – 50%
High shading	71 – 90%	Very low shading	11 – 30%
Moderate shading	51 – 70%	No effective shading	< 10%

Reach scale measures

V_{chann} $V_{chanshape}$ V_{retain}	Type of channel modification (Page 29)	Proportion of channel (0 – 1)
Contributes to NFR, IPR & CGW	Natural channel with no modification	
	Natural channel, but flow patterns affected by a reduction in roughness elements (e.g. woody debris, or boulders)	0.2
	Channel not straightened or deepened, but upper banks widened to increase flood flow capacity (score for the worst bank)	
	Natural channel, but evidence of channel incision from flood flows	
	Natural channel, but flow patterns affected by increase in roughness elements (e.g. excessive macrophyte growth)	
	Flow patterns affected by artificial in-stream structure (e.g. ponding due to culvert, weir or unnatural debris)	0.2
	Channel straightened and/or deepened	

V_{pipe}	Size and number of piped inflows (Page 27)	Tick one
Contributes to NFR	No piped inflows to stream channel	✓
	One piped inflow, smaller than 20cm in diameter	
	Multiple piped inflows or inflow greater than 20cm in diameter	

V_{barr}	Barrier type (Page 45)	Tick one
Contributes to CSM	No barriers to migration	
	Partial or intermittent barrier to migration	
	Total barrier to migration	✓

V_{bank}	Floodplain description (Page 38)	Proportion of channel (0 – 1)
Contributes to FLE	Movement of flood flows onto and across the floodplain is not restricted by any artificial structures or modifications	0.8
	Floodplain present, but connectivity to the full floodplain is restricted by modification (e.g. stop banks or urban development)	
	Floodplain present, but connectivity to the floodplain reduced by channel incision or bank widening so that most flood flows are unlikely to reach the floodplain	
	No hydrological connectivity with the floodplain as all flows are likely to be artificially contained within the channel	0.2

V_{lining}	Type of channel lining (Page 34)	Proportion of channel (0 – 1)
Contributes to NFR & CGW	Natural channel with no modification	
	Bed with unnatural loading of fine sediment	0.9
	Bank OR bed lined with permeable artificial lining (e.g. gabion baskets)	
	Bank OR bed lined with impermeable artificial lining (e.g. concrete)	0.1
	Bank AND bed lined with permeable artificial lining	
	Bank AND bed lined with impermeable artificial lining	

V_{dod}	Indicators of oxygen reducing processes (Page 47)	Tick one
Contributes to DOM	**Optimal** •No anaerobic sediment •No odours or bubbling when sediments are disturbed •Little or no macrophyte biomass (in summer), or no areas of slow flow, low shade and soft substrate (in winter)	
	Sub-optimal •No anaerobic sediment •Some bubbling when sediments are disturbed, but no sulphide odour •Moderate macrophyte biomass (in summer), or moderate areas of slow flow, low shade and soft substrate (in winter)	
	Marginal •Small patches of anaerobic sediment •Some sediment bubbling and sulphide odour when sediments are disturbed •Some sewage fungus may be present •Dense macrophyte biomass (in summer), or large areas of slow flow, low shade and soft substrate (in winter)	
	Poor •Much black anaerobic sediment •Extensive bubbling with sulphide odour when sediments are disturbed •Surface scums present •Abundant sewage fungus may be present	✓

For "proportion of channel (0 – 1)" assessments the sum of values in the proportion of channel column should always be 1

