TECHNICAL REPORT 16

ECOLOGICAL IMPACT ASSESSMENT

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NZ TRANSPORT AGENCY
WAKA KOTAHI

East West Link

Myers ecology

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Glossary of Technical Terms/Abbreviations

Abbreviation	Term
AEE	Assessment of Effects on the Environment
ALW Plan	Auckland Council Regional Plan: Air, Land and Water
ARP:C	Auckland Council Regional Plan: Coastal ARP:C
AR	Artificial Retreat
ARs	Acoustic Recorders
BoI	Board of Inquiry
CMA	Coastal Marine Area
DoC	Department of Conservation
EIANZ	Environmental Institute of Australia and New Zealand
EPA	Environmental protection authority
EWL	East West Link
EWLA	East West Link Alliance
MACA Act	Marine and Coastal Area (Takutai Moana) Act 2011
MCA	Multi Criteria Analysis process
MOU	Memorandum of Understanding
NES	East West Link Alliance
NPS	National Policy Statement
NZCPS	New Zealand Coastal Policy Statement 2010
NoR	Notice of Requirement
NZFFD	New Zealand Freshwater Fish Database
ONFs	Outstanding Natural Features
OSNZ	Ornithological Society of New Zealand
The NZ Transport Agency	New Zealand Transport Agency
The Plan	The Auckland Plan
PAUP	Proposed Auckland Unitary Plan
RMA	Resource Management Act 1991
SEA	Significant Ecological Area
SH(x)	State Highway (number)
SEV	Stream Ecological Valuation
UDLF	Urban Design Landscape Plans

CHAPTER 1
INTRODUCTION

Quality Assurance Statement	
Prepared by	Dr Sharon De Luca
Reviewed by	Mike Trebitsch

Disclaimer

This report has been prepared by Boffa Miskell Ltd and Myers Ecology Ltd on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Boffa Miskell Ltd and Myers Ecology Ltd has not given its prior written consent, is at that person's own risk.

1 Chapter 1 – Introduction

1.1 Introduction

1.1.1 Purpose and scope

This report forms part of a suite of technical reports prepared for the Transport Agency's East West Link project (the Project). Its purpose is to inform the AEE and to support the resource consent applications, new NoR and alterations to existing designation required for the EWL.

This report assesses the ecological effects of the Project as shown on the Project Drawings in Volume 3: Drawing Set. This report brings together all ecological elements of the project (i.e. terrestrial, freshwater, marine and avifauna). Chapters 2-5 of the report describe and assess each of those specific elements. Chapter 6 (proposed mitigation) brings together a holistic integrated approach to mitigation[1] for potential adverse effects identified in each area of ecology.

The report comprises the following chapters:

- **Chapter 1:** **Introduction**
- **Chapter 2:** **Terrestrial Ecology Assessment**

  Authors: Shona Myers (vegetation) and Katherine Muchna (herpetofauna)
- **Chapter 3:** **Freshwater Ecology Assessment**

  Author: Eddie Sides, Katherine Muchna, Dr Ian Boothroyd
- **Chapter 4:** **Marine Ecology Assessment**

  Author: Dr Sharon De Luca
- **Chapter 5:** **Avifauna Ecology Assessment**

  Author: Dr Leigh Bull
- **Chapter 6:** **Proposed Mitigation**

  Authors: Dr Sharon De Luca, Dr Leigh Bull, Shona Myers, Katherine Muchna and Eddie Sides

1.1.2 Project description

1.1.2.1 Overview

The EWL Project involves the construction, operation and maintenance of a new four lane arterial road from State Highway 20 (SH20) at the Neilson Street Interchange in Onehunga, connecting to State Highway 1 (SH1) at Mt Wellington as well as an upgrade to SH1 between the Mt Wellington Interchange and the Princes Street Interchange at Otahuhu. New local road connections are provided at Galway Street, Captain Springs Road, the port link road and Hugo Johnston Drive. Cycle and pedestrian facilities are provided along the alignment.

[1] The Proposed Auckland Unitary Plan provides guidance on mitigation and offset (see Chapter 6 of this report).

The primary objective of the Project is to address the current traffic congestion problems in the Onehunga, Penrose and Mt Wellington commercial areas which will improve freight efficiency and travel reliability for all road users. Improvements to public transport, cycling and walking facilities are also proposed.

For description purposes in this report, the Project has been divided into six sectors. These are:

Sector 1. Neilson Street Interchange and Galway Street connections;

Sector 2. Foreshore works along the Mangere Inlet foreshore including dredging;

Sector 3. Anns Creek from the end of the reclamation to Great South Road;

Sector 4. Great South Road to SH1 at Mt Wellington;

Sector 5. SH1 at Mt Wellington to the Princes Street Interchange; and

Sector 6. Onehunga local road works.

A full description of the Project including its design, construction and operation is provided in Part C: Description of the Project in the Assessment of Effects on the Environment Report contained in Volume 1: AEE and shown on the Drawings in Volume 3: Drawing Set.

1.1.3 Ecological design principles

The following set of simple ecological principles, based on a combination of ecological best practice, our collective experience and expertise and the policy framework were used to help guide the project design as well as the proposed mitigation and offset outcomes:

- Avoid, where practicable, and otherwise minimise loss of rare ecosystem types and habitats for *Threatened* and *At Risk* species;
- Minimise permanent habitat loss[2];
- Avoid habitat fragmentation / barriers where practicable;
- Avoid loss of, enhance or create habitat connectivity;
- Enhance existing habitats and ecosystems (including weed control and pest animal control) – particularly habitat sequences;
- Create safe habitats, especially for *Threatened* or *At Risk* species;
- Improve water and sediment quality;
- Recreate habitats no longer present and ecosystem that were unique to the area;
- Increase biodiversity – including investigating options for re-introducing locally rare or threatened species; and
- Measure mitigation success, where required, for an appropriate period of time and in a way which is practicable to implement.

1.2 Statutory and Planning Framework

The statutory and planning documents that provide the framework for the assessment of ecological effects is comprised of Part 2 of the Resource Management Act 1991, and the objectives and policies of the New Zealand Coastal Policy Statement (NZCPS), the Auckland Unitary Plan (AUP), and the Auckland

[2] Total avoidance of permanent habitat loss was not possible/practicable due to operational needs and other design requirements.

Regional Plan: Coastal and the Isthmus District Plan, to the extent that the provisions of those plans are still operative following decisions on the AUP. We have also considered non-statutory documents.

There are additional requirements for the capture and relocation of native lizards and native fish under the Wildlife Act 1953 and Fisheries Regulations 1983.

1.2.1 Resource Management Act Policy

1.2.1.1 New Zealand Coastal Policy Statement

Policy 11 of the NZCPS requires the protection of indigenous biological diversity in the coastal environment.

Policy 11(a) requires a higher level of protection and the avoidance of adverse effects on *Threatened* and *At Risk* species, rare habitats and ecosystems, and habitats which are nationally significant, rare or threatened.

Policy 11(b) is less restrictive and requires significant adverse effects to be avoided and for adverse effects of activities to be avoided, remedied or mitigated, including in areas of predominantly indigenous vegetation, vulnerable ecosystem types, ecological corridors, and areas important for migratory species and the vulnerable life stages of species.

The Statutory Analysis contained in Report 2 (Volume 3) contains a full assessment of Policy 11 and other relevant policies of the NZCPS.

1.2.1.2 Auckland Unitary Plan

The Auckland Unitary Plan (AUP) contains an RPS, RCP, RP and DT. It is required to give effect to the NZCPS among other requirements.

The Regional Policy Statement section of the AUP contains objectives and policies relating to:

- Significant Indigenous Biodiversity (Chapter B.7.2);
- Freshwater Systems (B7.3);
- Coastal Water, Freshwater and Geothermal Water (Chapter B7.4); and
- Coastal Environment (B8).

The Project area includes a number of identified significant terrestrial and marine ecological area overlays (SEA_T and SEA_M) identified in the AUP. These are shown on Map 2-2 (terrestrial ecology chapter) and Map 4-2 (marine ecology chapter) and in summary are:

- Hopua Crater wetland (SEA_T_6103);
- Lava flows within the area of mangroves at Pikes Point (SEA_T_9022);
- Lava flow (SEA_T_5304) and mangroves (SEA_M1_21) at the mouth of Anns Creek;
- Wading bird habitat (SEA_M2w) and mangrove ecosystems along the coastline (SEA_M2_23a);
- The northern section of Anns Creek (SEA_T_5309) (at 791-793 Great South Road), and SEA_T_5306 (at 211 Hugo Johnston Drive);
- Southdown Reserve (SEA_T_6104) on the north-western edge of Sector 3; and
- Anns Creek Reserve (SEA_T_5308) on the south-eastern edge of Sector 3.

In addition to these SEA, the AUP identifies Outstanding Natural Features (ONF) that include components of terrestrial significance. The ONF in Anns Creek (ONF92) is an example of pahoehoe surfaces on basalt lava flows and extends into the northern and middle sections of Anns Creek and out from the coastline at the mouth of Anns Creek. The pahoehoe lava flows are also identified as an Area of Significant Conservation Value (ASCV) of national significance by the Department of Conservation. This feature is assessed in further detail in Technical Report 4: Geological Heritage Assessment.

Chapter D of the AUP contains the objectives and policies for the natural resources overlays including SEAs. In particular, Chapter D9 sets out the criteria for identification of SEA and associated objectives and policies to manage the following:

- Managing effects on significant ecological areas – terrestrial and marine;
- Vegetation management; and
- Protecting significant ecological areas in the coastal environment.

Of particular relevance to this assessment, Policy D9.3(1) contains policies on managing effects of activities on significant indigenous biodiversity identified in the SEA overlay. Policy (a) requires *"avoiding adverse effects as far as practicable, and where avoidance is not practicable, minimising adverse effects on the identified values*". Policy (b) and (c) require adverse effects to be remedied or mitigated respectively. Policy (d) sets out when biodiversity offsetting is to be considered and requires *"considering the appropriateness of offsetting any residual adverse effects that are significant and where they have not been able to be mitigated, through protection, restoration and enhancement measures...".* Policy D9.3(2) sets out the adverse effects on indigenous biodiversity values in significant ecological areas that are required to be avoided, remedied, mitigated or offset. Appendix 8 of the AUP sets out a framework for the use of biodiversity offsets.

Chapter E15: Vegetation Management and Biodiversity of the AUP contains additional provisions for vegetation management and biodiversity. These include a requirement that the contribution of trees and vegetation to the provision of ecosystem services, and to historic, cultural and natural heritage is recognised and protected. This chapter also contains detailed policy including Policy 7 regarding infrastructure, and Policies 9 and 10 which reflect the NZCPS Policy 11, and seek to avoid certain effects in the coastal environment. In addition, B7.2.2 Policy 5 sets a broad policy direction to avoid adverse effects on SEAs.

Chapter F: Coastal contains specific vegetation management provisions that apply to SEA Marine overlays, for example mangrove management.

1.2.2 Non Statutory Documents

The New Zealand Biodiversity Strategy 2000 was prepared in response to the state of decline of New Zealand's indigenous biodiversity and establishes a strategic framework for conservation. A statement of national priorities for the protection of rare and threatened indigenous biodiversity was developed in 2007.

A Proposed National Policy Statement on Indigenous Biodiversity was developed for consultation in 2011 but was not formally adopted. The Ministry for the Environment is now looking to develop a new National Policy Statement for Biodiversity.

1.2.3 Herpetofauna

All native lizard species are 'absolutely protected' under the section 63 of the Wildlife Act, and lizard habitats are protected by the Resource Management Act (1991), administered by the Department of Conservation (DOC) and local authorities (Auckland Council) respectively.

Native lizards often occupy habitats of otherwise low ecological value (i.e., weedy vegetation, vegetation margins), and guidelines have been developed to identify and address lizard habitat loss through land development (Anderson et al. 2012). These guidelines identify the procedures involved to meet the legislative requirements for the protection of lizard fauna outside of specific conditions of consent. A permit is required from DOC under the Wildlife Act 1953 to handle and translocate lizards.

1.2.4 Native fish

The Freshwater Fisheries Regulations 1983 contains legal requirements that aim to protect New Zealand's freshwater fish and aquatic life through provisions surrounding fish passage. Approval from the Director-General of Conservation would be required for the construction of culverts where the passage of fish would be impeded.

CHAPTER 2

TERRESTRIAL AND HERPETOFAUNA

Quality Assurance Statement	
Prepared by	Shona Myers
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Disclaimer

Executive Summary

Terrestrial and Herpetofauna Ecology

1. The terrestrial and herpetofauna ecology report describes the land, wetland and estuarine ecological values of the Project area. The assessment of terrestrial ecology included desktop investigations, literature reviews and ecological, botanical and herpetofauna field surveys of Mangere Inlet, the coastal foreshore, Hopua Crater, Anns Creek and Otahuhu Creek.

Existing Environment

2. The Project area lies within the Tamaki Ecological District (McEwen 1987) where vegetation has been modified by urban and industrial development and by reclamation of the foreshore and intertidal areas. The area lies within a threatened land environment where between 10 to 20% of indigenous vegetation cover remains and less than 20% is legally protected (Walker *et al* 2015). The ecological values of the coastal foreshore of Mangere Inlet and Anns Creek are strongly influenced by the volcanic history of the area and by the extent of urban and industrial development. The northern shore of Mangere Inlet has been highly modified due to port activities, roading, rail, coastal reclamation and other infrastructure.

3. Valuable intertidal areas, mangroves and saltmarsh and wading bird habitat remain in Mangere Inlet. The lava flow vegetation at Anns Creek are the last remaining areas of this ecosystem type in Auckland (Gardner 1992). Volcanic boulderfields are identified as a scarce ecosystem type in Auckland (Lindsay *et al* 2009) and at a national level as a naturally uncommon ecosystem type (Williams *et al* 2007), with a threat status of 'endangered' (Holdaway *et al* 2012). The substrate of lava flows results in a unique and unusual assemblage of native plants, including *Threatened* plant species.

4. There are a number of Significant Terrestrial and Marine Ecological Areas (SEAs) identified within and adjacent to the proposed alignment. The complex of terrestrial, freshwater and marine ecosystems within Anns Creek and Mangere Inlet are identified as SEAs. Anns Creek is also identified as a Significant Ecological Area in the Operative Auckland City District Plan.

5. Anns Creek is identified as an SEA for the ecological sequences from saltwater to freshwater, and for the mosaic of vegetation types present including basalt lava shrubland. Ecological gradients from mangroves (*Avicennia marina* var. *australasica)* to glasswort (*Sarcocornia quinqueflora* subsp. *quinqueflora*) and bachelors button (*Cotula coronopifolia)*, and into marsh clubrush (*Bolboschoenus fluviatilis*) in the brackish areas, and into raupo (*Typha orientalis*) at the edge of the lava flow, are present. Anns Creek is the only area remaining in the Auckland region where native herb species, including *Threatened* species, grow together on lava, and is the type locality for *Coprosma crassifolia*. The area provides inanga (whitebait) spawning habitat, and *Threatened* wetland bird species, Australasian bittern and banded rail, have been recorded in the creek.

6. The mangroves, saltmarsh and wading bird habitat at the mouth of Anns Creek in Mangere Inlet is identified as SEA-M1 and is contiguous with wading bird habitat. The SEA-M2 wading bird area in the wider Mangere Inlet extends to Pikes Point. The marine and avifauna ecological values of the area are described in more detail in the marine and avifauna chapters of Technical Report 16.

7. The basalt lava flows and shrubland ecosystems at Pikes Point are identified as SEAs in the PAUP and Operative District Plan, and the saltmarsh wetland present within Hopua Crater as a SEA in the PAUP.

8. Southdown Reserve lies on the northwestern edge of Sector 3. It comprises native and exotic plantings, riparian vegetation and mangroves and is identified as an SEA in the PAUP. The freshwater wetland in Anns Creek Reserve, on the southeastern edge of Sector 3 and the native plantings on Mutukaroa-Hamlins Hill on the edge of the proposed alignment are also identified as SEAs in the PAUP. Otahuhu Creek forms part of the upper reaches of the Tamaki River and contains mangroves and intertidal habitat for wading birds.

9. The wider project area includes a range of potential lizard habitat types including public reserves with replanted native vegetation (e.g., Miami Reserve), vegetated reserve margins with refugia including piled basalt rocks and wood debris (e.g., Manukau foreshore walkway) and grasslands that provide basking habitat and refugia (e.g., Captain Springs Road).

10. The majority of potential lizard habitat was classified as ‘poor’ quality, but small areas of ‘moderate’ and ‘high’ quality habitat were observed.

11. Native lizard were not detected during lizard surveys.

Ecological Effects

12. The effects of the project on terrestrial ecology will include loss of vegetation, ecosystems and habitat in Mangere Inlet and Anns Creek. There will be adverse ecological effects on naturally uncommon ecosystem types and habitats for *Threatened* plant species.

13. Construction will avoid adverse effects on the wetland in Hopua Crater.

14. Effects to the moderate and high quality lizard habitat identified will be avoided (if possible) through detailed design.

15. Adverse effects on the lava flows at Victoria St and Pikes Point in Sector 2 will be minimised, however construction of the coastal embankment will result in reduction in extent of vegetation associated with these basalt lava flows. This will result in the loss of lava shrubland ecosystems closest to the coastal edge. A boardwalk will be cantilevered across the lava at Pikes Point and will result in shading of the mangrove shrubland.

16. There will be substantial earthworks and loss of intertidal habitat along the existing coastal edge and areas of mangroves, saltmarsh and glasswort saltmeadow through construction of the coastal embankment in Sector 1 and 2. The ecological effects of this on marine ecology are discussed in more detail in chapter 6 of this report.

17. Anns Creek East contains sensitive and unique ecological values with lava shrubland habitats, *Threatened* plant habitats and gradients between mangroves to saltmarsh to freshwater wetland. Construction of the Anns Creek viaducts, including access for temporary staging and location of a construction yard will result in significant ecological effects. Construction of piers for the viaduct, as well as the temporary staging structures will result in direct loss of habitats within the footprint of these structures.

18. The viaduct has been designed to be located within the more modified northern edges of the creek which contain weed species, native plantings and areas of fill. However it will adversely affect lava shrubland ecosystems on the northern and eastern parts of the lava flow. The location of the construction yard will destroy saline and freshwater ecosystems in the eastern end of the creek. The effects of the contruction yard and the viaduct will result in significant loss of habitats in Anns Creek. The effects will be cumulative as they add to the effects of past reclamation and development in Anns Creek.

19. Adverse ecological effects of the proposed works for construction of the viaduct together with the construction yard will include the following:

- disturbance and loss of lava shrubland ecosystems;
- disturbance and loss of freshwater raupo wetland and saltmeadow communities;
- disturbance and loss of ecological sequences from terrestrial to saline to freshwater;
- loss of and impacts on a naturally uncommon ecosystem type.

20. The construction of the viaduct through Anns Creek Estuary will fragment the mangrove shrubland ecosystems in the inlet. The alignment has been positioned to minimise areas of lava shrubland in association with pahoehoe lava flows around the coastal edge of the inlet, however the saline ecosystems in the inlet will be fragmented.

21. Ongoing operational effects of the Anns Creek viaducts will including shading and rain shadow effects on vegetation in Anns Creek, and increased weed invasion from the construction and staging footprint. The indigenous shrub, grass and herb species in Anns Creek are adapted to growing in low open shrubland ecosystems. Shading and rain shadow from the viaduct will decrease light conditions and alter temperature, rainfall, humidity and soil moisture. These communities are unlikely to continue to exist in changed conditions. Plant communities will be disturbed and destroyed by viaduct construction. Plant species may recolonise areas following construction of the viaduct. However weed species will invade these areas.

22. The combination of effects in Anns Creek Estuary and Anns Creek East will lead to cumulative effects. The ecosystems in Anns Creek are unique and irreplaceable and are therefore difficult to mitigate for and offset.

23. The removal of the existing box culverts and building a bridge over Otahuhu Creek will have significant positive ecological effects.

24. Potential effects on lizards (if present) include mortality and injury, habitat loss and fragmentation, and displacement into unsuitable habitat. Potential adverse effects on lizards can be avoided and / or mitigated by lizard salvage and managed through implementation of a lizard management plan.

Recommendations

25. Construction effects should be minimised and avoided within the lava flow shrublands, freshwater wetland and saltmarsh habitats in Anns Creek. The location of bridge piers should be placed to avoid and minimise effects on sensitive lava shrubland vegetation. A plan identifying exclusion areas for pier location within Anns Creek East is being developed and will guide detailed design.

26. Protection and enhancement of *Threatened* plant communities (lava shrublands) in Anns Creek should be undertaken through weed control and revegetation. Providing legal protection, for example, as a reserve or covenant for Anns Creek East should be investigated, and an ongoing ecological management plan (including weed management objectives and measures) should be developed for the area.

27. Rehabilitation of lava shrubland species could be undertaken through planting on the new coastal edge as part of a mitigation programme, using eco-sourced local genetic stock e.g. *Coprosma crassifolia*, ngaio, akeake, saltmarsh ribbonwood, oioi, *Austrostipa stipoides*, *Puccinellia stricta* (salt grass). Planting can be guided by species recorded in Anns Creek by Gardner (1992) and in consultation with appropriately qualified terrestrial ecologist.

28. Further lizard surveys should be carried out at moderate and high quality lizard habitats within the project footprint during peak lizard activity periods (September–April). These surveys will identify key sites and inform the preparation of a lizard management plan (in accordance with Auckland Council requirements detailed in the Proposed Auckland Unitary Plan).

29. Identify opportunities to incorporate lizard habitat creation, enhancement and connection in landscape design.

30. Where revegetation is proposed, use vegetation species throughout the alignment that are ecologically appropriate (in consultation with terrestrial ecologist and potentially in collaboration with expert from DOC).

2 Chapter 2 – Terrestrial and Herpetofauna

2.1 Introduction

2.1.1 Purpose and scope of this report

This report forms part of a suite of technical reports prepared for the NZ Transport Agency's East West Link project (the EWL or Project). Its purpose is to inform the Assessment of Effects on the Environment Report (AEE) and to support the resource consent applications, new Notice of Requirement and an alteration to existing designation required for the EWL.

This report assesses the terrestrial and herpetofauna effects of the proposed alignment of the Project as shown on the Project Drawings (Drawing numbers AEE-AL-100-116).

The purpose of this report is to:

a) Identify and describe the existing terrestrial and herpetofauna ecological values, habitats and environment;

b) Describe the potential effects (positive and adverse), of the Project on the existing terrestrial and herpetofauna ecological values;

c) Recommend measures as appropriate to avoid, remedy or mitigate[3] potential adverse effects on terrestrial and herpetofauna ecological values (including any conditions/management plan required); and

d) Present an overall conclusion of the level of potential adverse effects of the Project on terrestrial and herpetofauna ecological values after recommended measures are implemented.

2.2 Experience

2.2.1 Expertise

The assessment was prepared by Shona Myers and Katherine Muchna.

2.2.1.1 Shona Myers, Principal Ecologist, Myers Ecology Limited.

Shona Myers holds the degrees of Bachelor of Science and Master of Science (First Class Honours) in botany and ecology. She has over 30 years' experience as an ecologist and has been employed by regional and central government agencies, and recently established her own ecological consultancy company. She has undertaken ecological survey and monitoring projects in many parts of New Zealand and is very familiar with NZs flora and fauna and ecosystems, in particular the Auckland region. Her experience includes presenting ecological evidence at a number of Council, Environment Court and Board of Inquiry hearings, most recently on behalf of the Auckland Council at the Proposed Auckland Unitary Plan hearings. Shona assessed effects on ecology and presented evidence on behalf of Kapiti Coast District Council at the Board of Inquiry hearings for the Kapiti Coast Expressway and Transmission Gully.

[3] Including offset mitigation where appropriate.

Shona is a council member of the New Zealand Ecological Society, and a past-president and past secretary of that society. She is also a committee member of the Auckland Botanical Society, and a member of the New Zealand Plant Conservation Network and the New Zealand Wetland Trust, and is the President of the International Association for Ecology (INTECOL).

2.2.1.2 Katherine Muchna, Senior Ecologist, Boffa Miskell Ltd

Katherine Muchna is an ecologist with over eleven years' experience in both technical and consulting roles. Katherine has an MSc (Hons) in Environmental Science from the University of Auckland, where she studied the ecology of an introduced lizard (*Lampropholis delicata*, Australian plague skink) with a focus on its spread dynamics and potential impacts on native species.

Katherine has worked on a diverse range of both terrestrial and freshwater based projects in energy generation, mining, urban development and water resources sectors throughout New Zealand. Katherine's terrestrial ecology experience includes herpetofauna habitat use and quality assessment, environmental effects assessment, lizard habitat restoration and management. Katherine is a member of the New Zealand Ecological Society and the Society for Research of Amphibians and Reptiles in New Zealand.

2.3 Assessment Methodology

2.3.1 Terrestrial ecology

Our assessment of terrestrial ecology included desktop investigations, literature reviews and ecological and botanical field surveys, and consultation with Auckland Council and DOC experts. It was undertaken in the following four phases.

2.3.1.1 Phase 1 – Preliminary investigations

- Review of maps and plans of ecological areas potentially affected by the project;
- Literature review of existing information including herbarium records, botanical reports, and ecological survey reports;
- Reconnaissance site visit and preliminary assessment for MCA; and
- Gap analysis to assess information gaps and further investigations.

2.3.1.2 Phase 2 – Existing environment

- Botanical and ecological site investigations on ecological areas;
- Compilation of plant species lists and vegetation descriptions for ecological areas, and compilation of vegetation map from field survey and aerial photographs;
- Compilation of information on *Threatened* plants and threatened ecosystem types; and
- Assessment of ecological significance of ecological areas using 'significant ecological area - terrestrial criteria' in the PAUP.

