Attachment E

NZ Transport Agency and Auckland Transport

East West Connections Project

Ecological Assessment to Support Option Selection

November 2014

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Project Description

The East West Connections project is responding to the immediate and growing freight access issues at either end of the Neilson Street/Church Street corridor caused by inefficient transport connections and a lack of response to changes in the industry's supply chain strategies. The project is also addressing the inadequate quality of transport choices between Māngere, Ōtāhuhu and Sylvia Park.

The long list of options was developed in a 2-stage process. The option identification process began with identifying changes at a component level (e.g. lane widening; interchange improvements) across the geographical area. To ensure a full spectrum of components was considered, the study area was separated into segments. All components were then assessed through a multi-criteria analysis. Where broadly equivalent components (in terms of either transport performance or social, environmental or cultural outcomes) were identified, the best alternative proceeded to the development of the long list options. If no broadly equivalent alternative component existed, the component was progressed to the development of long list options. All options were assessed through a multi-criteria analysis, which considered a full range of impacts and performance against the project's objectives and the East West Connections outcomes. Six options were identified to progress to the short list for the Onehunga-Penrose connection. These options range from low investment to high investment.

These 6 options are the subject of this assessment and a detailed description of each are documented in the Detailed Business Case. The following summarised descriptions (and relevant design drawings) have been used as the basis of the following assessment.

1.1.1 Option A (Long List Option 1): Existing route upgrade

This option looks to upgrade the existing roads. This includes improving capacity on SH20, Neilson Street and Church Streets. It also provides freight lanes.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park)
- Some widening of Onehunga Harbour Road at Gloucester Park (e.g. around the Onehunga Port area, beneath SH20 and potential to increase this from 2 to 3 lanes up to Neilson Street / Onehunga Mall intersection).
- Upgrading of the intersection at Onehunga Mall / Neilson Street intersection (potentially including widening of bridge over the rail line) to provide for dedicated movements between Onehunga Mall / Neilson Street.
- Capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Church St (potential impact on some road frontages, but looking to minimise)
- New signalised intersection to provide access to Metroport (for example, providing for dedicated turning median).
- Cycleway uses Hugo Johnston Road (within the road corridor), may impact on tree planting etc in existing road reserve, will then connect to Church Street East and Great South Road (level crossing) to connect to existing cycle path to Sylvia Park.
- Freight lane priority at Mt Wellington Interchange where this can fit beneath existing bridge constraints.

1.1.2 Option B (Long List Option 2): Upgrade with South Eastern Highway Ramp

This option proposes an upgrade of existing roads with new ramp connections from Church Street to SH1 and South Eastern Highway.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- Some widening of Onehunga Harbour Road at Gloucester Park is likely (e.g. around the Onehunga Port area, beneath SH20 and potential to increase this from 2 to 3 lanes up to Neilson Street / Onehunga Mall intersection.
- At Onehunga Mall / Neilson Street intersection, upgrading of intersection is required (potentially including widening of bridge over the rail line) to provide for dedicated movements between Onehunga Mall / Neilson Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Church St (potential impact on some road frontages, but looking to minimise).
- New signalised intersections and upgrades to intersections at Metroport (for example: providing for a dedicated turning median), Church St, Hugo Johnston Drive and Great South Road (grade separation at Hugo Johnston Drive and Great South Road may be considered).
- Cycleway using Hugo Johnston Road (within the road corridor), may impact on tree planting etc in existing road reserve, will then connect to Church Street East and Great South Road (level crossing) to connect to existing cycle path to Sylvia Park.
- New connections for 'southern' traffic on SH1, with ramps from the South Eastern Arterial (looking at ramps of 2-lanes in each direction to connect from interchange to tie in with SH1 at Mt Wellington). This requires an auxiliary lane extension on SH1 down to Princes Street interchange.

1.1.3 Option C (Long List Option 5): Upgrade with new Galway Street and inland connections

This option proposes a new connection from Onehunga Harbour Road to Galway Street, and upgrade of Neilson and Angle Streets and Sylvia Park Road, and a new connection for Angle Street to Sylvia Park Road and to SH1.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park)
- Some widening of Onehunga Harbour Road at Gloucester Park is likely (e.g. around the Onehunga Port area, beneath SH20.
- New connection from Onehunga Harbour Road onto Galway Street (may impact on traffic movements / access to SH20 from Onehunga Mall / Onehunga Harbour Road)
- 4-lanes on Galway Street with upgraded intersection to Neilson Street, upgrading of intersection required (potentially including widening of bridge over the rail line) and to address increased traffic from Onehunga Mall to Galway Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Angle St and upgrading of Angle Street (e.g. up to 4-lane, which may require some additional land).
- New connection from Angle Street to Great South Road for between 2 and 4 lanes, and where practicable on land between Transpower towers and foreshore (not reclamation).

- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.1.4 Option D (Long List Option 8): Upgrade with Gloucester Park interchange and new Galway St and inland connections.

This option proposes an upgrade at Gloucester Park Interchange and a new connection from Onehunga Harbour Road to Galway Street. It also proposes an upgrade of Neilson and Angle Streets and Sylvia Park Road, and a new connection for Angle Street to Sylvia Park Road and to SH1.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, to restrict access to Neilson Street and divert all traffic onto Onehunga Harbour Road (widening requirements for Onehunga Harbour Road, e.g. 3+ lanes).
- New connection from Onehunga Harbour Road onto Galway Street (may impact on traffic movements / access to SH20 from Onehunga Mall / Onehunga Harbour Road).
- 4-lanes on Galway Street with upgraded intersection to Neilson Street, upgrading of intersection required (potentially including widening of bridge over the rail line) and to address increased traffic from Onehunga Mall to Galway Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Angle St and upgrading of Angle Street (e.g. up to 4-lane, which may require some additional land).
- New connection from Angle Street to Great South Road for between 2 and 4 lanes, and where practicable on land between Transpower towers and foreshore (not reclamation).
- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.1.5 Option E (Long List Option 13): New foreshore Connection

This option proposes a new connection from SH20 to SH1 along the foreshore.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, with access to Neilson Street and onto Onehunga Harbour Road (may require some changes to traffic movements from Onehunga Harbour Road onto SH20).
- New connection from Gloucester Park along foreshore to Great South Road, with local connections at Captain Springs Road, Southdown (Metroport) and Great South Road to connect (via intersection) onto Vesty Drive.

- New bridge from Vesty Road to provide new ramp connection to SH1 at Panama Road (between businesses and residential areas).
- New ramp connections at Panama Road (potentially requiring replacement of Panama Road Bridge) with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to Great South Road and then onto alignment around Hamlin's Hill.

1.1.6 Option F (Long List Option 14): New foreshore and inland connection

This option proposes a new connection form SH20 to SH1 (partly along the foreshore and partly inland).

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, with access to Neilson Street and onto Onehunga Harbour Road (may require some changes to traffic movements from Onehunga Harbour Road onto SH20).
- New connection from Gloucester Park along foreshore to Captain Springs Road and then inland to Great South Road.
- New intersections at Captain Springs Road, Southdown (Metroport) and Great South Road (may require relocation of Transpower towers).
- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.2 Limitations

This report has been prepared by GHD for NZ Transport Agency and Auckland Transport and may only be used and relied on by NZ Transport Agency and Auckland Transport for the purpose agreed between GHD and the NZ Transport Agency and Auckland Transport as set out in 1.1.

GHD otherwise disclaims responsibility to any person other than NZ Transport Agency and Auckland Transport arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

If the clients wish to provide this Report to a third party recipient to use and rely upon, then GHD's prior written consent will be required. Before this Report is released to the third party recipient, the third party recipient will be required to execute a GHD prepared deed poll under which the recipient agrees:

- to acknowledge that the basis on which this Report may be relied upon is consistent with the principles in this section of the Report; and
- to the maximum extent permitted by law, GHD shall not have, and the recipient forever releases GHD from, any liability to the recipient for loss or damage howsoever in connection with, arising from or in respect of this Report whether such liability arises in contract, or tort (including negligence).

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described below (Section 1.3). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by NZ Transport Agency and Auckland Transport and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.3 Assumptions

The following assumptions apply to this report:

- This report has been prepared by reviewing a wide range of reports applicable to the project area including Auckland Council technical reports; however this information has not been independently verified or checked. The limitations of this report are further discussed in Section 1.2. A full list of reviewed reports can be found in Section 6.
- GHD has endeavoured to collate and review the relevant reports which are considered adequate to inform the ecological assessment but acknowledges there may be some which are not included.
- No detailed field surveys or assessments have been carried out as part of this information review. One site walkover was carried out with the wider technical team on 17th July, 2014. The principal author is also familiar with the study area.
- Based on the findings of the information review we have assumed water quality and sediment quality within Mangere Inlet is improving.
- The assessed coastal area within the footprint of the six EWC alignments is limited to:
  - the Manukau Harbour from Gloucester Park South along the Manukau Inlet Foreshore to Ann's Creek.
  - SH1 crossing of Otahuhu Creek.
- The assessed land based reserves were limited to Hamlins Hill – Mutukaroa and Southdown Reserve. No published information detailing the ecological significance of the Southdown Reserve was available and so the description is based on anecdotal evidence and opinion only.
- An assessment of current water and sediment quality within the Mangere Inlet and wider Manukau harbour is based on existing information only to understand baseline contaminant levels.

2. Assessment Methodology

This report provides a summary of reviewed information including the environmental condition and value of the Manukau Harbour with a particular focus on the areas impacted by the proposed alignments. The aim of this review was to build a picture of the current environment located from the Mangere SH20 Harbour Bridge to Ann's Creek, the SH1 crossing at Otahuhu Creek and the two reserves located at Hamlins Hill – Mutukaroa and Southdown Reserve.

The baseline information was used to understand the potential ecological impacts that may arise from construction and operation of the six options. These potential impacts were identified as:

- Habitat loss.
- Noise and vibration.
- Water and sediment contamination.
- Impacts to flora and fauna.

The background information related to these impacts is discussed in greater detail in Appendix A. We present an assessment of ecological effects for each option contained in Section 5.

3. Background Information - Existing Environment

A review of available and related environmental information was carried out to provide context and baseline information for assessing the potential ecological effects presented by each of the six (6) alignment options.

It is not the intent of this section to provide a detailed summary of the information review but to provide a list of the potential high level ecological risks presented by each option.

The summary information used to support this list can be found in Appendix A and should be read in conjunction with this section.

Of the information assessed the following potential effects were identified:

- Loss of intertidal vegetation along the Mangere foreshore, at Ann's Creek (particularly mangroves and salt marsh – *Coprosma crassifolia* shrubland);
- Loss of vegetation at Southdown Reserve and Hamlins Hill – Mutukaroa;
- Loss of habitat including the intertidal area along the Mangere Inlet foreshore, intertidal area at Gloucester Park, loss of mangrove habitat including within Ann's Creek, loss of trees/shrubs at Southdown Reserve and Hamlins Hill – Mutukaroa;
- Loss of diversity and/or complete loss of macrofauna communities particularly within the intertidal mudflats present along the Mangere Inlet foreshore;
- Potential reduction in shorebird feeding and foraging area along the foreshore intertidal mudflats;
- The foreshore sections are likely to result in displacement of a variety of species particularly birds from within and adjacent to the project area during construction activities and under normal operation of the road;
- Potential increase in noise and vibration during construction and normal operation of the road;
- Increased sediment and water contamination entering the receiving environments acknowledging treatment options including wetlands, swales and stormwater filters will be used to reduce loads as much as practicable.

4. Key Design Assumptions

The following design assumptions apply to this report:

- The design principles and measures that will be implemented during construction for erosion and sediment are provided in the Erosion and Sediment Control (ESC) assessment report.
- Detail of stormwater effects and proposed treatment (eg, TP90 guidance) are included in the Stormwater assessment report. We have assumed all additional stormwater diverted to the receiving environment will be treated to reduce contaminant loadings prior to discharge.
- An overview of contaminants derived from land based sources such as closed landfills is contained within the Contaminated Land assessment report.
- No detailed field surveys have been carried out to quantify the potential ecological impacts resulting from each of the alignment options. This report provides a high level summary of available information only.
- The alignments that follow the southern Onehunga foreshore (Options E and F) will be constructed on a new embankment approximately 60m wide to accommodate a four lane road carriageway and a shared path and cycleway with swales for stormwater treatment. The embankment is separate from the existing foreshore and as such will create an area between the two that can be used for additional treatment and containment of any leachate etc.
  - The intended construction of the embankment may include pre-loading and *in situ* wick drainage to reduce long term settlement.
  - The finished road carriageway elevation will be approximately 4.5m above mean seal level.
  - It is anticipated that some 'headland' features would be constructed along the seaward side of the embankment to provide a more natural coastal edge.
  - Existing drainage to the Mangere Inlet will be provided for using culverts.
- Option F has an inland alignment through the current MetroPort area.
- We have assumed that the alignments that follow existing roads (including widening of the road carriageway and intersection improvements) require no land vegetation removal.
- We have assumed that the alignments that follow the foreshore will require removal of mangrove trees and other intertidal vegetation. We have assumed this area will be calculated in the detailed design of the preferred option.
- Based on the current preliminary design of the six options, there does not appear to be a requirement for stream diversions. Only diversions of existing overland flowpaths are likely to be required as a consequence of the project. No stream diversions are proposed for any of the options at this stage.
- It is assumed that the subsequent phases of the project will adopt an ecologically sensitive design approach to minimise environmental impacts.
- We assumed no translocation of any flora or fauna species will be required during any stage of the project.

- We have assumed any proposed stormwater treatment wetlands will be designed and planted to create a habitat for wildlife. We have assumed planting plans will be developed by a suitably qualified ecologist.
- While every attempt to identify and address potential risk areas (as summarised in Section 3) there may be areas that have not been included in this assessment. This is a consequence of the high level overview nature of the review and design work carried out to date. The detailed design of the preferred option is expected to address any information gaps.
- The Option B alignment directly affects Hamlins Hill – Mutukaroa. The vegetation identified on the high level plans indicates vegetation on Hamlins Hill is mostly pasture with one gully including some scrubby native vegetation. We have assumed a potential land cut of approximately 30m wide.