Reach scale measures

$V_{ripcond}$ V_{rough}	Riparian zone vegetation (20m wide on each bank) (Page 40)	Proportion of bank length (0 – 1)
Contributes to FLE & RVI	Mature indigenous vegetation with diverse canopy and understorey	
	Regenerating indigenous vegetation in late stage of succession	
	Natural, diverse wetland vegetation on banks	
	Mature native trees, but damaged understorey	
	Mature exotic trees (e.g. Willows and plantation forest)	
	Low diversity regenerating bush with stock excluded OR tall exotic shrubs (> 2m)	0.1
	Mature flax, long grasses and sedges	
	Low diversity regenerating bush with stock access OR Early stage restoration planting OR Short exotic shrubs (< 2m) OR Immature plantation forest	
	Mainly long grasses (not grazed or mown)	
	Grazed wetlands	
	Mainly short grasses	0.2
	Disturbed bare soil or artificial surfaces	0.1

$V_{ripconn}$	Connection between riparian zone and stream channel (Page 61)	Proportion of reach (0 – 1)
Contributes to RVI	Assess the proportion of the stream reach where the connection between riparian zone and stream channel is not obstructed by artificial structures (e.g. culverts, or channel lining) or prevented by channel incision (e.g. the water level is below the root zone of existing riparian vegetation) . If there are no impediments to connection then the score should be 1, if there is no connection the score should be 0	0.6

$V_{ripfilt}$	Riparian zone description (Page 48)	Proportion of bank length (0 – 1)
Contributes to DOP	**Very high filtering activity** Dense ground cover vegetation OR thick organic litter layer under a tree canopy AND run-off into stream diffuse, with only minor defined drainage channels AND width of buffer greater than 5x channel width	
	High filtering activity Dense ground cover vegetation OR thick organic litter layer under a tree canopy AND run-off into stream diffuse, with only minor defined drainage channels AND width of buffer less than 5x channel width	
	Moderate filtering activity Uniform ground cover vegetation OR abundant organic litter layer under a tree canopy AND run-off into stream mostly diffuse, with few defined drainage channels	0.4
	Low filtering activity Patchy ground cover vegetation OR little organic litter layer under a tree canopy AND/OR some run-off into stream in small defined drainage channels	0.6
	Very low filtering activity Short (mown or grazed) vegetation with high soil compaction AND/OR run-off into stream mostly contained in small defined drainage channels	
	No filtering activity Banks bare or impermeable	

V_{ripar}	Intactness of riparian zone (Page 48)	Proportion of zone (0 – 1)
Contributes to OMI	Assess the proportion of the riparian zone (defined as 20m on each bank) that is covered by trees or bush. If the riparian zone is covered entirely in trees or bush then the score should 1, if there are no trees or bush in the riparian zone the score should be 0.	0.75

For "proportion of bank length (0 – 1)" assessments the sum of values in the proportion of channel column should always be 1

Reach scale measures

$V_{galspwn}$	Extent of Galaxiidae spawning habitat (Page 54)	Length (m)
Contributes to FSH	Assess the length of near-flat (slope < 10°) on both banks that would be inundated by floods or high tides. Assess the length for both banks and add the two lengths together .	40
	Total length of sample reach	80

$V_{galqual}$	Quality of Galaxiidae spawning habitat (Page 56)		Tick one
	Tidally influenced reaches	Above tidal influence	
Contributes to FSH	•Nearly flat (< 1°) stream bank, with near total (> 60%) cover by dense stemmed, low growing vegetation •Inundated by spring tides and/or floods	•Under a dense tree canopy (> 80% shade) •Nearly flat (< 1°) stream bank, with heavy cover (> 50%) of dense stemmed, low growing vegetation, twigs or gravels •Inundated by high rainfall events	High
	•Gently sloping (1 - 5°) bank, with moderate (20 - 60%) cover of low growing vegetation •Inundated by spring tides and/or floods	•Under a moderate tree canopy (50 - 80% shade) •Gently sloping (1 - 5°) stream bank, with moderate cover (20 - 50%) of low growing vegetation, twigs or gravels •Inundated by high rainfall events	Medium
	•Sloping (5 - 10°) bank, with sparse (10 - 20%) cover of low growing vegetation •Inundated by spring tides and/or floods	•Under a partial tree canopy (10 - 50% shade) •Sloping 5 – 10°) bank with sparse cover (1 - 20%) of low growing vegetation, twigs or gravels •Inundated by high rainfall events	Low ✓
	•Bank slope > 10°, or less than 10% cover of low growing vegetation	•Less than 10% shade from tree canopy, or slope > 10°, tor < 1% cover of low-growing vegetation, twigs or gravels	Unsuitable