2.3.1.3 Phase 3 – Design input and mitigation of adverse effects

- Input to project design to avoid, remedy or mitigate adverse ecological effects; and
- Development of specific measures to offset effects on terrestrial ecology.

2.3.1.4 Phase 4 – Assessment of Effects

The ecological significance of terrestrial ecological values was assessed using the ecological significance criteria in the PAUP and in Davis *et al* 2016. The EIANZ Impact Assessment Guidelines (EIANZ 2015) were used to assess the magnitude of impact and level of ecological effects. The assessment of adverse and beneficial effects of the project on terrestrial ecology values, included:

- Fragmentation, reduction in size and permanent habitat loss;
- Fragmentation, disruption or damage to ecological connections and sequences;
- Loss of rare or *Threatened* plant species, populations, habitats, originally rare ecosystem types;
- Modification of the viability of ecosystems; and
- Habitat disturbance during construction and operation.

In Phase 1 the review of existing information included collating Auckland Museum herbarium records, existing botanical and ecological survey reports, significant ecological area information and maps, and contacting experts including from the Auckland Council Biodiversity team. The eastern area of Anns Creek has been well described in a number of previous reports (Gardner 1992, Gardner 2001, Golder Associates 2013, Wildlands 2014) and in ecological evidence prepared by ecologists as part of a resource consent hearing[4] and an Environment Court case in 2011 (Decision No. [2011] NZEnvC364)[5,6].

In Phase 2 botanical field surveys were undertaken of the ecological areas identified in Phase 1. The ecological areas were walked and ground surveyed, and as much of the site covered by field survey as possible. Plant species lists were compiled for each area, and vegetation and ecosystem types were described and mapped. Field survey of the whole area was undertaken rather than vegetation plots and transects as the mosaic of sites required full survey rather than only a selected part of the area. Plant nomenclature follows the New Zealand Plant Conservation website and de Lange and Rolfe (2010). The threat status of plants was assessed against de Lange et al (2013). Plant samples were taken to Auckland Museum herbarium for identification. Vegetation descriptions have followed Atkinson structural classes (Atkinson 1985), with reference also to Singers and Rogers (2014).

Phase 3 included providing advice to project engineers and urban designers/landscape architects on design opportunities to avoid and reduce effects on terrestrial ecology, and develop mitigation where significant adverse effects on terrestrial ecology was identified. This included detailed discussion of avoiding and minimising adverse effects on Anns Creek.

Phase 4 included a detailed assessment of effects of the project on terrestrial ecological values and evaluation of the overall significance and magnitude of effects. The assessment of adverse effects on indigenous biodiversity followed the list that are required to be avoided, remedied, mitigated or offset in Policy 10 Chapter E (Overlay objectives and policies) 6.2 (significant ecological areas terrestrial) of the PAUP. The ecological significance of terrestrial ecological values was assessed using the ecological significance criteria in the PAUP and in Davis *et al* 2016. The EIANZ Impact Assessment Guidelines (EIANZ 2015) were used to assess the magnitude of impact and level of ecological effects.

2.3.2 Herpetofauna ecology

Our Assessment was undertaken in four phases and included the following:

[4] Statement of evidence of Rebecca Stanley, undated, in the matter of a submission by ARC to a resource consent application by TR Group in relation to land at 781 and 791-793 Great South Road, Penrose.

[5] Statement of evidence of Sarah Flynn 26 August 2009, in the matter of resource consent applications by TR Group to develop and use land at 781, 791-793 Great South Road, Penrose.

[6] Statement of evidence of Andrea Julian on behalf of Auckland Council 21st March 2011.

Phase 1 – Preliminary investigations

- Review of plans and maps and identification of herpetofauna ecological values potentially affected by the Project;
- Literature review of existing information on herpetofauna in the project area;
- Site visit and preliminary assessment for MCA;
- Gap analysis to assess information gaps and further investigations.

Phase 2 – Existing environment

- Site investigations;
- Assessment of existing herpetofauna ecology values.

Phase 3 – Design input and mitigation of adverse effects

- Review of project activities;
- Input to project design to avoid, remedy of mitigate adverse ecological effects;
- Development of specific measures to off-set effects on herpetofauna ecology

Phase 4 – Assessment of Effects

Assessment of adverse and beneficial effects of the project on herpetofauna ecology values, including permanent habitat loss, habitat disturbance and removal during construction and operation. Beneficial effects include habitat creation and restoration.

2.3.2.1 Description of methods

Phase 1

The literature review of existing information on herpetofauna in the project area included the Department of Conservation Bioweb database and additional literature (published and unpublished). Data from the Bioweb database (accessed 16 April 2016) was used to assess local lizard communities within 10 km of the proposed road alignment. Records more than 20 years old (pre-1996) were excluded. This species list served as the base species list of lizards recorded within the wider area and that could potentially occupy the project area. The threat status of lizards were assessed against Hitchmough et al (2013).

High resolution aerial photography was used to select survey sites and assess and describe habitats in the context of the wider landscape, in particular vegetation age and connectivity were considered.

The desktop assessment also included a review of plans and maps and identification of herpetofauna ecological values potentially affected by the Project. Findings from these preliminary assessments were incorporated into multi-criteria assessment of design options.

Site investigations included a preliminary habitat assessment throughout the alignment by foot and rapid visual assessment by car where access was not possible. This assessment identified potential lizard habitats and their likelihood of being occupied by lizards based on their connectivity and age, and the frequency of disturbance, i.e. by mowing, as well as the potential to provide suitable food and cover for lizards.

Phase 2

Potential high and moderate quality lizard habitats identified in the desktop review and site assessment were selected for survey. Lizards often occupy areas of otherwise low ecological value, and terrestrial lizard habitats within the Auckland Region include rank grass, scrub, weedfield, regenerating and established bush. Areas of mown grass are considered poor habitat, although where these areas have boulder or shrub margins, they may provide sufficient cover and corridors to connect larger habitat fragments (e.g., along the Manukau foreshore walkway).

Lizards were surveyed using artificial refuges (ARs) and systematic searches of natural refuges and raking leaf litter[7]. Survey sites included the Manukau Foreshore Walkway (approx. 2.5 km in length), Gloucester Reserve South, Miami Reserve and Captain Springs Road. Systematic search transects were located near areas with natural cover that were undisturbed by mowing and pedestrians and were most likely to be occupied by lizards.

Artificial refuges were micro-sited near potential natural refuges including logs, boulders and in light gaps where possible in transects of eight ARs, a total of five transects were established. Artificial refuges comprised two sheets of Onduline™ with spacers between them placed on the ground. No spotlight surveys were carried out as the habitat within the road footprint was deemed unsuitable for arboreal geckos. ARs installed in Miami Reserve were stolen between 26 April and 14 May, and the survey at that site was discontinued. The AR transects and systematic searches surveyed the available habitats, comprising approximately 70% of the Manukau Foreshore Walkway, 20% Gloucester Reserve South, 60% of Miami Parade Reserve, and 20% of Captain Springs Road areas.

Lizard survey methods are strongly weather dependent, and surveys should be carried out in fine weather, ideally in the days following rain when lizards are most likely to be active. A description of specific limitations associated with survey methods is provided in Department of Conservation Inventory and Monitoring Toolbox: Herpetofauna (Hare 2012; Lettink 2013).

We note that surveys were carried out towards the end of the ‘lizard activity period’ (loosely September – May). However, all surveys were carried out in fine, warm (temperatures exceeding 16°C) weather, and active lizards were observed. Time restrictions prevented ARs being installed 4-8 weeks[8] in advance of surveys as recommended in guideline documents. The method requires that active lizards encounter ARs and use them preferentially based on the shelter, protection and thermal advantages they offer. A short period of deployment reduces the potential that they are encountered, and used consistently by local lizards. As such, the results of the survey likely under represent the lizard community. Further lizard survey work will be carried in summer 2016/2017 to inform lizard distribution. Survey dates and weather conditions are provided in Table 2-1.

Table 2-1: Lizard survey[9] times and weather.

Date	Temperature	Weather	Survey Effort (person hours)
13 April	20°C	Overcast, light wind	3.0 hr
19 April	20°C	Fine, light wind	2.5 hr
26 April	19°C	Fine, strong winds	2.5 hr
14 May	19°C	Fine, calm.	1.75 hr
15 May	18°C	Fine, calm	1.0 hr

Further, we note that lizard survey methods currently available have poor detection rates as a consequence of typically low population densities, species’ cryptic colouration, difficulty in surveying

[7] Lizard surveys were carried out over five visits between 19 April and 15 May 2016 in fine weather and when temperatures exceeded 16°C.

[8] The first AR survey was carried out 8 days after installation and the last AR survey was carried out 32 days after installation.

[9] Surveys included all sites and both systematic searches and AR checks

preferred habitats and behaviour/activity patterns. As such, even an intensive lizard survey will not detect all individuals in the population or, possibly all species present.

The SH1 road margin between Mt Wellington and Princes St could not be surveyed for Health and Safety reasons. The habitat value of these areas is based on a desktop assessment.

Phase 3

Phase 3 included providing advice to project engineers and urban designers/landscape architects on design opportunities to avoid and reduce effects where possible, and develop mitigation where potential adverse effects on herpetofauna habitats were identified.

Phase 4

Phase 4 included a detailed assessment of effects of the project on herpetofauna ecological values and evaluation of the overall significance of residual effects after mitigation. EIANZ Impact Assessment Guidelines (EIANZ 2015) were used as an approach for the assessment of values and effects.

The EIANZ provides a method for assigning value (Table 2-2) to species for the purposes of assessing actual and potential effects of activities.

Table 2-2: Criteria for assigning ecological value to species

Ecological Value	Species
Very High	*Threatened (Nationally Critical, Nationally Endangered, Nationally Vulnerable)*
High	*At Risk (Declining, Recovering, Relict, Naturally Uncommon)*
Medium	Native - *Not Threatened*
Low	*Introduced*

We then assessed the magnitude of ecological effects in accordance with EIANZ (Table 2-3).

Table 2-3: Criteria for describing effect magnitude (EIANZ 2015).

Magnitude	Description
Very High	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element/feature.

Magnitude	Description
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation; AND/OR Having negligible effect on the known population or range of the element/feature.

We then assessed the level of ecological effects (Table 2-4) using ecological value (determined in Table 2-2) and effect magnitude (Table 2-3) using Table 2-4 as a guide. Magnitude of effect was assessed on a local population scale.

The EIANZ guideline document states that the purpose of the document is to provide guidance on good practice in environmental management without being prescriptive. Further that the guidelines state that they are not binding and will be revised from time to time with user feedback and evolving good practice. Ecologists are able to deviate from the guidelines where they consider it is ecologically relevant and justifiable to do so.

Table 2-4: Matrix combining magnitude and value for determining the level of ecological impacts.

Effect Level		Ecological &/or Conservation Value			
		Very High	High	Moderate	Low
Magnitude	Very High	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Low	Very Low
	Low	Moderate	Moderate	Low	Very low
	Negligible	Low	Low	Very Low	Very Low

2.4 Existing Environment

2.4.1 Terrestrial ecology

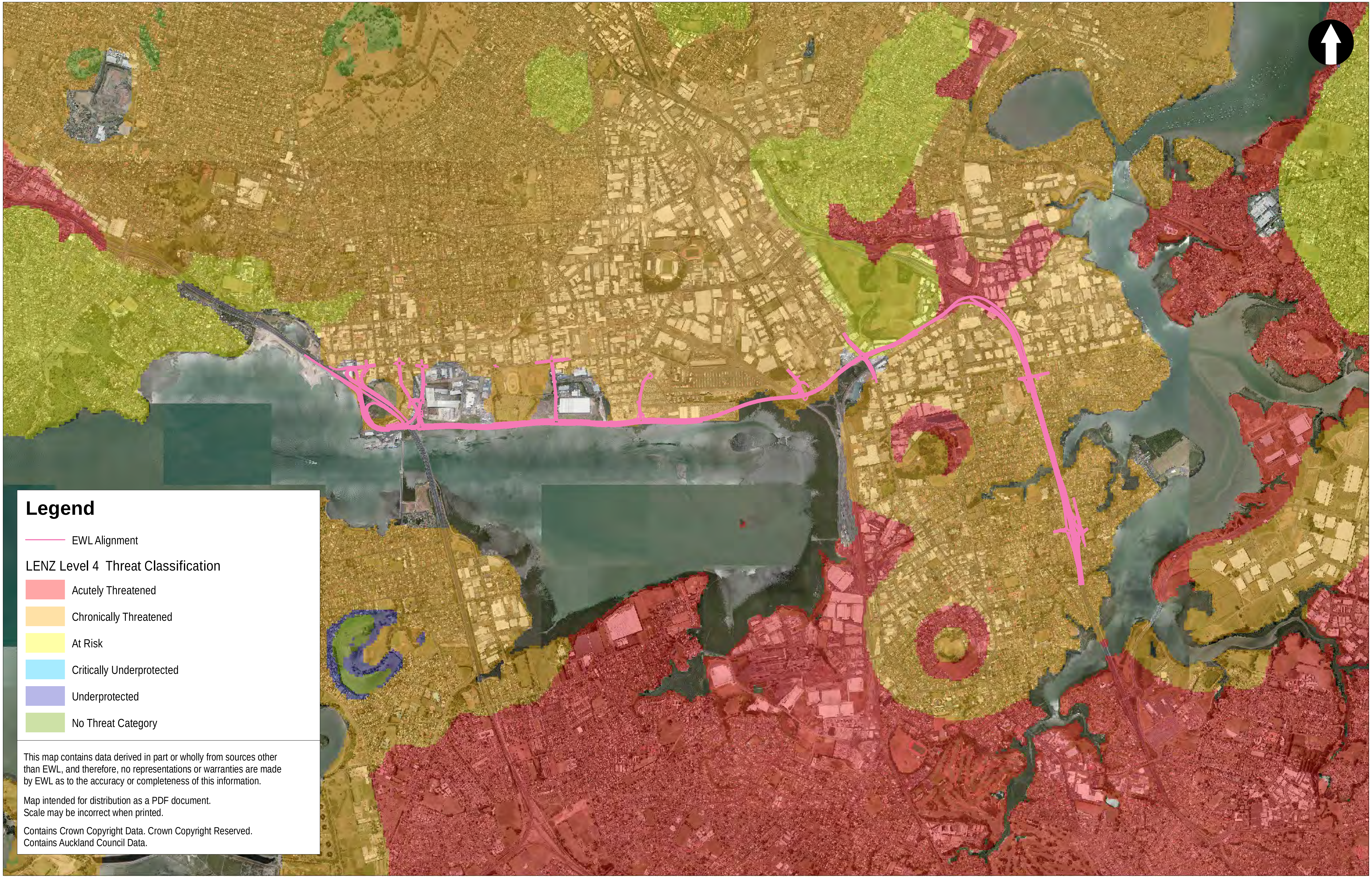
In this chapter we describe the terrestrial ecological values of the Mangere Inlet, Hopua Crater, Anns Creek and Otahuhu Creek. These are areas affected by the proposed alignment. The ecological context of Mangere Inlet and Anns Creek is described and the vegetation types present within each sector are described.

2.4.1.1 Ecological context

The Project area lies within the Tamaki Ecological District (McEwen 1987) where vegetation has been modified by urban and industrial development and by reclamation of the foreshore and intertidal areas. The area lies within a threatened land environment where between 10 to 20% of indigenous vegetation cover remains and less than 20% is legally protected (Walker *et al* 2015) (Map 2-1).

The ecological values of the coastal foreshore of Mangere Inlet and Anns Creek are strongly influenced by the volcanic history of the area and by the extent of urban and industrial development. The Manukau lava field was built up by the lava flows from the volcanic eruptions that formed One Tree Hill, Mount Smart, and Mount Wellington (Kermode 1992). These eruptions created extensive areas of basalt and lava flows, including the lava outcrops in Anns Creek.

GIS@beca.com



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NZ TRANSPORT AGENCY WAKA KOTAHI

East West Link

Drawn	Drafting Check	Reviewed Design Manager	Approved Alliance Manager
Designed	Design Check		
Scale: 1:30,000	Original Size: A3	Contract No PA4041	

Drawing Title

ECOLOGY

Map 2-1 : Threatened Land Environments

Drawing Number GIS-AEE-EC-VH-002

Rev No. A

Plot Date: 27/10/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskel\GIS-EC-AEE-VH-002_T16006_16_VegetationLizard_Map2_ThreatenedLandEnvironments.mxd

The northern shore of Mangere Inlet has been highly modified due to port activities, roading and coastal reclamation. Aerial photos taken in 1940 show that the coastline at Onehunga and Anns Creek was originally highly convoluted with a mosaic of lavaflows, estuarine vegetation, intertidal areas and wetlands.The coastal foreshore is now reclaimed in a straight line from Onehunga to Anns Creek. Tidal inundation to the Hopua volcanic crater has also been lost, however a saltmarsh wetland has established in the crater and is fed by saltwater influence. Valuable intertidal areas, mangroves and saltmarsh and wading bird habitat remain in Mangere Inlet. The extent of mangroves has expanded in Mangere Inlet to 110ha in 2001/2006 (Kelly 2008).

Remnants of the original lava flows remain along the coastline at Mangere Inlet. The pahoehoe surfaces on the basalt lava at Southdown and Anns Creek are identified as an Oustanding Natural Feature in the PAUP. The lava flow vegetation located at Anns Creek and Mangere Inlet comprise the last remaining areas of this ecosystem type in Auckland (Gardner 1992). Reclamation has continued in Anns Creek with further development recently consented on TR Group land.

A number of documents have identified the scarce and unique nature of lava flows from an ecological perspective. Volcanic boulderfields are identified as a scarce ecosystem type in Auckland, with only 29 hectares in total remaining, of which only five hectares are protected (Lindsay *et al* 2009). Recent lava flows (<1000 years) have also been identified by NZ Landcare Research at a national level as a naturally uncommon ecosystem type (Williams *et al* 2007), with a threat status of 'endangered' (Holdaway *et al* 2012). The substrate of lava flows results in a unique and unusual assemblage of native plants, including *Threatened* plant species. Early botanical reports (Esler 1991, Kirk 1871) record native lava field vegetation as typically comprising broadleaved forest and shrub species, herbs and ferns. A number of these species still occur on the lava flows at Anns Creek.

Other lava flow forest remnants occur at Mt Eden, the Otuataua Stonefields and on Rangitoto Island. The lava flow vegetation remaining at Anns Creek however is unique due to its association with intertidal to freshwater ecosystem gradients, the combination of shrub, fern and herb species growing on lava, and is the only example of this mosaic of vegetation remaining in the Auckland region.

Significant Ecological Areas

Significant Ecological Areas (PAUP)

There are a number of Significant Terrestrial and Marine Ecological Areas (SEAs) identified within and in proximity to the proposed alignment (see Map 2-2), including the mosaic of terrestrial, freshwater and marine ecosystems within Anns Creek and Mangere Inlet.

Significant Marine Ecological Areas (SEA-M) and Significant Terrestrial Ecological Areas (SEA-T) identified are:

- The eastern section of Anns Creek (SEA-T-5309) at 791-793 Great South Rd, and SEA_T_5306 (211 Hugo Johnston Drive).
- The lava flow vegetation (SEA-T-5304) and mangroves (SEA-M1-21) in Anns Creek estuary. The mangroves here are contiguous with wading bird habitat (SEA-M2w) and with mangrove ecosystems along the coastline (SEA-M2-23a).
- Lava flows within the area of mangroves at Pikes Point (SEA-T-9022).
- Saltmarsh wetland in Hopua Crater (SEA-T-6103).
- Southdown Reserve (SEA-T-6104) lies on the northwestern edge of Sector 3. It comprises native and exotic plantings, mahoe forest, riparian vegetation and a small area of mangroves and saltmarsh. The reserve has been closed by Auckland Council due to asbestos contamination.
- The freshwater wetland in Anns Creek Reserve (SEA-T-5308) is on the southeastern edge of Sector 3.

- Native plantings on Mutukaroa-Hamlins Hill (SEA-T-6074) immediately north of the proposed alignment.
- Anns Creek (SEA_T_5309, 5306, 5304 and SEA_M1_21) is recognised in the PAUP for the ecological sequences from saltwater to freshwater, and for the mosaic of vegetation types present including basalt lava shrubland. Ecological gradients are present from saline vegetation, with mangroves (*Avicennia marina* var. *australasica*); to saltmedow communities with glasswort (*Sarcocornia quinqueflora* subsp. *quinqueflora*) and bachelors button (*Cotula coronopifolia*); to brackish wetlands with marsh clubrush (*Bolboschoenus fluviatilis*); and then into freshwater wetland with raupo (*Typha orientalis*) at the edge of the lava flow. Anns Creek is the only area remaining in the Auckland region where native herb species, including *Threatened* species, grow together on lava, and is the type locality for *Coprosma crassifolia* (Gardner 1992) collected by William Colenso. William Colenso describes his visit to the area in 1841-42 as follows:
    - "The next morning we continued our course by the sinuous shores of Manukau Bay…and engaging a canoe, paddled to the upper extremity of the harbour; landing at Otahuhu, the isthmus connecting the northern and southern parts of the North Island of New Zealand…The whole appearance of the country in this neighbourhood is of a highly volcanic character…A peculiar species of *Coprosma* (*C. crassifolia* W.C.) I detected growing among the scoria on the northern side of the bay…"
- The area provides inanga (whitebait) spawning habitat, and *Threatened* wetland bird species, Australasian bittern and banded rail, have been recorded in the creek. More details on the fauna values of the area are contained within the avifauna and freshwater chapters of Technical Report 16.
- The mangroves, saltmarsh and wading bird habitat at the mouth of Anns Creek (Anns Creek Estuary) are identified as SEA-M1 (SEA-M1-21, SEA-M1w) and are contiguous with wading bird habitat (SEA-M2w) and with mangrove ecosystems along the coastline (SEA-M2-23a). One of the lava flows in Anns Creek Estuary is identified as a significant terrestrial ecological area (SEA-T-5304) for its values as basalt lava shrubland. The SEA-M2 overlay and wading bird area in the wider Mangere Inlet extends to Pikes Point. The marine and avifauna ecological values of the area are described in more detail in the marine coastal and avifauna chapters of Technical Report 16.
- The pahoehoe lava flows at Anns Creek are also identified in the PAUP as an Oustanding Natural Feature (ONF 92). Appendix 3.1 of the PAUP describes this ONF as being "one of the few examples of pahoehoe surfaces on basalt lava flows in the Auckland volcanic field". This feature includes the lava flows that extend into the eastern and western sections of Anns Creek and in the Anns Creek estuary, at the mouth of Anns Creek.
- The Hopua explosion crater and tuff exposure is also identified as an ONF (46).
- The geological values are described in more detail in Technical Report 4 Geological Heritage Assessment.

Significant Ecological Areas, Auckland Council District Plan

The lava flow, wetland and shrubland ecosystems in Anns Creek are identified as a Significant Ecological Area in Appendix 3c of the Operative Auckland Council Isthmus District Plan (H13-24, H13-21 and H13-23). The District Plan also identifies the mangroves and lava flows at Pikes Point (H13-23) and the Anns Creek Reserve Stormwater Wetland (H13-25) on the southeastern edge of Sector 3 as SEA.

The following parts of Anns Creek are identified as SEA within Sectors 2 and 3 of the Project area:

- Anns Creek Lava Flow Wetland and Shrubland (H13-24) in the eastern section of Anns Creek (at 781 Great South Rd and 791-793 Great South Rd);
- Anns Creek Coastal Margin 1 and 3 (H13-21 and H13-23) on the southern edge of the Mighty River Power Co-Generation Plant and between the railway lines;

This map contains data derived in part or wholly from sources other than EWL, and therefore, no representations or warranties are made by EWL as to the accuracy or completeness of this information.

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Designed | Design Check
Scale: 1:25,000 | Original Size: A3 | Contract No PA4041

Drawing Title
ECOLOGY
Map 2-2 : Significant Ecological Areas, PAUP

Drawing Number GIS-AEE-EC-VH-003 | Rev No. A

Plot Date: 27/10/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskell\GIS-EC-AEE-VH-003_T16006_17_VegetationLizard_Map3_PAUP_SEAs.mxd

- Anns Creek Coastal Margin 2 (H13-23) at Pikes Point;
- Anns Creek Reserve Wetland (H13-25) on the southeastern edge of Sector 3.

Area of Significant Conservation Value (ASCV)

The whole of the Manukau Harbour is identified by Department of Conservation as an Area of Significant Conservation Value (ASCV 007) in the Operative Auckland Regional Plan: Coastal. It is recognised as an internationally significant area for wading birds and containing important intertidal areas, mangroves and saltmarsh. The Mangere Mountain foreshore and pahoehoe lava flows in Mangere Inlet are also identified as ASCV 059. They are described as "*A nationally significant example of ropey pahoehoe lava from the Mt Mangere volcano…The formation extends across the foreshore and approximately half-way across the entrance to the Mangere Inlet*."

2.4.1.2 Terrestrial Ecological Descriptions and Vegetation Types

The vegetation and ecosystem types present are described and mapped in Map 2-3 through to Map 2-6 for each Sector of the Project area. The vegetation types follow Atkinson vegetation structural classes (Atkinson 1985).

Sector 1 - Gloucester Park South, Hopua Crater and Mangere Bridge Area

Hopua Crater is a small explosion crater and low tuff ring. The crater was a shallow lagoon, breached by the sea until about 60 years ago. The crater originally contained a shallow lagoon. Past modification has included reclamation of the crater lagoon in the 1940s and the motorway constructed across the centre of the basin. A small area of saltmarsh wetland has established in Gloucester Park South (SEA-T-6103) and is fed by saltwater intrusion through groundwater.