5. Assessment of Options

In this section we build on the information summarised in Appendix A and provide information on the potential environmental effects of the proposed EWC alignments. The key impacts across all alignment options are identified as:

- Habitat loss.
- Noise and vibration.
- Water and sediment contamination.
- Impacts to flora and fauna.

The baseline information summarised in Appendix A is used in this section to discuss the high level potential environmental impacts common to all alignment options. Following this overview we consider each option in turn. No detailed assessments were carried out to quantify the level of impact and it is recommended that investigations are carried out to quantify these impacts.

5.1 Potential Environmental Effects

5.1.1 Marine flora communities

Marine flora communities within the EWC project area comprise mangroves and saltmarsh, particularly within and immediately adjacent to Ann's Creek in the Mangere Inlet. These areas provide a range of ecological benefits to the species inhabiting the areas and the wider built environment through ecosystem services such as coastal erosion protection, sediment retention, cultural benefits and provision of habitat for fish spawning (eg, commercial yellow-eyed mullet). While the ecosystem services provided by these flora communities and the interactions these areas have on wider ecological habitats have not been studied within the project area we recommend this be carried out prior to construction.

As described in Appendix A the project area supports mangrove communities and an area of ecologically significant saltmarsh vegetation in Ann's Creek. Construction activities within the CMA for options E and F will have a direct impact resulting in the loss of mangrove and intertidal vegetation along localised shoreline areas. In addition there are potential effects from sediment derived from construction activities resulting in potential vegetation decline. Ann's Creek is particularly vulnerable to construction activities as the area supports the only remaining significant piece of native *Coprosma crassifolia* shrubland on lava flows and the most complete sequence of marine and intertidal vegetation in the Tamaki ecological district. With appropriate mitigation measures we expect any potential long-term effects (eg, vegetation loss) to be manageable.

5.1.2 Marine macrofauna communities

While the communities present within the project area may be able to adapt to existing short term natural impacts, they may experience chronic impacts given the likely magnitude and duration of the proposed construction program for options E and F that require reclamation within the Mangere Inlet foreshore.

As described in Appendix A the intertidal mudflats support a diverse assemblage of soft sediment flora and fauna species. The impact to some of these species from construction in the coastal zone will likely have an immediate impact resulting in a reduction in the diversity of these taxa. Given these taxa currently occupy the existing intertidal mudflats, it is likely that this will cause a temporary disturbance and that any affected areas will be recolonised over time. Reclamation is expected to have a direct impact on the coastal environment through habitat loss and species displacement but may be reduced by combining ecologically sensitive design to recreate a variable foreshore environment that more closely reflects the original Mangere Inlet foreshore which has been highly modified.

Given the importance of intertidal areas within the project area for common and migratory shorebirds, the impact of construction activities on bird populations is expected to occur over a prolonged period. However, we also acknowledge the ability of shorebirds to vacate the area during construction activities to adjacent sites thereby reducing the direct impact to individuals. Appropriate management of construction activities through appropriate management plans are expected to manage these impacts.

5.1.3 Habitat loss

Each of the six alignment options are likely to result in some habitat loss with potential loss at Gloucester Park common across all six options. The foreshore options E and F will result in a greater degree of habitat loss where the alignment will result in reclamation of the Mangere Inlet foreshore. The alignment E option is likely to affect Ann's Creek through the construction of piles which will permanently occupy the sea bed. Additionally, it is worth noting that the foreshore embankments specific to the foreshore alignments will cap and contain the existing contaminated sediments in those areas.

Habitat loss in Southdown Reserve is expected to occur as the current alignment traverses this area. However as discussed in Section 3 the reserve is disconnected from neighbouring reserves and the adjacent coastline and is as a result a bioisland of unknown ecological value.

5.1.4 Sediment and water contamination

Of the contaminants reported in the reviewed reports and known to be produced in association with road surfaces, four key contaminants of concern were identified, including copper, lead, zinc and polycyclic aromatic hydrocarbons (PAHs). The predominant source of these key contaminants is from tyre wear and therefore directly associated with the volume of traffic using the alignment, the type of vehicle, road speed limits and the type of road surface used. Particulates, fines and sediments are further sources of contamination and are also considered in Appendix A.

Stormwater treatment measures including swales, wetlands and erosion and sediment control measures (refer to Erosion and Sediment Control Assessment) will be used to manage stormwater from the EWC alignments and the existing road surface in those areas where the option involves pavement widening on the current road network. Given the construction of new treatment devices it is likely that stormwater will be treated to a higher level than currently, leading to potentially improved discharge quality.

5.2 Assessment of the Proposed Alignment Options

Each of the six options has been assessed in terms of potential ecological effects. These are summarised below and we refer to Table 1 for a full list of potential effects.

5.2.1 Option A

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option A.

Option A introduces approximately 2.3ha of additional impervious area and is generally widening of existing road infrastructure. With regards to changes to the existing ecology within the project area there are minimal impacts introduced by Option A.

Option A:

- Uses the existing road network and bypasses sensitive ecological areas including the Mangere Inlet foreshore.
- Has minimal impact to the Mangere foreshore at the Hopua tuff ring.
- Has no direct effect on Hamlins Hill – Mutukaroa Reserve.

Based on the high level potential effects of the project on ecology, Option A is likely to have the least potential adverse effects.

5.2.2 Option B

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option B.

Option B is similar to Option A from SH20 to the connection to/from SH1. It introduces approximately 7.6ha of additional impervious area. At SH1 there are significant works proposed to implement new on and off ramps.

Option B follows a similar alignment as Option A but instead requires a landtake along the edge of Hamlins Hill – Mutukaroa a site of cultural and potential ecological significance. An upgrade of the SH1 bridge at Otahuhu Creek is also proposed which may result in some localised effects to the creek including loss of mangroves and increased sedimentation during construction activities.

5.2.3 Option C

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option C.

Option C introduces 14.7ha of additional impervious area. This is generally located in the middle section of the new alignment, between the Mangere Inlet foreshore and SH1.

Option C alignment passes in close proximity to Ann's Creek a site of ecological and cultural significance. Loss of mangroves and intertidal vegetation (eg, saltmarsh) is likely with increased sedimentation during construction activities. While stormwater treatment options have not been confirmed, wetlands and stormwater filters will be used to manage flows and provide contaminant treatment. Construction of the alignment is also expected to incorporate additional stormwater treatment above that already provided for on the roading network but will nevertheless still contribute additional stormwater contaminants to the CMA. Provision of wetlands in upper Ann's Creek may provide additional ecological habitat and should be investigated further by a suitably qualified ecologist.

5.2.4 Option D

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option D.

Option D introduces the largest area of impervious area compared to the other options – approximately 17.3ha. The works proposed for Option C within the Ann's Creek environment are also applicable to Option D. Refer to Option C above for a brief summary of potential ecological effects.

5.2.5 Option E

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option E.

The alignments that follow the southern Onehunga foreshore (Options E and F) will be constructed on a new embankment separate from the foreshore.

Option E represents the largest potential ecological effects as the alignment traverses the CMA from Mangere Bridge to Ann's Creek. This option requires reclamation of the CMA to accommodate the road including space for a bicycle passageway and a revetment wall to stabilise the road. The effects of this will include habitat loss of the intertidal area, loss of potential shorebird feeding area and potential noise and vibration effects. The alignment is also expected to traverse Ann's Creek with the alignment passing through the mangrove area. Construction of this alignment will require the removal of mangroves to accommodate the alignment and will affect shorebirds feeding/foraging area and introduce more noise and vibration to the CMA.

Option E provides a high degree of ecological impact.

5.2.6 Option F

Refer to Table 1 for risks relevant to the assessment of environmental effects that relate to ecology for Option F.

Similar to Option E, the alignment that follows the southern Onehunga foreshore will be constructed on a new embankment separate from the foreshore.

The works proposed for Option E along the foreshore and within the Ann's Creek environment are also applicable to Option F. The difference being the alignment takes an inland path at approximately Waikaraka Park and then rejoins the CMA in the upper reaches of Ann's Creek. The potential ecological effects of Option F are less than for Option E in that the alignment will no traverse the CMA until above the railway lines and will not require the same extent of mangrove removal to accommodate any alignment structure.

Option F also provides a high degree of ecological impact but provides a lower risk than Option E.

Table 1 High level indicative ecological risks for each alignment option

Option	Impact	Impact Description	Indicative Risk Rating
A	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
	Water quality	Stormwater contaminants (above current levels) entering network and discharging to CMA	Medium
	Pest species	Provision of habitat for pest species and transference of pest species to adjacent areas	Low
B	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
		Habitat loss at Hamlins Hill (approximately 30m width along SH1) and removal of terrestrial bush	High
		Habitat loss and displacement of species from existing bush areas	Medium
		Loss of mangrove trees associated with bridge upgrade	Low
	Water quality	Additional contaminated stormwater flow into Otahuhu Creek – increased toxicity to organisms at discharge	Low
		Additional stormwater contaminants entering Hamlins Hill Reserve	Low
	Landtake	Landtake at Hamlins Hill	High
	Pest species	Suitable habitat for pest species colonisation and spread of pests	Low

Option	Impact	Impact Description	Indicative Risk Rating
C	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
		Loss of riparian vegetation at Ann's Creek	Medium
		Loss of coastal margin mangroves for alignment construction	High
		Impact to potential fish spawning habitat within mangrove stands	High
		Loss of upstream intertidal vegetation	Medium
		Habitat loss of Southdown Reserve vegetation - ecological value unknown at this stage	Medium
		Impact to mangroves from bridge upgrade at Otahuhu Creek	Low
	Water quality	Stormwater contaminants (above current levels) entering network and discharging to CMA	Medium
		Loss of riparian vegetation at Ann's Creek	Medium
		Loss of coastal margin mangroves for alignment construction	Low
	Sediment quality	Increase in sediments from road margin not contained within treatment infrastructure	Medium
	Pest species	Construction activities providing new transmission pathways for pest species colonisation	Low
	Landtake	Displacement of shorebirds from intertidal feeding area	Low
	Noise and vibration	Displacement of shorebirds from intertidal feeding area	Medium
		Loss of upstream intertidal vegetation	Medium

Option	Impact	Impact Description	Indicative Risk Rating
D	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
		Loss of localised mangroves and riparian vegetation (Ann's Creek) for alignment construction	High
		Impact to potential fish spawning habitat within mangrove stands	High
		Loss of upstream intertidal vegetation (Ann's Creek)	Low
		Habitat loss of Southdown Reserve vegetation - ecological value unknown at this stage	Medium
		Impact to mangroves from bridge upgrade at Otahuhu Creek	Low
	Water quality	Potential increase of contaminated stormwater entering freshwater stream at Waikaraka Park and discharging to CMA	Low
		Stormwater contaminants (above current levels) entering network and discharging to CMA	Low
		Stormwater discharging into Ann's Creek contributing to a potential decrease in water quality	Medium
		Potential increase in stormwater entering Otahuhu Creek from alignment	Low
	Sediment quality	Increase in sedimentation from road runoff and contributing additional sediment bound contaminants to sediment dwelling/feeding organisms	Medium
	Pest species	Construction activities providing new transmission pathways for pest species colonisation	Low
	Noise and vibration	Displacement of shorebirds from intertidal feeding area	Medium
		Displacement of species inhabiting intertidal area and increase in area not favourable for recolonisation	Low
		Displacement of species inhabiting Southdown Reserve	Medium

Option	Impact	Impact Description	Indicative Risk Rating
E	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
		Loss of intertidal area - macrofauna and sediment	High
		Loss of potential shorebird feeding habitat	High
		Removal of mangroves - loss of mangrove habitat for juvenile fish, shorebirds etc	High
		Separation of Ann's Creek habitat from wider Inlet area – ie, lower quality habitat due to increase noise	High
		Sediment scouring and creation of new channels from bridge pile establishment	Medium
		Loss of shorebird feeding habitat due to alignment construction	High
		Loss of localised mangrove habitat from Otahuhu Creek at SH1 bridge upgrade	Low
	Water quality	Stormwater contaminants (above current levels) entering network and discharging to CMA	Medium
		Stormwater discharging into Ann's Creek contributing to a potential decrease in water quality	High
		Potential increase in stormwater entering Otahuhu Creek from alignment	Low
	Landtake	Reclamation of foreshore CMA area for construction	High
	Noise and vibration	Displacement of shorebirds and other fauna from the area	High

F	Habitat loss	Loss of intertidal section adjacent to the tuff ring	Medium
		Loss of intertidal area - macrofauna and sediment	High
		Loss of potential shorebird feeding habitat	High
		Removal of mangroves - loss of mangrove habitat for juvenile fish, shorebirds etc	High
		Sediment scouring and creation of new channels from bridge pile establishment	Medium
		Loss of shorebird feeding habitat due to alignment construction	High
		Loss of potential fish breeding habitat (ie yellow eyed mullet)	High
		Loss of mangrove habitat from Otahuhu Creek at SH1 bridge upgrade	Low
		Modification to freshwater stream adjacent to Waikaraka Park	Medium
	Water quality	Additional stormwater contaminants entering network and discharging to CMA	Medium
		Potential increase in contaminated stormwater discharging into Ann's Creek	High
		Potential discharge of contaminated stormwater into Otahuhu Creek potentially impacting flora and fauna, increased scour of channel	Low
		Discharge of stormwater contaminants to freshwater stream above current levels with potential for organism effects	Low
	Landtake	Reclamation of foreshore CMA area for construction	High
	Noise and vibration	Displacement of shorebirds and other fauna from the area	High

6. Recommended Mitigation Required

The construction and operational phase of the East West Connections project will affect the environment.

There are a wide range of negative ecological effects such as habitat loss within the foreshore environment and potential increased stormwater contamination to Ann's Creek and along the foreshore discharge areas. The adverse ecological effects generated from each of the alignments may be limited by appropriate mitigation measures designed and implemented using a best practicable option design process.

