WESTERN RING ROUTE – WATERVIEW CONNECTION:

Review of the Assessment of Marine Ecological Effects and Submissions with Relevance to Marine Ecology

prepared by

Ryder Consulting

November 2010

ryderconsulting
environment + planning + project management

WESTERN RING ROUTE – WATERVIEW CONNECTION:

Review of the Assessment of Marine Ecological Effects and Submissions with Relevance to Marine Ecology

prepared by

Brian Stewart PhD

Ryder Consulting

November 2010

Cover photograph: Mangroves adjacent to SH16, Sector 4.

Ryder Consulting Ltd.
PO Box 1023
Dunedin
New Zealand
Ph: 03 477 2113
Fax: 03 477 3119

Table of Contents

Executive Summary

i. The New Zealand Transport Agency has lodged applications with the Environmental Protection Authority for the proposed Waterview Connection Project, a project of National Significance. The EPA has engaged Ryder Consulting Ltd to review the Assessment of Marine Ecological Effects.

ii. The Assessment was found to be a generally thorough and robust document that examined the existing environment and used a variety of descriptions to determine ecological values and the likely adverse effects of construction and operational activities on those values for each Sector of the proposed Project.

iii. Ecological values ranged from low to high with lower to moderate values generally falling within the Waterview Estuary while moderate to high values were generally found to the north of SH16 and within the Motu Manawa Marine Reserve.

iv. Overall, temporary occupation of land and/or disturbance of intertidal habitats, noise and vibration and sediment discharges associated with construction activities were deemed to have transitory effects with negligible significance. Stormwater runoff during construction and post construction will continue to add contaminants to the marine environment, albeit at a reduced rate due to the treatment measures that will be used. Permanent occupation of the coastal marine area during and after construction is an issue of some concern and is described as having a moderate adverse ecological effect.

v. A range of measures are proposed to mitigate any adverse effects and, in the case of transitory and negligible effects these are judged to be generally satisfactory. Additional sampling is recommended in Oakley Inlet to determine the extent of possible contamination from a historic tannery that operated near the site.

vi. For permanent reclamation, although the the proposed mitigation measures are judged to go some way towards ameliorating adverse effects, it is suggested that expansion of the Motu Manawa Marine Reserve may be an additional mitigation measure that would find favour with many submitters.

1. Introduction

1.1 The New Zealand Transport Agency (NZTA) has lodged applications (matters) with the Environmental Protection Authority (EPA) for the proposed Waterview Connection Project. The Project is deemed to be a project of National Significance and it is the task of the EPA to assess the proposal. To assist the EPA board of inquiry (the Board) the Board has engaged Dr Brian Stewart of Ryder Consulting Ltd to provide marine ecology services, including assistance with a report pursuant to section 42A of the Resource Management Act 1991 (RMA) and other assistance as requested by the Board.

1.2 The following is Dr Stewart's appraisal of the Assessment of Marine Ecological Effects and the relevant submissions made on the proposal.

2. Background

2.1 In 2009 the NZTA confirmed its intention that the Project would be lodged with the Environmental Protection Authority as a Proposal of National Significance. The Project includes works previously investigated and developed as two separate projects: being the SH16 Causeway Project and the SH20 Waterview Connection. The key elements of the Waterview Connection Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunnelled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a cycleway throughout the surface road elements of the Waterview Connection Project corridor.

2.2 Sectors 1-5 of the Project cross, or abut, the coastal marine area (CMA) and are, as a result, the subject of an assessment of effects on marine ecological values.

3. Ecological Assessment

3.1 A high percentage of the population of New Zealand lives on or near the coast. Thus, many commercial, recreational and traditional activities impact on marine environments. What constitutes an appropriate use of these environments is often a subject of heated debate because many activities can be in conflict (Kingsford and Battershill 1998). The project under consideration (the Project) is a good case in point. In addition to the physical impacts from construction activities, contaminants may be released into the coastal marine area, flow and sedimentation patterns may be altered and biodiversity may be affected.

3.2 The overarching purpose of the Assessment of Marine Ecological Effects prepared for the Project (de Luca 2010) is to provide an assessment of the proposed Project as it pertains to marine ecology and an assessment of the significance of potential adverse effects. As such the assessment consolidates the research undertaken by a number of agencies (Boffa Miskell Ltd, Bioresearches Group Ltd, NIWA, and the Auckland Regional Council) and reports on the current ecological values in the coastal marine area likely to be affected by the proposal, potential adverse effects, and provides a scope of works to avoid, remedy or mitigate these effects. Where there is uncertainty regarding likely effects it recommends an approach for monitoring and appropriate responses.