The wetland in Hopua Crater is dominated by indigenous saltmarsh species. It is surrounded by large groups of planted shrubs (a mix of native and exotic species) and rank grassland. There is a large pohutukawa (*Metrosideros excelsa*) tree beside Onehunga Harbour Rd on the rim of the crater, adjacent to a planted area.

Mangroves and saltmarsh dominated by glasswort occur on the coast, on the western side of Mangere Bridge beside the coastal walkway. An area of mangroves has been cleared on the western edge of the bridge. There are groups of native plantings beside the walkway, and a large embankment dominated by weed species.

The following vegetation types occur within Sector 1 (see Map 2-3).

a) Glasswort – sea rush – oioi rushland (vegetation type 25).

The wetland in southern part of Hopua Crater is dominated by saltmarsh and saltmeadow species, including glasswort, bachelors button, sea rush (*Juncus kraussii* subsp. *australiensis*), oioi (*Apodasmia similis*), with umbrella sedge (*Cyperus ustulatus*) also present. Exotic carex (*Carex divisa*) is also present. This wetland is surrounded by rank grassland and plantings.

b) Mixed native and exotic shrubland plantings (vegetation types 23 and 24).

Plantings of harakeke (*Phormium tenax*), cabbage tree (*Cordyline australis*), manuka (*Leptospermum scoparium*), karo (*Pittosporum crassifolium*), ngaio (*Myoprum laetum*), taupata (*Coprosma repens*), karamu (*Coprosma robusta*), with Tasmanian blackwood (*Acacia melanoxylon*), woolly nightshade (*Solanum mauritianum*), and pampas (*Cortaderia selloana*) present.

c) Pohutukawa tree (vegetation type 20).

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Legend

EWL Alignment

Vegetation Types

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- 3, Marsh clubrush reedland
- 4, Tall fescue grassland
- 5, Pampas tussockland
- 6, Mangrove scrub and forest
- 7, Glasswort - bachelors button herbfield
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- 24, Flax Plantings
- 25, Glasswort - Searush - oioi rushland
- 26, Glasswort - Austrostipa herbfield
- 27, Bamboo
- 28, Tutu Tree
- 29, Mixed native and exotic plantings

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Drawing Title
ECOLOGY
Map 2-3 : Vegetation Types, Sector 1

Drawing Number GIS-EC-AEE-VH-001.1 | Rev No. A

A pohutukawa (*Metrosideros excelsa*) tree, approximately 12m tall, on north western crater rim beside Onehunga Harbour Rd.

d) Mangrove scrub and forest (vegetation type 6).

Mangroves along coastal foreshore in association with glasswort herbfield.

e) Glasswort – *Austrostipa stipoides* herbfield (vegetation type 26).

Saltmarsh in inlet beside the bridge, surrounded by mangroves with *Austrostipa stipoides*, pohuehue (*Muehlenbeckia complexa*), and saltwater paspalum (*Paspalum virginatum*).

f) Wattle - pampas - wild ginger weedfield on embankment (vegetation type 21).

Weed species are dominant on an embankment on the northern side of the coastal walkway. The area is dominated by wild ginger (*Hedychium gardnerianum*), nasturtium (*Tropaeolum majus*), blue morning glory (*Ipomoea indica*), pampas and other weed species.

Sector 2 - Manukau Foreshore

The coastal foreshore has several remnant basalt lava outcrops which extend out from the coastal reclamation. The largest is at Pikes Point. These outcrops are dominated by mangrove forest with small pockets of lava shrubland. At Pikes Point within the mangroves there are lava shrublands dominated by ngaio, karo, harakeke and saltmarsh species. The whole of the mangrove forest and lava outcrops at Pikes Point are identified as SEA in the Operative District Plan, while in the PAUP five of the lava shrubland areas at Pikes Point are identified as SEA (SEA-T-9022). Weed species such as gorse (*Ulex europeaus*) and pampas are common on the lava. On the coast at Waikaraka Park there are several small lava flows extending out from the rock wall, dominated by saltmarsh and lava shrubland species including *Austrostipa stipoides*, glasswort, saltmarsh ribbonwood, buck's horn plantain (*Plantago coronopus*), and harakeke.

Mangroves are scattered sporadically along the majority of the rocky shoreline. The rocky embankment has small pockets of shrubs such as taupata, karo, and pohuehue. Native plantings and mown grass line the edges of the coastal walkway. Weed species such as moth plant (*Araujia hortorum*) are common. At Waikaraka Cemetery, there is a grove of planted pohutukawa either side of the walkway.

Miami Stream, to the west of Pikes Point is a tidal channel dominated by mangroves, with tall plantings of native coastal shrubland species including ngaio on the western riparian edge. Historic aerial photos show that Miami Stream comprises a channel that is a residual part of the coast that remained unreclaimed.

Vegetation types present within Sector 2 are as follows (see Map 2-4).

a) Lava Shrubland at Pikes Point

Native shrub species on lava outcrop surrounded by mangroves. Lava shrubland dominated by flax, ngaio, taupata and karo, with saltmarsh ribbonwood, pohuehue, tall fescue (*Schedonorous arundinaceus*), glasswort, remuremu (*Selliera radicans*) and sea primrose (*Samolus repens* var. *repens*) and buck's horn plantain. Weed species such as wattle, gorse and pampas are also dominant.

b) Mangrove - taupata - karo shrubland on coastal edge (vegetation type 22).

Scattered mangrove shrubs line the reclaimed coastal foreshore, with occassional taupata, karo, pohuehue on the bank.

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Legend

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Drawing Title
ECOLOGY
Map 2-4: Vegetation types, Sector 2

Drawing Number GIS-EC-AEE-VH-001.2 | Rev No. A

Plot Date: 1/11/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskell\GIS-EC-AEE-VH-001_T16006_15_VegetationLizard_Map1_Vegetation_Types.mxd

c) Native shrubland plantings beside coastal walkway (vegetation type 19).

Native plantings consisting of karo, karamu, karaka (*Corynocarpus laevigatus*), puriri (*Vitex lucens*), coastal kowhai (*Sophora chathamica*). Weed species area common including moth plant, smilax (*Asparagus asparagoides*), pampas, morning glory, and kikuyu (*Pennisetum clandestinum*).

a) Avenue of planted pohutukawa trees (vegetation type 20).

Grove of 6m - 10m tall pohutukawa trees lining both sides of the walkway at Waikaraka Cemetery.

Sector 3 - Anns Creek

The eastern section of Anns Creek contains a mosaic of vegetation types in an ecological sequence including basalt lava shrubland, freshwater wetlands, brackish wetlands, saltmarsh and mangrove forest. This grades into an area of mangroves in the western and central area which is bisected by railway lines, and then into mangroves and lava shrublands on basalt outcrops in the estuary.

Anns Creek is characteristic of the early vegetation cover of the Auckland isthmus. It is the only remaining area in Auckland where native shrubs, herbs and ferns, including *Threatened* species remain growing together on lava. Three *Threatened Geranium* species have been recorded from Anns Creek: *G. retrorsum* (*Nationally Vulnerable*), *G. solanderi* (*At Risk – Declining)*, and *Pelargonium inodorum* (regionally ‘sparse’). A *Threatened* volcanic fern, *Pellaea falcata* (*At Risk – Declining*) has also been recorded on the lava. The lava field at Anns Creek is the type locality for the shrub *Coprosma crassifolia* collected there by William Colenso in 1846 (Gardner 1992).

The saltmarsh wetlands in Anns Creek East comprise glasswort, oioi, bachelors button and saltmarsh ribbonwood (*Plagianthus divaricatus*). These saltmarsh wetlands grade into mangroves, into brackish wetlands dominated by marsh clubrush, and into freshwater raupo reedland. Anns Creek East, apart from the area at the eastern end which is consented for development by TR Group, and which contains sequences from saline to freshwater wetland, is identified as SEA in the PAUP (SEA-T-5309).

Anns Creek West, south of the Mighty River Power Co-Generation Plant is dominated by mangrove forest, with pockets of saltmarsh ribbonwood. The lava flows and the bank on the northern side is dominated by weed species including fennel (*Foeniculum vulgare*) and brush wattle (*Paraserianthes lophantha*). This area is identified as SEA in the Operative District Plan and as ONF in the PAUP.

The mouth of Anns Creek in Mangere Inlet contains an extensive area of mangroves with basalt lava flows extending out into the harbour. Native shrub and saltmarsh species occur on the pahoehoe basalt lava flows together with a mix of exotic weed species including blackberry (*Rubus fruiticosus* agg.) and gorse. This area is identified as SEA-M1 in the PAUP. The areas of lava flow around the inland edges of the estuary area identified as ONF, with the central lava flow idenitfied as SEA (SEA-T-5304).

On the landward eastern half of the inlet, exotic trees such as brush wattle are dominant together with exotic weeds and grasses including moth plant, blue morning glory and cape ivy (*Senecio angulatus*). Beside the walkway are planted groves of trees with taupata, karo, and ngaio.

The vegetation types present in Anns Creek and Sector 3 are as follows (see Map 2-5):

a) Marsh clubrush reedland (vegetation types 2 and 3).

Marsh clubrush is dominant in the brackish upper reaches of Anns Creek, on low-lying flats beside the stream. This reedland grades into mangrove forest and tall fescue grassland.

b) Tall fescue grassland (vegetation type 4).

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Legend

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Drawing Title
ECOLOGY
Map 2-5: Vegetation types, Sector 3

Drawing Number GIS-EC-AEE-VH-001.3 | Rev No. A

Plot Date: 1/11/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskell\GIS-EC-AEE-VH-001_T16006_15_VegetationLizard_Map1_Vegetation_Types.mxd

Dense, tall fescue-dominated vegetation beside the upper reaches of Anns Creeks, with some blackberry present.

c) Mangrove forest and scrub (vegetation type 6).

Dense mangrove forest and 2m tall mangrove scrub dominates the intertidal flats in Anns Creek. The mangroves support a diverse lichen flora.

d) Glasswort - bachelor's button herbfield (vegetation type 7).

Glasswort and bachelors button are dominant in these saltmeadow herbfields with arrow grass (*Triglochin striata*), knobby clubrush (*Ficinia nodosa*) and occasional small mangroves present. Other saltmarsh species present include sea rush, sea primrose, remuremu and *Isolepis cernua* var. *cernua*. *Spartina anglica* is also present in one area.

e) Raupo reedland (vegetation type 8).

Freshwater wetland in one pocket on the northern side of Anns Creek dominated by raupo. Swamp willow weed (*Persicaria maculosa*), marsh clubrush, and pampas are also present. This grades into lava shrubland to the south and saltmarsh to the east.

f) Lava shrubland (vegetation type 10).

Basalt outcrops contain lava shrubland communities dominated by akeake (*Dodonaea viscosa*) and *Coprosma crassifolia* (type locaility), with *Astelia banksii*, karo, pohuehue and taupata. Gorse, smilax, blackberry, and moth plant are very common with the ends of the lava flows dominated by native species, including dense swards of the native slender rice grass (*Microlaena stipoides*). Threatened plant species, *Geranium retrorsum* (*Nationally Vulnerable*), *G. solanderi* (*At Risk – Declining*), *Pelargonium inodorum* (regionally 'sparse'), and a *Threatened* volcanic fern, *Pellaea falcata* (*At Risk - Declining*), are present on the lava flows and were recorded during the survey for this project. Ngaio (regionally threatened 'gradual decline') is also present.

g) Oioi saltmarsh (vegetation type 9).

h) Sea rush and oioi dominated saltmarsh on edge of lava flow.Brush wattle – pampas shrubland (vegetation type 1)

A mixture of exotic weed species, with brush wattle tree, pampas, nasturtium (*Nasturtium officianale*), and cape ivy on the road embankment and below Great South Road.

i) Pampas tussockland (vegetation type 5).

A line of pampas parallel with the watercourse at the eastern and southern parts of Anns Creek East. Also occurs sporadically throughout much of Sectors 1 and 2.

j) Native shrubland plantings on embankment (vegetation type 11).

Mixed native plantings including akeake, karo, saltmarsh ribbonwood, taupata, and coastal tree daisy (*Olearia solandri*).

k) Brush wattle - gorse weedfield (vegetation type 12).

l) Brush wattle - fennel weedfield (vegetation type 13).

Weed infested area of upper lava flows dominated by fennel and small wattle up to 2m tall. Numerous other weed species also present.

m) Saltmarsh ribbonwood shrubland (vegetation type 14).

In the area of mangroves south of the Might River Power Co-Generation Plant there are small areas of saltmarsh ribbonwood with tall fescue and *Austrostipa stipoides* on the lava outcrops. Pohuehue, karo, remuremu, buck's horn plantain (*Plantago coronopus*) and glasswort also present.

n) Lava shrubland (vegetation 17 and 18).

Lava flows on the coast out from Anns Creek West with a mix of native shrubs, herbs, grasses, ferns and saltmarsh species including taupata, karo, coastal tree daisy, *Austrostipa stipoides*, knobby clubrush, glasswort, sea primrose, harakeke, pohuehue and saltmarsh ribbonwood. *Geranium solanderi* (*At Risk – Declining*) is common on the ends of the lava flows. Salt grass (*Puccinellia stricta*) (regional threat status: 'acutely threatened') is present on the lava. Tall fescue and weed species such pampas and smilax are also common.

o) Ngaio forest on lava flow (vegetation type 16).

A line of ngaio on the edge of the lava flow and fringing the mangroves, with taupata, native ferns (*Pyrrosia eleagnifolia* and *Microsorum pustulatum* subsp. *pustulatum*), and pohuehue present. *Geranium solanderi* is present on the edge of coastal walkway. Weed species are common.

p) Wattle shrubland and exotic grassland (vegetation type 15).

On the edge of the coastal track and between the walkway and cycle track, brush wattle is dominant with exotic grasses and weeds including giant reed (*Arundo donax*), moth plant, pampas, smilax, blue morning glory, cape ivy, *Tradescantia fluminensis* and blackberry.

Southdown Reserve

This site (SEA-T-6104) is contaminated with asbestos and survey was limited to walking the track that runs through the reserve. The reserve lies on the northern edge of Sector 3. It is dominated by a mix of 20 year or older native and exotic plantings, and mahoe (*Melicytus ramiflorus*). The stream flowing through the reserve has an area of raupo and harakeke at the freshwater end which grades into mangroves, and into a small area of saltmarsh at the southern end, with oioi, salt marsh ribbonwood and *Carex flagellifera*. Weed species are common. The alignment will avoid this area.

The abandoned lot adjacent to Southdown Reserve at 213 Hugo Johnson Drive contains rank grass and weeds. This area was not surveyed.

Anns Creek Reserve Wetland

A wetland reserve on the southern edge of Sector 3 (SEA-T-5308). A large area of freshwater wetland with raupo, kutakuta (*Eleocharis sphacelata*), marsh club rush, jointed twig rush (*Machaerina articulata*), purei (*Carex secta*) and exotic reed sweet grass (*Glyceria maxima*). The alignment will avoid this area.

Sector 4 – Mutukaroa-Hamlins Hill and Motorway Interchange

The proposed road alignment will avoid Mutukaroa-Hamlin's Hill. The base of Mutukaroa-Hamlin's Hill adjacent to the alignment is mown grass. This area was not surveyed.

Sector 5 - Otahuhu Creek

Where State Highway 1 crosses Otahuhu Creek there are three box culverts. Mangrove forest lines the creek. Vegetation on the bank on the eastern side of the motorway is dominated by exotic species including bamboo (*Phyllostachys* sp.) and brush wattle. On the western side of the motorway there is a mix of native and exotic trees and shrubs including tutu (*Coriaria arborea*). North and south of Otahuhu Creek, there are planted trees beside the motorway in a number of locations.

Vegetation types present in Otahuhu Creek are as follows (Map 2-6):

a) Mangrove scrub and forest (vegetation type 6).

Mangroves line the edges of the creek with some glasswort present on the margins.

b) Mixed exotic and native plantings (vegetation types 20, 28, 29).

Mixed native and exotic tree and shrub species and weed species on the banks beside the motorway and creek edge. Brush wattle, Chinese privet (*Ligustrum chinensis*), hawthorn (*Craetaegus monogyna*) and woolly nightshade are common. Two pohutukawa trees are growing out of the motorway retaining wall on either side. There is a mature tutu shrub on the western side.

c) Bamboo (vegetation type 27).

A thicket of bamboo on the eastern side of the motorway.

Sector 6 - Princes Street Overbridge

This sector includes planted trees and shrubs beside the motorway. This area was not surveyed.

2.4.1.3 Significant Trees and Plantings

Throughout the proposed road alignment there are a number of plantings of native and exotic shrubs and trees. These trees will be providing ecosystem services including absorbing air pollutants and providing amenity values and bird habitat. The effects on trees and plantings is discussed in Technical Report 5 Arboricultural Assessment.

2.4.1.4 Threatened Plant Species

Records of *Threatened* plant species from the Auckland Museum herbarium and from survey reports for Anns Creek and Mangere Inlet are provided in Table 2-5.

Pomaderris phylicifolia var*. ericifolia* was also recorded in Anns Creek by Gardner (1992). It is assumed this record is *P. phylicifolia* which is a nationally *Threatened* species, rather than *P. amoena* (which the New Zealand Plant Conservation Network notes as having been treated as *P. phylicifolia* var. *ericifolia*).

During this survey *Geranium solanderi* and *G retrosum* were recorded on the lava flows in Anns Creek East, and *G. solanderi* on the edges of the coastal walkway in Anns Creek estuary. Ngaio (*Myoporum laetum*) was recorded on the lava flows in Anns Creek East and on the edge of Anns Creek Estuary. *Pellaea falcata* and *Coprosma propinqua* var. *propinqua* were recorded on the lava flows in Anns Creek East. *Pucinella stricta* was recorded on a lava flow beside the coastal walkway in Anns Creek Estuary.

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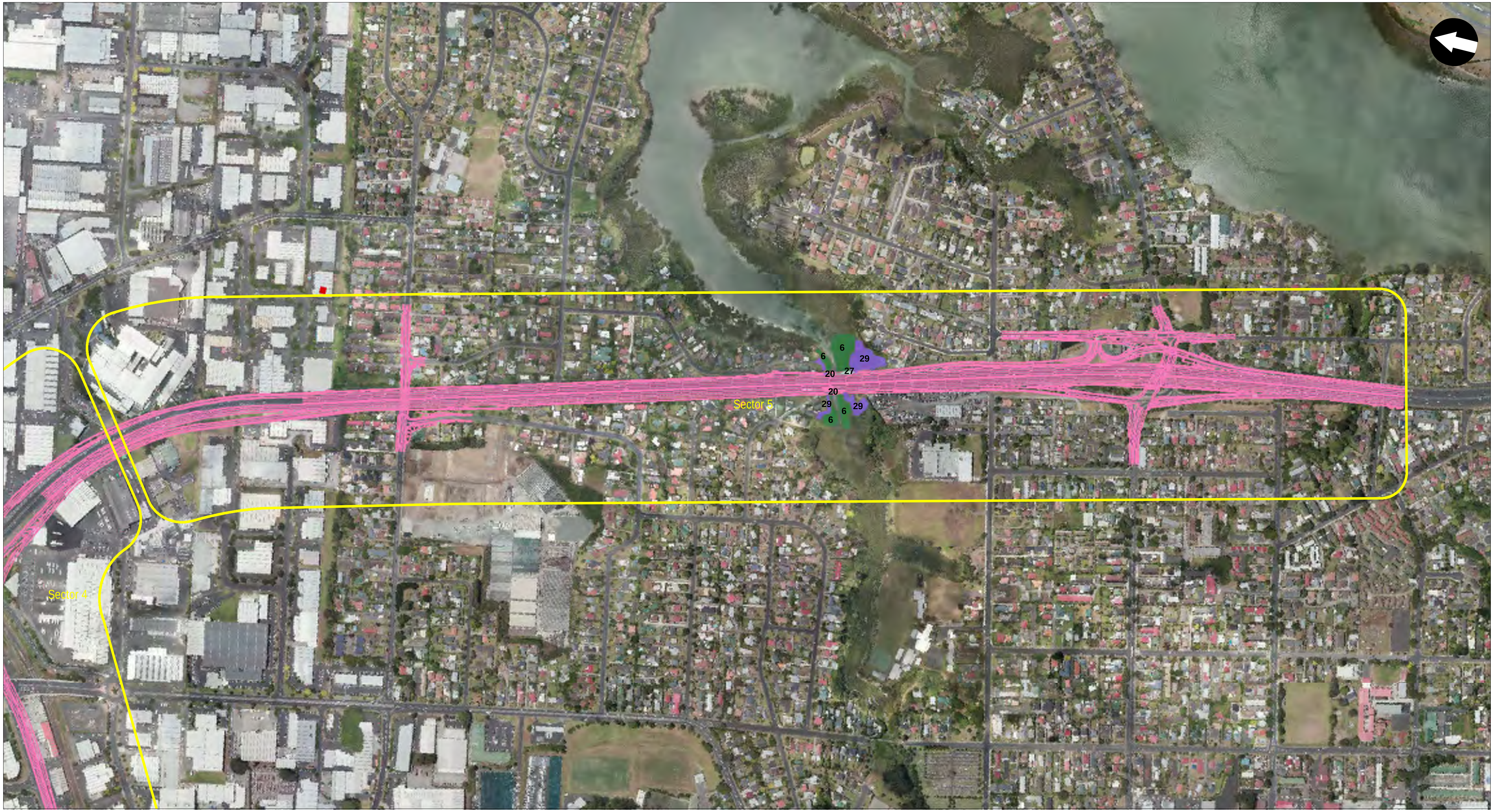

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Drawing Title
ECOLOGY
Map 2-6: Vegetation types, Sector 5

Drawing Number GIS-EC-AEE-VH-001.5
Rev No. A

Plot Date: 1/11/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskell\GIS-EC-AEE-VH-001_T16006_15_VegetationLizard_Map1_Vegetation_Types.mxd

Table 2-5: *Threatened* plant species records from Anns Creek, Mangere Inlet and Onehunga walkway.

Name	Threat Status[10]	Location	Most recent herbarium record	Found in this survey
Coprsoma propinqua var. *propinqua*	*Regional threat status: regionally vulnerable*	Anns Creek		yes
Geranium retrorsum	*Threatened* - Nationally Vulnerable	Anns Creek	17 Feb 2004	yes
Geranium solanderi	*At Risk* - Declining	Anns Creek	7 Feb 2004	yes
Myoporum laetum	Regional threat status: gradual decline	Mangere Inlet	23 Nov 1993	yes
Pelargonium inodorum[11]	Regional threat status: sparse	Anns Creek		no
Pellaea falcata	*At Risk* - Declining	Anns Creek	10 Dec 1993	yes
Puccinellia stricta	Regional threat status: acutely threatened	Onehunga walkway	12 Jan 2001	yes

2.4.1.5 Ecological Significance

There are a number of significant ecological areas identified within the project alignment. The ecological significance of these existing SEAs has been described, as well as the ecological significance of other areas within the project alignment. The ecological significance of terrestrial vegetation and ecosystems has been assessed using the 'Significant Ecological Areas – Terrestrial Criteria' in Part 5 Appendix 3.1[12] of the PAUP. The ecological criteria met have been assigned a high, medium, low rating using the details for applying ecological significance criteria in Davis et al. (2016). Sites only need to meet one PAUP criteria to be significant.

An overall value (very high, high, moderate and low) has been given to each site. This overall value has been based on the ratings for ecological significance criteria as well as guidance for assessment scoring for areas of terrestrial vegetation and habitats in Table 6 of the EIANZ Ecological Impact Assessment Guidelines (EcIA). This overall rating of value is separate to the assessment of the ecological significance of a site. Assessment of significance is undertaken as part of section 6c of the RMA (only one PAUP criteria needs to be met for a site to be significant), wheras an overall rating for a site provides an assessment of importance or priority for management (Davis et al. 2016).

Table 2-6 describes the ecological significance of areas already idenitified as SEA in the PAUP or Operative District Plan. Additional areas that have been assessed as part of this survey as also significant are described in Table 2-7. All areas indentified as significant through this survey are mapped in Map 2-7.

[10] De Lange et al. (2013)

[11] Recorded by Gardner 2001 and in Statement of evidence of Rebecca Stanley, undated, in the matter of a submission by ARC to a resource consent application by TR Group in relation to land at 781 and 791-793 Great South Road, Penrose.