The following mitigation measures are proposed but should not be limited to:

- Implement ecological sensitive design into all alignment options with a particular focus on Options E and F.
- Stormwater treatment at all proposed discharges to reduce contaminant loadings to the CMA and creek environments (Ann's Creek and Otahuhu Creek).
- Where possible use constructed wetlands to improve stormwater retention and contaminant reduction. Wetlands should be designed in consultation with a suitably qualified ecologist to ensure appropriate planting and overall design encourages habitat creation.
- Avoid destruction of the lava remnants at the coastal margins by considering alternative road construction methods (eg, elevated structure over lava flows).
- Consider road pavement composition to reduce tyre wear and tear and contribute to overall contaminant reduction.
- Incorporate intertidal habitat creation along seaward side of foreshore alignments. This should be done in consultation with the landscape team and a suitably qualified ecologist.
- If significant ecological effects are unavoidable, suitable mitigation measures should be selected and implemented. Where no mitigation is possible suitable sites for ecological offset should be identified and assessed. Identification of these sites requires the involvement of a suitably qualified ecologist.
- Where removal of vegetation is unavoidable, replacement with suitable native species should be carried out.
- Where construction within Ann's Creek is unavoidable, translocation of sensitive species (eg, *Coprosma crassifolia*) should be discussed in consultation with appropriate Auckland Council ecologists. These species should be returned to the area following construction and monitored thereafter to ensure successful recolonization.
- Mitigating loss of macrofauna habitats could be achieved by reducing the footprint of coastal construction to reduce the displacement pressure on remaining habitats.

7. Conclusions and Recommendations

7.1 Conclusions

- Option A appears to have the least potential to cause adverse ecological effects.
- Option B introduces ecological effects at Hamlins Hill – Mutukaroa.
- Option C introduces ecological effects at the upper reaches of Ann's Creek.
- Option D introduces ecological effects at the upper reaches of Ann's Creek and Otahuhu Creek (Tamaki Estuary).
- Option E appears to have the most significant ecological effect across the entire alignment length with the greatest risk to the foreshore and Ann's Creek environments. Option E will likely require the greatest degree of mitigation.
- Option F involves the largest extent of reclamation and has an alignment that crosses the outer reaches of Ann's Creek on a bridge structure. This option therefore has similar ecological effects as for Option E but the extent of the foreshore effects is reduced in comparison (ie, reduced extent of reclamation) and an improved alignment at Ann's Creek.

With further assessment and analysis carried out on a more robust and final design of a preferred option; implementation of the mitigation measures described in Section 6; and particular focus given to areas of particular risk described in Table 1, Section 6; then the overall ecological effects are likely to be manageable for any option that may be selected through the optioneering/multi criteria analysis phase. We acknowledge that the proposed stormwater treatment options for the new EWC alignments are likely to cater for existing catchment loads as well as any additional loads with an overall predicted improvement in water quality above current conditions. Further assessment and analysis of the preferred option is expected to quantify this.

We have carried out a very high level assessment of environmental effects that relate to ecology based on a high level design. We have identified measures that can potentially be implemented to avoid, remedy and mitigate possible ecological effects that are a consequence of the project options.

7.2 Recommendations

We recommend undertaking a comprehensive quantitative assessment of the magnitude of the environmental effects that relate to ecology and the subsequent required measures required to minimise these effects. To do this the project may require the following detailed analyses and at a minimum, it is essential that the following is carried out to inform this quantitative assessment (list in not in preferential order):

- Investigate the presence of permanent or ephemeral streams and where appropriate carry out instream surveys (ie stream ecological valuations) prior to construction.
- We recommend a detailed site assessment of Southdown Reserve and Hamlins Hill be carried out in the next stage of works to determine the ecological value of the site.
- Review and assess information from other discipline assessors. Collaborate with these assessors as required to ensure consistent assessments are being carried out and efficient sharing of knowledge, findings and information is being shared.
- Hydrological assessment in the consenting phase to compare catchment contaminant runoff for pre and post development scenarios.

- Determine the stormwater discharge amount and flow rates from each of the discharge outlets.
- Assess potential areas of risk not included in this assessment.
- Adopt an ecologically sensitive design approach in consultation with a suitably qualified ecologist for the preferred option to minimise environmental impacts.
- Determine the actual ecological impacts associated with any reclamation of the foreshore (Option E and Option F) through targeted field surveys.
- Determine the ecological value of Ann's Creek (including the presence of *Coprosma crassifolia*) and quantify the ecological impacts to the marine environment associated with construction of Option C, D, E and F.
- Determine the ecological impacts associated with discharging additional stormwater flow to Ann's Creek.
- Assess the effects of foreshore habitat loss on flora and fauna (eg, mangroves on lava flow remnants, shorebird feeding habitat).
- Determine best stormwater treatment options in consultation with stormwater team to provide additional habitat (eg, constructed wetlands) and improve stormwater quality conveyed from the alignment and discharged to the receiving environment.
- Investigate existing watercourses affected by the project options and assess the potential impact on their flow regime, instream ecology and baseline environmental quality.
- Where culverting or piping of existing watercourses is proposed assess and provide mitigation measures for fish passage (where appropriate).
- Where habitat loss is unavoidable, identify sites for potential remediation and ecological offset.
- Assess shorebird presence/absence, foraging and breeding areas within the EWC project area to assess the potential effects at a species level for each option.

8. References

Auckland Regional Council. 2003. Effects of suspended sediment concentrations on suspension and deposit feeding marine macrofauna. Auckland Regional Council Technical publication TP 211, August 2003. ISSN 1175 205X.

Auckland Regional Council. 2004. Blueprint for monitoring urban receiving environment. Auckland Regional Council Technical publication TP 168, August 2004. ISSN 1175-205XISBN 1-877353-39-6

Auckland Regional Council. 2004a. Auckland Council Regional Plan: Coastal.

Auckland Regional Council. 2007. Marine receiving environment stormwater contaminants: status report 2007. Technical report No. 333, June 2007. ISSN 1175-205X

Auckland Regional Council. 2009. Environmental condition and value of Manukau Harbour. Technical report No. 112, September 2009. ISSN 1179-0512 (Online).

Auckland Regional Council. 2010. Ecological Impacts from stormwater in the Auckland region: a literature review. Technical report No. 021, April 2010. ISSN 1179-0512 (Online).

Auckland Regional Council. 2010a. State of the Auckland Region. ISBN 978-1-877540-45-5.

Auckland Council. 2012. Marine sediment contaminants: Status and trends assessment 1998-2010. Technical report TR2012/041. ISSN 2230-4533 (Online).

Auckland Council. 2012a. State of Auckland Marine Report Card: Manukau Harbour.

Auckland Council 2012b. State of Auckland Marine Report Card: Tamaki Estuary.

Auckland Council. 2013. Manukau Harbour Ecological Monitoring Programme: Report on data collected up until February 2013. Technical report 2013/027. ISSN 2230-4533 (Online).

Auckland Council. 2014. Marine sediment contaminant monitoring: Organic contaminant data review 2003 – 2010. Technical report TR2014/001. ISSN 2230-4533 (Online).

Auckland Council. 2014a. Climate change. http://www.aucklandcouncil.govt.nz/EN/ENVIRONMENTWASTE/NATURALHAZARDSEMERGENCIES/HAZARDS/Pages/climatechangehazards.aspx. Accessed 03/10/2014.

Baird, S.J. 2011. New Zealand fur seals – summary of current knowledge. New Zealand Aquatic Environment and Biodiversity Report No. 72. ISSN 1176-9440.

Bell, R.G., Dumnov, S.V., Williams, B.L., Grieg, M.J.N. 1998. Hydrodynamics of Manukau Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research. 32:81 – 100.

Croucher, A.E., Bogle, M.G.V., O'Sullivan, M.J. 2005a.Coastal receiving environment assessment (CREA). Report 1: Modelling framework. Uniservices, University of Auckland.

Croucher, A.E., Bogle, M.G.V., O'Sullivan, M.J. 2005b.Coastal receiving environment assessment (CREA). Report VI: Manukau Harbour. Uniservices, University of Auckland.

DeMaster, D.P., Fowler, C.W., Perry S.L., Richlen, M.E. 2001. Predation and competition: the impact of fisheries on marine-mammal populations over the next one hundred years. Journal of Mammalogy. 82(3): 641-651.

Gardner, R.O. 1992. Native vegetation at Ann's Creek, Southdown, July 1992 [Online]. Available: http://bts.nzpcn.org.nz/bts_pdf/Auck_1992_47_2_39-40.pdf. [19 September 2014].

Hamner, R. M., Oremus, M., Stanley, M., Brown, P., Constantine, R., Baker, C.S. 2012. Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2010-11, with retrospective matching to 2001-07. Department of Conservation, Auckland.

Henriques, P.R. 1977. Selected ecological aspects of the Manukau Harbour. PhD Thesis. University of Auckland.

Hume, T.M., Snelder, T., Weatherhead, M., Liefting, R. 2007 A controlling factor approach to estuary classification. Ocean and Coastal Management. 50:905-929

Kelly, S. 2007. Contaminant monitoring in shellfish: Results of the 2005 Shellfish Contaminant Monitoring Programme. Auckland Regional Council Technical publication 332.

Mills, G.N., Williamson, R.B. 2008. The Impacts of Urban Stormwater in Auckland's Aquatic Receiving Environment: A Review of Information 1995 to 2005. Prepared by Diffuse Sources Ltd and Geosyntec Consultants for Auckland Regional Council. Technical Report 2008/029.

Ministry for the Environment. (2008). Preparing for climate change: A guide for local government in New Zealand.

Moore, C.J. 2008. Synthetic polymers in the marine environment: A rapidly increasing long-term threat. Environmental Research 108: 131.

Morrisey, D., Beard, C., Morrison, M., Craggs, R., Lowe. M. 2007. The New Zealand Mangrove: Review of the Current State of Knowledge. NIWA Client Report: HAM2007-052. Prepared for Auckland Regional Council.

NIWA. 1994. The distribution and fate of contaminants in estuarine sediments. Auckland Regional Council Technical Publication No. 47.

Taylor, B.L. 2002. Conservation biology. Encyclopedia of marine mammals. Perrin W.F., Würsig B. and Thewissen H. San Diego, CA, Academic Press: 273-276.

Thompson, P.M., Wilson, B., Grellier, K., Hammond, P.S. 2000. Combining power analysis and population viability analysis to compare traditional and precautionary approaches to conservation of coastal cetaceans. Conservation Biology. 14(5): 1253-1263.

Turner, S., Schwarz, A.M. 2006. Management and conservation of seagrass in New Zealand: an introduction. Prepared for Department of Conservation.

Vant, W.N., Williams, B.L. 1992. Residence times of Manukau Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research. 26: 393 – 404.

Williamson, R.B., Van Dam, L.F., Bell, R.G., Green, M.O., Kim, J.P. 1996. Heavy metal and suspended sediment fluxes from a contaminated intertidal inlet (Manukau Harbour, New Zealand). Marine Pollution Bulletin. 32: 812 – 822.

Appendices

Appendix A – Background Information: Existing Environment

In this section we provide a summary of available and related environmental information that provides the context for assessing the potential ecological effects presented by each of the six (6) alignment options.

The EWC proposed alignments cross two marine environments, namely the Manukau Harbour and an upper tributary of the Tamaki Estuary (Waitemata Harbour) at SH1.

The proposed EWC alignments also cross a small area of non-descript vegetation at the Southdown Reserve and again along Hamlins Hill. A description of the baseline environment for each of these locations except Hamlins Hill is provided below. Ecological considerations for Hamilins Hill are addressed briefly in the main body of this report. Hamlins Hill is also described in the Landscape Assessment and the Built Heritage Assessment and should be referred to for detailed site information.

The environment within the project area is characterised to provide the baseline condition against which potential impacts originating from the six (6) alignment options can be identified.

Location and Description

Description of the Manukau Harbour

The Manukau Harbour is the second largest harbour in New Zealand with an area of approximately 365km^2 and a shore length of approximately 460km. The total catchment surrounding the harbour is approximately 895km^2 and includes rural, industrial and urban land uses (ARC 2009). The East West Connections project is located in proximity to Mangere Inlet which has seen extensive modification including reclamation along the eastern shore in the 1960's in relation to the development of the Westfield rail yards (ARC 2009). The southern shore is not as modified with Tararata and Harania Creeks still remaining largely unaffected by reclamation or urban and industrial development (ARC 2009). However Ann's Creek, a historic portage route between the Manukau Harbour and Waitemata Harbour is a highly modified environment with only a short section of open stream remaining due to land development and coastal reclamation (ARC 2009). The northern shore of Mangere inlet has also seen extensive reclamation for additional land uses including a cemetery; landfill (now closed) and industry (refer to the contaminated land assessment report for a full description).

Description of Mangere Inlet

Mangere Inlet (Figure 1) located in the northeast portion of the Manukau Harbour has also been a deposition site for contaminants derived from sewage, urban and industrial stormwater and rural runoff due to its shallow basin and extensive mudflats. Up until 1962 these contaminants were discharged directly into the Manukau Harbour (with substantial contaminant settlement within Mangere Inlet) at a rate of 25 million litres of trade waste and 675,000 litres of untreated sewage daily (ARC 2009). Since 1962 these contaminants were treated at the Mangere Wastewater Treatment Plant (MWWTP) and discharged to the Manukau Harbour (NIWA 1994). However, while commissioning of the MWWTP improved water quality and indirectly the environmental condition of the harbour, there was a significant loss of coastal and intertidal habitat between the Mangere coastline and Puketutu Island, blocking off of Oruarangi Creek and habitat loss of Mangere Lagoon. The water quality impacts were partly improved when the MWWTP was upgraded in 2002 including the decommissioning and removal of the oxidation ponds and their replacement with nine biological nitrogen removal activated sludge reactor clarifiers (ARC 2009). The upgrade also included re-opening Oruarangi Creek and the Mangere Lagoon to the sea and the restoration of beaches and sand flats between the Mangere coastline and Puketutu Island (ARC 2009).