Significance of Ecological Parameters Assessed

3.3 Throughout the Assessment of Marine Ecological Effects the default guidelines used to estimate ecological "health" are based on the Environmental Response Criteria, developed by the ARC (ARC 2004) (Table 1). These, in turn, are based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). The guiding principles for the ANZECC (2000) document are based primarily on the philosophy of ecologically sustainable development (ESD), defined as "development using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future can be increased." In New Zealand the purpose of the RMA is to promote sustainable development, which is broadly equivalent to the ESD philosophy.

Table 1. *Environmental Response Criteria for Sediment Contaminants (mg/kg)*

Parameter	Red	Amber	Green
Copper	>34	19-34	<19
Lead	>50	30-50	<30
Zinc	>150	124-150	<124
HMW PAH	>1.7	0.66-1.7	<0.66

3.4 Direct effects on the quality of marine water attributable to the Project are likely to be low and transitory and will largely occur as a result of stormwater runoff, directly and to streams. As such, these effects are assessed in Technical Report G.15 Assessment of Stormwater and Streamworks Effects (Fisher *et al.* 2010).

Sediment Quality

3.5 For marine sediments, which will likely be affected by disturbance and as a repository for contaminants the guidelines used are based on the "effects range-low" used in the NOAA (US National Oceanic and Atmospheric Administration) listings (Long *et al.* 1995). That is to say, a level for each particular contaminant is set at a concentration below which there would be a low probability of effects on benthic organisms. Values above the low trigger value **may** result in some adverse biological effects; and values above the high trigger value **would** be expected to result in adverse biological effects. The threshold (or 'trigger') levels therefore represent the concentration at which potential effects on organisms may occur and further investigation is recommended. The principal sediment contaminants assessed by de Luca (2010) were copper, lead, zinc and PAHs.

Copper

3.6 The likely major sources of copper in marine sediments include copper water piping, copper roofing and spouting, food processing, tanning, and wear of tyres and brake pads. Industrial processes such as electroplating may also play a role (Stevenson 1998).

3.7 Copper is toxic to most marine organisms and may have an effect on the flora and fauna in the areas of highest concentration (Bryan 1971, Morrisey *et al.* 2003). It could be argued that much of the copper will be buried in the sediment and is, therefore, not available to many organisms. The area affected, however, is extremely shallow and the sediments will likely be readily stirred up by wave action

on windy days, and by ground works, thus making copper and other buried contaminants available.

Lead

3.8 Probable sources of lead in marine sediments around the Project are old water and waste pipes, wear of tyres, petrol (prior to 1986 for regular; prior to 1996 for super), paint, batteries and roofing (Stevenson 1998).

3.9 Like copper, lead is toxic to most marine organisms and in high concentrations can have deleterious effects on the ecology of an area (Bryan 1971, Morrisey *et al.* 2003). As with most heavy metals, the lead is buried within the sediment for most of the time, but wave action during windy weather and ground disturbance may easily re-suspend sediments containing lead.

Zinc

3.10 Zinc contamination in coastal marine sediments is often quite high, with probable sources of zinc being water pipes, building materials including galvanised products such as nails, wire and roofing iron, and wear of tyres and brake pads (Stevenson 1998). Not as toxic as copper or lead, as evidenced by the higher levels allowable in the guidelines (Table 2), zinc still has the potential to be ecologically damaging in high enough concentrations.

Table 2. *Recommended sediment quality guideline (from ANZECC 2000).*

Trace element or organic compound	ISQG-Low (mg/kg dry weight of sediment)	ISQG-High (mg/kg dry weight of sediment)
Antimony	2	25
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1	3.7
Zinc	200	410
Total DDT	0.0016	0.046
Dieldrin	0.00002	0.008
High MW PAHs	1.7	9.6
Total PAHs	4	45

PAHs

3.11 PAHs (polycyclic aromatic hydrocarbons) are one of the most widespread organic pollutants. In addition to their presence in fossil fuels they are also formed by incomplete combustion of carbon-containing fuels such as wood, coal, petrol and diesel, among other things. Different types of combustion yield different distributions of PAHs in both relative amounts of individual PAHs and which isomers are produced. Thus, coal burning produces a different mixture than motor-fuel combustion, or a forest fire.