[12] PAUP 010 Hearing Auckland Council Closing Statement Tracked Changes Attachment B (B4.3.3, B4.3.4, B4.3.5)

Table 2-6: Significant Ecological Areas in East West Link Corridor

Site Name	Vegetation Types meeting criteria	Description of criteria met	Existing SEA or ONF in PAUP or SEA in District Plan	Unitary Plan criteria	Overall Rating
Anns Creek East (south of TR Group land)	Lava Shrubland, Marsh clubrush reedland, tall fescue grassland, mangroves, saltmarsh herbfield, raupo reedland	Contains naturally uncommon ecosystem type that is threatened. Supports *Threatened* and *At Risk* plant species. Indigeous vegetation within wetland. Type locality for taxon. Important as intact sequence. Indigenous vegetation extending across environmental gradient. Supports typical species richness for type.	SEA-T-5309 ONF192	Representativeness (H) Threat status & rarity (H) Uniqueness or distinctiveness (H) Diversity (H)	Very High
Anns Creek West (south of Powerstation)	Mangroves, saltmarsh ribbonwood	Contains naturally uncommon ecosystem type that is threatened.	H13-21 ONF192	Threat status & rarity (H)	High
Anns Creek Estuary (Mangere Inlet)	Lava shrubland, mangrove	Contains naturally uncommon ecosystem type that is threatened. Supports *Threatened* and *At Risk* plant species. Indigenous vegetation within wetland. Type locality for taxon. Important as intact sequence. Supports typical species richness for type.	SEA-T-5304 SEA-M1-21 ONF192	Representativeness (H) Threat status & rarity (H) Uniqueness or distinctiveness (H) Diversity (H)	Very High
Lava flow at Pikes Point	Lava shrubland, mangroves	Contains naturally uncommon ecosystem type that is threatened. Supports *Threatened* and *At Risk* plant species.	SEA-T-9022 H13-23	Threat status & rarity (H)	High
Hopua Crater	Glasswort-sea rush-oioi rushland	Indigenous vegetation within a wetland.	SEA-T-6103	Threat status & rarity (M)	Moderate
Southdown Reserve	Planted and native shrubland, mangroves, oioi saltmarsh	Indigenous vegetation within a wetland. Forms part of a network of sites.	SEA-T-6104	Threat status & rarity (M) Stepping stones, migration pathways & buffers (M)	Moderate
Anns Creek Reserve Wetland	Freshwater wetland	Indigenous vegetation within a wetland.	SEA-T-5308 H13-25	Threat status & rarity (H) Stepping stones, migration pathways & buffers (M)	High

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Map 2-7: Areas with significant ecological values, from assessment

Drawing Number GISAEE-EC-VH-005 | Rev No. A

Plot Date: 27/10/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskel\GIS-EC-AEE-VH-005_T16006_22_VegetationLizard_Map5_Significant terrestrial areas based on assessment.mxd

Table 2-7: Assessment of Ecological Areas not identified as SEA in PAUP or District Plan

Site Name	Vegetation Types	Description of criteria met	Unitary Plan criteria	Overall Value
Lava Flows (at Waikaraka Cemetery and Victoria St)	Lava shrubland, mangroves	Contains naturally uncommon ecosystem type that is threatened.	Threat status & rarity (M)	Moderate
Saltmarsh by Mangere Bridge SH20	Glasswort herbfield, mangroves	Indigenous vegetation within a wetland.	Threat status & rarity (M)	Moderate
Miami Stream	Mangroves saltmarsh, native plantings			Low, Moderate

This assessment of ecological significance has been informed by:

- Existing SEA descriptions;
- The results of vegetation and botanical surveys;
- *Threatened* plant records for the area;
- Existing survey reports and information on significant ecological areas.

Through this assessment the existing SEAs have been endorsed and confirmed. Boundaries of the SEAs have been reviewed and refined, and some additional areas (lava flows and saltmarsh areas) have been identified. In Map 2-7 we have identified the mosaic of mangrove shrubland and lava outcrops at Pikes Point as significant. This is consistent with the SEA for this area in the Operative District Plan. In the PAUP however only the five small areas of lava outcrop are identified as SEA. The mangrove shrubland and saltmarsh ribbonwood in Anns Creek West is identified as significant in Map 2-7. Anns Creek West is identified as SEA in the Operative District Plan but not as SEA in the PAUP. Anns Creek East is identified as significant in Map 2-7 including the area at the eastern end which lies outside of the SEA and contains sequences from saltmarsh to freshwater wetland. The areas of Anns Creek East that have been consented for development by TR Group are not included in the SEA in the PAUP.

The national priorities for protecting indigenous biodiversity[13] have been addressed in this assessment of ecological significance. The coastal foreshore of Mangere Inlet lies within a threatened land environment with less than 20% remaining indigenous vegetation cover (National Priority 1). Anns Creek and Hoteo Crater contain indigenous vegetation associated with wetlands (National Priority 2). The lava flows in Anns Creek, in Mangere Inlet, along the coastal foreshore and at Pikes Point contain indigenous vegetation associated with a naturally uncommon ecosystem type (recent lava flows) (National Priority 3). The lava flows of Anns Creek support nationally *Threatened* plant species: *Geranium retrorsum*, *G. solanderi* and *Pellaea falcata* (National Priority 4).

There is a total of approximately 22,000m^2 of lava shrubland mapped within the sectors of the Project, with over 1,000m^2 at Pikes Point and the coastal foreshore, 8,200m^2 in Anns Creek Estuary, 270m^2 in Anns Creek West and approximately 12,800m^2 in Anns Creek East.

[13] Ministry for the Environment and Department of Conservation 2007: Protecting our Places. Introducing the national priorities for protecting rare and threatened native biodiversity on private land. Ministry for the Environment and Department of Conservation, Wellington. 7-page brochure.

2.4.2 Herpetofauna ecology

2.4.2.1 Sector 1: Gloucester Park South

Gloucester Park South is a small public reserve bounded by SH20 and the Onehunga Harbour Road. Vegetation within the reserve predominantly comprises mown grass, with a margin of mixed exotic/native vegetation along the south-eastern margin and recently planted (approximately 2010 based on aerial imagery) restoration planting areas. Restoration planting includes harakeke, kanuka scrub with margins of rank grass. The vegetation and habitats within the reserve were assessed as having moderate potential lizard habitat value. Two AR transects of four ARs each were installed in Gloucester Park South (Map 2-8).

2.4.2.2 Sector 2: Manukau Foreshore Walkway

Potential lizard habitat within the Manukau Foreshore Walkway comprises narrow margin of native planting on either side of the footpath for most of its length. These plantings include harakeke and divaricating shrubs with a ground layer of logs and leaf litter. Boulders on the coastal margin may provide some refuge habitat for lizards, but frequent disturbance by mowing reduces its habitat value. The vegetation and habitats within the Manukau Foreshore Walkway are variable, but generally provide moderate value habitats (Map 2-8). This areas was surveyed by systematic hand searching and raking leaf litter.

2.4.2.3 Sector 3: Anns Creek and Southdown Reserve:

Anns Creek has moderate lizard habitat around the margins where pampas tussockland, lava shrubland and native plantings interspersed with basalt outcrops provide both basking and refuge habitats. The majority of the interior comprises estuarine habitats with scattered rocky outcrops, although these are likely not permanently connected.

Southdown Reserve is a small reserve located at the end of Hugo Johnson Drive. The site is contaminated by asbestos and is closed to public access and is as a result, undisturbed. Vegetation within the reserve is dominated by weed species, with some native canopy species including kanuka. Potential lizard habitats within the reserve include thick leaf litter, logs and debris and a number of large boulders with abundant light gaps provide both basking and refuge opportunities for lizards such as ornate and copper skinks. Southdown Reserve was assessed as providing high quality lizard habitat, although the site was not surveyed for health and safety reasons (Map 2-8). The current design does not include any works within Southdown Reserve and the area will be avoided.

The abandoned lot adjacent to Southdown Reserve at 213 Hugo Johnson Drive is overgrown with grass and weeds interspersed with boulders. This site was assessed as potentially providing moderate value lizard habitats (Map 2-8). This site was not surveyed because of suspected asbestos contamination. The current design (8 August 2016) includes a large stormwater treatment pond at this site.

2.4.2.4 Sector 4: Great South Road to State Highway 1

Potential lizard habitat within the proposed road alignment between Great South Road and State Highway 1 was assessed as having low lizard habitat value based on the lack of refugia and frequency of disturbance by mowing (Map 2-8). The lower slopes of Mutukaroa (Hamlins Hill) similarly have low grass with little cover and are likely intermittently grazed. The current design (8 August 2016) limits construction activities around Mutukaroa-Hamlins Hill to the mown berm that has low lizard habitat value.

2.4.2.5 Sector 5: State Highway 1 widening

Vegetation within the proposed footprint of the expanded SH1 corridor between Mt Wellington and Princes St primarily comprises a thin margin of rank or mown grass and amenity plantings. A rapid visual assessment recorded little refugia or suitable habitat for lizards and this area was assessed as having predominantly low lizard habitat value (Map 2-8). This area was not surveyed.

2.4.2.6 Sector 6: Local works within Onehunga

Local works in Onehunga are in predominantly industrial areas with no potential lizard habitat. However, the vacant land at the end of Captain Springs Road was assessed as providing moderate value lizard habitat based on the dense, complex grassland and sunny aspect (Map 2-8).

The project includes an onramp on Captain Springs Road, and this grassy habitat will be cleared.

Local works within Onehunga include vegetation clearance and construction within Miami Reserve. The reserve comprises replanted native vegetation with large, established specimens. The lizard habitat within this area was assessed as high quality based on the abundant leaf litter, logs and debris that provide basking and refuge opportunities for lizards.

2.4.2.7 Lizard records

A total of four lizard species have been recorded in the Department of Conservation Bioweb Database within a 10 km radius of the proposed alignment since 1996 (DOC 2016). Of these, two are native skinks (copper skink and ornate skink), one is a native gecko (forest gecko), and one is an exotic skink (plague skink, Table 2-8). Of the species recorded in the database, plague skink was the most common.

Plague skinks were the only lizard species recorded during the lizard survey. Plague skinks are classified as an unwanted organism (UO) and require no further management (i.e. capture/relocation).

Table 2-8: Lizard records within 10 km of the proposed road alignment (1998-2015; DOC 2016).

Species		# records	Threat Classification[14]	Location of nearest record
Lampropholis delicata	Plague Skink	7	*Introduced*	Mangere
Mokopirirakau granulatus	Forest Gecko	1	*At Risk* - Declining	Orakei
Oligosoma aeneum	Copper Skink	4	*Not Threatened*	Otahuhu
Oligosoma ornatum	Ornate Skink	1	*At Risk* - Declining	Otahuhu

[14] Hitchmough et al. 2013

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EWL Alignment

lizard survey points

lizard observations

Lizard habitat areas

- High Quality
- Moderate Quality
- Low Quality

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Drawing Title
ECOLOGY
Map 2-8 : Lizard survey sites and habitat assessment

Drawing Number GIS-EC-AEE-VH-004.1 | Rev No. A

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EWL Alignment
lizard survey points
lizard observations

Lizard habitat areas
- High Quality
- Moderate Quality
- Low Quality

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Drawing Title
ECOLOGY
Map 2-8 : Lizard survey sites and habitat assessment

Drawing Number GIS-EC-AEE-VH-004.2
Rev No. A

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EWL Alignment
lizard survey points
lizard observations

Lizard habitat areas
- High Quality
- Moderate Quality
- Low Quality

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Drawing Title: ECOLOGY
Map 2-8 : Lizard survey sites and habitat assessment

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EWL Alignment

lizard survey points

lizard observations

Lizard habitat areas

- High Quality
- Moderate Quality
- Low Quality

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Drawing Title: ECOLOGY
Map 2-8 : Lizard survey sites and habitat assessment

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EWL Alignment

lizard survey points

lizard observations

Lizard habitat areas

- High Quality
- Moderate Quality
- Low Quality

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Drawing Title: ECOLOGY
Map 2-8 : Lizard survey sites and habitat assessment

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- EWL Alignment
- lizard survey points
- lizard observations

Lizard habitat areas

- High Quality
- Moderate Quality
- Low Quality

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Map 2-8 : Lizard survey sites and habitat assessment

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EWL Alignment

lizard survey points

lizard observations

Lizard habitat areas

- High Quality
- Moderate Quality
- Low Quality

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Drawing Title
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Map 2-8 : Lizard survey sites and habitat assessment

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2.5 Predicted Project Terrestrial Ecology Effects

2.5.1 Terrestrial Ecology

2.5.1.1 Terrestrial ecology effects within each sector

The effects of the project on terrestrial ecology will include loss of vegetation, ecosystems and habitat. There will also be adverse ecological effects on naturally uncommon ecosystem types and habitats for *Threatened* plant species. The ecological effects of the project within each sector are described.

Sector 1 - Gloucester Reserve, Hopua Crater and Mangere Bridge Area

The interchange at Neilson St will involve new structures over SH20 and the construction of on and off ramps. The coastal embankment described in Sector 2 will be constructed through to the wharf area underneath the SH1 Bridge.

Ecological Effects

Construction will result in loss of plantings on the southern edge of Gloucester Reserve by the road and the pohutukawa tree on the edge of the crater. The alignment at SH20 Neilson St is immediately adjacent to the edge of the brackish saltmarsh wetland in Hopua Crater (SEA-T-6103).

East of SH20 Mangere Bridge the foreshore embankment will result in loss of mangroves and saltmarsh (approximately 9,400m^2) along the coastal edge in Sector 1. An area of glasswort saltmeadow on the northern side of the walkway (approximately 900m^2) will be lost. Stormwater wetlands will also be constructed in this location which will result in loss of saltmarsh habitat.

Sector 2 – Mangere Inlet Foreshore

There is an existing reclamation along this coast. The proposed design consists of additional reclamation along the edge of the Coastal Marine Area (CMA) for a road, and construction of stormwater treatment wetlands, and amenity landscape plantings. The road will be built primarily on land from the east of Waikaraka Park. Reclamation will be undertaken for the construction of stormwater treatment wetlands in three main locations, one to the west of Waikaraka Park, the second to the east of Waikaraka Park and the third to the east of Pikes Point. A bund will be constructed to encase the road and stormwater treatment. Reclamation for construction of stormwater wetlands will minimise adverse effects on the lava flows at Pikes Point and Victoria St.

The embankment earthworks will involve reclamation within the existing coastline. This will invlove considerable earthworks and reclamation primarily associated with forming the outer bund and construction of the road embankment. The embankment will consist of an outer mudcrete barrier. Marine sediments will be excavated and stabilised with cement to form mudcrete. The remainder of the embankment will be formed of engineered fill.

The foreshore stormwater wetlands will lie immediately adjacent to the road embankment. Tidal intrusion will be restricted to maintain a freshwater environment. The alignment provides an opportunity to reduce leachate from reaching the CMA and for stormwater pollutants to be treated inside the outer bund.

Ecological Effects

Construction of the stormwater bund will result in loss of 14.7ha of intertidal habitat. The effects of this are discussed in detail in the marine ecology chapter of this report. Construction of the foreshore embankment and stormwater wetlands will result in direct loss of lava flow vegetation and mangroves which are scattered along the edge of the Manukau Foreshore East Walkway. This will result in the loss of approximately 7,000m^2 of mangroves at the Victoria St lava flow. Construction will be minimised at the Pikes Point basalt lava flow. Here the road will be built primarily on land with the construction of stormwater wetlands avoiding this area. There will be direct loss of mangroves along the inner edge of the Pikes Point lava flow. Here the alignment will result in loss of approximately 3,300m^2 of mangroves, and approximately half of the lava shrubland closest to the coastline (SEA-T-9022). The outer areas of lava shrubland at Pikes Point (SEA-T-9022) will be avoided. A coastal boardwalk will be cantilevered across the lava flow at Pikes Point and will shade the mangrove shrubland.

The coastal foreshore reclamation will result in loss of the fringe of mangroves and smaller lava flows present on the coast at Waikaraka Park (approximately 6,200m^2). Construction of a coastal walkway across the lava features will also have effects including shading of vegetation and habitat fragmentation.

Stormwater treatment wetlands will be built in Miami Stream. This will result in the loss of approximately 4,900m^2 mangroves.

Sector 3 – Anns Creek

A viaduct structure is proposed through Anns Creek. A raised viaduct will be constructed across the mangroves in Anns Creek Estuary (SEA-M1 and M2), across the northern edge of Anns Creek West (through the Mighty River Co-Generation Plant), and across the northern edge of Anns Creek East (SEA-T-5309) through to Great South Road/Sylvia Park Road.

The Anns Creek viaducts will be a single structure with a maximum width of 30m, on 1800mm diameter piers supported by 2100mm diameter bored pole structures, with a 35m span. The viaduct will have a 6m minimum clearance. There will be 19 pile structures located within Anns Creek estuary, two within Anns Creek West, and five within Anns Creek East.

The construction of the viaducts will be undertaken using a temporary staging structure with bored pile supports. The temporary staging structure will provide access for pile and pier construction. Access for temporary staging will be required from the northern edges of Anns Creek East and from the southern seaward edge of Anns Creek Estuary. Temporary staging will require installation of approximately 150 temorary piles in Anns Creek Estuary and 25 710mm diameter temporary piles in Anns Creek East.

A construction yard is proposed for the eastern end of Anns Creek beside Great South Rd. The construction yard is located in the area of Anns Creek East which is consented for reclamation by TR Group.

Ecological Effects

Anns Creek East

Construction of the viaduct, including access for temporary staging and location of a construction yard in the eastern end of Anns Creek will result in significant ecological effects. Anns Creek East contains sensitive and unique ecological values with lava shrubland habitats, threatened plant habitats and gradients between mangroves to saltmarsh to freshwater wetland. Construction of piers for the viaduct, as well as the temporary staging structures, will result in direct loss of habitats within the footprint of these structures.

The viaduct has been designed to be located within the more modified northern edges of the creek which contain weed species, native plantings and areas of fill. It will avoid and minimise effects on the lava flows in the southern section of the creek, but will it may adversely affect lava shrubland ecosystems on the northern and eastern parts of the lava flow. The location of the construction yard will destroy saline and freshwater ecosystems in the eastern end of the creek.

The effects of construction of the viaducts and the location of the construction yard will be significant and cumulative on this sensitive area. Over the years Anns Creek has been subject to the impacts of industrial development and this will add to the cumulative effects.

The designation footprint for construction of the viaduct together with the construction yard covers approximately 34% of vegetation communities in Anns Creek East. Adverse effects will include the following:

- Disturbance and loss of lava shrubland ecosystems;
- Disturbance and loss of freshwater raupo wetland and saltmeadow communities;
- Disturbance and loss of ecological sequences from terrestrial to saline to freshwater;
- Loss of and impacts on a naturally uncommon ecosystem type.

Construction staging and construction of the bridge piers will result in direct loss of vegetation and habitats within the immediate area of disturbance. An exclusion plan delineating the highest value lava and lava shrubland areas is being developed to guide location of piers during detailed design (see Chapter 6 of this report). Vegetation types within the designation footprint of the project area (beneath the viaduct structure and bridge piers, and within the area of staging) that will be adversely affected are as follows:

- Lava shrubland (approx 1,800m^2);
- Raupo reedland (approx. 1,400m^2);
- Mangrove shrubland (approx. 1,900m^2);
- Saltmeadow herbfield (approx. 700m^2);
- Degraded lava shrubland dominated by weed species on northern edges and at western end of Anns creek (approx. 2,600m^2).

The construction yard will result in direct loss of the following:

- Marsh clubrush freshwater wetland (approx. 2,000m^2);
- Mangrove shrubland (approx. 2,800m^2);
- Saltmeadow herbfield (approx. 300m^2);
- Tall fescue grassland beside creek (approx. 500m^2).

There is a total of approximately 2.2ha of lava shrubland mapped within Sectors 2 and 3 of the Project, with approximately 12,800m^2 in Anns Creek East. The designation footprint for construction of the viaduct will adversely affect approximately 9% of the total area of lava shrubland and 16% of the area within Anns Creek East (excluding the areas of degraded shrubland and weedfield).

Anns Creek Estuary

The construction of the viaduct through Anns Creek Estuary will fragment the mangrove shrubland ecosystems in the inlet. The alignment has been positioned to avoid areas of lava shrubland in association with pahoehoe lava flows around the coastal edge of the inlet. It is recommended that bridge construction in this location avoids the lava shrubland areas (see Chapter 6 of this report).

Ongoing operational effects of the Anns Creek East and Anns Creek Estuary viaducts will include shading and rain shadow effects on vegetation, and increased weed invasion from the construction and staging footprint. The indigenous shrub, grass and herb species in Anns Creek are adapted to high light conditions and growing in low open shrubland ecosystems. Shading and rain shadow from the viaduct will decrease light conditions and alter temperature, rainfall, humidity and soil moisture. These communities are unlikely to continue to exist in changed conditions. Plant communities will be disturbed and destroyed by viaduct construction. Plant species may recolonise areas that are suitable following construction of the viaduct. However, weed species are more likely to invade these areas. Threatened plant communities are particulalrly vulnerable to weed invasion.

Sector 5 – Otahuhu Creek

The existing bridge at SH1 across Otahuhu Creek will be widened, requiring the installation of eight new permanent piers (2100mm piles) in the CMA, plus approximately 100 temporary piers for staging.

Ecological Effects

There will be loss of exotic vegetation and plantings on the edge of the motorway, and permanent loss of mangroves due to temporary staging for construction of the bridge and permanent occupation of piers. Restoration and planting on the margins of Otahuhu Creek as proposed by this project, will replace exotic vegetation and have a positive ecological effect. Replacement of culverts with a bridge over Otahuhu Creek will alter coastal processes and have positive long term effects on the creek. The effects on marine ecology are discussed further in the marine ecology chapter of this report.

2.5.2 Terrestrial ecology effects of the project

Effects on terrestrial ecology in Anns Creek and Mangere Inlet include fragmentation, reduction in the size and extent of ecosystems, disruption of connections, potential loss of rare or *Threatened* species, loss or degradation of originally rare ecosystems, cumulative loss, and damage to ecological mosaics or sequences. These effects are discussed.

2.5.2.1 Fragmentation, reduction in size and extent of ecosystems

In Sector 1, construction will avoid adverse effects on the wetland in Hopua Crater (SEA-T-6103). There will be adverse effects from the loss of mangroves and glasswort saltmeadow through construction of the coastal embankment in Sectors 1 and 2.

In Sector 2, construction of the coastal embankment at Pikes Point will result in the loss of lava shrubland ecosystems closest to the coastal edge. A boardwalk for the coastal walkway and cycleway will be cantilevered off the embankment and across the lava flow at Pikes Point. This elevated structure will shade mangroves and lava under the structure. The remaining mangroves and lava shrublands associated with these lava flows will be avoided. There will be substantial earthworks and loss of intertidal habitat along the existing coastal edge and the ecological effects of this are discussed in more detail in the marine and avifauna chapters of this report.

In Sector 3, construction of viaduct piles and construction staging through Anns Creek will result in loss in extent and fragmentation of the mosaic of vegetation communities (lava shrubland, saltmarsh and freshwater wetland) within Anns Creek. The construction yard in the eastern end of Anns Creek will have additional effects and result in loss of the majority of the freshwater wetland and the gradient in the upper reaches from saltmarsh to freshwater. Avoiding this area would reduce the overall adverse effects and loss of habitats in Anns Creek.

Construction of a viaduct over Anns Creek Estuary in Mangere Inlet will cross the mangroves in this portion of Anns Creek. This will fragment this area of mangroves. It is recommended that construction of the viaduct piers avoids the lava shrublands on the coastal edge.

In Sector 5 there may be minor loss of mangroves in Otahuhu Creek. There will be significant benefits to the creek from removal of the box culverts and replacement with a bridge.

2.5.2.2 Fragmentation, disruption of ecological connections, loss or damage to ecological mosaics and sequences

Construction of the Anns Creek viaducts and the construction yard in Anns Creek East will result in adverse effects on lava shrubland, mangrove, saltmarsh and freshwater wetland communities, and fragmentation and disturbance of the ecological sequences and connections and the mosaic of habitats in Anns Creek East.

2.5.2.3 Changes resulting in increase in pests

There are significant weed issues throughout many parts of the project area. Control of moth plant is being undertaken by Auckland Council along the coastal foreshore and there has been restoration planting undertaken on the edges of Anns Creek East within the TR Group land. However there are a number of weed species including moth plant, pampas, smilax, gorse and wattle that are common along the edges of the coastal foreshore, the lava flows and edges of Anns Creek. Further disturbance in this area will result in the spread of weeds. There is a significant opportunity to undertake ecological restoration and rehabilitation through weed control and ongoing maintenance in Anns Creek, Mangere Inlet and in the remaining lava flows along the coastal foreshore.

2.5.2.4 Loss of rare, *Threatened* species, population, habitat

The position of the viaduct stucture through Anns Creek has been designed to minimise effects on the lava shrublands dominated by native species in Anns Creek East and Anns Creek Estuary. The location has been designed to concentrate effects on the degraded edges dominated by weed species and native plantings. Construction of the viaduct through Anns Creek East however will adversely affect at least 1,600m^2 of lava shrubland habitat, and the footprint extends into the lava flows that provide habitat for native shrubs such as akeake, *Coprosma crassifolia* and *Threatened* herb and fern species. Construction will result in loss of lava shrubland ecosystems.

2.5.2.5 Loss or degradation of originally rare ecosystems

The lava shrublands in Anns Creek and in Mangere Inlet are considered to be an originally rare/naturally uncommon ecosystem type (Williams *et al.* 2007). Construction of the Anns Creek viaduct will result in a reduction in the extent of lava shrublands in Anns Creek through location of piers and construction staging. Approximately 16% of the area of the higher quality lava shrublands in Anns Creek will be adversely affected by the footprint of the alignment. The location of the viaduct has been designed to avoid and minimise adverse effects on the lava flows characterised by native shrubs, including akeake, *Coprosma crassifolia* and *Astelia banksii* and to be located within the degraded areas dominated by weed species and recent plantings. Construction however will result in loss of lava shrubland ecosystems.

2.5.2.6 Cumulative loss or degradation of ecosystems

Construction through Anns Creek Estuary and Anns Creek East will result in cumulative loss and degradation of lava shrubland, mangrove, saltmarsh and freshwater habitats. This adds to the effects of past reclamation and development in Anns Creek.

2.5.2.7 Modification of the viability or value of indigenous vegetation or habitats

Construction through Anns Creek will damage ecological communities and modify the value and viability of the mosaic of ecosystem types in Anns Creek. Construction will open up areas to weed invasion. Shading from the viaduct structure will impact on shrubland ecosystems adapted to high light conditions. There are a significant number of weed species on the edges of the lava flows in Anns Creek and these have the potential to spread. There is opportunity for restoration and better conservation management in the area if it was provided permanent protection as a reserve or covenant, and an ongoing conservation management programme.