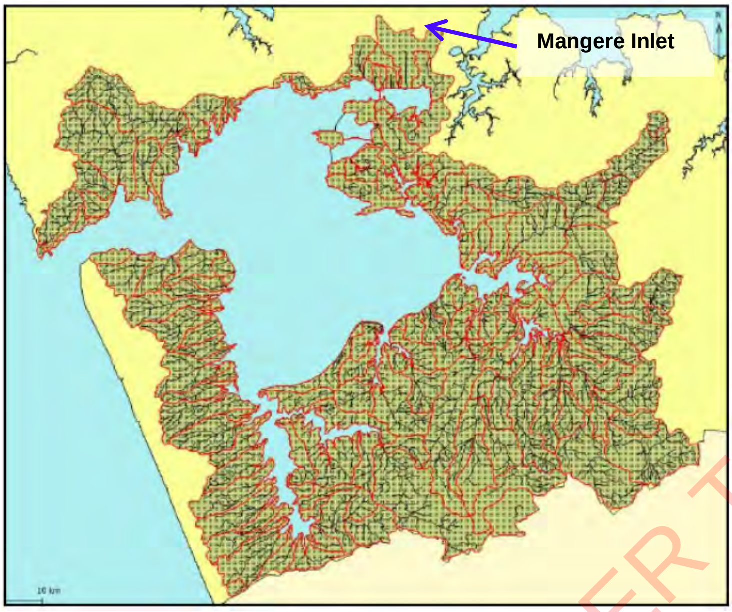

Figure 1 Manukau harbour catchment and stream systems

Description of the Tamaki Estuary

The Tamaki Estuary is a 17km long tidal inlet and covers an area of approximately 1,600ha. The catchment is predominantly urban covering an area of approximately 11,500ha. As reported by ARC (2008) the main channel splits into a number of tributaries, the largest of which are: Pakuranga Creek, Panmure Basin, Otahuhu Creek and Otara Creek. Otahuhu Creek is currently crossed by SH1 and will be the focus of a bridge upgrade to accommodate increased traffic associated with the EWC proposed alignments Option B, Option C, Option D, Option E and Option F.

A large proportion of the estuary consists of intertidal sand and mud flats similar to the Mangere Inlet. Mangrove forests dominate in the upper reaches of the estuary particularly along the tidal arm of Otahuhu Creek. While no vegetation records were located specific to the Creek area it is likely that Otahuhu Creek intertidal vegetation is similar in its form and function as other estuarine sites located throughout the Auckland region.

Otahuhu Creek

Otahuhu Creek is located in the upper reaches of the Tamaki Estuary where extensive mangrove forests have colonised the coastal margin. The Creek was strategically important to local Maori communities prior to the 1840s because of the narrow corridor of land that separates Otahuhu Creek from Ann's Creek in the Mangere Inlet. The corridor was used by both Maori and Europeans for portage of canoes and boats between the east and west coasts and together with the Waiuku portage provided a critical link to the Waikato River (ARC 2008). Today, the Ann's Creek/Otahuhu Creek portage is overgrown with invasive weeds, receives stormwater and wastewater from multiple discharge points and contains large amounts of rubbish.

Ecological monitoring carried out in the Tamaki Estuary as part of the State of the Environment (SoE). Monitoring showed high levels of sediment associated contaminants particularly zinc in the upper intertidal areas with an overall estuarine quality grade of D (ie, poor ecological quality). The accumulation of contaminants in these areas is likely due to historic influences and current catchment and stormwater discharges. This trend is also seen in the intertidal creeks within the Mangere Inlet where tidal energy is low leading to increased deposition of contaminants (AC 2012b).

A check of the Auckland Regional Plan: Coastal identified no sites of ecological significance within Otahuhu Creek but identified two areas (45a and 45b) in the adjacent Pakuranga Creek (Table 2; Figure 2). The Department of Conservation (DOC) has also identified the entire Tamaki Estuary as a regionally important wildlife habitat and as such has been identified as an Area of Significant Conservation Value (ASCV). Table 2 describes the CPA areas within close proximity to Otahuhu Creek but does not describe the remaining sites as identified on Figure 2. A full description of the CPA and ASCV sites is contained in Appendix B.

Table 2 Coastal protection areas (CPA) and areas of significant conservation value (ASCV) in the Tamaki Estuary

Protection Type	CPA/ASCV Number	Description
Coastal Protection Area 1	45a and 45b	**Pakuranga Creek and Roost** Pakuranga Creek roost (45a) is one of the roosting sites used by some of the hundreds of wading birds that feed within the Tamaki Estuary. The whole of the Tamaki Estuary is a regionally important wildlife habitat and has been selected by the Department of Conservation as an Area of Significant Conservation Value (ASCV). This roost is associated with the values of Coastal Protection Areas 47, 48 and 49 and forms an integral part of the wildlife habitat values of the estuary. The mangrove areas of Pakuranga Creek (45b) are regarded as the best example of mangrove habitat in the Tamaki Estuary.

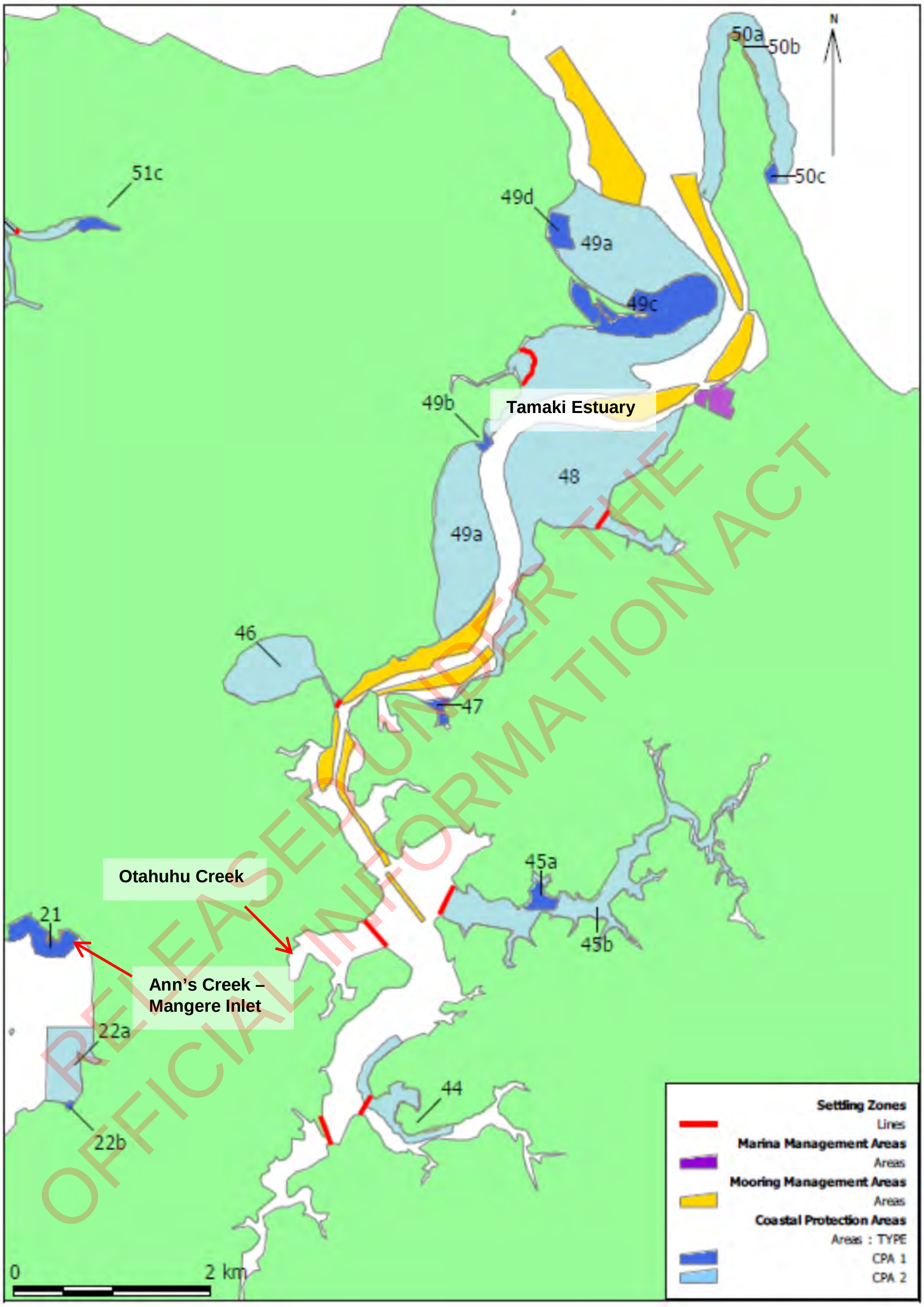

Figure 2 Coastal protection areas (CPAs) and areas of significant conservation value (ASCV) in Tamaki Estuary. The sediment and contaminant settling zones identified in the Auckland Regional Plan:Coastal are also shown (ARC 2004a)

Areas of Significant Conservation Value

Five primary coastal protection areas (CPAs 21 to 23b) in Mangere Inlet are either in, or in the immediate vicinity of the EWC project area (ARC 2004a; Figure 3; Table 3). Coastal protection area 22 is subdivided into two sub-areas and coastal protection area 23 is divided into three sub-areas: two of which are located within Mangere Inlet (Figure 3). The primary reasons for the CPA designations are:

- Geology and landforms: CPA23b.
- Wading birds: CPA23a-b.
- Mangroves: CPA21
- Shrublands and saline vegetation: CPA21, CPA22a-b.
- Intertidal mud or sandflats: CPA22a, CPA23a-b.

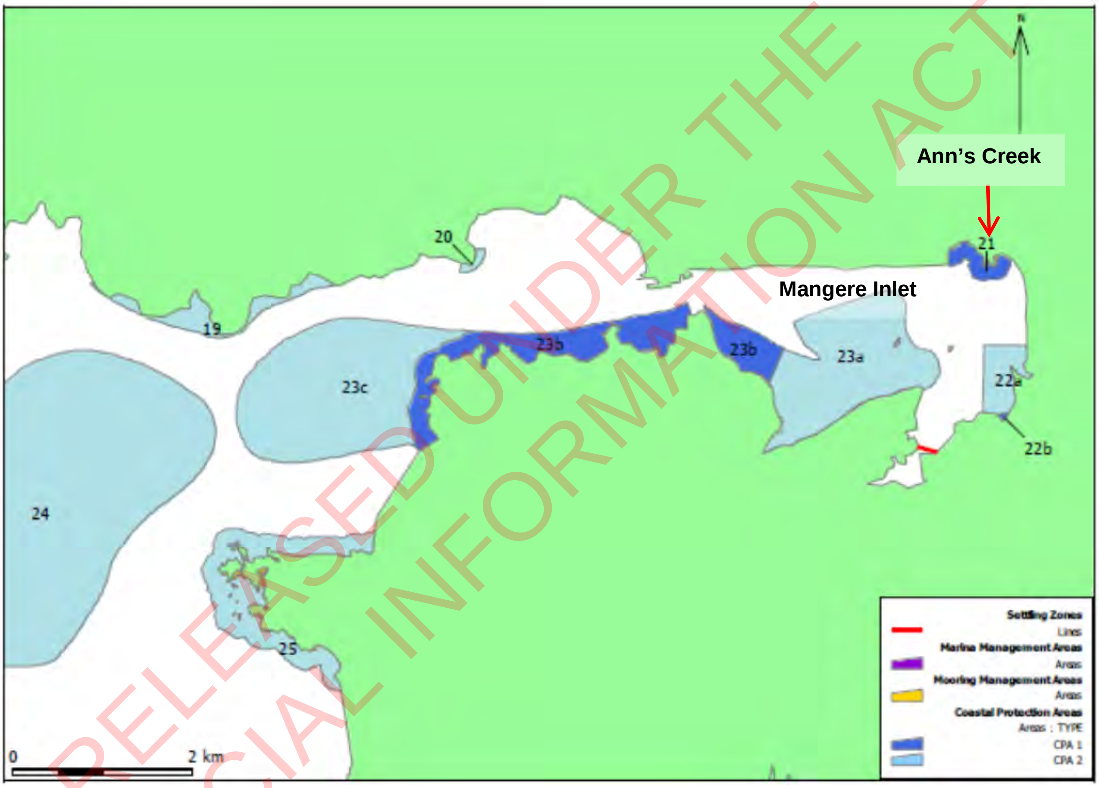

Figure 3 Coastal protection areas (CPAs) and areas of significant conservation value (ASCV) in Mangere Inlet

Table 3 Coastal protection areas (CPAs) and areas of significant conservation value (ASCV) in Mangere Inlet (ARC 2004a)

Coastal Protection Area	CPA/ASCV No.	Description
Coastal Protection Area 1 and Area of Significant Conservation Value	21/7	**Ann's Creek** Mangroves in the intertidal area form part of a unique gradient with the only significant remaining piece of native shrublands on lava flows in the Tamaki ecological district. The shrubland is the first ever collection site of the shrub, *Coprosma crassifolia*.

Coastal Protection Area	CPA/ASCV No.	Description
Coastal Protection Area 2 and Area of Significant Conservation Value	22a/7	**South East Mangere Inlet** A diverse maritime marsh and small raised banks of clean sand supporting several species of plants characteristic of such areas. In the intertidal areas below the vegetated areas are extensive upper intertidal mudflats with dense populations of characteristic species.
Coastal Protection Area 2 and Area of Significant Conservation Value	22b/7	**South East Mangere Inlet** Small upper intertidal area supporting a high diversity of native saline vegetation. In the south-east corner is a 0.25ha meadow of bachelor's button, *Cotula coronopifolia*.
Coastal Protection Area 2 and Area of Significant Conservation Value	23a	**Ambury** This modified shoreline is used as a high tide roost by thousands of international migratory and New Zealand endemic wading birds including a number of threatened species. It is the most important winter roost on the Manukau Harbour for South Island Pied Oystercatchers.
Coastal Protection Area 1 and Area of Significant Conservation Value	23b	**Ambury** The intertidal banks are a feeding ground for the migratory birds and New Zealand endemic wading birds and a variety of other coastal bird species. The rocky area contains the best example of pahoehoe lava flows in New Zealand. These are located in the northern side of Kiwi Esplanade. For these reasons, the site has been selected by the Department of Conservation as an Area of Significant Conservation Value (ASCV).

Ann's Creek

An assessment of the Auckland Regional Plan: Coastal summarised Ann's Creek located within Mangere Inlet as CPA 1 and defined as an ASCV:

'mangroves in the intertidal area of Ann's Creek form part of a unique gradient with the only significant remaining piece of native shrublands on lava flows in the Tamaki ecological district. The shrubland is the first ever collection site of the shrub, Coprosma crassifolia'.