3.12 The lower molecular weight PAHs can be acutely toxic to aquatic organisms, but the major concern is that some PAHs form carcinogenically-active metabolites (benzo[a]pyrene is the prime example) and PAH concentrations in sediments have been linked with liver neoplasms and other abnormalities in bottom-dwelling fish (Malins *et al*., 1988, Vethaak and ap Rheinallt, 1992). Elevated PAH concentrations may therefore pose a threat to aquatic organisms and potentially also to human consumers of fish and shellfish (MPMMG 1998).

Other contaminants

3.13 As can be seen from Table 1, there are a number of other contaminants (among others which are not listed) that are of concern. An obvious one is DDT which is discussed in Technical Report G.9 Assessment of Land and Groundwater Effects, and may require further investigation with respect to the marine environment. Additionally, as pointed out in the Assessment of Archaeological Effects, among others, the land adjacent to Oakley Inlet was the site of a now defunct tannery (Clough *et al.* 2010). This Tannery likely discharged to the Oakley Stream and as such, there are likely historic contaminants buried in the sediments within Oakley Inlet. Such contaminants will probably include arsenic, cadmium and chromium.

Arsenic

3.14 Arsenic may be sourced from pesticides, tanning, and mining operations. Aquatic and terrestrial biota show a wide range of sensitivities to different arsenic species. Effects range from lethality, inhibition of growth and effects on reproduction, usually as a result of chronic exposure.

Cadmium

3.15 Probable sources of cadmium are water pipes, tanning, paint pigments and dry cell batteries (Stevenson 1998). Cadmium, like the other heavy metals, is toxic to most organisms and many species are highly susceptible to cadmium poisoning. In aquatic ecosystems cadmium can bio accumulate in mussels, oysters, shrimps, lobsters and fish.

Chromium

3.16 Chromium contamination in the harbour sediments likely arises from tanning but will also arise from detergents, pigments, electroplating, and wear of engine parts and brake pads (Stevenson 1998). Like copper, it is moderately toxic and can damage the gills of fish that swim near the point of disposal. In other animals chromium can cause respiratory problems, a lower ability to fight disease, birth defects, infertility and tumour formation.

3.17 These last three contaminants will be discussed further under likely effects of activities in Sectors 4 and 5 and in Section 8 of this report.

Grain Size

3.18 Grain size is assessed for a number of reasons. Generally, the less diverse the particle size distribution in a sample of sediment, the less diverse will be the ecological community inhabiting it (Etter and Grassle 1992). This may be a result of the narrowing of ecological niches available, but may also be due to size of interstitial spaces and/or the fact that many contaminants adhere more strongly to smaller sized particles in a particular environment.

3.19 From a purely physical point of view, finer particles are more readily suspended leading to transport over longer distances from the source and possible smothering of marine organisms or clogging of respiratory structures.

Depth of RDL

3.20 The depth of the RDL (redox discontinuity layer) is assessed as it gives an indication of the depth of sediment that is oxygenated and which is more likely to be life supporting. This is generally discernible as a change in colour of the sediment with

anoxic sediments being darker coloured (often dark grey or almost black) with, in many instances, an associated odour of hydrogen sulphide (rotten egg smell).

Vegetation

3.21 Marine vegetation is assessed in this instance, to ascertain community diversity and to determine the presence of absence of significant plants. Many plants found in estuarine situations are highly adapted to withstand high salt conditions (halophytes) and often low soil oxygen concentrations. Such salt marsh plants can be confined to very restricted, and often diminishing, habitats.

Marine Invertebrates

3.22 Communities of benthic (bottom-living) marine animals are known to be good indicators of the presence of pollutants in the environment (Pearson and Rosenburg 1978, Warwick *et al.* 1990). Like plants, species diversity for marine invertebrates is an indicator of community health. Generally speaking, the more diverse the community, the more healthy the ecosystem (e.g. Smith 1998). Additionally the tolerance of some marine invertebrate species to pollution is known or has been hypothesised (e.g. Pearson and Rosenburg 1978, Thrush and Roper 1988). Thus, family level taxonomy can be used to measure the effects of pollutants on marine benthic fauna (e.g. Stewart 2010a). A further consideration is the likely effects that suspended sediments, generated as a result of construction activities, may have on invertebrate communities.

Fish

3.23 Fish are generally very mobile animals, although some coastal species are fiercely territorial (Vasques 1999). The concern here is disturbance of habitat, disturbance due to noise and vibration, and the effects of suspended sediment, i.e. lowered clarity/light levels may affect the hunting ability of diurnal predators or may smother gill surfaces. Additionally, the assessment ought to note whether or not any rare or significant species are present.