2.5.3 Herpetofauna ecology

The following potential construction and operational phase effects (both direct and indirect) were considered for this assessment:

- Direct loss of lizard habitat within the project area;
- Displacement to unsuitable surrounding habitat; and
- Lizard mortality during vegetation clearance and site works.

These potential effects may affect native lizard species that may be present, but were not observed during the survey. As described above, lizard survey methods have poor detection rates, and combined with the short survey duration, it is possible that additional species are present within the works area but were not detected. Vegetation and habitats within the alignment could support a range of lizard species, including copper and ornate skink. In the absence of sufficient survey data, this assessment has taken a precautionary approach based on the potential native lizard fauna (copper skink (*Not Threatened*) and ornate skink (*At Risk*)). Further lizard surveys will be carried out in 2016-2017 to inform this assessment.

2.5.3.1 Loss of habitat within the project area

Project works may result in direct habitat loss for lizards within the road footprint and temporary occupation areas such as spoil sites, accessways and laydown areas. Construction will result in loss of plantings and other vegetation and potential habitats including Gloucester Park South, along the Manukau Foreshore Walkway, in Miami Parade Reserve, in the abandoned lot next to Southdown Reserve, within Anns Creek and at the end of Captain Springs Road. Additional areas may be included in the final design and should be assessed when these are known. Potential habitats outside of the known footprint include Southdown Reserve and Mutukaroa-Hamlins Hill.

2.5.3.2 Displacement into unsuitable surrounding habitat

Project works may also result in displacement of disturbed lizards into unsuitable or occupied surrounding habitat. Displacement may expose lizards to increased competition for refuge habitats and increased exposure to predators. We assume that existing lizard population size is limited by predation pressure and availability of suitable refuges and food. As such, displacement of lizards into surrounding habitat, if present, may have an adverse population-level effect where lizards are unable to survive or breed.

2.5.3.3 Lizard mortality and injury

Lizard fauna are mobile over short distances, but may not be able to escape during site preparation and construction, particularly if carried out during colder months when lizards are less active. Activities that may impact lizards include vegetation clearance and earthworks. Lizard mortality and injury will be avoided as much as practicable by salvaging lizards during vegetation clearance.

2.6 Assessment of Potential Adverse Terrestrial Ecological Effects

2.6.1 Terrestrial ecology

There are significant terrestrial ecological values identified within Anns Creek and Mangere Inlet which will be adversely affected by the alignment. The magnitude and level of effects are assessed in Table 2-9, based on EIANZ (2015) guidelines.

Table 2-9: Potential Adverse Effects on Significant Ecological Areas in East West Link Corridor (without mitigation)

Site Name	Vegetation Types	Potential Effects	Existing SEA or ONF in PAUP or SES in District Plan	Overall Value	Magnitude of Effect	Level of Effect
Anns Creek East	Lava Shrubland, Marsh clubrush reedland, tall fescue grassland, mangroves, saltmarsh herbfield, raupo reedland	Fragmentation and reduction in size of lava shrubland, mangroves, saltmarsh through construction of viaduct piers and access staging; Loss of threatened plant habitat; Loss or degradation of naturally uncommon lava shrubland ecosystem; Cumulative loss; Increased weeds	SEA_T_5309 ONF192	Very High	High	Very High
Anns Creek West (south of Mighty River Power Co-Generation Plant)	Mangroves, saltmarsh ribbonwood	Effects avoided through alignment on northern side.	H13-21 ONF192	High	Negligible	Low
Anns Creek Estuary (Mangere Inlet)	Lava shrubland, mangrove	Adverse effects on lava shrubland, loss of mangroves, through construction of viaduct piers and access staging; Potential loss of threatened plant habitat; Potential loss or degradation of naturally uncommon lava shrubland ecosystem; Cumulative loss; Increased weeds.	SEA_T_5304 SEA_M1_21 SEA_Mw1 ONF192	Very High	High	Very High
Lava flow Pikes Point	Lava shrubland, mangroves	Fragmentation and reduction of lava shrublands and mangroves close to coast. Boardwalk cantilevered across lava flow. Avoidance of outer mangroves and lava shrublands.	SEA_T_9022 H13-23	High	High	Very High
Lava Flows (at Waikaraka Cemetary and west)	Lava shrubland, mangroves	Loss of naturally uncommon ecosystem type that is threatened.		Moderate	High	Moderate
Lava flow (Victoria St)	Mangroves	Reduction in size of mangrove ecosystems associated with lava flow.		Moderate	High	Moderate
Saltmarsh at Mangere Bridge	Glasswort herbfield, mangroves	Loss of mangroves and glasswort herbfield.		Moderate	High	Moderate

Site Name	Vegetation Types	Potential Effects	Existing SEA or ONF in PAUP or SES in District Plan	Overall Value	Magnitude of Effect	Level of Effect
Hopua Crater	Glasswort-sea rush-oioi rushland	Avoided.	SEA_T_6103	Moderate	Negligible	Very Low
Southdown Reserve	Planted and native shrubland, Mangroves, oioi saltmarsh	Avoided.	SEA_T_6104	Moderate	Avoided	Avoided
Anns Creek Reserve	Freshwater wetland	Avoided.	SEA_T_5308 H13-25	High	Avoided	Avoided
Otahuhu Creek	Mangroves	Relacement of culverts with bridge.		Moderate	Low	Low

2.6.2 Herpetofauna ecology

The assessment of ecological effects on lizards considered both the magnitude of ecological effects and the value of ecological features affected. Assessment of effects in specific locations is not possible at this stage because of insufficient information about lizard presence and/or distribution and final construction footprints (i.e., delineation of vegetation clearance boundaries).

A summary of potential ecological effects without mitigation (i.e., lizard salvage) is provided in Table 2-10. We recommend that a further surveys are carried out prior to construction based on the final development footprint and a lizard management plan is developed. A lizard management plan will describe management actions to minimise and mitigate the adverse effects identified in Table 2-10.

Table 2-10: Assessment of ecological effects on lizards (if present) (without mitigation).

Potential Effect	Threat class	Ecological Value	Magnitude of Effect	Level of Effect
ADVERSE EFFECTS				
Injury/death	*Not Threatened* *At Risk*	Moderate High	Very high Very high	Very High* Very High*
Habitat loss/displacement	*Not Threatened* *At Risk*	Moderate High	High High	Moderate Very High
Habitat fragmentation	*Not Threatened* *At Risk*	Moderate High	Moderate Moderate	Low High
POSITIVE EFFECTS				
Habitat enhancement	n/a	Moderate	Low	Low
Habitat creation	n/a	Moderate	Moderate	Low

Note: **Lizard injury and death will be avoided as much as possible by lizard salvage during vegetation clearance. It is unlikely that it will be possible to capture all lizards, but the 'very high' level of effect identified in this table will be avoided in the first instance.*

EIANZ guidelines state that very high, high and moderate levels of effect require avoidance or mitigation, whereas low and very low levels of effect are normally not of concern, but design, construction and operational care should be taken to minimise adverse effects.

Level of effect for all potential effects identified in Table 2-10 were assessed at a local population level. Injury and death were assessed as a 'very high' level of effect for the local population because lizards in urban areas typically have isolated populations and large scale vegetation clearance can severely impact a small population. Habitat loss and displacement were assessed as 'moderate' and 'very high' level effects for *Not Threatened* and *At Risk* species, respectively. Habitat loss and displacement, depending on scale, may cause a small population to become non-viable or to disperse resulting in reduced breeding potential and increased exposure to predators. Habitat fragmentation can have similar effects on smaller scale, and was assessed as 'low' or 'high' level impact for *Not Threatened* and *At Risk* species, respectively.

2.7 Recommendations

The key principles recommended during the design phase to date to minimise the effects on terrestrial and herpetofauna ecological values included:

- Minimising fragmentation and loss of significant vegetation species and ecosystems including Hopua Crater saltmarsh, Anns Creek East, Anns Creek Estuary and lava shrublands at Pikes Point, Waikaraka Cemetery and Victoria Street.
- Design of bridge structure placement in Anns Creek East to avoid sensitive areas and prevent modification to the viability of this vegetation mosaic.
- Minimise loss and disturbance to high and moderate quality lizard habitats.
- Identify opportunities to incorporate lizard habitat creation in landscape design.

2.7.1 Terrestrial ecology

2.7.1.1 Sector 1

The existing saltmarsh wetland in Hopua Crater (Gloucester Park South) should be enhanced through weed control and buffer planting of appropriate native species (e.g. harakeke, manuka, taupata, ti kouka) around the edges. Landscaping proposed here could enhance and expand the existing wetland vegetation (e.g. through planting of oioi, sea rush, glasswort, salt marsh ribbonwood).

The wetland in Hopua Crater recieves saltwater influence from groundwater. There is an opportunity to enhance and increase the area of wetland in the crater through restoration and replanting of saltmarsh. Re-opening of the crater to the sea may be an option that can be further explored.

The loss of glasswort saltmeadow to the east of SH20 bridge should be mitigated by restoration of saltmarsh habitat elsewhere along the coastal foreshore.

2.7.1.2 Sector 2

Adverse effects on the lava flow vegetation should be avoided and minimised through avoiding construction effects in sensitive areas. The remaining basalt lava flows and lava shrubland habitats at Pikes Point and Victoria St should be protected and enhanced through weed control.

Rehabilitation of lava shrubland species should be undertaken through planting on the new coastal edge, using eco-sourced local genetic stock e.g. *Coprosma crassifolia*, ngaio, akeake, saltmarsh ribbonwood, oioi, *Austrostipa stipoides*, *Puccinellia stricta* (salt grass). Planting of *Threatened* coastal species such as *Mimulus repens* could be undertaken. Revegetation and planting can be guided by the species recorded in Anns Creek by Gardner (1992).

There is significant opportunity for planting and restoration of coastal plant species to be undertaken as part of the stormwater wetlands and landscape planting along the coastal foreshore edge and on islands.

Salvage and relocation of remnant basalt lava flow features and rocks and associated native plants, which will be destroyed as part of reclamation, should be investigated. These could be re-used as part of the re-creation of the coastal foreshore.

2.7.1.3 Sector 3 – Mangere Inlet and Anns Creek East

Construction effects should be minimised and avoided within the lava flow shrublands and saltmarsh habitats in Anns Creek. Construction of the Anns Creek East viaduct should be located as close as possible to the degraded northern edges of the lava flow in Anns Creek East. The location of bridge piers should be avoided in sensitive lava shrubland vegetation.

Protection and enhancement of threatened plant communities (lava shrublands) in Anns Creek should be undertaken through weed control and a conservation management plan.

Relocation of the construction yard away from Anns Creek East is recommended.

Provide for legal protection as a reserve or covenant for Anns Creek East and an ongoing conservation management plan for the area.

2.7.1.4 Sector 5

There are significant opportunities for restoration of coastal ecosystems in Otahuhu Creek through declamation and restoration of fringing saltmarsh and riparian vegetation.

2.7.2 Herpetofauna ecology

We acknowledge that the lizard survey undertaken as part of this project was limited by seasonal constraints and was insufficient to assess lizard presence and distribution. As such, we recommend that further lizard surveys are undertaken in high and moderate quality lizard habitats within the confirmed project footprint in 2016-2017.

In order to avoid potential effects of the project on lizard fauna, we recommend that a lizard management plan is prepared to guide vegetation clearance works and identify key habitat areas where lizards can be salvaged prior to, or during clearance. The objective of lizard management is to maintain or enhance the population of lizards present within the site by capturing and relocating lizards to a purposely designed safe habitat. We note that if present, it is unlikely that all native lizards within the project footprint will be salvaged, however, implementation of a lizard management plan will reduce these unavoidable effects to an acceptable level.

In order to mitigate the potential effects of the EWL project on the potential lizard values present, we recommend that the following should be included in the suite of actions within the proposed mitigation (Chapter 6 of this report):

- Identify opportunities to create, enhance and connect lizard habitats within the project area. Habitat enhancement includes the provision of habitat elements (logs and natural debris) and pest control if deemed appropriate; and
- Create a site for lizards to be released within wider project areas that is planted with species that provide lizard refuge and food. This site must be sufficient to support a viable population of native lizards for all species present before development. Potential sites include Mutukaroa-Hamlins Hill and Southdown Reserve.

2.8 Conclusion

The most significant terrestrial ecology effects of construction will be through impacts on the remnants of lava flow vegetation at Pikes Point, along the coastal edge of Mangere Inlet, and the loss of threatened ecosystems in Anns Creek. Anns Creek East contains the highest diversity of habitat types, with a mosaic and ecological sequence of shrubland, mangrove and saltmarsh habitat, and sequences with freshwater.

The Anns Creek Viaducts have been positioned to minimise effects on areas of lava shrubland ecosystems with unique combinations of native plant species, and to position the project footprint within the more degraded areas on the northern side. However there will still be significant adverse ecological effects on lava shrubland, freshwater wetland and saline ecosystems.

The placement of a construction yard in the eastern end of Anns Creek will result in direct loss of freshwater and saline ecosystems. The combination of effects in the western and eastern arms of Anns Creek will lead to cumulative effects.

The mosaic of lava shrubland, freshwater wetland and saline ecosystems in Anns Creek are unique and irreplaceable and therefore difficult to mitigate for and offset. Providing legal protection and an ongoing conservation management plan for Anns Creek East would contribute towards providing a better long-term outcome for Anns Creek.

The majority of the site provides poor quality lizard habitat, although there are some areas of moderate and high quality lizard habitat in terrestrial reserves near the Mangere inlet and Anns Creek. Effects of the project on lizard fauna are not fully understood at this stage because of lizard surveys were limited by seasonal constraints. If present, potential impacts on native lizards include injury/death, habitat loss and displacement and habitat fragmentation.

Further surveys should be carried out to identify key areas and inform a lizard management plan (based on the final design and vegetation clearance boundaries). If further surveys confirm lizards are present, adverse effects can be avoided by salvage and relocation of lizards to a safe site. Lizard habitat creation, enhancement and connection should be incorporated into the landscape design.

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Appendix A

Terrestrial Ecology Site Photos

Sector 3 - Anns Creek East, mosaic of mangrove saltmarsh and lava shrubland.

Sector 3 – Anns Creek East, lava shrubland with *Astelia banksii,* akeake, pohuehue and *Coprosma crassifolia.*

Sector 3 – Anns Creek East, lava shrubland with akeake, Geranium and fern species on lava flow

Sector 3 – Anns Creek West, saltmarsh ribbonwood on lava.

Sector 3 - Anns Creek Estuary, ngaio and saltmarsh species on lava flow beside coastal walkway.

Sector 3 – Anns Creek Estuary, lava shrubland on pahoehoe lava by walkway.

Sector 2 - Mangroves on lava at Pikes Point.

Sector 2 - Plantings beside coastal walkway looking east.

Sector 2 – Waikaraka Cemetery, grove of pohutukawa looking east.

Sector 2 - Waikaraka Cemetery, small lava flow.

Sector 1 – Hopua Crater, glasswort herbfield and sea rush wetland.

Sector 1 – East of Mangere Bridge, mangroves and saltmarsh.

Sector 5 - Otahuhu Creek, eastern side looking south.

Appendix B

Vascular Plant Species Lists

Sector 1: Hopua Crater Wetland and Plantings - Indigenous Species

Scientific Name	Maori/Common Name
Monocotyledons	
Apodasmia similis	oioi
*Cordyline australis**[15]	ti kouka, cabbage tree
Cyperus ustulatus	giant umbrella sedge
Juncus krausii subsp.*australiensis*	sea rush
*Phormium tenax**	harakeke
Dicotyledons	
Avicennia marina var. *australasica*	manawa
*Coprosma repens**	taupata
*Coprosma robusta**	karamu
Cotula coronopifolia	bachelor's button
*Leptospermum scoparium**	manuka
*Metrosideros excelsa**	pohutukawa
*Pseudopanax crassifolium**	karo
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort

Sector 1: Hopua Crater Wetland and Plantings - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Carex divisa	Carex
Cortaderia selloana	pampas
Holcus lanatus	Yorkshire fog
Pennisetum clandestinum	kikuyu
Schedonorous arundinaceus	tall fescue
Dicotyledons	
*Acacia melanoxylon**	blackwood
Atriplex prostrata	orache
Myoporum aff. *insulare**	Tasmanian ngaio
Plantago coronopus	buck's horn plantain
Ranunculus repens	buttercup
Senecio bipinnatisectus	Australian fireweed
Solanum mauritianum	woolly nightshade

[15] * planted

Scientific Name	Maori/Common Name
Solanum nigra	black nightshade

Sector 1: Foreshore East of Mangere Bridge - Indigenous Species

Scientific Name	Maori/Common Name
Monocotyledons	
Austrostipa stipoides	buggar grass
Dicotyledons	
Avicennia marina var. *australasica*	manawa
*Metrosideros excelsa**	pohutukawa
Muehlenbeckia complexa	pohuehue
*Pseudopanax crassifolium**	karo
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort

Sector 1: Foreshore East of Mangere Bridge - Exotic Species:

Scientific Name	Maori/Common Name
Monocotyledons	
Cortaderia selloana	pampas
Hedychium gardnerianum	wild ginger
Paspalum dilitatum	paspalum
Pennisetum clandestinum	kikuyu
Dicotyledons	
Atriplex prostrata	orache
Citrullus lanatus	watermelon
Foeniculum vulgare	fennel
Ipomoea indica	blue morning glory
Tropaeolum majus	nasturtium
Paraserianthes lophantha	brush wattle
Solanum mauritianum	woolly nightshade

Sector 2: Foreshore Cemetery and West - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Asplenium flaccidum	hanging spleenwort
Microsorum pustulatum subsp. *pustulatum*	hounds tongue
Pyrrosia eleagnifolia	leather-leaf fern
Monocotyledons	

Scientific Name	Maori/Common Name
Apodasmia similis	oioi
Austrostipa stipoides	buggar grass
*Cordyline australis**	ti kouka, cabbage tree
*Phormium tenax**	harakekeke

Sector 2: Foreshore Cemetery and West - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Cortaderia selloana	pampas
Paspalum vaginatum	saltwater paspalum
Pennisetum clandestinum	kikuyu
Schedonorous arundinaceus	tall fescue
Dicotyledons	
Allocasuarinus littoralis	black sheoak
Araujia hortorum	moth plant
Asparagus asparagoides	smilax
Atriplex prostrata	orache
Ipomoea indica	blue morning glory
Oxalis sp.	Oxalis
Paraserianthes lophantha	brush wattle
Plantago coronoplus	buck's horn plantain
Solanum mauritianum	woolly nightshade
Taraxacum officianale agg	dandelion

Sector 2: Foreshore East of Cemetery and Pikes Point - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Microsorum pustulatum subsp. *pustulatum*	hounds tongue
Monocotyledons	
Austrostipa stipoides	buggar Grass
*Phormium tenax**	harakeke
Dicotyledons	
Avicennia marina var. *australasica*	manawa
*Coprosma repens**	taupata
*Corynocarpus laevigatus**	karaka
Geranium homeanum	
Geranium solanderi	
*Melicytus ramiflorus**	mahoe
*Metrosideros excelsa**	pohutukawa
Muehlenbeckia complexa	pohuehue
Myoporum laetum	ngaio
*Pseudopanax crassifolia**	karo
Samolus repens var. *repens*	sea primrose
*Vitex lucens**	puriri

Sector 2: Foreshore East of Cemetery and Pikes Point - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Agrostis capillaris	brown top
Cortaderia selloana	pampas
Schedonorous arundinaceus	tall fescue
Dicotyledons	
*Acacia melanoxylon**	blackwood
Araujia hortorum	moth plant
Asparagus asparagoides	smilax
Genista monspessulana	Montpellier broom
Ipomoea indica	blue morning glory
Lagunaria patersonia subsp. *patersonia**	Norfolk Island hibiscus
Paraserianthes lophantha	brush wattle
Plantago coronopus	buck's horn plantain
Senecio angulatus	Cape ivy
Solanum mauritianum	woolly nightshade
Solanum nigrum	black nightshade

Sector 3: Anns Creek Estuary - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Microsorum pustulatum subsp. *pustulatum*	hound's tongue fern
Pyrrosia eleagnifolia	leather-leaf fern
Monocotyledons	
Apodasmia similis	oioi
Austrostipa stipoides	buggar grass
*Cordyline australis**	ti kouka, cabbage tree
Ficinia nodosa	knobby clubrush
Juncus krausii subsp.*australiensis*	sea rush
Microlaena stipoides	meadow rice grass
Phormium tenax	harakeke
Puccinellia stricta	saltgrass
Dicotyledons	
Avicennia marina var. *australasica*	manawa
Coprosma crassifolia	
Coprosma lucida	shining karamu
Coprosma macrocarpa	large-seeded coprosma
*Coprosma repens**	taupata
*Coprosma robusta**	karamu
Geranium homeanum	
Geranium solanderi	
*Hebe stricta**	koromiko

Scientific Name	Maori/Common Name
*Hoheria populnea**	houhere
*Metrosideros excelsa**	pohutukawa
Muehlenbeckia complexa	pohuehue
Myoporum laetum	ngaio
*Myrsine australis**	mapou
Nestegis lanceolata	white maire
*Olearia solandri**	coastal tree daisy
Oxalis rubens	dune oxalis
Plagianthus divaricatus	saltmarsh ribbonwood
*Pseudopanax crassifolium**	karo
Samolus repens var. *repens*	sea primrose
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort
Selliera radicans	remuremu

Sector 3: Anns Creek Estuary- Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Agrostis stolonifera	creeping bent
Arundo donax	giant reed
Asparagus asparagoides	climbing asparagus
Carex divisa	
Cortaderia selloana	pampas
Holcus lanatus	Yorkshire fog
Paspalum dilatatum	paspalum
Schedonorous arundinaceus	tall fescue
Dicotyledons	
*Acacia longifolia**	Sydney golden wattle
*Acacia mearnsii**	black wattle
Araujia hortorum	moth plant
Foeniculum vulgare	fennel
Geranium robertianum	herb Robert
Ipomoea indica	blue morning glory
*Paraserianthes lophantha**	brush wattle
Plantago coronopus	buck's horn plantain
Rumex sagittatus	climbing dock
Rubus fruiticosus agg	blackberry
Senecio angulatus	cape ivy
Solanum mauritianum	woolly nightshade
Solanum nigrum	black nightshade
Tradescantia fluminensis	
Ulex europaeus	gorse

Sector 3: Anns Creek West - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Pellaea rotundifolia	round-leaved fern
Pteris tremula	Australian bracken
Pyrrosia eleagnifolia	leather-leaf fern
Monocotyledons	
Apodasmia similis	oioi
Austrostipa stipoides	buggar grass
Cyperus ustulatus	giant umbrella sedge
Ficinia nodosa	knobby clubrush
Phormium tenax	harakeke
Dicotyledons	
Avicennia marina var. *australasica*	manawa
Coprosma robusta	karamu
Muehlenbeckia complexa	pohuehue
Plagianthus divaricatus	saltmarsh ribbonwood
Pseudopanax crassifolium	karo
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort
Selliera radicans	remuremu

Sector 3: Anns Creek West - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Cortaderia selloana	pampas
Crocosmia x crocosmiiflora	montbretia
Schedonorous arundinaceus	tall fescue
Dicotyledons	
Araujia hortorum	moth plant
Asparagus asparagoides	smilax
Atriplex prostrata	orache
Craetaegus monogyna	hawthorn
Foeniculum vulgare	fennel
Galium aparine	cleavers
Ipomoea indica	blue morning glory
Paraserianthes lophantha	brush wattle
Plantago coronopus	buck's horn plantain
Rosa rubiginosa	briar
Rubus fruiticosus agg	blackberry
Senecio angulatus	Cape ivy
Solanum mauritianum	woolly nightshade
Solanum nigrum	black nightshade
Ulex europaeus	gorse

Scientific Name	Maori/Common Name
Verbena bonariensis	purple top vervain

Sector 3: Anns Creek East - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Asplenium flabellifolium	necklace fern
Asplenium flaccidum	hanging spleenwort
Cheilanthes distans	woolly rock fern
Microsorum pustulatum subsp. *pustulatum*	hounds tongue
Pellaea falcata	sickle fern
Pellaea rotundifolia	round-leaved fern
Pteridium esculentum	bracken
Pyrrosia eleagnifolia	leather-leaf fern
Monocotyledons	
Apodasmia similis	oioi
Astelia banksii	coastal astelia
Austrostipa stipoides	buggar grass
Bolboschoenus fluviatilis	marsh clubrush
Carex flagellifera	Glen Murray tussock
Cyperus ustulatus	giant umbrella sedge
Ficinia nodosa	knobby clubrush
Juncus krausii subsp. *australiensis*	sea rush
Microlaena stipoides	slender rice grass
Triglochin striata	triglochin
Typha orientalis	raupo
Dicotyledons	
Acaena novae-zelandiae	piripiri
Avicennia marina var. *australasica*	manawa
Coprosma crassifolia	
Coprosma propinqua var. *propinqua*	mingimingi
Coprosma repens	taupata
Coprosma robusta	karamu
Cotula coronopifolia	bachelor's button
Dodonaea viscosa	akeake
Geranium homeanum	
Geranium retrorsum	
Geranium solanderi	
Haloragis erecta subsp. *erecta*	
Melicytus ramiflorus	mahoe
Muehlenbeckia complexa	pohuehue
Myoporum laetum	ngaio
Myrsine australis	mapou
Olearia solandri	coastal tree daisy
Plagianthus divaricatus	saltmarsh ribbonwood
Pseudopanax crassifolium	karo

Scientific Name	Maori/Common Name
Pseudopanax lessonii	houpara
Samolus repens var. *repens*	sea primrose
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort
Selliera radicans	remuremu