The Auckland Draft Unitary Plan also identified Ann's Creek as a Significant Ecological Area (SEA) with a M1 grading which due to the sites physical form, scale or inherent values, are considered to be the most vulnerable to any adverse effects of inappropriate subdivision, use or development. Specifically, Ann's Creek was described as:

'including a mosaic of vegetation types in an ecological sequence including basalt lava shrubland, freshwater wetlands, saltmarsh and mangroves. The freshwater wetland comprises an area of deep aquifer-fed water dominated by raupo and stream (Ann's Creek) which is dominated by grasses and sedges. The saltwater wetlands include a range of habitat types distributed along the salinity gradient. These include marsh clubrush (in brackish water – where salt and freshwater meet), glasswort, oioi, ribbonwood and mangrove communities. The lava substrate supports a shrubland community with a patchy distribution of native shrubs but the rocky substrate prevents a thick shrub cover leaving open patches of lava for herbs and ferns. Ann's Creek is the only site in the region where a suite of native herbs remain growing together

on lava, indicative of much of the vegetation cover of early Auckland. These include three threatened Geraniums (G. retrorsum (nationally vulnerable), G. solanderi and Pelargonium inodorum). The lava field at Ann's Creek is also the type locality for the shrub Coprosma crassifolia collected there by William Colenso in 1846. Mature inanga (Galaxia maculatus) spawn there and both Australian bittern ('nationally endangered') and banded rail ('naturally uncommon') are present'.

Despite the ecological classifications of Ann's Creek, the site has not been well maintained with litter present on site and substantial areas of weed growth (ARC 2009). Gardner (1992) reported the area to contain blackberry as well as shrubby weeds including flannel-leaf and boneseed.

Climate Change

The Auckland region is known to have a sub-tropical climate with warm humid summers and mild winters. Summer daytime temperatures generally range from 20^{o}C to 26^{o}C with temperatures seldom exceeding 30^{o}C. In comparison, winter daytime temperatures generally range from 12^{o}C to 16^{o}C. Auckland is also affected by significant rainfall events predominantly in winter with fewer events during summer. Summer rainfall is predicted to increase as temperature rises resulting in a more tropical climate.

According to Auckland Council the climate change projections for the region include (AC 2014a):

- Increase in the mean air temperature.
- Increase in sea level due to thermal expansion within oceans.
- Fewer periods of cold temperatures and an increase in the number and intensity of periods of high temperatures. Auckland is predicted to have more temperatures above 25^{o}C.
- Decrease in annual mean rainfall.
- Increased frequency and intensity of extreme rainfall events due to a warmer atmosphere.
- Increased intensity of El Niño and a possible increase in El Niño frequency with an associated increase in the annual mean westerly wind flow.
- Possibly more intense tropical cyclones bringing torrential rain, strong winds and storm surges.

The potential effects of climate change on the Auckland region are unknown but the substantive information base and scientific investigations provides a good base on which to make an informed assessment of potential effects (MfE 2008). For the Auckland region climate change is predicted to exacerbate or create a range of environmental issues including:

- Damage to properties and critical infrastructure from more intense inland flooding and coastal inundation.
- Coastal erosion from larger waves hitting the coastline.
- Intertidal inundation leading to habitat loss particularly intertidal vegetation.
- Drought conditions leading to loss of shallow wetlands.
- Salinisation of land flooded by sea level rise.
- Loss of land resulting in shorelines retreating closer to coastal infrastructure.

- Small increases in temperature may significantly increase the incidence of pest outbreaks in Auckland with both existing and potential new plant and animal pests becoming established more widely.

Seasonality

All six (6) preferred East West Connection alignment options will be influenced by a marine environment that will at times be hostile to sections of road in proximity to the coastal marine area. This constant attack from weather conditions on the road surfaces is influenced by seasonal conditions (temperature, rainfall, and storm frequency). The climate of the Auckland region is dominated by low pressure weather systems that during winter produce strong winds, rough seas and prolonged rainfall. During summer and autumn, the Auckland region is more often affected by storms and can produce short periods of high winds and seas, and heavy rainfall. Mean annual rainfall within the Manukau Harbour ranges between

Data from the National Climate Database (NIWA 2014) from the Mangere weather station (Agent number 22719) shows that the average monthly rainfall in winter (May – August) ranges between 108 to 137mm (Figure 4).

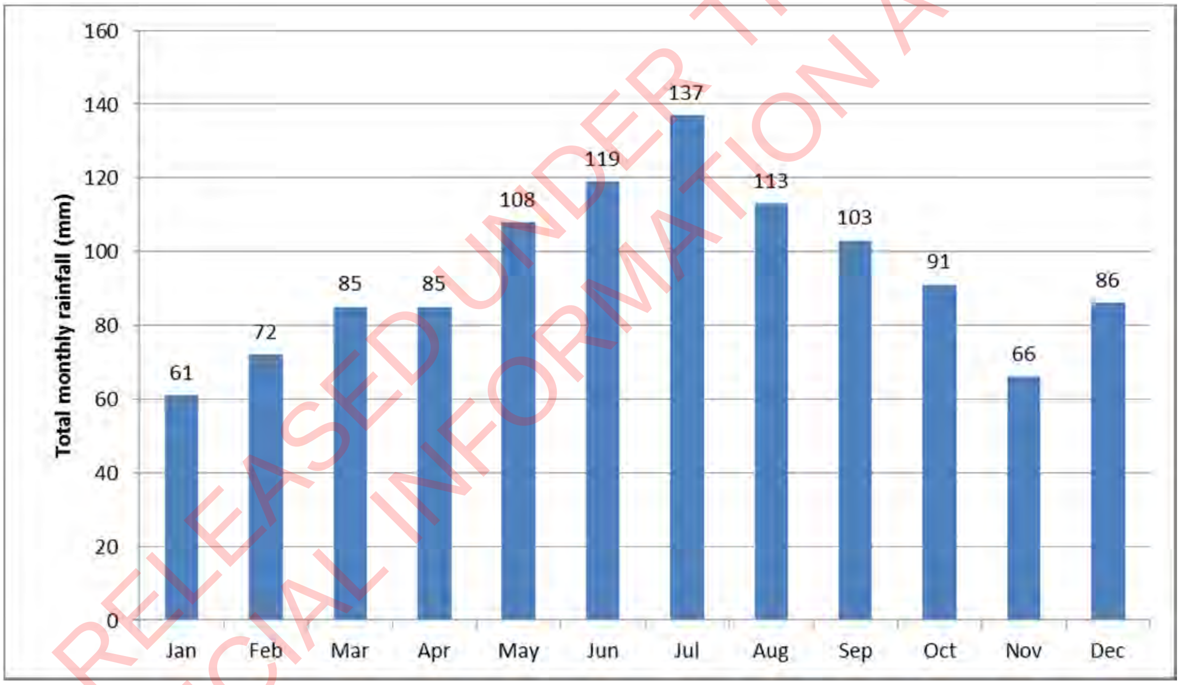

Figure 4 Total monthly rainfall (mm) from 1981 to 2010 for Auckland (NIWA 2014)

Rainfall events can increase the discharge of residues that have built up on road surfaces from associated traffic and maintenance activities to receiving environments. Therefore, alignment options that are located near to the coastal marine area will increase the chance of contaminants being discharged into the surrounding marine environment.

High suspended sediment concentration (SSC) recordings from catchment runoff into marine environments are also often attributed to prolonged rainfall periods (Oldman et al. 2008). While the EWC alignment options will not accumulate the same types of sediments (terrigenous source), it indicates the impact heavy rainfall can have as a medium for transporting contaminants and sediments.

Hydrodynamics

A Coastal Processes assessment report has been prepared for the project.

Hydrodynamics of the Manukau Harbour have been studied by Bell et al. (1998) with tidal ranges in the harbour reported as among the highest in New Zealand especially inside the harbour. Tidal height ranges at Onehunga wharf have been recorded between 3.4m and 2.0m with peak velocities at the neck of Mangere Inlet recorded at 1.0ms^{-1} during spring tides and 0.5ms^{-1} during neap tides (Bell et al. 1998). Residence times of marine water within the Manukau Harbour indicate that average harbour-wide exchange rates are between 11 and 22 days (Vant and Williams 1992). Residence times for the Mangere Inlet were assessed in relation to freshwater inflows (eg, stormwater) and estimated to be 12.6 days. This supports the conclusion drawn by Williamson et al (1996) that the inlet acts as a sediment and contaminant sink as the fluxes of suspended sediment in the Inlet were greater during the flood than the ebb tide. Croucher et al (2005a, b) also investigated the effects of stormwater flow during large storm events and reported that flow velocities increased around consolidated outfalls located in shallower parts of Mangere Inlet.

The direction of the water flow and residence time within Mangere Inlet will influence the transportation and fate of suspended sediments and contaminants in any stormwater discharged from any of the six preferred road alignment options. Sediments or contaminants discharged via stormwater outfalls on a high tide will primarily be transported to the upper reaches of Mangere Inlet and settle out in sheltered intertidal and embayment areas that already receive large volumes of sediment and contaminants from surrounding catchments.

Contaminants discharged from the road alignment options during a low tide will be transported either into the greater Mangere Inlet or will be dispersed in the intertidal area. Given the 12.6 day residence time it is unlikely that contaminated stormwater will be transported out of Mangere Inlet on each tidal cycle. Instead it is expected that the majority of suspended fine particles will be dispersed and deposited within Mangere Inlet with coarser sediments settling closer to the point source.

Geology

The Manukau Harbour has been described as a Category F estuary based on the Estuary Environment Classification of Hume et al. (2007). Category F estuaries are characterised as shallow basins with narrow mouths that are usually formed by a spit or sand barrier. The harbour has a complex shoreline with many side-branches extending off the main body of the estuary. Harbour sediments have been described to be sandy in the main body and muddy in the side branches (ARC 2009).

Marine Water Quality

The Manukau harbour has tended to have low water quality due to contaminants entering or being discharged into the harbour from various catchment land-uses and contaminant sources. Water quality has been of particular interest to the Auckland Council (formerly Auckland Regional Council) with State of the Environmental (SoE) monitoring carried out at multiple marine sites in both the Manukau and Waitemata harbours. Water quality was measured as the amount of measured metal concentrations (ie, copper, lead and zinc) as well as a range of nutrients and physical parameters (eg, temperature, total suspended solids, salinity). SoE reporting indicated the Manukau harbour sites generally had 'poor' water quality (based on contaminant levels long-term median values) particularly sites near to the MWWTP. Concentrations of copper and zinc were reported at their highest levels in sheltered areas of the harbour with relatively rapid accumulation of metals at the entrance to Ann's Creek. In comparison, metal concentrations decreased with increasing distance from the MWWTP with further decreases where tidal mixing was an influencing factor (ARC 2007).

Interestingly, ARC (2009) reported a strong positive association between median salinity and the average water quality ranking which suggests that overall water quality was strongly influenced by catchment freshwater runoff. However, it was also noted that this relationship wasn't a key feature in the Manukau Harbour which suggests that the influence of catchment freshwater runoff was overwhelmed by the discharge from the MWWTP (ARC 2000). However water quality within the Manukau harbour particularly Mangere Inlet has substantially improved since the upgrade to the MWWTP. Total suspended solids (TSS), turbidity and total phosphorus have all reported reductions with faecal coliforms and ammoniacal-nitrogen concentrations also declining significantly at sites closest to the MWWTP (ARC 2009). Overall, sites within Mangere Inlet reported some of the most elevated levels of contaminants and have been reported to be getting progressively worse compared with relatively clean sites which are either stable or deteriorating only slowly(ARC 2007).

Stormwater and environmental contamination

Heavy metals are one of the main constituents of Auckland's stormwater with copper, lead and zinc the main metals of concern. Given the majority of stormwater finds its way into Auckland's freshwater waterways contamination levels tend to be highest in urban streams compared with the coastal marine area (ARC 2010). The main reason being Auckland's waterways are the primary receiving environment for stormwater and depending on the system's ability to flush the contaminants will either retain and accumulate the contaminants within streambed sediments or be flushed from the system under high stormwater flows (ARC 2010). In comparison, stormwater contaminants tend to rapidly disperse and dilute in high energy receiving environments such as the coastal marine.

Copper, lead and zinc are not the only contaminants associated with stormwater with microbiological, organic and other metals also recorded from stormwater. The make-up of the contaminants depends on the size of the catchment, the activities occurring within it and the type (if any) treatment that the stormwater undergoes as it finds its way to the receiving environment (ARC 2010).

Given stormwater treatment is proposed for the six EWC alignments it is probable that any contaminants entering the harbour above current levels will be low and may have short-term impacts. Construction of the new alignment will be coupled with robust stormwater treatment infrastructure which is expected to treat stormwater to a higher level than what is currently discharged. The result is a potential improvement in water quality discharging into the harbour.

Marine Sediment Quality

The Manukau Harbour is influenced by contaminants from various catchment sources and is the focus on ongoing sediment quality investigations (Auckland Council 2012). The aim of the investigations is to understand the baseline condition against which changes in sediment quality parameters can be compared. By understanding the baseline sediment quality condition, an assessment of the potential environmental effects can be carried out on each of the six (6) road alignment options. The following paragraphs discuss current sediment quality of Manukau Harbour and Mangere Inlet.

The 2014 State of Auckland Marine Report Card for sediment quality found Mangere Inlet within the Manukau Harbour to be widely contaminated. Environmental Response Criteria (ERC) thresholds, which are set by Auckland Council (ARC 2004; Table 4), were reported in the

Auckland Council's marine report card for 2014. The ERC thresholds provide an indication of the potential effects of these contaminants on benthic ecology (ARC 2004).

Table 4 Environmental Response Criteria (ERC) and associated sediment quality guidelines (SQGs)

Substance	ERC (ARC 2004)			ANZECC (2000)	
	Green	Amber	Red	ISQG-Low	ISQG-High
Copper	<19	19-34	>34	65	270
Lead	<30	30-50	>50	50	220
Zinc	<124	124-150	>150	200	410
HWPAH[1]	<0.66	0.66-1.7	>1.7	1.7	9.6

It also found that Mangere Inlet is widely contaminated, with the highest concentrations recorded at Ann's Creek which receives runoff from predominantly urban catchments (AC 2012). As discussed in Section 0, the catchment surrounding Mangere Inlet is predominantly industrial/commercial with Mangere Cemetery and Waikaraka Park also located to the west of Ann's Creek. Mangere Inlet has also been the site of historic contamination including the presence of a number of closed landfill and contaminated sites to the west of Ann's Creek, potential landfill leachate and runoff from industrial processes (AC 2012). Figure 5 illustrates the distribution of some of these potential sediment contaminant sources, and we also refer the reader to the Contaminated Land assessment report.