4. Review of the Assessment of Marine Ecological Effects by Sector

4.1 The Assessment of Marine Ecological Effects (de Luca 2010) is a generally robust and thorough document. The current round of surveys (by Bioresearches and Boffa Miskell) appear to have been conducted in a professional manner and meet the

requirements set out in New Zealand Estuary Monitoring Protocol (Robertson *et al*. 2002). Likewise, earlier surveys (Sivaguru and Grace 2002, NIWA in 2003 and ARC in 2004 and 2005), some of which pre-date the Estuary Monitoring Protocol, appear to have been carried out in a robust fashion using accepted methodologies and give a reasonable coverage of most of the areas likely to be affected by works associated with the Project.

4.2 Ecological values in the Assessment are described as low, moderate or high, these classifications having been determined using a weight of evidence approach, based on the descriptors outlined below.

Low Ecological Value

- benthic invertebrate community is dominated by tolerant organisms with few/no sensitive taxa present
- marine sediments dominated by silt and clay grain sizes
- shallow depth of oxygenated surface sediment
- elevated contaminant concentrations in surface sediment
- invasive opportunistic and disturbance tolerant species present
- habitat highly modified

Moderate Ecological Value

- benthic invertebrate community has moderate species richness and diversity
- benthic invertebrate community has both tolerant and sensitive taxa present
- marine sediments typically comprise approximately 50-70% silt and clay grain sizes
- depth of oxygenated surface sediment typically greater than 0.5 cm
- contaminant concentrations in surface sediment generally below effects threshold concentrations
- few invasive opportunistic and disturbance tolerant species present
- habitat modification limited

High Ecological Value

- benthic invertebrate community is highly diverse and has high species richness
- benthic invertebrate community contains many sensitive taxa
- marine sediments typically comprise <50% silt and clay grain sizes
- depth of oxygenated surface sediment typically greater than 1.0 cm
- contaminant concentrations in surface sediment below low effects threshold concentrations
- habitat largely unmodified

4.3 Although subjective, such methods are common practice and the experience of the personnel involved in the preparation of the Assessment is such that the conclusions reached regarding ecological values have considerable veracity.

4.4 The actual assessment of effects is also subjective, albeit slightly less so. The significance of impacts has been considered based on the following criteria:

- Type of impact (adverse/beneficial);
- Extent and magnitude of the impact;
- Duration of the impact (permanent, long-term, short-term);
- Sensitivity of the receptor / receiving environment;
- Comparison with legal requirements, policies and standards and guidelines.

These criteria are further broken down as in Tables 3 and 4.

Table 3. *Criteria for describing ecological impact magnitude (from de Luca 2010).*

Magnitude	Criteria
High	There is a large-scale permanent change in the ecological receptor and changes in its overall integrity
Medium	There is a permanent change in the ecological receptor but no permanent change in its overall integrity
Low	There is a small-scale permanent change or medium-term temporary change in the ecological receptor but its overall integrity is not permanently affected

Table 4. *Scales of temporal magnitude (from de Luca 2010).*

Magnitude	Scale
Permanent	Impacts continuing indefinitely beyond the span of one human generation (taken as approximately 25 years)
Temporary	Long term (15-25 years) Medium term (5-15 years) Short term (up to 5 years)

4.5 The significance of the impacts arising from the Project has been categorised as Major, Moderate, Minor, or Negligible. Major or moderate impacts are considered to be 'significant' and have been explored in greater depth.

4.6 In the assessment of construction and operational phase effects, combinations of ecological impact magnitude (Table 3) and temporal magnitude (Table 4) have been used to determine the significance of an effect. i.e:

Major High ecological impact of a temporary or permanent nature.

Moderate	Low ecological impact of a permanent nature or medium ecological impact of a permanent or temporary nature.
Minor	Low ecological impact of a temporary nature.
Negligible	Neutral ecological impact of a temporary or permanent nature.

4.7 The amount that the marine environment will be affected by the Project varies with each Sector according to how much of the coastline is impinged upon and the ecological value of that particular stretch of coastline.

Sector One – Te Atatu Interchange

4.8 Adjacent to Jack Colvin Park, a permanent stormwater treatment wetland is to be constructed which will receive stormwater from the proposed widened and existing SH16 within this Sector. The marine area affected here comprises a relatively small reclamation (1100m^2) that will be occupied by the proposed stormwater treatment area and an additional area of 538m^2 that will be temporarily occupied during construction (Figures 1a and 1b).