$V_{physhab}$	Physical habitat quality (Page 58)			
Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
Aquatic Habitat Diversity	Wide variety of favourable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Favourable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 (3) 2 1 0
Aquatic Habitat Abundance - proportion of stream channel occupied by suitable habitat features for in-stream fauna	> 50% of channel favourable for macroinvertebrate colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	30-50% of channel contains favourable habitat.	10-30% of channel contains favourable habitat.	< 10% of channel contains favourable habitat. Note: Algae does not constitute stable habitat.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 (3) 2 1 0
Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream) .	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 18 17 16	15 14 13 12 11	10 (9) 8 7 6	5 4 3 2 1 0
Riparian Vegetation Integrity (within 20 metres)	No direct human activity in the last 30 years; mature native tree canopy and intact native understorey	Minimal human activity; mature native tree canopy or native scrub; understorey shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understorey; trees exotic (pine, willow, poplar); understorey native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, car parks).
Left bank	10 9	8 7 6	5 4 (3)	2 1 0
Right bank	10 9	8 7 6	5 4 (3)	2 1 0

Stream 6600

Water quality on back page.

SEV field sheets V10.2 July 2012

Stream Ecological Valuation (SEV) field sheets

Site description

Date		27/11/14
Stream name		6600
Site code		
Site location		Site 1 Aberley Rd.
GPS coordinates	Easting	
	Northing	

Current weather conditions (tick)	
Clear/sunny	
Overcast	/
Rain	
Heavy rain in past week? (tick)	
Yes	
No	/

Biological sample information	
Invertebrate sampling protocol used (HB/SB?)	HB
Dominant substrate type sampled (e.g. wood/macrophyte/ cobble?)	Wood
Fish sampling protocol used?	electric
Length of reach fished?	100

Site sketch map

Comments

Cross sectional measures

Record the substrate at 10 points across each cross section

Inorganic and wood categories should total 10 points for each cross section; organic categories can be between 0 and 10 dependent on the occurrence of organic material over the bed substrate

	Inorganic material categories									Wood categories			Organic material categories			Channel width
Substrate category	Silt/ sand (SI/SA)	Small gravel (SG)	Small medium gravel (SMG)	Medium large gravel (MLG)	Large gravel (LG)	Small cobble (SC)	Large cobbles (LC)	Boulders (B)	Bedrock (BR)	Small (SW)	Medium (MW)	Large (LW)	Leaf litter	Periphyton, moss, submerged macrophyte	Roots, non-submerged macrophytes	
Substrate size (mm)	<2	2-8	8-16	16-32	32-64	64-128	128-256	>256	n/a	< 50	50 – 100	> 100				
Cross section 1	4	||	|	|						2			||			2.3m
Cross section 2	||||	|	||		||						|					1.4m
Cross section 3	|||		||										|			1.35m
Cross section 4	||||		||	|	|								|||			0.7m
Cross section 5	||||								||||	||						1.7m
Cross section 6	|||								|||| |	|				|		1.15m
Cross section 7	||	|		|	||	||			|		|	||		|||			1.8m
Cross section 8	||||	|		||	|	|							|		1.4
Cross section 9	||||								|||| |					|	1.85
Cross section 10	||||	||	|						||							0.65
Example	///	//		/	/					/	//		//	/		

This assessment contributes to the Fish Spawning Habitat (FSH) and Decontamination of Pollutants (DOP) functions.

The aim is to determine the relative proportion of different particle sizes and organic materials within the test reach . This is achieved by recording the size of 10 particles across each of the 10 cross sections (100 particles in total). Woody debris is included with the inorganic categories for the purposes of this assessment. Refer to page 14 of the SEV User Guide for further information.