Potential contaminant deposition methods and pathways

Physical pollutants of concern for the Mangere Inlet and wider Manukau Harbour marine environment include gross pollutants (eg, road litter) and suspended sediments. Both pollutant sources are dependent on the types and loads of gross pollutants and sediments entering the coastal marine area (ARC 2010).

Particle size and hydrodynamics influence the fate of sediments in marine environments. As discussed above, coarse sediment particles will settle out quickly in the water column within close vicinity of the current and proposed discharge outlets, whereas finer sediment particles will tend to remain in suspended in the water column. Generally, larger and denser sediment particles will be removed from suspension more rapidly than smaller and less dense particles. However the rate of removal from suspension will depend on hydrodynamic factors including tidal movement, bed shear stress and salinity. Therefore, based on the current available information, sediment particles from the proposed alignments are expected to enter coastal waters surrounding the existing and proposed new discharge outlets with fine particles settling out in sheltered areas.

Sediment discharged from construction of the selected EWC alignment is likely to include coarse to fine particles with a proportion likely to enter the marine environment from any proposed coastal reclamation if no sediment control measures are put in place. However, implementation of appropriate sediment and erosion control measures will help to manage the amount of sediment entering the coastal marine environment. Sediment and erosion control measures are discussed in detail in the Erosion and Sediment Control Assessment and should be read for further information. Post construction and during operation of the road, sediment is likely to originate from general road surface debris and through the stormwater network.

[1] High molecular weight polycyclic aromatic hydrocarbons

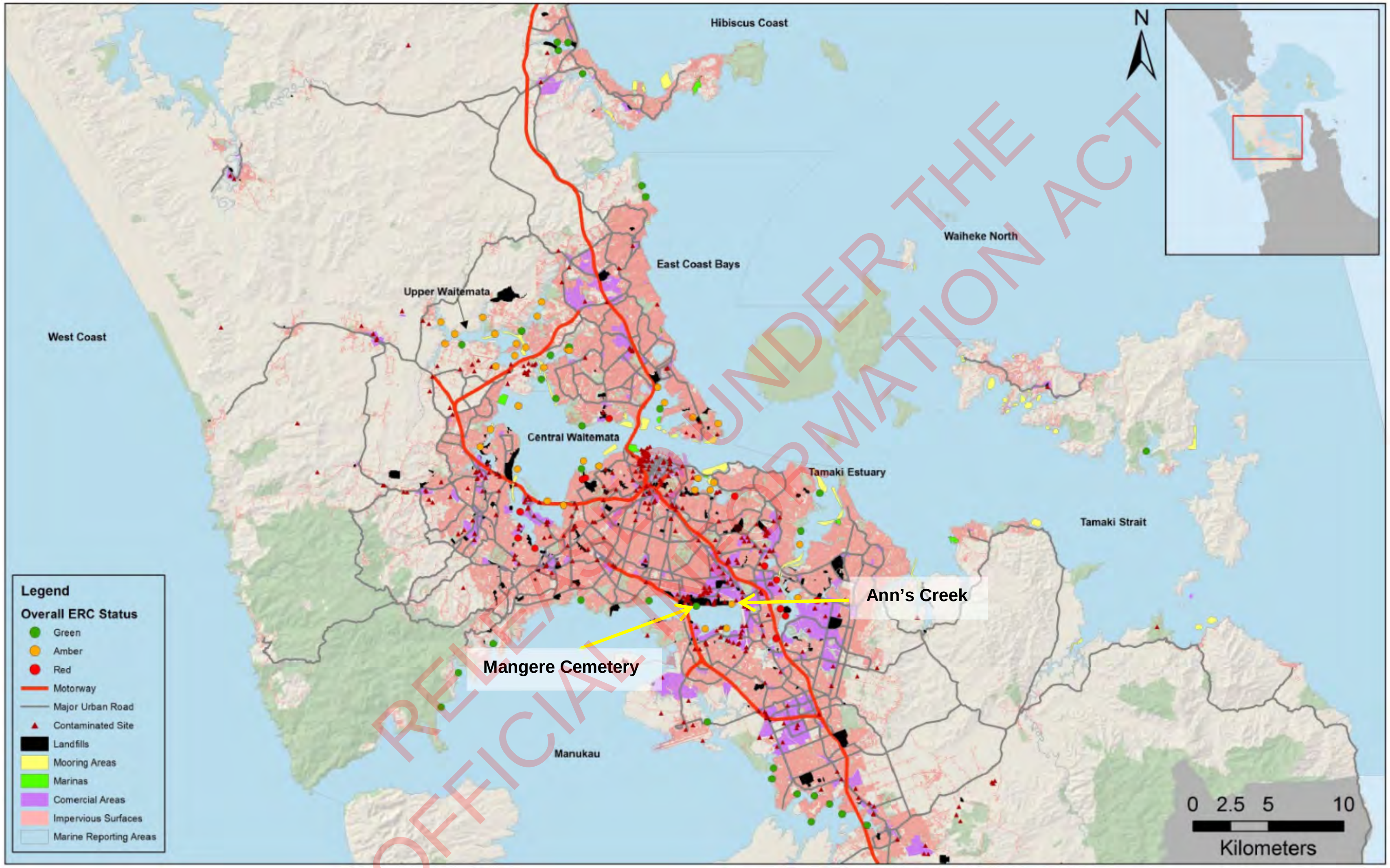

Figure 5 Potential contaminant sources contributing to metal and PAH contamination of Aucklands marine receiving environment. Monitoring sites and their ERC grades are shown (ARC 2004)

Looking at Mangere Inlet in more detail, the ERC results showed amber levels of copper and zinc at Ann's Creek with lead and HWPAC within the green ERC level. Samples collected from the Mangere Cemetery site showed all measured Table 4 contaminants at or below the green ERC threshold. The ERC results for the Mangere Inlet showed:

- Decreases in lead concentrations which is likely attributable to the removal of lead from petroleum in 1996 (ARC 2004).
- Decreases in zinc concentrations in Ann's Creek and Mangere Cemetery sites (ARC 2004).
- Elevated DDT levels recorded at Ann's Creek and Mangere Cemetery sampling sites (AC 2014).
- Dieldrin concentrations recorded above the ERC-red threshold at Ann's Creek and Mangere Cemetery sites (AC 2014).

Overall, the ERC contaminant status for the Mangere Cemetery site (ERC green threshold) showed a low level of impact while Ann's Creek (ERC amber threshold) showed signs of contamination having at least one contaminant above the ERC threshold at which adverse effects on benthic ecology may begin to show (Figure 6).

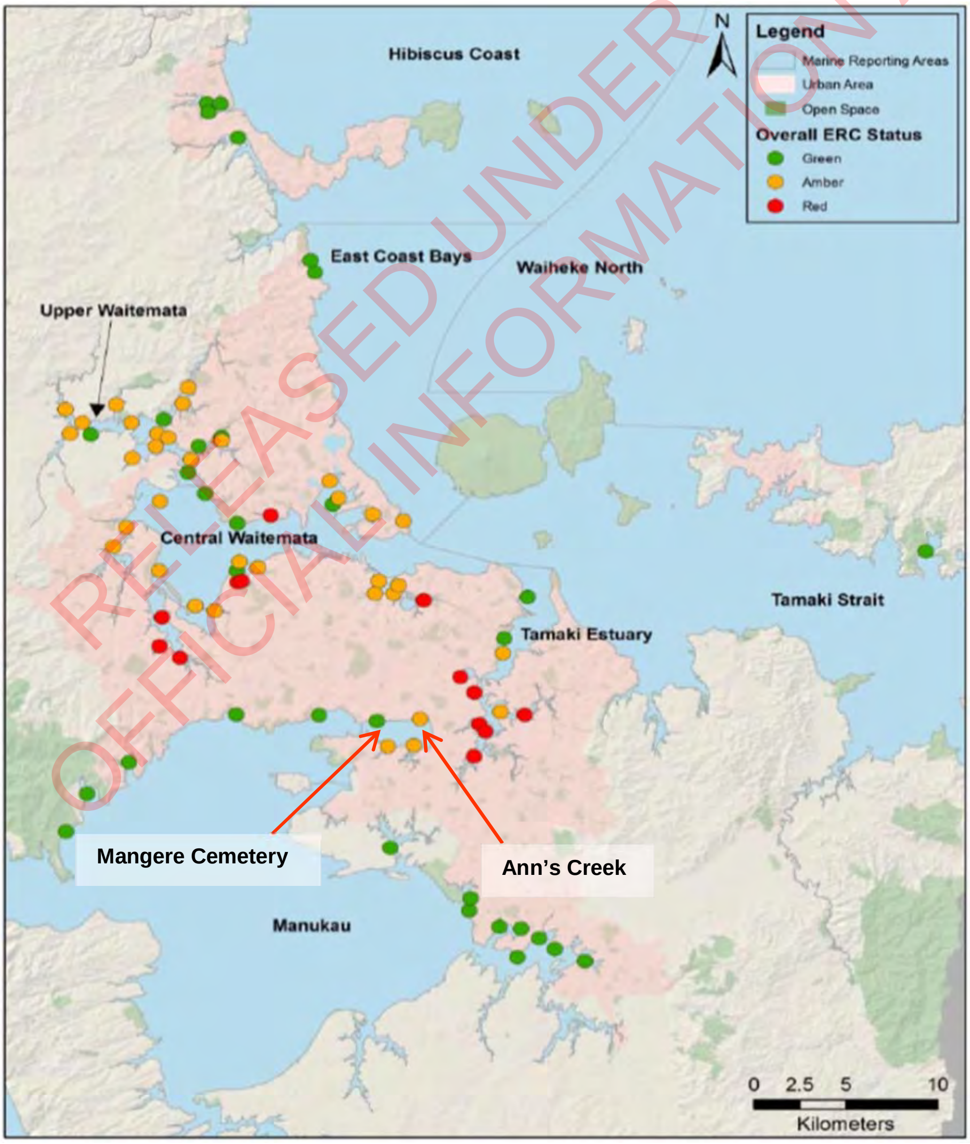

Figure 6 Overall environmental response criteria status (ARC 2004)

Sediment deposition and salinity gradients

Salinity while not specifically categorised as a hydrodynamic process, is nevertheless strongly influenced by wave action and subsequent mixing of the water column. The Manukau Harbour is a well-mixed harbour due to the tidal processes from river and creek discharges and the tidal forces within the harbour. Mixing of the water column generated by tidal currents and waves results in mixing of salt and fresh water over the majority of the harbour resulting in a well-mixed water column (ie, unstratified). However, as in most harbour and estuarine environments salinity gradients do occur where freshwater inputs including stream environments and precipitation enter and cause stratification in the water column. While no information detailing stratification within Mangere Inlet and associated creeks was available it is likely that freshwater inputs from Ann's Creek and associated Mangere Inlet foreshore (ie, adjacent to Mangere Cemetery) influence salinity concentrations in their immediate discharge area.

The environmental effect of a salinity gradient is the influence this has on flocculation and precipitation of fine particulate suspended sediment; the more saline the environment the greater the amount of sediment flocculation and therefore removal from the water column.

Biological effects of sedimentation

Sediment deposition can affect sediment dwelling organisms (ie, surface and interstitial) particularly where background levels are exceeded. Species that inhabit estuarine environments including tidal creeks and tidal embayments (eg, Ann's Creek) are generally adapted to a dynamic environment where sediment regimes may be affected due to short-term fluctuations (eg, increased land runoff due to heavy rainfall). In most cases these short-term fluctuations are moderated by tidal flow transporting and depositing sediment over a wide area. However, if deposition exceeds natural tidal sediment transportation rates, smothering of benthic organisms may occur, leading to displacement of individuals, and in prolonged cases of smothering, removal of biological communities and death of individuals.

Species community diversity and abundance are not constant over time and are subjected to internal and external processes (eg, recruitment patterns, community dynamics, seasonal patterns and sedimentation rates) which influence the number of individuals and species present in a community. Therefore the response of an individual species to contaminants depends on their tolerance levels as well as the physical nature of their habitat (ARC 2004).

While no detailed assessment of the amount of contaminants originating from the six EWC alignments has been made, the level of proposed treatment via methods such as wetlands, swales and treatment devices (see Stormwater and Sediment and Erosion Control Assessment reports) in addition to what is currently in operation is expected to reduce potential contaminant loads entering the coastal area. We acknowledge that under some storm events contaminants may find their way into the harbour due to potential over capacity of the treatment devices. Therefore based on current species tolerance of contaminated sediments within Mangere Inlet it is possible that additional effects will be low and can be managed through the proposed stormwater treatment measures (refer Stormwater Assessment report).

Marine Flora and Fauna

Loosely speaking marine flora and fauna are either highly motile or are sessile (benthic community). It is this latter category that is initially vulnerable to contaminants and sedimentation process shaping and entering the marine environment (ARC 2003, AC 2013). Understanding the flora and fauna communities within and adjacent to the EWC project area will assist in determining species that are more vulnerable to contaminants and have the potential to biomagnify in the food chains within the Mangere Inlet and with wider Manukau Harbour. Understanding the lifecycle events for species (e.g., spawning and migration) also contributes to determining the ecological effect of the construction and operation of each of the six road alignment options on the coastal receiving environment.

The following paragraphs discuss the key marine flora and fauna components present within and adjacent to the EWC project area.

Mangroves

Extensive stands of mangroves (*Avicennia marina*) have been recorded throughout the Manukau Harbour including the Mangere Inlet and are expected to continue increasing in extent (Figure 7).

There is only one species of mangrove in New Zealand, *Avicennia marina*, and its distribution is restricted to the northern coastlines of New Zealand. Mangroves are important habitats for a variety of fauna within New Zealand estuarine ecosystems (Mills and Williamson 2008). Mangrove habitats are often dotted or fringed on the landward side with saltmarsh patches, including glasswort, oioi and sea rush, and salt tolerant grasses or herbs such as shore primrose and needle grass. These habitats are considered to be ecologically important areas (ARC 2009). The Auckland Regional Coastal Plan (2004a) described the mangroves and native saline vegetation present within Ann's Creek and South East Mangere Inlet respectively as the only significant remaining piece of native vegetation associated with lava flows in Tamaki ecological district.