Sediment Quality

4.9 Just one sample was collected in this area. From this sample, assuming it is representative, sediment in the area is largely fine silt (~81%) and contaminant levels are moderate. Copper and lead levels fall within the ARCs amber range while zinc lies within the red range. PAHs are below the response threshold. Copper, lead and zinc levels all fall below the ANZECC low trigger values. PAHs, at 0.465mg/kg lie marginally over the low trigger value, but well below the high value where adverse effects might be expected.

4.10 Likely effects on sediment quality are reported as being increased sedimentation and possible release of buried or bound historical contaminants during the construction phase, cumulative input of contaminants during the operational phase and minor changes to the flow regime in Pixie Inlet.

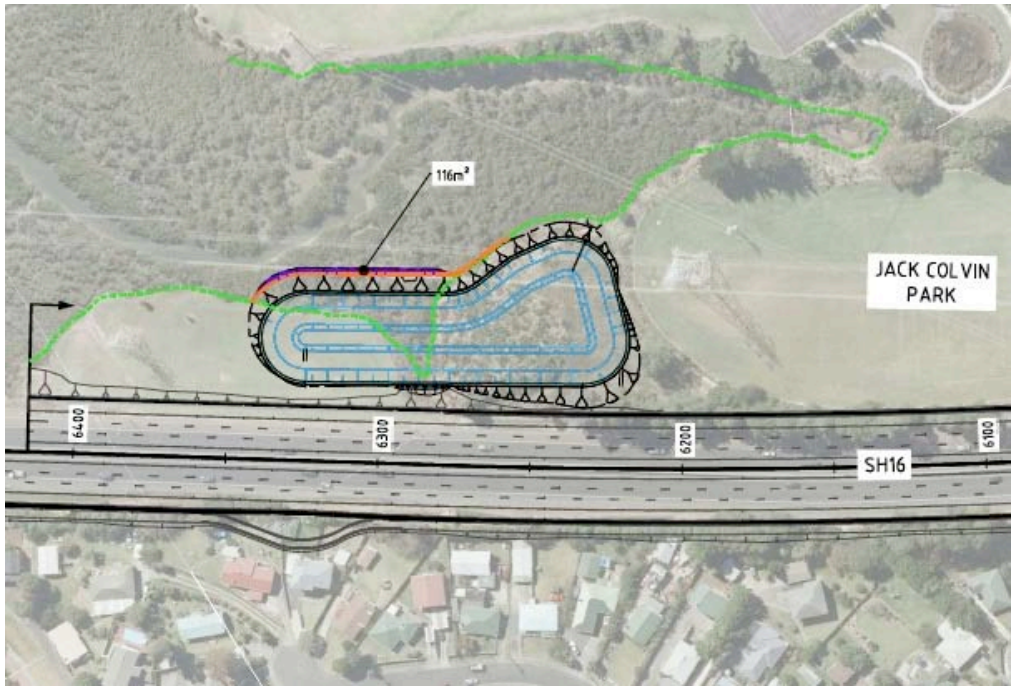

Figure 1.a *Area of CMA to be permanently lost to the proposed stormwater treatment area, Sector 1. Green dotted line denotes the limit of the CMA.*