If organic matter overlies the inorganic or wood substrate record the type of organic material in the appropriate column under the "organic material categories". It is possible to record between 0 and 10 particles in the organic material columns for each cross section dependent on the occurrence of organic material over the dominant bed substrate

Cross sectional measures

Assess the following variables at each of your 10 cross sections

	V_{depth} (Page 14)					V_{macro} (Page 21)		V_{veloc} (Page 23)			V_{shade} (Page 17)	V_{decid} (Page 48)
	Record depth (in metres) at five equally spaced locations at each cross section					Assess proportional cover of macrophytes in a 1 m band at each cross section (0-1)		Estimate maximum current velocity at each cross section using the ruler method or floating particle method (if ruler d2-d1 = <2mm)			Assess shading at stream surface from vegetation and topography	Assess the permanence of vegetation shading at each cross section
	10%	30%	50%	70%	90%	Surface-reaching, emergent and bankside	Submerged	Ruler method (d2 – d1) in mm	Floating particle method		One category for each cross section (see shade category descriptors below)	Record proportion of canopy cover that is NOT deciduous (0-1)
									Distance travelled (m)	Time taken (s)		
Cross section 1	0.05	.07	.01	.07	.06	0	0		0.1	5	High	1
Cross section 2	1.41	0.23	0.24	0.2	0.17	0	0		0.1	4	"	1
Cross section 3	0.31	0.36	0.35	0.30	0.25	0	0		0.1	16	High	1
Cross section 4	0.2	0.35	0.05	0.05	0.05	0	0		0.1	2	High	1
Cross section 5	0.05	0.12	0.21	0.22	0.14	0	0		0.1	12	High	1
Cross section 6	0.11	0.23	0.23	0.22	0.11	0	0		0.1	4.5	High	1
Cross section 7	0.04	0.089	0.007	0.013	0.05	0	0		0.1	5	High	1
Cross section 8	0.25	0.03	0.55	0.9	0.05	0	0		0.1	6	High	1
Cross section 9	0.24	0.15	0.12	0.75	0.02	0	0		0.1	13.5	Moderate	1
Cross section 10	0.025	0.04	0.04	0.025	0.02	0	0		0.1	2.75	Moderate	1
Example	*0.32*	*0.24*	*0.46*	*0.31*	*0.15*	*0.2*	*0.1*	*12*	*n/a*	*n/a*	*moderate*	*0.8*

V_{shade} categories			
Very high shading	> 90%	Low shading	31 – 50%
High shading	71 – 90%	Very low shading	11 – 30%
Moderate shading	51 – 70%	No effective shading	< 10%

Reach scale measures

V_{chann} $V_{chanshape}$ V_{retain}	Type of channel modification (Page 29)	Proportion of channel (0 – 1)
Contributes to NFR, IPR & CGW	Natural channel with no modification	0.6
	Natural channel, but flow patterns affected by a reduction in roughness elements (e.g. woody debris, or boulders)	
	Channel not straightened or deepened, but upper banks widened to increase flood flow capacity	
	Natural channel, but evidence of channel incision from flood flows	0.3
	Natural channel, but flow patterns affected by increase in roughness elements (e.g. excessive macrophyte growth)	
	Flow patterns affected by artificial in-stream structure (e.g. ponding due to culvert, weir or unnatural debris)	0.1
	Channel straightened and/or deepened	

V_{pipe}	Size and number of piped inflows (Page 27)	Tick one
Contributes to NFR	No piped inflows to stream channel	✓
	One piped inflow, smaller than 20cm in diameter	
	Multiple piped inflows or inflow greater than 20cm in diameter	

V_{barr}	Barrier type (Page 45)	Tick one
Contributes to CSM	No barriers to migration	
	Partial or intermittent barrier to migration	✓
	Total barrier to migration	