While mangrove habitats in the past were removed and reclaimed as farm land, more recently mangrove stands are also expanding (Mills and Williamson 2008). In the 1930s it was recognised that mangroves were spreading in many estuaries. The spread is thought to be due mainly to increases in sedimentation, but potentially also from elevated nutrient loadings in runoff (Morrisey et al. 2007). Areas where high sedimentation occurs, such as Ann's Creek and other sheltered intertidal habitats and embayments, have the potential for increases of mangrove spread. Over the past 55 years mangrove cover within the Manukau Harbour has increased with the most substantial increases occurring over the past 30 years (ARC 2009). Similarly, Mangere Inlet has seen a significant increase in mangrove colonisation from an occasional scattered tree recorded in 1959 to approximately 97 ha recorded in 2006 (ARC 2009). Ann's Creek has also seen significant mangrove colonisation with only scattered trees recorded around 1959 to the presence of 1 ha of mangroves in 1976 (ARC 2009). The increase in mangrove extent isn't isolated to Mangere Inlet with similar increases recorded in Pahurehure Inlet from 113 ha to 272 ha over the same time period (ARC 2009).

Figure 7 Mangrove distribution (red areas) in the northern section of the Manukau Harbour including Mangere Inlet (ARC 2009)

Seagrass

Seagrass beds have been recorded from within the Manukau Harbour (ARC 2009) and represent a significant habitat for a range of species including fish and seabirds. In the 1970's seagrass beds (*Zostera novazelandica*) were reported to cover approximately 171 ha in the Manukau Harbour or approximately 1.2% of the intertidal area (ARC 2009). The seagrass beds were predominantly associated with the open, intertidal sandflats in the main Manukau Harbour rather than the sheltered muddy embayments and tidal creeks such as Mangere Inlet and Ann's Creek.

Seagrass are considered important marine systems, providing high primary productivity including benthic and epiphytic production, trapping and stabilising bottom sediments, cycling nutrients and providing a complex structure for colonisation by numerous taxa, including epiphytes, algae, zooplankton, as well as sessile and mobile fauna (Turner and Schwarz 2006). While seagrasses are important components of marine systems, the reviewed literature suggests they are not found within the EWC project area. Therefore we will not discuss seagrasses further in this report.

Saltmarsh

Saltmarsh communities have been recorded from within the Manukau Harbour by Henriques (1977) who estimated the harbour contained 91 ha of saltmarsh in 1976. The majority of this saltmarsh was recorded from within Mangere Inlet and similar sheltered coastal embayments. Saltmarsh species commonly found in these areas have been reported to include (Gardner 1992; ARC 2009):

- Karamu (*Coprosma robusta*).
- Mākaka/saltmarsh ribbonwood (*Plagianthus divaricatus*).
- Needle grass (*Austrostipa stipoides*).
- Oioi/jointed wire rush (*Apodasmia similis*).

The Auckland Regional Plan: Coastal (2004) also reported the presence of a small upper intertidal area in the south-east corner of Mangere Inlet supporting a high diversity of native saline vegetation. The plan also reports the presence of a 0.25 ha meadow of bachelor's button (*Cotula coronopifolia*) in the same area and has designated this area as a Coastal Protection Area (CPA 22b). The plan also notes that the seaward margin of CPA 22b is characterised by a diverse maritime marsh and small raised banks of clean sand supporting several species of plants characteristic of these areas. The plan also reports Ann's Creek to have the only remaining significant piece of native *Coprosma crassifolia* shrubland on lava flows in the Tamaki ecological district. The significance of Ann's Creek as a Coastal Protection Area (CPA 21) is also due to the site being the first ever collection site of the shrub.

Macrofauna

The intertidal mud and sand flats of the Manukau Harbour and Mangere Inlet provide habitat for a variety of macrofauna species with community composition dependent on external environmental factors such as tidal forces, sediment composition and location within the wider harbour (eg, sheltered embayments or tidal channels). Macrofaunal species recorded from Mangere Inlet included polychaetes, mud snails, cockles and whelks with oysters and barnacles also growing in association with the mangrove stands (ARC 2009; AC 2013). ARC (2009) reported large numbers of macrofauna occurring within Mangere Inlet with the pollution tolerant polychaete *Heteromastus filiformis* the most dominant species.

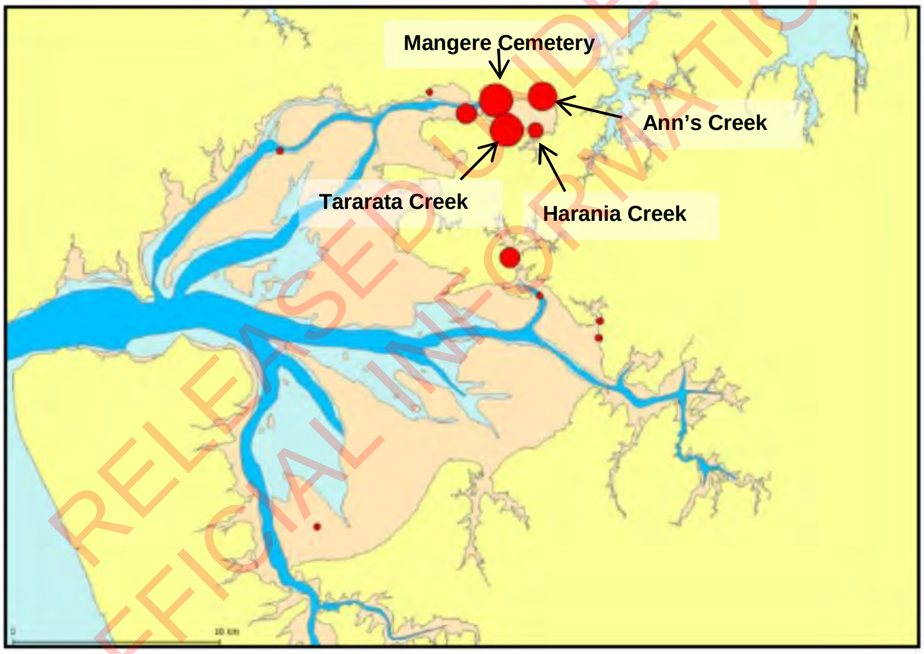

Figure 8 Relative abundance of the polychaete *Heteromastus filiformis* (ARC 2009). Relative abundance is represented by the size of the circles

Of the shellfish species recorded within Mangere Inlet the cockle (*Austrovenus stutchburyi*) was reported in the lowest numbers at Ann's Creek followed by Mangere Cemetery, Tararata Creek and Harania Creek (ARC 2009). Numbers of cockle increased outside Mangere Inlet which may be a result of several factors including sediment substrate suitable for colonisation and lower sediment associated contaminants.

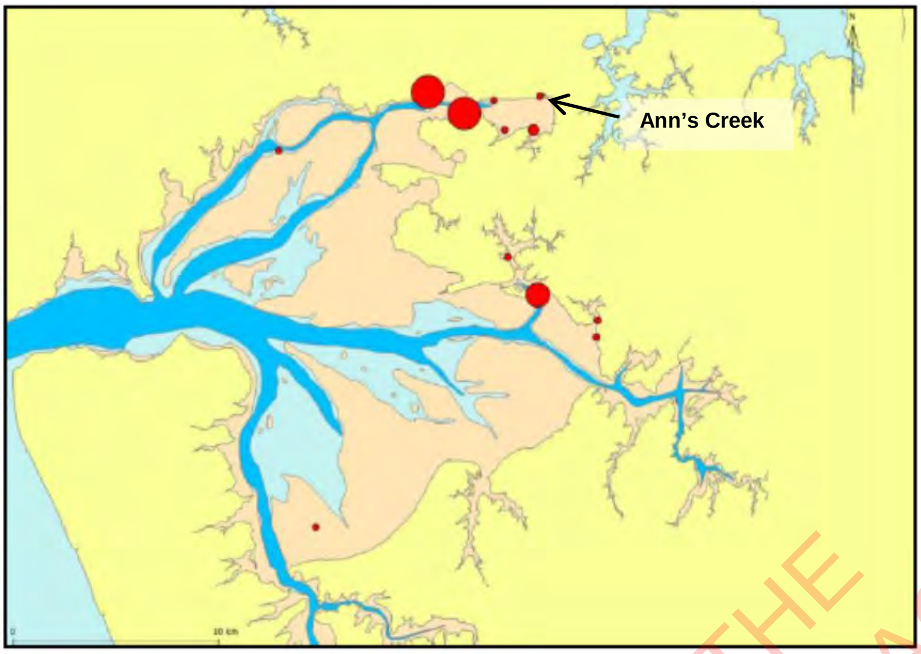

Figure 9 Relative abundance of the shellfish *Austrovenus stutchburyi* (ARC 2009). Relative abundance is represented by the size of the circles

Shorebirds

The Manukau Harbour contains extensive sand and mud flats which provide a rich food resource for a range of shore birds including nationally and internationally important species. The Manukau Harbour has been reported by ARC (2009) as being a national 'hotspot' for bird diversity in coastal and wetland habitats with a high number of endemic and native species using the harbour for foraging and breeding habitat. In terms of significance, the Manukau Harbour has been reported to support over 20% of the total New Zealand wader population with potentially more than 60% of all New Zealand waders using the harbour on a temporary basis (ARC 2009). As well as being nationally important, the harbour is also an internationally recognised area for a range of Northern Hemisphere waders that use the harbour as a foraging site during summer. Common Northern Hemisphere migrants to the Manukau Harbour include:

- Bar-tailed godwits.
- Lesser knots.
- Turnstones.
- Pacific golden plovers.
- Eastern curlews.
- Red-necked stints.
- Sharp-tailed sandpipers.
- Whimbrels.
- Curlew sandpipers.

Mangere Inlet is considered an important roosting and feeding habitat for shorebird species because of its value as a bird roosting and foraging area. Because of this the value of the area has been recognised through designation of CPAs and areas of significant conservation value in order to protect the identified foraging and roosting areas (ASCV) (ARC 2009; Figure 3; Table 3). Of those bird species known to frequent the wider Manukau Harbour 48 of these species also frequent the Mangere Inlet area (Appendix C). As reported in ARC (2009) 15 of these species have been classified as threatened by Hitchmough et al (2007) with 7 species having threat codes[2] 1, 2 or 3 (Table 5). While no bird records were available for Ann's Creek it is possible that the species listed in Table 5 forage on the intertidal mudflats and roost in the mangroves adjacent to the Creek.

Table 5 Threatened birds recorded within the Mangere Inlet (ARC 2009)

Common Name	Latin Name	Origin	Threat Status
All black stilt and pied stilt	*Himantopus spp*	Endemic	1
Brown Teal	*Anas aucklandica chlorotis*	Endemic	2
Grey duck	*Anas superciliosa superciliosa*	Native	2
New Zealand dotterel	*Charadrius obscurus*	Endemic	3
Caspian Tern	*Sterna caspia*	Native	3
Reef heron	*Gretta sacra sacra*	Native	3
Wrybill	*Anarhynchus frontalis*	Endemic	3

Fish

The Manukau Harbour is an important area for recreational and commercial fisheries with species including grey mullet, flatfish, rig, kahawai, trevally, yellow eyed mullet, parore, red gurnard and snapper caught within the main harbour and sheltered embayments. As reported by ARC (2009) the Manukau Harbour is a particularly important area for the grey and yellow eyed mullet fisheries, with around 25% of the national commercial catches coming from the harbour. Recreational fishing is also carried out on structures providing good over water access such as the old Mangere Bridge in Mangere Inlet. Other fish species recorded from within the Manukau Harbour by NIWA (NIWA research project CO1X0022/25) and likely to occur within the Mangere Inlet are listed in Table 6.

Surveys investigating fish species and numbers within the intertidal to low tide sand and mudflats in the Manukau Harbour were carried out by Morrison et al (2005) and found that Mangere Inlet had the highest counts of yellow eyed mullet and sand flounder. In total, 7 species of fish were recorded from one site within Mangere Inlet and it is probable that these species would also frequent the sheltered creeks such as Ann's Creek for foraging or breeding.

Table 6 Fish species recorded from within the Manukau Harbour

Common Species Name	Scientific Species Name
Marine straggler	
Blue warehou	*Seriolella brama*
Barracouta	*Thyrsites atun*
Kingfish	*Seriola lalandi*
Marine migrants (opportunistic/dependent)	
Snapper	*Chrysophrys auratus*

[2] Threat code 1 equates to nationally critical, 2 nationally endangered and 3 nationally vulnerable

Common Species Name	Scientific Species Name
Kahawai	*Arripis trutta*
Trevally	*Pseudocaranx dentex*
Yellow-eyed mullet	*Aldrichetta forsteri*
Various small sharks	*Various species*
Anchovies	*Engraulis australis*
Sprats	*Various fish species including Sardinops neopilchardus*
Pilchards	*Sardinops sagax*
Garfish (piper)	*Hyporhamphus ihi*
NZ Jack mackerel	*Trachurus novaezelandiae*
Snake eels (3 species)	*Various species*
Ahuru	*Auchenoceros punctatus*
Estuarine Species (resident/migrant)	
Grey mullet	*Mugil cephalus*
Sand and yellow-belly flounder	*Rhombosolea plebeian*
Estuarine triplefin	*Grahamina sp.*
Sole	*Peltorhamphus novaezeelandiae*
Graham's gudgeon	*Grahamichthys radiata*
Freshwater migrants	
Smelt	*Retropinna retropinna*

Marine cetaceans

While we acknowledge Maui's dolphin is known to frequent the Manukau Harbour it is unlikely that individuals will be found within the Mangere Inlet as the majority of individuals have been recorded within the wider harbour and in open waters between the Manukau Harbour and Port Waikato (Thompson et. Al., 2000, DeMaster et. Al., 2001, www.forestandbird.org.nz). Therefore we will not discuss Maui's dolphin further in this report.