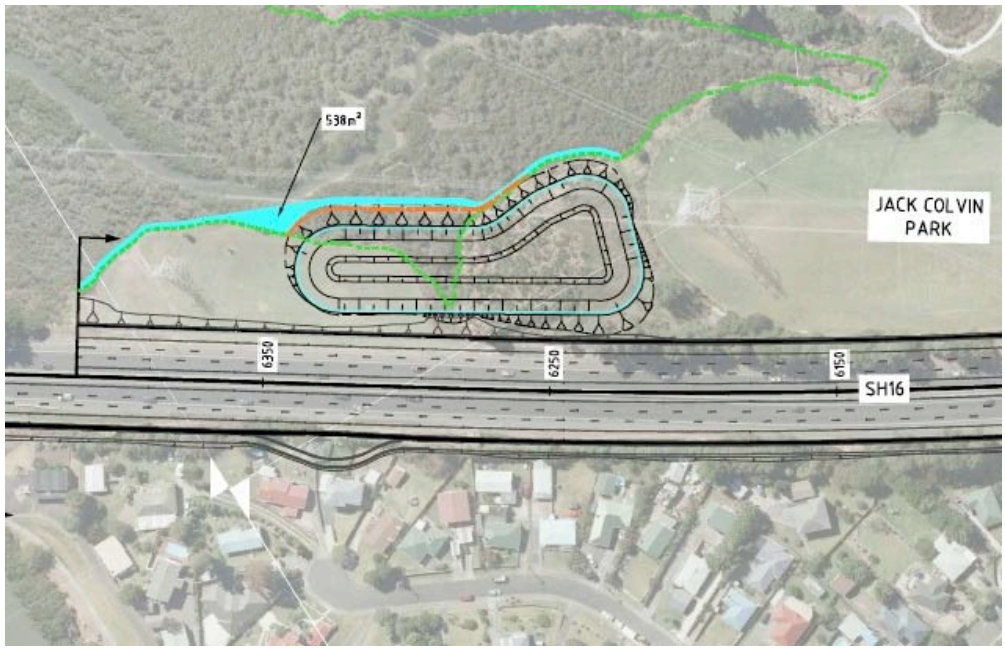

Figure 1b. *Area of CMA to be temporarily occupied (light blue) during construction of the proposed stormwater treatment area, Sector 1. Green dotted line denotes the limit of the CMA.*

Vegetation

4.11 Operational activities in the area will necessitate the permanent removal of ~1000m^2 of coastal vegetation, mainly mangroves (Figure 1a). While such vegetation is not

uncommon in the area nor in the wider Waitemata Harbour and Hauraki Gulf, it is described as "Valued Vegetation (Saline)" in the Assessment of Terrestrial Vegetation (Gardner 2010). A further small area of mangrove and coastal vegetation will be removed during the construction phase.

Invertebrates

4.12 Some 1000m^2 of habitat will be permanently lost as a result of reclamation and a further 538m^3 will be disturbed during the construction phase. Invertebrate communities will be affected by habitat loss, noise and vibration, possible increased sedimentation and the likely alteration of flow regimes. All of these will be temporary with the exception of habitat loss in the area of the proposed stormwater treatment area. None of the invertebrates in the affected area are rare or nationally significant and it is anticipated that the area disturbed during the construction phase will be recolonised by a very similar suite of organism once construction ceases. Such recolonisations are commonplace where construction activities have been carried out in the CMA without gross disturbance or contamination (e.g. Stewart 2009, 2010b).

Fish

4.13 Fish will likely be very little affected by the proposed activities in Sector 1, with the exception of some habitat loss in mangrove areas, possible increased sediment loads and minor alterations to flow regimes where drainage channels may be realigned slightly.

Mitigation of Effects

4.14 It has been recommended that further sediment analysis be carried out prior to construction commencing and, if sediments are found to be contaminated, they should be removed from the site to a licensed landfill site, thus minimising the likelihood to releasing more contaminants into the environment. Further, stormwater and runoff during construction activities are to be treated (by rock toe silt fences) such that 94% of suspended solids are removed. Treatment post construction is anticipated to remove 80% of suspended solids from stormwater runoff.

4.15 Accepting that contaminants sourced from stormwater will continue to accumulate in the environment, regardless or whether or not the Project proceeds, and that the

construction of a stormwater treatment pond will ultimately result in some improvement in runoff quality, the conclusion that the effect of the discharge of treated stormwater on sediments will be negligible seems reasonable.

4.16 For plants and animals it is anticipated that the affected area will be recolonised within a relatively short space of time once construction activities cease. Based on personal experience, this will likely be the case. The conclusion that the effect on vegetation of reclamation of the CMA for wetland will be moderate seems reasonable. Likewise, the conclusion that effects of the temporary occupation of the CMA will be minor also seems reasonable.

4.17 The proposed replanting programme for wetland and coastal margin areas within Jack Colvin Park with locally sourced and appropriate indigenous species, including *Carex litterosa* or perhaps *Mimulus repens* is a positive action.

4.18 The conclusion that effects of discharge of treated stormwater and alteration of flows as a result of continued operation of the Project (Operational Phase) are negligible is correct according to the criteria upon which the decision was made. However, cumulative effects must be considered and the author quite rightly states that ongoing monitoring, outlined in the Construction Environment Monitoring Plan, needs to take place to ensure that mitigation measures have been effective.

4.19 Overall, mitigation measures proposed for Sector 1 appear to be adequate, with improved stormwater runoff and removal of contaminated sediments, if found, compensating for the loss of a relatively small area of habitat that is valued, but not rare or nationally significant. Marine faunal communities are likely to be only temporarily affected.