V_{bank}	Floodplain description (Page 38)	Proportion of channel (0 – 1)
Contributes to FLE	Movement of flood flows onto and across the floodplain is not restricted by any artificial structures or modifications	1
	Floodplain present, but connectivity to the full floodplain is restricted by modification (e.g. stop banks or urban development)	
	Floodplain present, but connectivity to the floodplain reduced by channel incision or bank widening so that most flood flows are unlikely to reach the floodplain	
	No hydrological connectivity with the floodplain as all flows are likely to be artificially contained within the channel	

V_{lining}	Type of channel lining (Page 34)	Proportion of channel (0 – 1)
Contributes to NFR & CGW	Natural channel with no modification	0.4
	Bed with unnatural loading of fine sediment	0.6
	Bank OR bed lined with permeable artificial lining (e.g. gabion baskets)	
	Bank OR bed lined with impermeable artificial lining (e.g. concrete)	
	Bank AND bed lined with permeable artificial lining	
	Bank AND bed lined with impermeable artificial lining	

V_{dod}	Indicators of oxygen reducing processes (Page 47)	Tick one
Contributes to DOM	**Optimal** •No anaerobic sediment •No odours or bubbling when sediments are disturbed •Little or no macrophyte biomass (in summer), or no areas of slow flow, low shade and soft substrate (in winter)	✓
	Sub-optimal •No anaerobic sediment •Some bubbling when sediments are disturbed, but no sulphide odour •Moderate macrophyte biomass (in summer), or moderate areas of slow flow, low shade and soft substrate (in winter)	
	Marginal •Small patches of anaerobic sediment •Some sediment bubbling and sulphide odour when sediments are disturbed •Some sewage fungus may be present •Dense macrophyte biomass (in summer), or large areas of slow flow, low shade and soft substrate (in winter)	
	Poor •Much black anaerobic sediment •Extensive bubbling with sulphide odour when sediments are disturbed •Surface scums present •Abundant sewage fungus may be present	

For "proportion of channel (0 – 1)" assessments the sum of values in the proportion of channel column should always be 1

Reach scale measures

$V_{ripcond}$ V_{rough}	Riparian zone vegetation (20m wide on each bank) (Page 40)	Proportion of bank length (0 – 1)
Contributes to FLE & RVI	Mature indigenous vegetation with diverse canopy and understorey	
	Regenerating indigenous vegetation in late stage of succession	0.6
	Natural, diverse wetland vegetation on banks	
	Mature native trees, but damaged understorey	
	Mature exotic trees (e.g. Willows and plantation forest)	
	Low diversity regenerating bush with stock excluded OR tall exotic shrubs (> 2m)	0.4
	Mature flax, long grasses and sedges	
	Low diversity regenerating bush with stock access OR Early stage restoration planting OR Short exotic shrubs (< 2m) OR Immature plantation forest	
	Mainly long grasses (not grazed or mown)	
	Grazed wetlands	
	Mainly short grasses	
	Disturbed bare soil or artificial surfaces	

$V_{ripconn}$	Connection between riparian zone and stream channel (Page 61)	Proportion of reach (0 – 1)
Contributes to RVI	Assess the proportion of the stream reach where the connection between riparian zone and stream channel is not obstructed by artificial structures (e.g. culverts, or channel lining) or prevented by channel incision (e.g. the water level is below the root zone of existing riparian vegetation) . If there are no impediments to connection then the score should be 1, if there is no connection the score should be 0	0.7