Sector 3: Anns Creek East - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Agrostis stolonifera	creeping bent
Allium triquetrum	onion weed
Cortaderia selloana	pampas
Cyperus eragrostis	umbrella sedge
Hedychium gardnerianum	wild ginger
Holcus lanatus	yorkshire fog
Paspalum vaginatum	salt water paspalum
Schedonorous arundinaceus	tall fescue
Spartina anglica	Spartina
Dicotyledons	
Apium nodiflorum	water celery
Alternanthera philoxeroides	alligator weed
Araujia hortorum	moth plant
Asparagus asparagoides	smilax
Atriplex prostrata	orache
Calystegia sylvatica subsp. *disjuncta*	great bindweed
Chrysanthemoides monilifera subsp. *monilifera*	boneseed
Daucus carota	wild carrot
Foeniculum vulgare	fennel
Fumaria bastardii	bastard’s fumitory
Galium aparine	cleavers
Geranium robertianum	herb Robert
Ipomoea indica	blue morning glory
Lantana camara var. *aculeata*	lantana
Ligustrum lucidum	tree privet
Ligustrum sinense	Chinese privet
Lonicera japonica	Japanese honeysuckle
Malva parviflora	small-flowered mallow
Natsutium officianale	watercress
Olea europaea	olive
Paraserianthes lophantha	brush wattle
Persicaria maculosa maculosa	swamp willow weed
Plantago coronopus	buck’s horn plantain
Phytolacca octandra	inkweed
Ranunculus repens	buttercup
Ranunculus sceleratus	celery-leafed buttercup
Ricinus communis	castor oil plant

Scientific Name	Maori/Common Name
Rubus fruiticosus agg	blackberry
Rumex obtusifolia	broadleaf dock
Salix xfragilis	crack willow
Senecio angulatus	Cape ivy
Senecio bipinnatisectus	Australian fireweed
Senecio skirhodon	gravel groundsel
Solanum mauritianum	woolly nightshade
Solanum nigrum	black nightshade
Stachys arvensis	staggerweed
Tradescantia fluminensis	tradescantia
Trifolium pretense	red clover
Tropaeolum majus	nasturtium
Ulex europeaus	gorse
Verbena bonariensis	purple top vervain
Vicia sativa	vetch

Southdown Reserve - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	
Pyrrosia eleagnifolia	leather-leaf fern
Conifers	
*Podocarpus totara**	totara
Monocotyledon	
Anthoxanthum odoratum	sweet vernal
Apodasmia similis	oioi
Carex flagellifera	Glen Murray tussock
*Cordyline australis**	ti kouka, cabbage tree
Cyperus ustulatus	giant umbrella sedge
*Phormium tenax**	harakeke
Typha orientalis	raupo
Dicotyledons	
Avicennia marina var. *australasica*	manawa
*Coprosma arborea**	mamangi
*Coprosma repens**	taupata
*Coprosma robusta**	karamu
*Corynocarpus laevigatus**	karaka
*Kunzea ericoides**	kanuka
*Melicope ternata**	wharangi
Melicytus ramiflorus	mahoe
*Metrosideros excelsa**	pohutukawa
*Muehlenbeckia complexa**	pohuehue
*Myoporum laetum**	ngaio
Oxalis rubens	dune oxalis
*Piper excelsum**	kawakawa
Piper excelsum subsp. *psittacorum**	coastal kawakawa
*Pittosporum eugenioides**	tarata

Scientific Name	Maori/Common Name
*Pittosporum tenuifolium**	kohuhu
*Pseudopanax arboreus**	whauwhaupaku
*Pseudopanax crassifolium**	karo
*Solanum aviculare**	poroporo
*Vitex lucens**	puriri

Southdown Reserve - Exotic Species

Scientific Name	Maori/Common Name
Conifers	
*Araucaria heterophylla**	Norfolk Island pine
Monocotyledons	
Agrostis stolonifera	creeping bent
Cortaderia selloana	pampas
Cyperus eragrostis	umbrella sedge
Holcus lanatus	Yorkshire fog
Hedychium gardnerianum	wild ginger
Paspalum vaginatum	salt water paspalum
Pennisetum clandestinum	kikuyu
Schedonorous arundinaceus	tall fescue
Dicotyledons	
Ailanthus altisssima	tree of heaven
Araujia hortorum	moth plant
Asparagus asparagoides	smilax
Callistemon citrinus	red bottle brush
Eucalyptus sp.*	gum
Hedera helix subsp. *helix*	English ivy
Ipomoea indica	blue morning flory
Lagunaria patersonia subsp. *patersonia**	Norfolk Island hibiscus
Ligustrum sinense	Chinese privet
Ligustrum lucida	tree privet
*Lycium ferocissimum**	boxthorn
*Magnolia grandiflora**	Southern magnolia
Myoporum aff. *insulare**	Tasmanian ngaio
Persicaria maculosa	swamp willow weed
Paraserianthes lophantha	brush wattle
Ricinus communis	castor oil plant
Rubus fruiticosus agg	blackberry
Senecio angulatus	Cape ivy
Solanum mauritianum	woolly nightshade
Solanum nigrum	black nightshade
Tradescantia fluminensis	wandering Jew

Sector 5: Otahuhu Creek - Indigenous Species

Scientific Name	Maori/Common Name
Ferns	

Scientific Name	Maori/Common Name
Doodia parrisiae	rasp fern
Dicotyledons	
Avicennia marina var. *australasica*	manawa
Coprosma repens	taupata
Coprosma robusta	karamu
Coriaria arborea	tutu
Metrosideros excelsa	pohutukawa
Pseudopanax crassifolium	karo
Sarcocornia quinqueflora subsp. *quinqueflora*	glasswort

Sector 5: Otahuhu Creek - Exotic Species

Scientific Name	Maori/Common Name
Monocotyledons	
Agapanthus praecox subsp. *orientalis*	agapanthus
Phyllostachys sp.	bamboo
Dicotyledons	
Jasminum polyanthum	jasmine
Ligustrum lucidum	tree privet
Ligustrum sinense	Chinese privet
Paraserianthes lophantha	brush wattle
Solanum mauritianum	woolly nightshade
Tradescantia fluminensis	wandering Jew

CHAPTER 3
FRESHWATER

Quality Assurance Statement	
Prepared by	Katherine Muchna
	Eddie Sides
	Dr Ian Boothroyd
Reviewed by	Dr Vaughan Keesing

Disclaimer

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Executive Summary

1. The East-West Link (EWL) project will provide an arterial linkage from SH20 to SH1 from Neilson Street, along the northern side of Mangere Inlet to Mt Wellington. Upgrades to SH1 will include replacing the Otahuhu Creek culverts with a bridge structure.

2. The project crosses several stream catchments along Mangere Inlet (Manukau Harbour), and also tributaries at Clemow Drive and Otahuhu Creek that connect to the Tamaki River.

3. To assess the effects of the project on freshwater environments, ecological values were evaluated at eight sites (Miami Stream, Southdown Stream, Anns Creek East (two sites), Hamlins Hill (two sites), Clemow Stream and Otahuhu Creek) within six catchments. These assessments were undertaken from April to August 2016.

4. Streams at each site were classified as Permanent, Intermittent or Ephemeral using the criteria in the Proposed Auckland Unitary Plan (PAUP). Stream Ecological Valuation (SEV) assessments were undertaken at each site except the Hamlins Hills sites, which were Intermittent Streams and did not contain flowing water. These assessments included quantification of functional attributes and sampling for aquatic macroinvertebrates and fish.

5. The streams had low to moderate values. Extensive piping of upstream catchments was common, resulting in modified hydrology and poor water quality. Most streams had modified ripairan areas and Clemow stream also had a concrete channel. Aquatic biodiversity was generally low. However, the stream mouths at Miami Stream, Southdown, Anns Creek and Otahuhu Portage provided potential inanga spawning habitat.

6. The effects assessed included streamworks (reclamation and culverting) and stormwater discharge. Streamworks will result in loss of a small proportion of stream habitat in the general locality of Mangere Inlet, and the magnitude of effects was low. The discharge of treated stormwater will increase annual contaminant loads but have little effect on sediment or water contaminant concentrations or ecological communities, also having a low magnitude of effect. In areas where treatment is provided to currently untreated runoff from impervious surfaces, concentrations of contaminants discharged to streams will reduce.

7. The overall level of effect in each of the streams was Low or Very Low. Effects will be further reduced by proposed restoration, which is described in Chapter 6 of this report.

8. In conclusion, the effects of the project on freshwater ecological values will be localised and are not signficant. The suite of proposed mitigation and offsetting for ecology provides for enhancement of freshwater systems where appropriate.

3 Chapter 3 - Freshwater

3.1 Introduction

3.1.1 Purpose and scope of this report

This report forms part of a suite of technical reports prepared for the Transport Agency's East West Link project (the EWL or Project). Its purpose is to inform the Assessment of Effect on the Environment Report (AEE) and to support the resource consent applications, new Notice of Requirement and an alteration to existing designations required for the EWL.

This report assesses the effects on freshwater environments of the proposed alignment of the Project as shown on the Project Drawings (Drawing numbers AEE-AL-100-116).

The purpose of this report is to:

b) Identify and describe the existing freshwater environment;

c) Describe the potential freshwater (positive and adverse) effects of the Project;

d) Recommend measures as appropriate to avoid, remedy or mitigate[16] potential adverse freshwater effects (including any conditions/management plan required); and

e) Present an overall conclusion of the level of potential adverse freshwater effects of the Project after recommended measures are implemented.

3.2 Experience

3.2.1 Expertise

The assessment was prepared by Boffa Miskell ecologists Eddie Sides, Katherine Muchna and Dr Ian Boothroyd.

Eddie Sides, Principal, Boffa Miskell

Eddie holds a BSc and an MSc in freshwater ecology from the University of Auckland (1994). Eddie has 20 years' professional experience, specialising in the assessment of effects of human activities on freshwater streams, rivers, and lakes and their biological communities of plants, macroinvertebrates and fishes. Eddie has undertaken freshwater ecological investigations for a wide range of projects including urban subdivisions, mining and quarrying operations, forestry, roading, hydroelectric power, pulp and paper, sewage treatment and stormwater management. This work has taken him too many parts of New Zealand including the Canterbury, Wellington, Wanganui-Manawatu, Bay of Plenty and Waikato regions, as well as throughout the Auckland region.

Eddie has investigated the ecological impacts of nutrient enrichment, contaminant discharges, sedimentation, barriers to fish passage, and stream modification including piping and realignment on stream health and values. He has an interest in stream restoration and rehabilitation and has provided expert advice for stream reconstruction or "daylighting" projects. He plays a key role in advising clients on appropriate measures to avoid or mitigate adverse effects on aquatic ecosystem values.

[16] Including offset where required.

Katherine Muchna, Senior Ecologist, Boffa Miskell

Katherine Muchna has an MSc (Hons) in Environmental Science from the University of Auckland, and has over ten years' experience as a professional ecologist in both technical and consulting roles. Katherine has worked on a diverse range of both terrestrial and freshwater based projects in energy generation, mining, urban development and water resources sectors, including freshwater based projects in local and regional government, mining and farming industries.

Katherine has extensive experience in ecological surveys including catchment-wide monitoring programmes, Integrated Catchment Management Plans, compliance monitoring, and effects assessments within the freshwater environment. Katherine has completed the Auckland Region Stream Ecological Valuation (SEV) training course and is an experienced electric fishing machine operator.

Dr Ian Boothroyd, Senior Principal, Boffa Miskell

Ian has over 25 years' experience in environmental management, monitoring, policy development and assessment, auditing, research and decision-making in the New Zealand environment. He has experienced in assessing and reviewing the environmental effects of small to large developments ranging from energy generation activities, extractive mining, roading, stormwater and sediment effects in urban and peri-urban subdivisions, and the effects of discharge of treated wastewater to water.

Ian has carried out extensive ecological surveys and provided resource management advice to national, regional and local governments, SOEs, private business and community groups. Recently, he has provided advice to several Councils on biodiversity-related matters including biodiversity offsets.

Co-author of several national standards for freshwater and biodiversity management and monitoring in New Zealand. Ian has substantial experience as an expert witness and has appeared at many resource consent hearings and in the Environment Court. He is regularly called upon to provide independent expert testimony and is also an accredited and experienced environmental commissioner.

3.3 Assessment methodology

3.3.1 Strategic approach

Our approach for the assessment of the effects of the EWL on freshwater ecosystems along the route followed the protocols provided in EIANZ Impact Assessment Guidelines (EIANZ 2015). Thus we carried out the following steps in reaching our conclusions:

- Screening – a broad review of the need for, and potential scope of, an ecological assessment; carried out as part of the initial project development;
- Scoping – a preliminary ecological assessment at the early planning stage which forms the basis for selecting those valued ecological resources to be subject to detailed assessment due to potentially serious impacts, and for early identification of impact strategies;
- Detailed investigations – work carried out during the detailed planning and design stages, to identify and describe ecological features of interest within the zone of influence;
- Assessment of actual and potential effects – identification and prediction of potential positive and adverse effects of the activity, and their degree of impact; determining the need for impact avoidance, remedy and mitigation, as well as other management opportunities such as enhancement; and
- Impact management and mitigation – establishing measures needed to avoid, remedy or mitigate adverse effects, and their likely success; then assessment of the residual effects; and

In addition to the assessment steps above, the communication of information to the project team and input to the design process to achieve the best overall project outcome was critical. The approach adopted for the project was an iterative one involving all members and disciplines involved in the project team. Typically held as workshops, this enabled findings from the freshwater assessment to be communicated as it happened and where appropriate the design, route and other engineering features were modified accordingly.

Table 3-1 summarises the tasks and methods for the four phases of the project.

Table 3-1: Summary of four phases of the assessment of effects of the proposed East West Link on freshwater environments, 2016.

Phase	Description	Tasks
1	Preliminary Investigations (screening and scoping)	• Review of plans and maps and identification of freshwater environments and catchments potentially affected by the Project; • Literature review of existing information on freshwater environments in the project area; • Site visit and preliminary assessment for Multi-Criteria Analysis (MCA); • Gap analysis to assess information gaps and further investigations.
2	Assessments of Existing Environment (detailed investigation)	• Stream classification; • SEV assessment of existing freshwater environment values, including: • Collection of benthic aquatic macroinvertebrate samples; • Collection of fish; • Habitat assessments.
3	Design input and mitigation of adverse effects	• Review of project activities; • Input to project design to avoid, remedy or mitigate adverse ecological effects; • Development of specific measures to off-set effects on freshwater.
4	Assessment of Effects (including impact management and mitigation)	• Assessment of adverse and beneficial effects of the project on freshwater ecology values, including stream loss, modification, earthworks sediment, stormwater quality and quantity, and stream enhancement; • Conclusion on overall project effects on freshwater.

3.3.2 Phase 1 Methods - Preliminary Investigations

Literature Review

The literature review included review of aerial photography, Auckland Council GIS layers, New Zealand Freshwater Fish Database (NZFFD) records and published and unpublished reports. We also reviewed Auckland Council State of the Environment (SoE) report card data (Auckland Council, 2014).

Multi-Criteria Analysis (MCA)

Phase 1 also included the MCA assessment process, which involved providing input of the ecological effects identified at project workshops and scoring for MCA analysis as described in Part D: Consideration of Alternatives of the Assessment of Effects Report (Volume 1) and the Report 1: Assessment of Alternatives (Volume 3).

3.3.3 Phase 2 Methods – Detailed Investigations

3.3.3.1 Freshwater Site Locations

The site locations and investigations undertaken are listed in Table 3-2 and sites are shown in Map 3-1. Assessments of ecological values were made at eight sites within six catchments during April to August 2016. With the exception of Hamlins Hill, at each site a stream classification was undertaken, SEV measurements taken, and sampling for aquatic macroinvertebrates and fish was completed. SEV assessments were not carried at Hamlin Hill because it is a remnant intermittent stream in the headwaters of Anns Creek catchment and contained no surface water[17].

Table 3-2: Freshwater survey sites and assessment type for East West Link, 2016.

Site	Name	Project sector	Classification undertaken	SEV undertaken	SEV survey date
1	Miami Stream	2	Yes	Yes	31 May 2016
2	Southdown Stream	3	Yes	Yes	15 June 2016
3a	Anns Creek East (north)	3	Yes	Yes	19 July 2016
3b	Anns Creek East (south)	3	Yes	Yes	19 July 2016
4	Hamlins Hill west	4	Yes	No	14 April 2016*
5	Hamlins Hill east	4	Yes	No	14 April 2016*
6	Clemow Drive	4	Yes	Yes	23 May 2016
7	Otahuhu Creek portage	5	Yes	Yes	2 August 2016

*site inspection date, no SEV

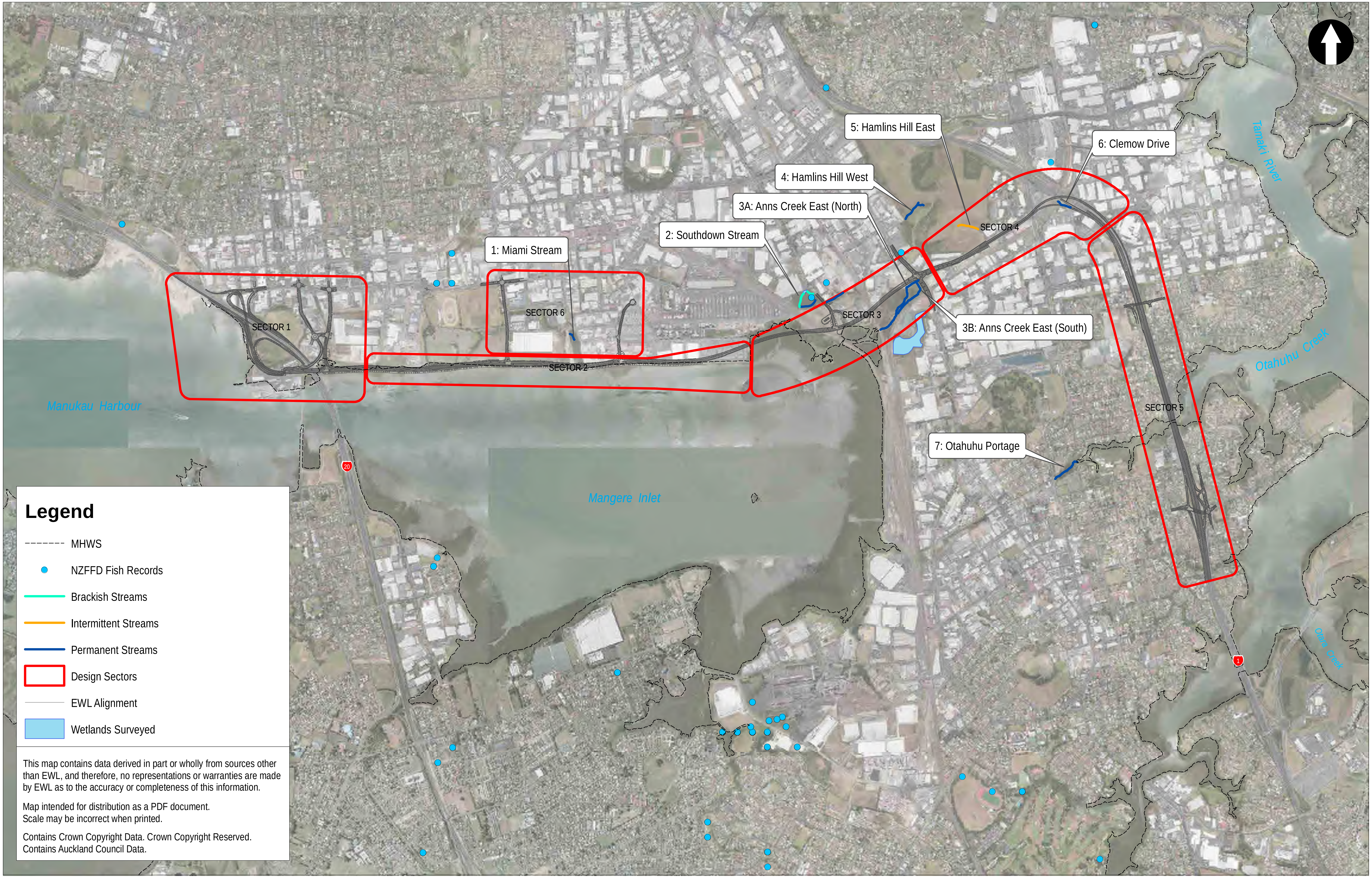
3.3.3.2 Stream Classification

Streams within, and adjacent to the Project area were assessed during a site reconnaissance and stream reaches were classified as Permanent, Intermittent or Ephemeral using the PAUP criteria. The location of streams and their classification in shown in Map 3-1.

3.3.3.3 Stream Ecological Valuation

Stream Ecological Valuation (SEV) assessments were undertaken at all Permanent Stream sites. The SEV provides a comprehensive method for assessing the ecological function of aquatic ecosystems (Storey et al., 2011). The SEV is the accepted method for assessing the ecological function of streams in Auckland and has been successfully applied in other areas of New Zealand. It uses a range of qualitative and quantitative variables to assess the ecological functions of streams (Table 3-3), including both the in-stream and riparian environment. The methodology includes a fish survey, aquatic macroinvertebrate sampling, cross-sections to record habitat characteristics such as depth and substrate, and qualitative assessment of attributes such as channel modification and riparian vegetation class. This data is analysed using a series of formulae in order to produce an SEV score of between 0 (a stream with the minimum ecological valuation) and 1 (a stream with the maximum ecological valuation). Different weightings are given to the different collections of attributes. Interpretation of SEV scores is given in Table 3-4. The SEV is a preferred tool of Auckland Council for comparing ecological function across a number of streams, and can be used for the development of ecological compensation ratios (ECR). The SEV can also be a significant component of assessment of ecological values, with higher SEV contributing to higher ranking of ecological values.

[17] Native amphibians, such as Hochstetters frogs, are not known to inhabit lowland streams and were therefore not included in the freshwater field surveys.



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Map intended for distribution as a PDF document.
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A	ISSUED FOR INFORMATION ONLY	BAP	AYF	SDL	5/09/2016

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NZ TRANSPORT AGENCY
East West Link

Drawn	Drafting Check	Reviewed Design Manager	Approved Alliance Manager
Designed	Design Check		

Scale: 1:22,500
Original Size: A3
Contract No PA4041

Drawing Title
ECOLOGY
Map 3-1 : Freshwater survey sites and fish records.

Drawing Number GIS-AEE-EC-FR-002
Rev No. A

Plot Date: 27/10/2016 Plotted by: Ben Peyton File: W:\CAD\ArcGIS\TGI\55_Workspaces\01_mxd\Environmental\WORKING\BoffaMiskell\GIS-EC-AEE-FR-002_T16006_19_FreshWater_Map2_FreshwaterSurveySites_FishRecordsRev3.mxd

Table 3-3: Summary of the ecological functions used to calculate the SEV score

SEV function	Explanation
Hydraulic functions	Processes associated with water storage, movement and transport.
Biogeochemical functions	Relates to the processing of minerals, particulates and water chemistry.
Habitat provision functions	The types, amount and quality of habitats that the stream reach provides for flora and fauna
Biodiversity functions	The occurrences of diverse populations of native plants and animals that would normally be associated with the stream reach

Table 3-4: Interpretation of SEV scores (adopted from Golder Associates, 2009)

Score	Category
0 – 0.4	Poor
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 +	Excellent

3.3.3.4 Aquatic macroinvertebrates

Macroinvertebrate communities were sampled using protocol C2 (soft-bottomed semi-quantitative; Stark et al. 2001). This was used in preference to the hard-bottom method here in order to collect a comprehensive sample of the taxa across a range of habitat units. A composite sample comprised of ten sample units was collected from structural habitat features at each site including woody debris, root mats, woody debris, and stony substrates over a 40-60 m length of stream at each site. Structural habitat features were sampled in proportion to their occurrence at each site. A number of aquatic indicators were derived from the aquatic macroinvertebrate data including Macroinvertebrate Community Index (MCI), Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT), and the proportional composition of the overall benthic invertebrate community.

3.3.3.5 Fish communities

Fish communities were sampled using single-pass electrofishing with an EFM300 backpack electrofishing machine over a 40- 60 m length of stream, following the method of Joy et al. (2013). Captured fish were identified, measured and returned to the stream. The Fish Index of Biotic Integrity (Fish IBI; Joy and Henderson, 2004), which is also a component of the SEV, was a metric used in the assessment of fish community values. Fish communities in Miami Stream were surveyed using fyke and gee-minnow traps because electrofishing machine cannot be used in estuarine environments.

3.3.4 Phase 3 Methods – Design Input and Mitigation of Adverse Effects

This phase involved collaboration between projects ecologists, planners and engineers to reduce the adverse effects of the project. This phase did not involve any specific technical methods for freshwater. Phase 3 included reviews of project activities and learnings from assessments carried out by other discipline areas (e.g., hydrology), and involved the provision of advice to project engineers on design opportunities to avoid, minimise or mitigate effects. Phase 4 Methods - Assessment of Effects.

3.3.4.1 Aquatic ecological values

The EIANZ 2015 guidelines provide a method for assigning value to habitats for the purposes of assessing actual and potential effects of activities (EIANZ 2015). This method involves classifying stream values and magnitude of effects using the criteria presented in Table 3-5 and Table 3-6 (respectively), and then using the risk matrix in Table 3-7 to determine the level of effects.

Table 3-5: Criteria for classification of stream values (EIANZ 2015).