Sector Two – Whau River

4.20 The works in Sector 2 primarily focus on widening the Whau River Bridges to accommodate additional lanes and enlarging SH16 between the Patiki Road Interchange and the Whau River Bridges (Figures 2a and 2b). The existing bridges will be widened by 7.25 m on the eastbound carriageway and 8.0 m on the westbound carriageway. In addition, a separate 3.0 m wide bridge will be provided as pedestrian/cycleway, adjacent to the westbound carriageway.

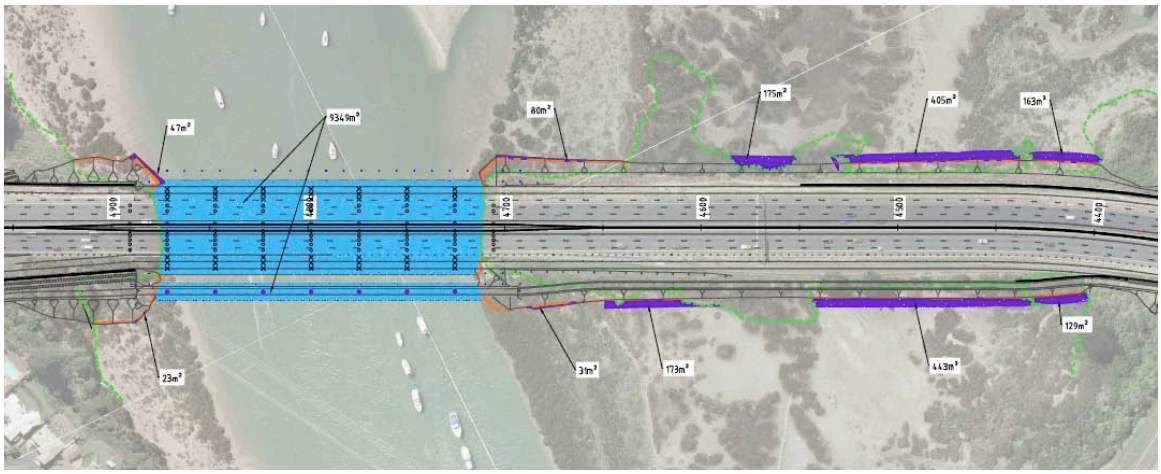

Figure 2a. *Area of CMA to be permanently affected by Sector 2. Green dotted line denotes the limit of the CMA.*

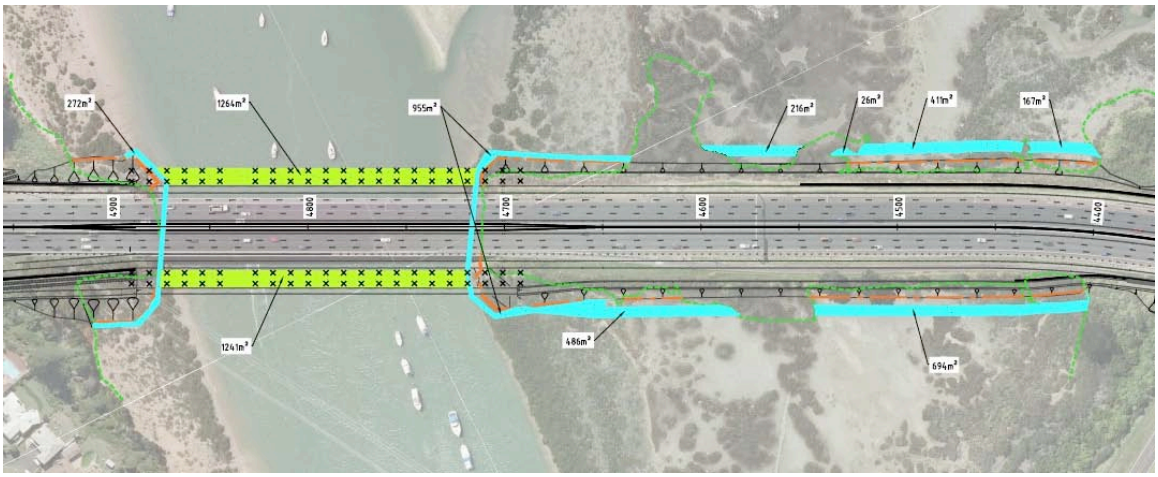

Figure 2b. *Area of CMA to be temporarily affected by construction activities in Sector 2. Green dotted line denotes the limit of the CMA.*

4.21 The marine area affected will include the permanent reclamation of 2540m^2 of intertidal CMA for the western and eastern bridge abutments, and the loss of 58m^2 of subtidal habitat and a further 22m^2 of intertidal habitat for bridge piling. Temporary losses will include 4800m^2 of intertidal habitat and 10m^2 of subtidal habitat (Figures 2a and 2b), plus an area of approximately 24m^2, mostly in the subtidal, for temporary piles. Disturbances will include ground improvements using Marine Deposit Displacement (MDD) and in-situ mudcrete. Habitat loss necessitated by widening of the SH16 Causeway Embankment will add a further ~1700m^2.