Pinnepeds

Pinnipeds are a group of mammals consisting of aquatic mammals including seals, walruses and similar animals with finlike flippers. In New Zealand there are four species of seal that inhabit our coastal waters, including:

- New Zealand sea lion (*Phocarctos hookeri*);
- New Zealand fur seal (*Arctocephalus fosteri*);
- Leopard seal (*Hydrurga leptonyx*); and

- Elephant seal (*Mirounga leonine*).

Of these pinnipeds, the species most likely to occur within the marine and intertidal areas of the project area is the New Zealand fur seal. Fur seals are found on coastal shores around New Zealand, including the Chatham Islands and the sub-Antarctic islands (including Macquarie Island). While named the New Zealand fur seal, the species is also found in South Australia, Western Australia and Tasmania. *Arctocephalus fosteri* represents the most common seal species in New Zealand.

The EWC project will require localised coastal development within the coastal zone. There was no published information available at the time of writing on the distribution of pinnipeds within the Manukau Harbour. It is possible that individuals may occasionally occur in the project area.

Ecological Condition of Mangere Inlet

The ecological condition of the Manukau Harbour has been a focus of Auckland Council state of the environment (SoE) monitoring which started in 1987 by the Auckland Regional Water Board (a precursor to the Auckland Regional Council (ARC)). The majority of the SoE sampling sites were located in the main body of the harbour where sediment bound contaminants do not tend to accumulate due to tidal and hydrodynamic forces. To account for this, the ARC established the Stormwater Contaminant Monitoring Programme to monitor concentrations of key sediment contaminants in more susceptible parts of the harbour, including Mangere Inlet (AC 2009). Results of the programme found that the condition of ecological communities in high depositional environments and tidal creeks of Mangere Inlet were degraded, with the community at Tararata Creek having the worst condition (health rank = 5) (Figure 10). Benthic communities recorded from Mangere Cemetery, Ann's Creek and Harania Creek were only slightly better with a health rank of 4 (Figure 10).

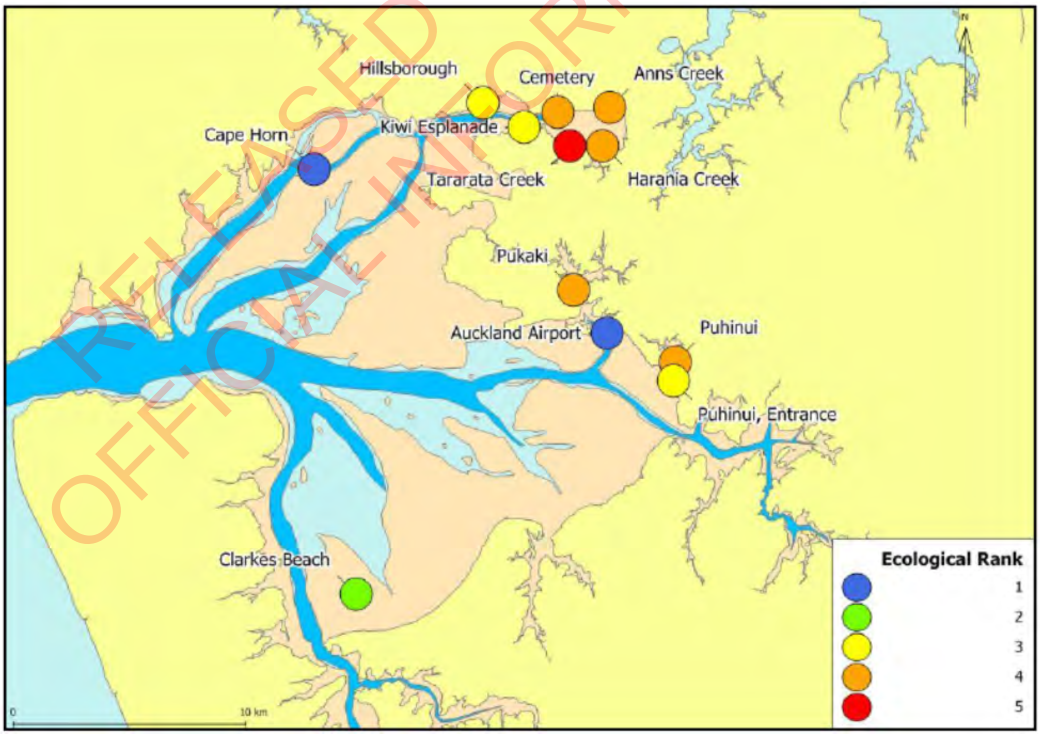

Figure 10 Ecological condition of benthic communities in Manukau Harbour. Condition is ranked from 1 (blue = healthy) to 5 (red = degraded) (ARC 2009)

Other Activities Surrounding Mangere Inlet

The Mangere Inlet is the site of many light and heavy industrial activities that discharge directly or indirectly to the Inlet and which may have environmental impacts. Although no quantification of these impacts is presented in this report it would be logical to assume that the discharges could have an impact on the Inlet and wider Manukau Harbour.

Mangere Inlet has seen extensive changes in land-use over the past 170 years with the area surrounding the inlet developed as Auckland's agricultural centre in the 1850's through to urban and industrial development in the 1900's; and which is still expanding today (ARC 2009). All these land-uses have contributed contaminants leading to environmental degradation of the Mangere Inlet, including:

- Leachate from various refuse tips.
- Cemetery.
- Glass production.
- Ports of Auckland.
- Westfield railway yards.
- Southdown Power Station.
- Mainfreight.
- Pacific Steel.

Terrestrial Sites of Significance

An assessment of the terrestrial sites within the EWC alignment project area identified two sites of significance, namely Southdown Reserve and Hamlins Hill.

Hamlins Hill – Mutukaroa

Hamlins Hill – Mutukaroa is a 48ha regional park located in Mt Wellington and administered by Auckland Council as a regional park and is the largest and most prominent non-volcanic geological feature in Auckland City (Figure 11).

The park is located in the middle of a highly modified urban and light industrial area and is still used to graze cattle with limited mature native vegetation (Figure 11). However, bush restoration has been carried out over the past 10 years by Forest and Bird and other volunteer organisations and these areas are now providing habitat and a food resource for native bird species. While the park does not have any permanent freshwater streams it is likely to have ephemeral streams particularly during the winter months. We recommend surveying the site for the presence of permanent or ephemeral streams and where appropriate carry out instream surveys prior to construction.

Hamlins Hill is predominantly pasture with a gully on the northern side vegetated with some scrubby native vegetation. A visual inspection of the available high level plans and imagery indicates the gully may be ephemeral running towards the existing motorway. The Option B alignment is expected to require a cut into the Hamlins Hill park of approximately 30m in width but given the proposed cut area is predominantly pasture we expect the ecological effects to low. Further assessment of the area depending on the preferred alignment is recommended to confirm this.

Figure 11 Location of Hamlins Hill – Mutukaroa Regional Park

8.1.1 Southdown Reserve

This section comprises a high level qualitative discussion of the Southdown Reserve only as no information was available discussing the ecological significance of the site. However, based on aerial imagery, the Southdown Reserve (located adjacent to the Southdown Power Plant and bounded by the Westfield Railway) is disconnected from the surrounding coastal marine area and other neighbouring reserve sites and therefore reduces the ability of species such as birds and reptiles to utilise this site as a foraging or roosting area.

Appendix B – CPA and ASCV sites within the Tamaki Estuary (ARC 2008)

Protection Type	CPA/ASCV Number	Description
Coastal Protection Area 2	44	**Waiouru Tuff Mound** A waiouru Tuff Mound, often incorrectly referred to as Pukekiwiriki, is an indistinct, crater-like depression about 300m in diameter. The crater is breached to the SW by tidal creeks and has an eight metre terrace along the Tamaki River. One of the oldest members of Auckland Volcanic Field, this geological landform is considered to be regionally important.
Coastal Protection Area 1	45a and b	**Pakuranga Creek and Roost** Pakuranga Creek roost (45a) is one of the roosting sites used by some of the hundreds of wading birds that feed within the Tamaki Estuary. The whole of the Tamaki Estuary is a regionally important wildlife habitat and has been selected by the Department of Conservation as an Area of Significant Conservation Value (ASCV). This roost is associated with the values of Coastal Protection Areas 47, 48 and 49 and forms an integral part of the wildlife habitat values of the estuary. The mangrove areas of Pakuranga Creek (45b) are regarded as the best example of mangrove habitat in the Tamaki Estuary.
Coastal Protection Area 2 and Area of Significant Concervation Value	46/62	**Panmure Basin Explosion Crater** An explosion crater and associated tuff ring that is naturally breached to form a tidal lagoon. This landform is still relatively complete and is considered to be regionally important. The Department of Conservation has selected this area as an Area of Significant Conservation Value (ASCV).
Coastal Protection Area 1	47	**Tamaki River East Roost** One of the roosting sites used by some of the hundreds of wading birds that feed within the Tamaki Estuary. This roost is associated with the values of Coastal Protection Areas 45, 48 and 49.
Coastal Protection Area 2 and Area of Significant Conservation Value	48/61	**Tamaki East Bank** This intertidal bank is a feeding ground for the hundreds of wading birds that use the Tamaki Estuary. This feeding ground is associated with the values of Coastal Protection Areas 45, 47 and 49. This area also includes part of the Farm Cover ignimbrite, most of which is above mean high water spring (MHWS).
Coastal Protection Area 2 and Area of Significant Conservation Value	49a – d and 60	**Tahuna Torea to Point England** The spit and associated northern and southern intertidal banks, together comprise a wildlife habitat of regional importance. This area is associated with the value of Coastal Protection Areas 46, 47 and 48. At Point England (49b) is a small geological exposure of rhyolitic co-ignimbritic accretionary lapilli from the Taupo Volcanic Zone, which is exposed as a thin bed near the base of an eroded low sea cliff. The site is considered to be nationally

Protection Type	CPA/ASCV Number	Description
		important and has been selected by the Department of Conservation as an Area of Significant Conservation Value (ASCV).
Coastal Protection Area 1	50a and b	**Musick Point** Two exposures in the cliffs and intertidal platforms are considered to be geologically important. One (50b) is an over thrust fold involving flysch beds and the other (50c) is the best example in the region of an anticline visible in three dimensions. Both of these geological features are considered to be regionally important.
Area of Significant Conservation Value	79	No Information

Appendix C – Manukau Harbour Bird Species List

Common Name	Latin Name	Origin	Threat Status
All black stilt and pied stilt	*Himantopus spp*	Endemic	1
Asiatic black-tailed godwit	*Limosa limosa melanuroides*	Straggler	
Australasian little grebe	*Tachybaptus novaehollandiae novaehollandiae*	Native	
Australasian pied stilt	*Himantopus himantopus leucocephalus*	Native	
Autralasian gannet	*Morus serrator*	Native	
Banded dotterel spp	*Charadrius bicinctus spp*	Endemic	5
Black billed gull	*Larus bulleri*	Endemic	4
Black fronted dotterel	*Charadrius melanops*	Native	
Black shag	*Phalacrocorax carbo novaehollandiae*	Native	6
Black stilt	*Himantopus novaezelandiae*	Endemic	1
Black swan	*Cygnus atratus*	Introduced	
Brown Teal	*Anas aucklandica chlorotis*	Endemic	2
Canada Goose	*Branta 51orphyria51 maxima*	Introduced	
Caspian Tern	*Sterna caspia*	Native	3
Cattle egret	*Bubulcus ibis coromandus*	Migrant	
Eastern bar-tailed godwit	*Limosa lapponica baueri*	Migrant	
Feral goose	*Anser anser*	Introduced	
Fluttering shearwater	*Puffinus gavial*	Endemic	
Grey duck	*Anas superciliosa superciliosa*	Native	2
Lesser knot	*Calidris canutus canutus*	Migrant	
Little black shag	*Phalacrocorax sulcirostris*	Native	7
Little shag	*Phalacrocorax melanoleucos brevirostris*	Endemic	
Mallard	*Anas platyrhynchos platyrhynchos*	Introduced	
New Zealand dabchick	*Poliocephalus rufopectus*	Endemic	6
New Zealand dotterel	*Charadrius obscurus*	Endemic	1
New Zealand Kingfisher	*Halcyon sancta vagans*	Native	
New Zealand Scaup	*Aythya novaeseelandiae*	Endemic	

Common Name	Latin Name	Origin	Threat Status
New Zealand shoveler	*Anas rhynchotis variegata*	Endemic	
Pacific golden plover	*Pluvialis fulva*	Migrant	
Paradise Shelduck	*Tadorna variegate*	Endemi	
Pectoral Sandpiper	*Calidris melanotos*	Sraggler	
Pied shag	*Phalacrocorax varius varius*	Native	
Pukeko	*Porphyrio 52orphyria melanotus*	Native	
Red billed gull	*Larus novaeholladiae scopulinus*	Endemic	5
Red necked stint	*Calidris ruficollis*	Migrant	
Reef heron	*Gretta sacra sacra*	Native	3
Royal spoonbill	*Platalea regia*	Native	
Siberian tattler	*Tringa brevipes*	Straggler	
Sooty shearwater	*Puffinus griseus*	Native	
South Island pied oystercatcher	*Haematopus ostralegus finschi*	Endemic	
Southern Black-backed gull	*Larus dominicanus dominicanus*	Native	
Spotted shag spp	*Stictocarbo punctatus punctatus*	Endemic	
Spur-wing plover	*Vanellus miles novaehollandiae*	Native	
Turnstone	*Arenaria interpres*	Migrant	
Variable oystercatcher	*Haematopus unicolor*	Endemic	
White faced heron	*Ardea novaehollandiae novaehollandiae*	Native	
White Fronted tern	*Sterna striata*	Native	5
Wrybill	*Anarhynchus frontalis*	Endemic	3

GHD

Level 3, 27 Napier Street
Freemans Bay
T: 64 9 370 8000 F: 64 9 370 8001 E: aklmail@ghd.co.nz

G:\51\32651\Technical\Environment\Ecology\EWC template\Working Draft\Template for Expert Assessments_Ecological Assessment_22102014 - FINAL.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L. Hack	J. Matthews				08/10/2014
1	L. Hack			M. Wallis		16/10/2014
2	L. Hack			M. Wallis		21/10/2014
3	L. Hack			M. Wallis		5/11/2014

www.ghd.com