Value	Explanation	Characteristics
Very High	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants for human induced activities. Negligible degradation e.g. stream within a native forest catchment.	• Benthic invertebrate community typically has high diversity, species richness and abundance. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with no single dominant species or group of species. • MCI scores typically 120 or greater. • EPT richness and proportion of overall benthic invertebrate community typically high. • SEV scores high, typically >0.8. • Fish communities typically diverse and abundant. • Riparian vegetation typically with a well-established closed canopy. • Stream channel and morphology natural. • Stream banks natural typically with limited erosion. • Habitat natural and unmodified.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers etc, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation e.g. exotic forest or mixed forest/agriculture catchment.	• Benthic invertebrate community typically has high diversity, species richness and abundance. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with no single dominant species or group of species. • MCI scores typically 80-100 or greater. • EPT richness and proportion of overall benthic invertebrate community typically moderate to high. • SEV scores moderate to high, typically 0.6-0.8. • Fish communities typically diverse and abundant. • Riparian vegetation typically with a well-established closed canopy. • No pest or invasive fish (excluding trout and salmon) species present. • Stream channel and morphology natural. • Stream banks natural typically with limited erosion. • Habitat largely unmodified.
Medium	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues	• Benthic invertebrate community typically has low diversity, species richness and abundance.

Value	Explanation	Characteristics
	and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agriculture catchment.	• Benthic invertebrate community dominated by taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with dominant species or group of species. • MCI scores typically 40-80. • EPT richness and proportion of overall benthic invertebrate community typically low. • SEV scores moderate, typically 0.4-0.6. • Fish communities typically moderate diversity of only 3-4 species. • Pest or invasive fish species (excluding trout and salmon) may be present. • Stream channel and morphology typically modified (e.g., channelised) • Stream banks may be modified or managed and maybe highly engineered and/or evidence of significant erosion. • Riparian vegetation may have a well-established closed canopy. • Habitat modified.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g. modified urban stream.	• Benthic invertebrate community typically has low diversity, species richness and abundance. • Benthic invertebrate community dominated by taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with dominant species or group of species. • MCI scores typically 60 or lower. • EPT richness and proportion of overall benthic invertebrate community typically low or zero. • SEV scores moderate to high, typically less than 0.4. • Fish communities typically low diversity of only 1-2 species. • No pest or invasive fish (excluding trout and salmon) species present. • Stream channel and morphology typically modified (e.g., channelised). • Stream banks often highly modified or managed and maybe highly engineered and/or evidence of significant erosion. • Riparian vegetation typically without a well-established closed canopy. • Habitat highly modified.

Table 3-6: Criteria for classification of Magnitude of Effects (EIANZ 2015).

Magnitude	Description
Very High	Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature.
High	Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element/feature.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation; AND/OR Having negligible effect on the known population or range of the element/feature.

Table 3-7: Matrix for determining level of effect (EIANZ 2015).

EFFECT LEVEL		Ecological &/or Conservation Value			
		Very High	High	Moderate	Low
Magnitude	Very High	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Low	Very Low
	Low	Moderate	Moderate	Low	Very low
	Negligible	Low	Low	Very Low	Very Low

3.4 Existing environment

In this section of the report we summarise the freshwater ecological values of the freshwater environments which are potentially affected by the proposed alignment. These waterbodies include Miami Stream, Southdown Stream, Anns Creek East, Hamlins Hill, Clemow Stream and Otahuhu Creek portage.

3.4.1 Site 1 - Miami Stream

3.4.1.1 Stream context

Miami Stream is a small, brackish stream reach located west of Miami Parade along the northern shore of the Mangere Inlet.

Miami Stream is stormwater-fed and reticulated for the majority of the upstream catchment. A number of eels were observed in Miami Stream after heavy rainfall; suggesting that there may be open stream habitat elsewhere in the heavily industrial catchment. Miami Stream has a short freshwater reach (approximately 30 m) that transitions into mangrove-dominated estuarine and then marine habitats in Mangere Inlet.

Plate 3-1: Miami stream freshwater reach above the pedestrian bridge (left) and the upstream stormwater culvert (right).

3.4.1.2 Previous and parallel studies

A total of five native and one exotic fish species have been recorded in waterways draining south to Mangere Inlet in the NZFFD (Table 3-8). Banded kokopu, common bully, redfin bully, shortfin eels and *Gambusia* have been recorded in streams draining to Mangere Inlet. All of these species are widespread in the Auckland Region. We note that riparian vegetation in Miami Stream has been replanted as part of a community restoration project and is of moderate quality and largely free of weeds (Chapter 2 of this report, Terrestrial Ecology Assessment).

Table 3-8: NZFFD records from Onehunga waterways draining to Mangere Inlet.

Species		Number of records	Threat classification[18]
Gambusia affinis	Gambusia	2	*Introduced*
Gobiomorphus cotidanus	Common bully	1	*Not Threatened*
Gobiomorphus huttoni	Redfin bully	2	*At Risk* - Declining
Gobiomorphus spp.	Unidentified bully	1	n/a
Galaxias maculatus	Inanga	1	*At Risk* - Declining
Galaxias fasciatus	Banded kokopu	1	*Not Threatened*
Anguilla australis	Shortfin eel	3	*Not Threatened*
Anguilla spp.	Unidentified eel	1	n/a

Assessment of sediment quality in Miami Stream, undertaken as part of the marine ecology assessment, (Chapter 4 of this report) is reported here being relevant to the ecological condition of Miami Stream. Surface sediment samples (top 0.1m of sediment) collected in the estuarine areas of Miami Stream (upstream and downstream of the existing pedestrian bridge) indicated average copper and zinc

[18] Goodman et al. (2014)

concentrations significantly above ISQG-High (590 and 1205 mg/kg respectively). Lead was detected above ISQG-low at 186 mg/kg, whereas HMW-PAHs were below ISQG-low. With respect to ERC-red concentrations, copper and lead were almost four times higher, zinc was 8 times higher and HMW-PAHs were twice as high (Section 4.4.2.3, Chapter 4 of this report, Marine Ecology Assessment).

3.4.1.3 Survey Results

The freshwater section of Miami Stream begins approximately above the pedestrian bridge in Miami Stream. The stream is short and likely influenced by stormwater inputs from upstream and tidal inputs from downstream. Sampling was carried out after moderate-heavy rainfall and the stream volume was higher than usual. The stream channel in Miami stream ranges from 1.8-3.1 m wide, and at the time of survey depth ranged from 0.10–0.44 m deep. Instream habitats were limited to scattered wood debris and leaf litter although both of these were smothered in fine sediment. Flow conditions within the stream were uniformly slow (>0.02 m/s). The stream substrate comprised approximately 70% silt-sand and 30% small gravels (Table 3-8).

Invertebrate fauna communities were of moderate diversity (sixteen species) and abundance (204 individuals), but included taxa with moderate-high MCI-sb scores (including Psychodid fly and Collembola), resulting in an MCI-sb score of 69 (Table 3-9). An SEV assessment was carried out on short freshwater section of Miami Stream (approximately 30 m). The overall SEV score for this section of stream was 0.34, indicative of a poor quality stream (Table 3-9). The primary drivers for this low score were the poor riparian vegetation quality (particularly the lack of ground layer vegetation) and absence of fish fauna which impact the hydraulic function and biodiversity function scores.

Inanga spawning habitat was assessed as unsuitable because of a lack of low, dense vegetation within the floodplain of the freshwater reach. Riparian vegetation was limited to mixed native/exotic canopy species with no ground layer (i.e., bare soils). Fish were surveyed using a range of methods including electric fishing, fyke nets and gee-minnow traps and spotlighting. No fish were recorded at the time of sampling.

Table 3-9: Summary of freshwater ecological data and metrics for freshwater locations, East-West Link, April-August 2016.

Location	Miami stream	Southdown stream	Anns Creek North	Anns Creek South	Clemow stream	Otahuhu
Site	1	2	3a	3b	6	7
Survey date	31/05/2016	15/06/2016	18/07/2016	18/07/2016	23/05/2016	2/08/2016
Habitat						
Stream width (m)	2.2	2.17	1.45	1.42	1.17	1.1
Stream length (m)	25	50	90	60	45	100
Substrate	Silt/sand	Silt/sand & boulders	Silt/sand	Silt/sand	Bedrock (artificial)	Silt
Fish						
Fish richness	0	1	4	5	1	1
Fish IBI	0	18	28	34	14	14

Location	Miami stream	Southdown stream	Anns Creek North	Anns Creek South	Clemow stream	Otahuhu
Species present	-	Shortfin eel	Longfin, inanga, *Gambusia*, yelloweye mullet	Longfin, common bully, inanga, *Gambusia*, yelloweye mullet	Shortfin eel	Shortfin eel
Macroinvertebrates						
Taxa richness	16	22	8	8	9	4
MCI	69	75	68	80	65	47
EPT	0	1	0	0	0	0
SEV						
Hydraulic score	0.35	0.3	0.58	0.62	0.23	0.83
Biogeochemical score	0.49	0.33	0.48	0.47	0.27	0.47
Habitat provision score	0.38	0.48	0.34	0.59	0.16	0.61
Biodiversity score	0.07	0.19	0.28	0.33	0.11	0.19
Overall SEV score	0.34	0.31	0.45	0.50	0.21	0.53

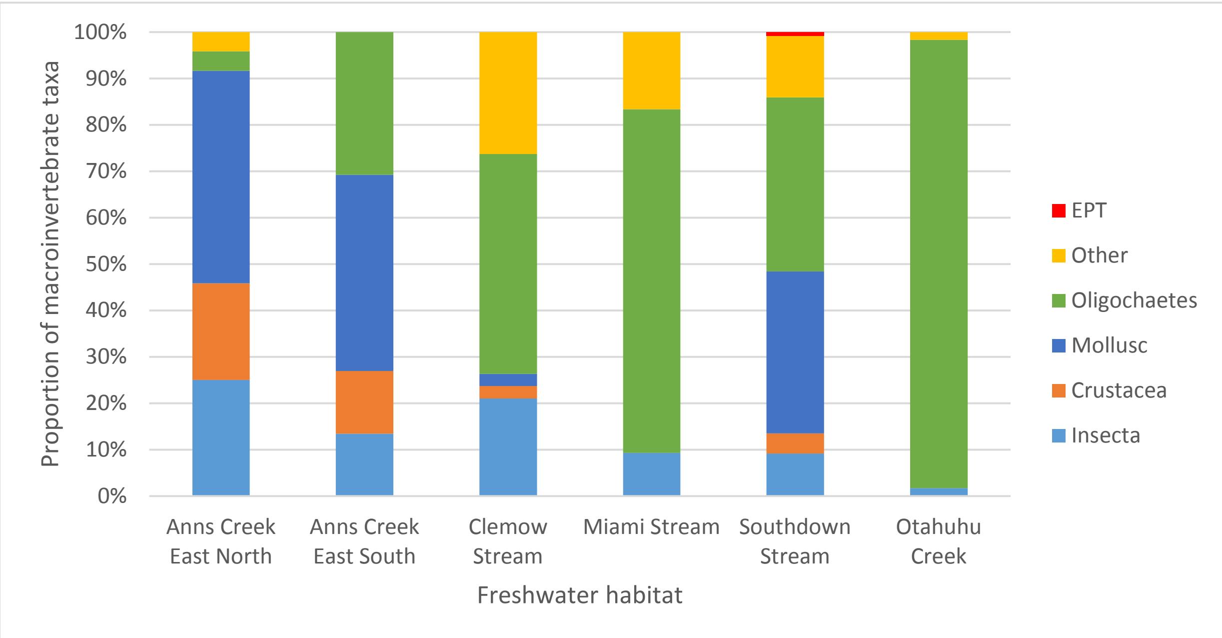


Figure 3-1: Relative proportion of macroinvertebrates at freshwater sample sites.

3.4.2 Site 2 - Southdown Stream

3.4.2.1 Stream context

Southdown stream is an unnamed stream located in Sector 3. The stream is bisected by Hugo Johnston drive at 142 Hugo Johnston Drive. The upstream reach (Plate 3-2) flows between a carpark area and an industrial property, and the downstream reach is located within Southdown Reserve. The stream is connected by a 34 m twin culvert under the road. The catchment above 142 Hugo Johnston Drive is reticulated (piped), and is predominantly industrial. The stream is stormwater and groundwater fed. The lower reaches of the stream in Southdown Reserve are estuarine and discharge to the north-east corner Mangere Inlet through an 80 m culvert.

3.4.2.2 Previous studies

A total of three native and one exotic fish species have been recorded in the vicinity of Southdown Reserve in the NZFFD (Table 3-10). Inanga, common bully, an unidentified eel and *Gambusia* have been recorded in an unnamed tributary of Mangere Inlet. All of these species are widespread in the Auckland Region.

Table 3-10: NZFFD records in the vicinity of Southdown Reserve.

Species		Number of records	Threat classification[18]
Gambusia affinis	Gambusia	2	*Introduced*
Gobiomorphus cotidanus	Common bully	2	*Not Threatened*
Galaxias maculatus	Inanga	1	*At Risk* - Declining
Anguilla spp.	Unidentified eel	1	n/a

3.4.2.3 Survey Results

The upstream reach of Southdown Stream is a moderately wide (average 1.7 m wide), slow flowing stream approximately 130 m in length. Riparian shading was poor and comprised a thin margin of exotic trees on the true right bank and overgrown grasses on the true left bank, where the stream was deeply incised (Plate 3-2). At the time of survey, some vegetation clearance and instream weed removal was being undertaken. Instream habitats within the upstream section of Southdown Stream comprised undercut banks, macrophyte beds and large artificial cobbles. Large cobbles and boulders within the stream indicated that the stream was modified and possibly widened at some point previously, potentially to reduce scour resulting from high stormwater flows. Stream velocity and water depth was variable with some deep pools, likely a result of ponding behind the culvert downstream (Table 3-9).

Southdown Reserve contains asbestos contamination and surveys were not undertaken due to potential contamination and health risks; however a visual inspection was carried out. The stream here is a wide (2 m in width) and slow flowing permanent stream with a predominantly mud substrate. Instream habitats include run with small areas of riffle and some leaf litter and instream debris (Plate 3-3). The lower reaches of the stream and a small tributary to the north have estuarine characteristics including the presence of mud crabs and some mangrove encroachment. The lower reaches of the stream may provide spawning habitat for inanga. Riparian cover and shading within Southdown Reserve was generally high and comprised a mixed native/exotic canopy and weedy understory. The lower section of the stream is piped to Mangere Inlet.

Plate 3-2: Upstream section of Southdown Stream.


Plate 3-3: Downstream section of Southdown Stream, August 2016


The macroinvertebrate community recorded in Southdown Stream comprised 22 taxa including a single pollution-sensitive caddisfly species (Triplectides) (Table 3-9). Other macroinvertebrate communities were recorded included pollution-tolerant including dipterans, molluscs and crustaceans. Fish species recorded were limited to five shortfin eels and two unidentified eels.

An SEV assessment was carried out on the lower 60 m of this upper section of stream, including the area potentially affected by construction works (because of the contamination within the reserve). The overall SEV score for this section of stream was 0.31, indicative of a poor quality stream (Table 3-9). The primary drivers for this low score were the riparian vegetation condition which affects the biochemical and biodiversity function scores; and the channel modification (straightening and channel lining) which affects the hydraulic function score.

3.4.3 Site 3 – Anns Creek East

3.4.3.1 Stream context

The north eastern section of Anns Creek contains a mosaic of vegetation types including freshwater and estuarine wetlands and brackish streams (Plate 3-4). A construction site is proposed within Anns Creek East, within the area proposed for reclamation under an existing consent held by TR Group.

Plate 3-4: Anns Creek East freshwater wetland (left) and estuary/stream (right), August 2016.

3.4.3.2 Previous studies

Vegetation types in the freshwater wetland include tall fescue grassland and raupō reedland. These vegetation types have high value for inanga that spawn amongst tidally inundated vegetation, and above the transition zone between the marine and freshwater environment. Inanga eggs develop out of water and at the base of moist vegetation. Vegetation preferred for inanga spawning includes wiwi, tall fescue, creeping bent, raupō and native rushes (Hickford and Scheil 2010, Taylor and Kelly 2001). Inanga have been recorded within Anns Creek (Wildland Consultants 2014).

3.4.3.3 Survey Results

Site 3a-Anns Creek East (North)

The stream channel had a low gradient and was on average 1.45 m wide and 0.42 m deep. Instream habitats were of low diversity, with occasional pools of low gradient, soft sediment substrate, and habitat structure limited to overhanging bank vegetation and occasional boulders and woody debris. The channel had moderately high banks and a broad floodplain (vegetated mainly with long rank grasses) that would be inundated by floods and possibly high tides.

Aquatic fish fauna consisted of abundant inanga (*Galaxias maculatus*), longfin eel (*Anguilla dieffenbachia*) yelloweye mullet (*Aldrichetta forsteri*) and Gambusia (*Gambusia affinis*) (Table 3-9). The macroinvertebrate community indicated low species diversity and abundance consisting predominantly of molluscs (*Potamopyrgus* spp.) and some crustacea (*Paratya* sp.) and true fly (Orthocladiinae). The MCI score was 68 (Table 3-9). This indicated that water quality was highly unfavourable to freshwater aquatic fauna, probably due to pollution with some influence of salinity.

The SEV indicated partially intact Hydraulic functions, a score of 0.58 reflecting the unmodified channel and potential for floodplain effectiveness. Low shade and high oxygen demand resulted in a moderate to low biogeochemical function score of 0.48. The instream habitat was poor quality, and potential fish spawning reflected this giving a Habitat Provision score of 0.34. Biodiversity function scores were very low, with an average of 0.28. The overall SEV score of 0.45 indicated moderately impaired functions (Table 3-9).

Site 3b-Anns Creek East (South)

Stream morphology of Anns Creek South was similar to Anns Creek North and comprised a natural, low gradient, predominantly shallow stream (mean stream depth of 0.29 m). Instream habitat diversity was low and the stream substrate was dominated by silt/sand (77% composition) with a lower percentage of cobbles and gravels (20%) and wood debris (3%). Leaf litter and organic debris was uncommon and reflected the poor riparian vegetation cover dominated by grasses and sedges.

The fish and invertebrate community recorded in Anns Creek South was similar to Anns Creek North. Fish species recorded included inanga (*Galaxias maculatus*), longfin eel (*Anguilla dieffenbachia*), common bully (*Gobiomorphus affinis*) yelloweye mullet (*Aldrichetta forsteri*) and Gambusia (*Gambusia affinis*). The macroinvertebrate community was limited to eight species, including range of tolerant taxa such as molluscs and true flies. The MCI score for Anns Creek South was 80 (Table 3-9). This indicated that water quality was highly unfavourable to freshwater aquatic fauna, probably due to pollution with some influence of salinity.

The SEV indicated partially intact hydraulic functions, a score of 0.62 reflecting the unmodified channel and potential for floodplain effectiveness. Low shade and high oxygen demand resulted in a moderate to low biogeochemical function score of 0.47. The instream habitat was moderate quality, with moderate potential fish spawning habitat reflected this giving a habitat provision score of 0.59. Biodiversity function scores were very low, with an average of 0.34. The overall SEV score of 0.50 indicated moderately impaired functions (Table 3-9).

3.4.4 Site 4 – Hamlins Hill West

3.4.4.1 Stream Context

This stream is located in a revegetated gully on the western slopes on Hamlins Hill (Plate 3-5). It is a headwater remnant of Anns Creek. The downstream reaches are piped.

3.4.4.2 Previous Studies

No previous studies have been identified.

3.4.4.3 Survey Results

The stream was classified as Intermittent (no SEV assessment or fish or macroinvertebrate sampling was undertaken as a consequence). The seasonality of flows reduce its value and aquatic habitat. The stream has been affected historically by agricultural landuse, and is isolated by the piping of downstream reaches. However, most of the channel and riparian functions are intact and have been enhanced by restoration planting. This watercourse is also notable due to the fact that there are few remaining streams in the catchment.

Plate 3-5: Intermittent channels at Hamlin's Hill West.

3.4.5 Site 5 – Hamlins Hill East

3.4.5.1 Stream Context

This stream is located in a revegetated gully on the southern slopes on Hamlins Hill (Plate 3-6). It is a headwater remnant of Anns Creek. The downstream reaches are piped.

3.4.5.2 Previous Studies

No previous studies have been identified.

3.4.5.3 Survey Results

This is stream is a narrow channel located in a grassed flowpath. The stream is not planted or fenced and the surrounding landuse is pastoral agriculture. As at Site 4, this stream was classified as Intermittent and no SEV assessment or fish or macroinvertebrate sampling was undertaken as a consequence. The seasonality of flows reduce its value and aquatic habitat. The stream is isolated by the piping of downstream reaches. This watercourse is notable as a remnant stream in the catchment.

Plate 3-6: Intermittent channels at Hamlin's Hill East.

3.4.6 Site 6 - Clemow Drive

3.4.6.1 Stream context

The unnamed tributary ('Clemow Stream') of Tamaki River located adjacent to Clemow Drive is within an industrial catchment in Sector 4 in a catchment with a high percentage of imperious area upstream. The stream is piped upstream and downstream, and drains northeast Tamaki River. Stormwater inputs from the neighbouring Turners and Growers property enter the stream through a large culvert on the southern side. The stream is bounded by SH1 infrastructure to the north, the Turners and Growers property to the south and east and Clemow Drive and railway lines to the west. Proposed works in Clemow Stream include upgrading the existing 1200 mm diameter culvert to a 1500 mm diameter and reclaiming c.20 m and diverting c.20 m of the stream to allow for construction of the motorway off ramps (Plate 3-7).

Plate 3-7: Clemow stream downstream culvert (left) and upstream reach (right).

3.4.6.2 Previous and parallel studies

No previous studies have been undertaken on the unnamed stream at Clemow Drive, although banded kokopu have been recorded in the lower Tamaki River catchment downstream of Clemow Drive.

3.4.6.3 Survey Results

The unnamed stream at Clemow Drive is modified stream reach with concrete channel and bank lining throughout most of its length (approximately 80 m). Stream width, depth and velocity was uniform and the channel substrate had a layer of deposited sediment. Riparian vegetation and shading was poor and limited to overgrown grass and pampas. Instream habitats were limited to slow runs and undercut banks. Water clarity was poor, probably due to preceding rainfall, and water depth was likely higher than usual. A surface layer of petrochemical film was observed during the survey.

Fish species recorded from the single pass electric fishing were limited to two shortfin eels caught and five eels observed, but not caught. The macroinvertebrate community recorded in Clemow Stream comprised nine species, all of which are associated with slow flowing streams and ponds and are considered pollution-tolerant taxa (Table 3-9). Macroinvertebrate taxa recorded included dragonflies and damselflies, dipterans, molluscs and oligochaete worms.

An SEV assessment was carried out on the lower 50 m of Clemow Stream (note not the full 80 m of stream). The overall SEV score for this section of stream was 0.21, indicative of a poor quality stream (Table 3-9). The primary drivers for this low score were the channel modifications (straightening, channel and bank lining) which affect hydraulic function and habitat provision function scores. Poor biochemical and biodiversity function scores also reflected the poor riparian vegetation condition where low shading and organic matter inputs reduce potential scores.

3.4.7 Site 7 – Otahuhu Creek

3.4.7.1 Stream Context

The stream is located at the head of the Otahuhu Creek, about 800 m above the SH1 motorway crossing (to be upgraded to a bridge as part of this project). Only about 200 m of the stream remains, between the estuarine reaches characterised by mangroves (downstream) and the piped catchment upstream of Atkinson Avenue. The Portage Canal Foreshore Reserve is located on the northern side of the stream gully and the Otahuhu Cemetery on the south side. A large wastewater pipe bridge is located about 50 m downstream.

3.4.7.2 Previous Studies

No previous studies have been identified.

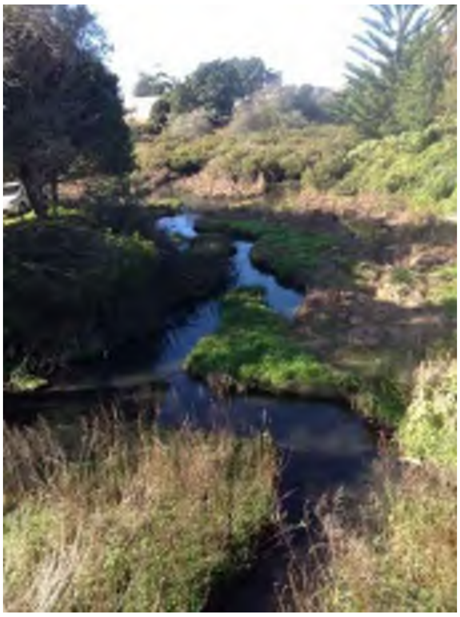
3.4.7.3 Survey Results

The stream channel had a low gradient and was about 1 m wide and 0.5 m deep (Plate 3-8). Instream habitats were of low diversity, with a relatively even depth and gradient, soft sediment substrate, and habitat structure limited to overhanging bank vegetation and occasional woody debris. The channel had low banks and a broad floodplain (vegetated mainly with *Tradescantia*) that would be inundated by floods and possibly high tides. Steep hillslopes were present on each side of the gully, surmounted by mature pine trees. The riparian understory was sparse and was comprised of mixed native and exotic species. Litter was abundant.

Aquatic biota comprised abundant shortfin eels (*Anguilla australis*) and a very depauperate macroinvertebrate community (consisting predominantly of oligochaete worms with low numbers of hover flies (Syrphidae) and hydrozoans) (Table 3-9). The Macroinvertebrate Community Index score was 47. This indicated that water quality was highly unfavourable to freshwater aquatic fauna, probably due to pollution with some influence of salinity.

The SEV indicated relatively intact Hydraulic functions, a score of 0.83 reflecting the unmodified channel and high floodplain effectiveness. Low shade and high oxygen demand resulted in a moderate to low Biogeochemical function score of 0.47. While instream habitat was poor quality, potential fish spawning was good and the Habitat Provision score was 0.61. Biodiversity functions scores were very low, with an average of 0.19. The overall SEV score of 0.53 indicated moderately impaired functions (Table 3-9).