$V_{ripfilt}$	Riparian zone description (Page 48)	Proportion of bank length (0 – 1)
Contributes to DOP	**Very high filtering activity** Dense ground cover vegetation OR thick organic litter layer under a tree canopy AND run-off into stream diffuse, with only minor defined drainage channels AND width of buffer greater than 5x channel width	1
	High filtering activity Dense ground cover vegetation OR thick organic litter layer under a tree canopy AND run-off into stream diffuse, with only minor defined drainage channels AND width of buffer less than 5x channel width	
	Moderate filtering activity Uniform ground cover vegetation OR abundant organic litter layer under a tree canopy AND run-off into stream mostly diffuse, with few defined drainage channels	
	Low filtering activity Patchy ground cover vegetation OR little organic litter layer under a tree canopy AND/OR some run-off into stream in small defined drainage channels	
	Very low filtering activity Short (mown or grazed) vegetation with high soil compaction AND/OR run-off into stream mostly contained in small defined drainage channels	
	No filtering activity Banks bare or impermeable	

V_{ripar}	Intactness of riparian zone (Page 48)	Proportion of zone (0 – 1)
Contributes to OMI	Assess the proportion of the riparian zone (defined as 20m on each bank) that is covered by trees or bush. If the riparian zone is covered entirely in trees or bush then the score should 1, if there are no trees or bush in the riparian zone the score should be 0.	0.75

For "proportion of bank length (0 – 1)" assessments the sum of values in the proportion of channel column should always be 1

Temp 15.7
DO % 99.1
DO mg/L 9.87
pH 7.4
Cond. 309

Reach scale measures

$V_{galspwn}$	Extent of Galaxiidae spawning habitat (Page 54)	Length (m)
Contributes to FSH	Assess the length of near-flat (slope < 10°) on both banks that would be inundated by floods or high tides. Assess the length for both banks and add the two lengths together .	0
	Total length of sample reach	0

$V_{galsqual}$	Quality of Galaxiidae spawning habitat (Page 56)		Tick one
	Tidally influenced reaches	Above tidal influence	
Contributes to FSH	•Nearly flat (< 1°) stream bank, with near total (> 60%) cover by dense stemmed, low growing vegetation •Inundated by spring tides and/or floods	•Under a dense tree canopy (> 80% shade) •Nearly flat (< 1°) stream bank, with heavy cover (> 50%) of dense stemmed, low growing vegetation, twigs or gravels •Inundated by high rainfall events	High
	•Gently sloping (1 - 5°) bank, with moderate (20 - 60%) cover of low growing vegetation •Inundated by spring tides and/or floods	•Under a moderate tree canopy (50 - 80% shade) •Gently sloping (1 - 5°) stream bank, with moderate cover (20 - 50%) of low growing vegetation, twigs or gravels •Inundated by high rainfall events	Medium
	•Sloping (5 - 10°) bank, with sparse (10 - 20%) cover of low growing vegetation •Inundated by spring tides and/or floods	•Under a partial tree canopy (10 - 50% shade) •Sloping 5 – 10°) bank with sparse cover (1 - 20%) of low growing vegetation, twigs or gravels •Inundated by high rainfall events	Low
	•Bank slope > 10°, or less than 10% cover of low growing vegetation	•Less than 10% shade from tree canopy, or slope > 10°, tor < 1% cover of low-growing vegetation, twigs or gravels	Unsuitable

$V_{physhab}$	Physical habitat quality (Page 58)			
Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
Aquatic Habitat Diversity	Wide variety of favourable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Favourable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Aquatic Habitat Abundance - proportion of stream channel occupied by suitable habitat features for in-stream fauna	> 50% of channel favourable for macroinvertebrate colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	30-50% of channel contains favourable habitat.	10-30% of channel contains favourable habitat.	< 10% of channel contains favourable habitat. Note: Algae does not constitute stable habitat.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream) .	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Riparian Vegetation Integrity (within 20 metres)	No direct human activity in the last 30 years; mature native tree canopy and intact native understorey	Minimal human activity; mature native tree canopy or native scrub; understorey shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understorey; trees exotic (pine, willow, poplar); understorey native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, car parks).
Left bank	10 9	8 7 6	5 4 3	2 1 0
Right bank	10 9	8 7 6	5 4 3	2 1 0