Plate 3-8: Otahuhu Stream, view downstream (left) and upstream (right).



3.4.8 Evaluation of Ecological Values

Onehunga, Mt Wellington and Penrose catchments are within the Maungakiekie-Tāmaki State of the Environment (SoE) reporting area. The freshwater report card grade given to the area in 2014 (the most recent available report) was F, the lowest possible grade (Auckland Council, 2014). Freshwater quality indicators used to derive this grade include water quality (grade E), flow patterns (grade D), nutrient cycling (grade F), habitat quality (grade F) and biodiversity (grade F). Approximately 58% of the respective catchment surface area is impervious, compared with a regional average of 9%. In general, river health in Maungakiekie-Tāmaki's rivers is considered to be impaired as a result of urban development. The effects of urban development include elevated water temperatures, reduced biodiversity value, changes to the natural flow patterns and increased pollution from contaminated stormwater.

The sites located at stream mouths, notably Anns Creek, Otahuhu Creek and Southdown Reserve, provide potential (probable) inanga spawning habitat. Inanga are classified as *At Risk - Declining*, with a very large population but ongoing decline (Goodman *et al*, 2014). Inanga spawning is an important ecological values at these sites, which should be managed for enhancement where practicable. Other opportunities for freshwater fish are limited in many of the stream where the upstream catchment are extensively piped.

We assessed the streams against the EIANZ criteria (Table 3-11). Key values of each stream, and the EIANZ value category, are summarised as follows:

- Miami Stream had a natural channel and limited inanga spawning, but a piped upstream catchment and a constrained and modified riparian zone; value was assessed as Low.
- Southdown Stream had a natural channel, brackish to freshwater habitat sequence and potential inanga spawning, but is within a landfill site and has extensive upstream piping; overall value was Medium.
- Anns Creek East had extensive inanga spawning and habitat sequences, but relatively low freshwater biodiversity; value was Medium.
- Clemow Stream had a highly modified channel (concrete lined) and poor water quality; value was assessed as Low.
- Otahuhu Creek had extensive inanga spawning, but modified riparian zone and piped upstream catchment; value was Medium.

Table 3-11: Freshwater ecological values based on narrative criteria for classification of stream values (EIANZ 2015, section 4.5.1).

Stream	Value	Criterion
Miami Stream	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g. modified urban stream.
Southdown Stream	Medium	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agriculture catchment.
Anns Creek East	Medium	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agriculture catchment.
Clemow Stream	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g. modified urban stream.
Otahuhu Creek	Medium	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agriculture catchment.

3.5 Predicted project freshwater ecology effects

3.5.1 Scope of Effects Assessment

Potential adverse effects to waterways are discussed in terms of construction effects (temporary) and operational effects (permanent). Temporary adverse effects on freshwater ecological values include disturbance to freshwater habitat and fauna during instream works and increased sediment load from open earthworks during construction. Permanent adverse effects include loss of habitat for fish and macroinvertebrates, and treated stormwater discharge to waterway during the operational phase. Positive effects such as benefits of habitat enhancement and increased stormwater treatment capacity are also assessed.

The potential adverse effects and benefits of the project on freshwater ecological values are discussed in the following sections.

3.5.2 Construction Effects

3.5.2.1 Habitat Disturbance

Temporary disturbance to freshwater habitats is likely in Southdown and Clemow Streams as existing culverts are extended and upgraded, respectively. Instream works to extend the existing culvert in Southdown Stream, beneath Hugo Johnston Drive will most likely need to include a clean water stream diversion to allow the culvert works to be constructed in dry environment. Temporary stream diversion will result in temporary loss of habitat and disruption to stream flows.

Proposed instream works in Clemow Stream include relocating the existing twin 1,200 mm diameter culvert and pumping station. The construction of the diversion will result in disruption to stream flow and temporary loss of habitat. The 1,200 mm diameter pipes will require upsizing to 1,500 mm diameter and will be re-routed through the Turners and Grower property and will discharge at the existing outfall for that site. The diversion of this culvert will allow the new ramps to be constructed as shown on the design drawings (Drawing AEE-AL-111). A new pumping station and stormfilter treatment system will be provided to cater for flows along the super-elevated section of SH1, the pumping station will then lift stormwater flows into one of the new 1,500 mm pipes. Details of the stream diversions are presented in Technical Report 12; Surface Water Assessment.

The freshwater wetland and estuary/stream in Anns Creek are expected to be out of the zone of influence of construction works (including bridge construction and stormwater pond construction); consequently any potential effects are not considered here. Construction of the wetland in Miami Stream is described in Section 3.5.3.2 of this chapter as operational activity as the loss of habitat will be permanent.

The project construction will result in temporary disturbance to habitat as a result of instream works to construct stream diversions and install culverts. Disturbance to fish fauna will be reduced by installing exclusion nets to exclude fish outside of the zone of works, and depletion fishing the stream area within the zone of works. Fish will be released outside of the works area. Mitigation for permanent habitat loss is discussed in Chapter 6 of this report (and ECR calculations provided in Appendix A of this chapter).

The magnitude of effect of physical habitat disturbance beyond the permanent footprint of the Project is considered to be Low in the short term and likely to be Low in the longer term, as freshwater habitats naturally recover from disturbance over time.

3.5.2.2 Sediment Discharge

Erosion and Sediment Control

The topography of the land surrounding around Southdown, Clemow and Miami streams is low gradient and the risk of sediment discharges into freshwater environments from open earthworks is likely to be less severe due to the topography. Erosion and Sediment Controls (ESC) are designed to minimise the extent of soil erosion and sediment yield discharging to the receiving environment during the construction life of the project. These controls will be designed and established in accordance with the Auckland Council's TP90 (Auckland Council, 1999) and NZ Transport Agency's Erosion and Sediment Control Guidelines for State Highway Infrastructure.

Proposed ESC measures are detailed in Technical Report 12, Surface Water Assessment and include:

- The establishment of perimeter controls to prevent sediment laden runoff from entering the Southdown reserve, particularly during the embankment and wetland construction;
- Appropriate staging of the works, to ensure earthworks are carried out ion a staged manner to reduce limit the area of exposed earth open to the elements at any one point in time;
- It is possible that the wetland area, if established early in the works could be used as a Sediment Retention Pond (SRP) during construction and the wetland established once work are complete on the embankment. If the open area is less than 0.3ha then a decanting earth bund can be used;
- Silt fences would also need to be installed to control smaller areas of earthworks, especially along Hugo Johnston Drive where the vertical alignment of the road would prevent stormwater from flowing by gravity to any established SRP or Decanting Earth Bund (DEB).

Sediment Discharge Effects

The Project construction may result in an increase in sediment discharge to each of the streams during the period of earthworks. Without control measures in place, elevated suspended sediment in streams may result in an increase in suspended sediment concentrations in estuarine and marine water and potentially some sediment localised deposition near discharge points (Chapter 4, Marine Ecology Assessment).

The amount of sediment discharge from potential open earthworks during a large rainfall event would be relatively small compared to the total contributing catchment of approximately 34 km^2. The runoff from 5 ha of open earthwork area would result in approximately 10 tonnes of sediment discharged to the harbour over a year, compared to 1000 tonnes i.e. 1% of the annual sediment load to the Inlet (Technical Report 12: Surface Water Assessment). As some of the earthworks will occur over historic landfills, it is even more important that potential discharges of sediment and water (and associated contaminants) from these areas are managed and appropriately treated prior to discharge into the CMA. The proposed construction erosion and sediment control management plan will address this risk and it is anticipated will effectively minimise sediment discharge.

The duration of earthworks near the three streams (Miami, Southdown and Clemow) is likely to be relatively short. Discharges of sediment would occur intermittently during and after rainfall, when water flows in the receiving environment will also be elevated (thus providing dilution and dispersion) and background sediment concentrations from the upstream catchments will also be elevated, which will tend to mask any effects from the project. Given the small area of earthworks in each stream catchment relative to the upstream catchment area, the additional sediment would be expected to produce only a small percentage increase in sediment concentrations.

The ecological communities in the receiving environments can be generally characterised as tolerant, and not sensitive to intermittent increases in sediment concentrations or localised and temporary sediment deposition. The streams potentially impacted by earthworks have high existing sediment loads. The risk of significant effects in this instance is low.

While the risk of significant ecological effects is low, it is nonetheless important to implement the proposed control measures effectively and thereby minimise potential effects. The process to ensure this will include approval of final control devices by Auckland Council, and inspection and monitoring during operation.

The magnitude of effect of physical habitat disturbance beyond the permanent footprint of the Project is considered to be Low in both the short term longer term, as remobilisation of sediments generally means that streams habitats naturally recover from disturbance. Elevated sediments during fish migratory or spawning should be avoided.

Provided an erosion and sediment control plan is developed and adhered to, given the low/moderate values of the streams in these locations, we expect the magnitude of effect of the discharge of treated runoff during open earthworks to be Low. However, in a large rainfall event, with a significant area of unstabilised open earthworks, the magnitude of effect could be Moderate due to sedimentation smothering benthic invertebrate fauna, and reducing visibility for fish.

3.5.3 Operational Effects

3.5.3.1 Streamworks

The Project will involve earthworks associated with land preparation, road widening and construction, bridge construction and stormwater treatment pond construction. Works adjacent to, or within streams and wetlands are described below.

Clemow Stream

This section of stream will be affected by the construction of Bridge Pile 5, which will result in the loss of approximately 20 m (10.5%) of stream length (and diversion of a further 20 m).

Southdown Stream

Permanent loss of habitat in Southdown Stream will result from an extension to the existing culvert under Hugo Johnston Drive to allow for road widening and/or construction of an onramp in this area. Approximately 20 lineal meters of the stream will be lost, of a total of some 130 m (i.e. 15% of stream length will be lost) in the upstream section of the stream (north of Hugo Johnston Drive).

The magnitude of loss of freshwater habitats and habitat function in Southdown Stream is considered Moderate as partial loss of the limited open stream channel available will occur.

Anns Creek East

Streamworks here would involve the construction of new headwall and extension of existing 2 x 1,800 mm diameter culvert, resulting in the loss of approximately 10 m (1.2%) of stream adjacent to Great South Road. There would also be construction earthworks near the stream, specifically the construction of a bridge and construction yard within the Anns Creek East wetland.

Miami Stream

Miami Stream and estuary are upstream of the culvert adjacent to the existing coastal walkway. This creek is predominantly mangroves, with a section of defined stream channel below the pipe outlet that delivers flow from the piped upstream catchment. The mangrove dominated area (210m long, 0.5ha), the stream reach (upstream, approximately 30m long) and surrounding riparian vegetation (approximately 0.8ha) will be removed in order to construct a freshwater stormwater treatment wetland.

While the extent of effects is small, this is the only open stream section of Miami Stream remaining and may provide inanga spawning habitat.

3.5.3.2 Stormwater Discharges

The Project will result in an increase in impermeable surface area in each stream catchment, increased traffic volumes, and an increase in generation of motorway stormwater contaminants include copper, lead, zinc and hydrocarbons. However, the project will also provide treatment of all stormwater from new motorway surfaces, and a significant proportion of existing, untreated stormwater. The stormwater management strategy and design for this project is described in Technical Report 12; Surface Water Assessment.

The design objective for runoff from the proposed alignment is to cater for a 1 in 10 year rainfall event, with treatment in accordance with Auckland Council and the NZ Transport Agency's requirements. In addition, where works occur within and adjacent to areas of existing state highway, runoff from both the new and existing impermeable surfaces will be treated.

A series of stormwater treatment ponds and proprietary devices are proposed along the alignment, with the annual average treatment being removal of 75% of total suspended solids and associated contaminants prior to discharge to receiving environments.

In the freshwater environment, sensitive species are often lost after 10% to 20% catchment surface area is made impervious (see list of examples in Morse et al., 2003), and as the catchments affected are highly impervious the reduction in overall catchment contaminant loads will probably not be sufficient to result in an increase in aquatic biodiversity. However, it will reduce the rate at which contaminants are accumulating in the marine environment and may have a beneficial effect on estuarine sediment quality in respect to effects thresholds (Chapter 4 of this report).

The adverse ecological effects of discharge of treated catchment stormwater from the project into these receiving environments is considered to be Negligible.

3.5.4 Positive Effects

3.5.4.1 Reduced contaminant load discharge to streams

Currently, the main contaminant sources captured in stormwater that is discharged into streams includes:

- Contaminants in groundwater from current and historic land uses including metals, nutrients, petroleum hydrocarbons, PAHs, solvents;
- Landfills and reclamation – nutrients such as ammoniacal nitrogen;
- Stormwater – copper, zinc, lead, nutrients and faecal coliforms; and
- Sewer leakage to ground and/or cross-connection with stormwater yielding faecal coliforms and nutrients.

The proposed EWL design incorporates treatment of runoff from new and existing highway alignment, catchment stormwater and landfill leachate. A reduction in the load of contaminants discharged to Southdown and Clemow Streams will reduce the accumulation of contaminants in benthic surface sediment and potentially reduce sublethal stress on invertebrates and fish. Any reduction in contaminants is regarded as a positive effect; however, because of other stressors, the response of communities here is likely to be low and may not be detectable. The reduction in contaminants will have a low ecological benefit to streams, but will also slow contaminant accumulation in the marine receiving environment.

The magnitude of positive effect on freshwater ecological values arising from the reduction of contaminants to the freshwater environment from a range of sources is considered to be low given the number of other stressors in the stream environment.

3.5.4.2 Increased habitat diversity

Freshwater stormwater treatment wetlands constructed along the embankment are likely to provide additional habitat for invertebrates and fish in a catchment that has very limited freshwater habitats available. Potential species that may occupy stormwater treatment wetlands include shortfin eels, inanga and tolerant freshwater invertebrates typically associated with slow flowing streams and pond (e.g., damselflies and snails).

These stormwater devices therefore provide a secondary benefit by providing habitat for common species. This will replace some freshwater functions lost in these catchments. While these stormwater wetlands will have some positive effects, they are not used as off-setting for adverse ecological effects because the primary purpose of the wetlands is water treatment. The magnitude of positive effect from increased habitat diversity is considered to be Low.

3.5.5 Evaluation of Magnitude of Effects

The EIANZ assessment of magnitude of effects, presented in Table 3-6 includes of two components:

- Degree of change to key element or features of baseline conditions (Criteria A); and
- Proportion of loss of known population or range of an element or feature (Criteria B)

The effects of the project can be summarised as stormwater discharge (both construction and operational stormwater), and streamworks (i.e. physical works in watercourses such as reclamation and culverting).

Stormwater effects do not result in loss of an element, but rather an effect along a gradient of impact, so we have assessed stormwater against Criteria A (degree of change against baseline). As reclamation and culverting result in “loss of an element”, we have assessed streamworks against Criteria B (proportion of loss).

The EIANZ criteria require assessment of effects on “key elements or features”. Key elements of these freshwater ecosystems are streambed area, biological communities, water quality, and inanga spawning habitat. These elements may be altered in character, composition or attributes from the baseline condition (per the EIANZ definition).

The categories for magnitude of effects are:

- Very High - Total loss or very major alteration to baseline conditions, resulting in a fundamental change in attributes;
- High - Major loss or alteration, resulting in a fundamental change in attributes;
- Moderate – Loss or alteration of one or more key elements, resulting in partial change in attributes;
- Low – Minor alteration, attributes generally similar to baseline; and
- Negligible – slight or no change to baseline conditions.

Table 3-12 summarises the magnitude of effects within each stream catchment.

Table 3-12: Assessment of Magnitude of Effect in Freshwater Stream Catchments (without mitigation).

Project Activity	Key Ecosystem Element or Feature	Effect	Criteria A: Degree of change from baseline	Criteria B: Proportion of loss of similar features in catchment	Magnitude of Effect
Miami Stream					
Reclamation (30 m)	Stream habitat	Localised habitat loss	-	Minor	Low
	Inanga spawning	Reduction in potential spawning area	-	Minor	Low

Project Activity	Key Ecosystem Element or Feature	Effect	Criteria A: Degree of change from baseline	Criteria B: Proportion of loss of similar features in catchment	Magnitude of Effect
Discharge of treated stormwater	Biological communities	No significant change in fauna	Low	-	Low
	Water quality	Increase in contaminant loads but no significant increase in concentrations	Low	-	Low
Southdown Stream					
Culverting (20 m)	Stream habitat	Localised habitat loss	-	Minor	Low
	Inanga spawning	Reduction in potential spawning area	-	Minor	Low
Discharge of treated stormwater	Biological communities	No significant change in fauna	Low	-	Low
	Water quality	Increase in contaminant loads but no significant increase in concentrations	Low	-	Low
Anns Creek					
Culverting (10 m)	Stream habitat	Localised habitat loss	-	Minor	Low
	Inanga spawning	Reduction in potential spawning area	-	Minor	Low
Discharge of treated stormwater	Biological communities	No significant change in fauna	Low	-	Low
	Water quality	Increase in contaminant loads but no significant increase in concentrations	Low	-	Low
Clemow Stream					
Reclamation (20 m), diversion (20 m)	Stream habitat	Localised habitat loss	-	Minor	Low
	Inanga spawning	Reduction in potential spawning area	-	Minor	Low
Discharge of treated stormwater	Biological communities	No significant change in fauna	Low	-	Low
	Water quality	Increase in contaminant loads but no significant increase in concentrations	Low	-	Low

This analysis shows that effects in each stream are localised and will either result in minor shift from baseline conditions in the case of stormwater, or a minor change in the proportion of stream habitat in the wider area (e.g. around the Mangere Inlet receiving environment).

3.6 Assessment of potential freshwater ecology effects

As described above, the Project will have localised adverse effects on four streams, these being Miami Stream, Southdown Stream, Anns Creek and Clemow Stream. The magnitude of effects at each site was assessed as Low. The level of effect on each stream was determined from ecological value and magnitude of effects, using the matrix in Table 3-7. The results are presented in Table 3-13.

Table 3-13: Assessment of Level of Effects, East-West Link Project.

Stream	Ecological Value	Magnitude of effect	Effect Level
Miami Stream	Low	Low	Very Low
Southdown Stream	Medium	Low	Low
Anns Creek East	Medium	Low	Low
Clemow Stream	Low	Low	Very Low

EIANZ guidelines state that very high, high and moderate levels of effect require avoidance or mitigation, whereas low and very low levels of effect are normally not of concern, but design, construction and operational care should be taken to minimise adverse effects.

The project will result in a total of 80 m of reclamation or culverting, and loss of about 60 m of potential inanga spawning habitat, and discharge of contaminants to four streams. The ecological effect after mitigation will be Low, and overall effects of the project of freshwater ecological values will be minor.

The project will undertake to mitigate adverse effects and have positive effects where practicable, as described in Chapter 6 of this report (Proposed Mitigation and Offset). Restoration measures, primarily riparian restoration, are proposed for Southdown Stream, Anns Creek, Clemow Stream and Otahuhu Creek. This will ensure that the level of effects described above will be further reduced.

We consider that this project will avoid, remedy or mitigate effect to the level practicable, in accordance with Auckland Council guidance and good environmental management practice.

3.7 Recommendations

Mitigation of overall effects on ecology, relating to freshwater ecology, listed below are discussed in detail in Chapter 6 (Proposed Mitigation and Offset).

- Restoration planting at Anns Creek, especially enhancement to inanga spawning areas;
- Restoration planting of inanga spawning areas elsewhere, e.g. Otahuhu Creek;
- Enhancements to remaining waterways e.g. riparian planting, habitat enhancements (for a period of five years, after which maintenance is handed back to the landowners[19]); and
- Monitoring of stream diversions to ensure avoidance of adverse effects on fish.

3.8 References

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Appendix A

Stream Mitigation Calculations

Memorandum

Boffa Miskell

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Attention:	Eddie Sides, Sharon De Luca
Company:	Boffa Miskell Limited
Date:	7 September 2016
From:	Ian Boothroyd, Katherine Muchna
Message Ref:	East West stream mitigation calculations
Project No:	T16006 – Appendix to Freshwater Chapter

This memo details Environmental Compensation Ratio (ECR) calculations generated for stream loss at each of Miami Stream, Southdown Stream, Clemow Stream and Anns Creek East. We note that mitigation for stream loss is captured within the proposed ecology mitigation package (Chapter 6 of Technical Report 16, BML 2016), but we provide the ECR calculations below to provide certainty regarding mitigation for stream loss specifically on a stream by stream basis.

Miami Stream

Proposed works

Miami Stream and estuary are upstream of the culvert adjacent to the existing coastal walkway. This creek includes a section of defined stream channel below the pipe outlet that delivers flow from the piped upstream catchment. The stream reach is approximately 25 m in length, and the proposed works will result in complete loss of this stream in order to construct a freshwater stormwater treatment wetland.

While the extent of effects is small, this is the only open stream section of Miami Stream remaining and may provide inanga spawning habitat. Ecological assessment of the stream indicated low diversity and abundance of invertebrate fauna. No fish were recorded. Further, we note that sediment quality was poor and copper, lead and zinc were recorded above ISQG trigger levels (Section 4.1.4.3, Chapter 4, Technical Report 16, Marine Ecology Assessment).

We consider that loss of Miami Stream could be adequately mitigated by restoration works in Southdown Stream (north) (Table 1). Approximately 68 lineal meters of stream restoration at Southdown Stream (north) would be required.

Table 1: Results of ECR calculation to mitigate loss of Miami stream by restoration of Southdown Stream.

Stream loss Miami Stream	
Area lost Miami	55 m^2
Mitigation area required at Southdown stream	148.19 m^2
Mitigation length at Southdown	68 m

Southdown Stream (north)

Proposed works

Extension of the existing culvert at Southdown Stream (north) to allow for road widening and/or construction of an onramp in this area will result in permanent loss of habitat in Southdown Stream. Approximately 20 lineal meters of the stream will be lost, of a total of some 130 m in the upstream section of the stream (north of Hugo Johnston Drive).

Mitigation

This section of open channel (about 130 m in length) runs near the property boundary within a corridor about 15 m in width. Riparian vegetation could be planted here to provide shade and enhance stream values (refer to Map 39). We consider that extending the culvert in Southdown Stream by 10 m could be adequately mitigated in by restoration works in Southdown Stream (north) (Table 2). Approximately 48 lineal meters of stream restoration at Southdown Stream (north) would be required.

Table 2: Results of ECR calculation to mitigate loss of 10 m of Southdown stream (north) by restoration planting in the remaining Southdown Stream.

Stream loss Southdown stream	
Area lost Southdown culvert	43 m^2
Mitigation area required at Southdown stream	103.49 m^2
Mitigation length at Southdown	48 m

Note: the length of Southdown stream is sufficient to accommodate mitigation for both the culvert in Southdown Stream and the loss of Miami Stream based on ECR calculations.

Clemow Stream

Proposed works

Proposed instream works in Clemow Stream include relocating the existing twin 1,200 mm diameter culvert and pumping station. The construction of the diversion will result in disruption to stream flow and temporary loss of habitat. This section of stream will be affected by the construction of Bridge Pile 5, which will result in the loss of approximately 20 m of stream length (and diversion of a further 20 m)

Mitigation:

The current Clemow Stream channel is about 90 m in length and has a concrete base (refer to Map 41). As the section of stream will be realigned as part of the project, there is potential to re-establish a more natural channel with a mud or rocky substrate and native riparian vegetation. The enhancement of this channel would improve stream values in the medium and long term.

We consider that installing a 20 m culvert in Clemow Stream could be adequately mitigated in by stream naturalisation and restoration planting works in and around Clemow Stream (Table 3). Approximately 31 lineal meters of stream restoration at Clemow Stream would be required.

Table 3: Results of ECR calculation to mitigate loss of 20 m of Clemow stream by naturalising the streambed and planting in the remaining length of stream.

Stream loss Clemow Stream	
Area lost Clemow Stream culvert	23 m^2
Mitigation area required at Clemow stream	36.48 m^2
Mitigation length at Clemow stream	31 m

Anns Creek north

Proposed works

Streamworks in Anns Creek north would involve the construction of new headwall and extension of an existing culvert, resulting in the loss of approximately 10 m of stream adjacent to Great South Road. There would also be construction earthworks near the stream, specifically the construction of a bridge and construction yard within the Anns Creek East wetland.

Proposed mitigation text

Within Anns Creek East, riparian planting has already been undertaken along the southern part of the stream, but could be extended along the north part. This would benefit about 150 m of stream length. This area is potential inanga spawning habitat, with existing grasses likely to provide good spawning substrate. As such, potential improvement to inanga spawning value may be limited for freshwater values, but vegetation values could be enhanced through replacement of exotic species with indigenous species.

We consider that extending the culvert in Anns Creek by 10 m could be adequately mitigated in by restoration works within Anns Creek (north) (Table 4). Approximately 37 lineal meters of stream restoration at Anns Creek (north) would be required.

Table 4: Results of ECR calculation to mitigate loss of 10 m of Southdown stream (north) by restoration planting in the remaining Southdown Stream.

Stream loss Anns Creek north	
Area lost Anns Creek culvert	15 m^2
Mitigation area required at Southdown stream	53.89 m^2
Mitigation length at Anns Creek North	37 m

Further, the raupo wetland (approximately 140 m^2) within Anns Creek East, currently providing habitat for Threatened Australasian bitten, will be impacted by the EWL Project. As such, it is recommended similar habitat be recreated. An area of approximately 280 m^2 has been identified within south-western corner of Anns Creek Reserve Wetland (refer to Map 39) which would provide an appropriate location of that habitat re-creation (further details are provided in Section 2.3.5). Following construction, attempts should be made to restore any area of the raupo wetland remaining within Anns Creek East.