Sediment Quality

4.22 Six samples were collected in this area, four immediately adjacent to the base of the present bridge abutments and two on the tidal flat to the north of the SH16

causeway. Sediment in the area is coarser than in the sheltered inlet of Sector 1 (35% - 41% silt), likely due to higher current speeds in the area. Contaminant levels are generally low to moderate with just one site falling into the ARCs amber range for all contaminants. None of the assessed contaminants exceed ANZECC low trigger values. However, sediment quality upstream of the Whau River Bridge is expected to decline due to diminished flushing, with likely adverse ecological effects.

Vegetation

4.23 Vegetation in the area comprises mangroves and saltmarsh species and has been deemed "Valued Vegetation (Saline)" by Gardner (2010), although both the Terrestrial Vegetation and Marine Ecology assessments appear to consider the saltmarsh area under Sector 3. The area of mangroves lost will be approximately 850m^2 with the area of saltmarsh to be lost to permanent reclamation in the order of 1488m^2.

Invertebrates

4.24 The area of habitat to be potentially affected is characterised by a typical assemblage of intertidal and subtidal marine invertebrate species. Some 4250m^2 of habitat will be permanently lost as a result of reclamation and a further 4800m^2 will be disturbed during the construction phase. Invertebrate communities will be affected by habitat loss, noise and vibration, possible increased sedimentation and the likely alteration of flow regimes. All of these will be temporary with the exception of habitat loss in the area of the bridge abutments and along the margins of the causeway. None of the invertebrates in the affected area are rare or nationally significant and it is anticipated that the area disturbed during the construction phase will be recolonised by a very similar suite of organism once construction ceases.

Fish

4.25 The majority of the area to be affected in intertidal in nature and effects on fish are likely to be confined to minor disturbance of tidal flows, disturbance from noise and vibration and additional sedimentation. Such effects are expected to be minor.

Mitigation of Effects

4.26 The permanent loss of intertidal habitat, mortality of marine organisms and removal of mangroves involved in widening the bridge abutments, installing the bridge piers,

widening and the Causeway Embankment in this Sector are all considered to be moderate adverse effects. Of the approximately 4250m^2 of habitat that will be reclaimed some 3150m^2 of habitat will be permanently lost from the Motu Manawa Marine Reserve in this Sector. Construction activities will necessitate the temporary occupation loss of an additional 4800m^2 of habitat.

4.27 The temporary habitat loss is considered to be minor, a conclusion I do not dispute. Permanent habitat loss is considered to be a moderate adverse effect requiring mitigation.

4.28 The following measures are considered to off-set these effects:

- Improving the efficiency of the removal of contaminants from the operational phase of stormwater discharge. The proposed stormwater treatment devices will meet and exceed ARCs TP10 requirement, and are considered to provide a positive effect of the Project (refer Section 15.8 and Technical Report G.15);
- Treating the runoff from the currently untreated existing SH16;
- Restoration of coastal fringe habitat (refer Plans F.16 *Urban Design and Landscape Plans* of the AEE for details); and
- Removal of gross litter and debris from within and adjacent to the CMA.

4.29 In addition, monitoring of the marine environment is suggested to ensure that proposed construction mitigation measures are effective in protecting the marine ecological values. This will include suspended sediments, pH and benthic invertebrate community composition. Details of the proposed monitoring are set out in the Ecological Management Plan

4.30 I believe that, given the loss of habitat from the Motu Manawa Marine Reserve, further mitigation measures are perhaps warranted in this Sector and will discuss such measures in Section 8.

Sector Three – Rosebank Terrestrial

4.31 Sector 3 comprises predominantly land, with little intertidal habitat. However, adjacent to the southern side of the Causeway to the east of the Rosebank Domain are areas of intertidal mudflats (Figures 3a and 3b). The realignment of the access to

the Rosebank Domain and its associated effects on a small portion of mangrove habitat appears to more correctly lie within this Sector rather than in Sector 2.

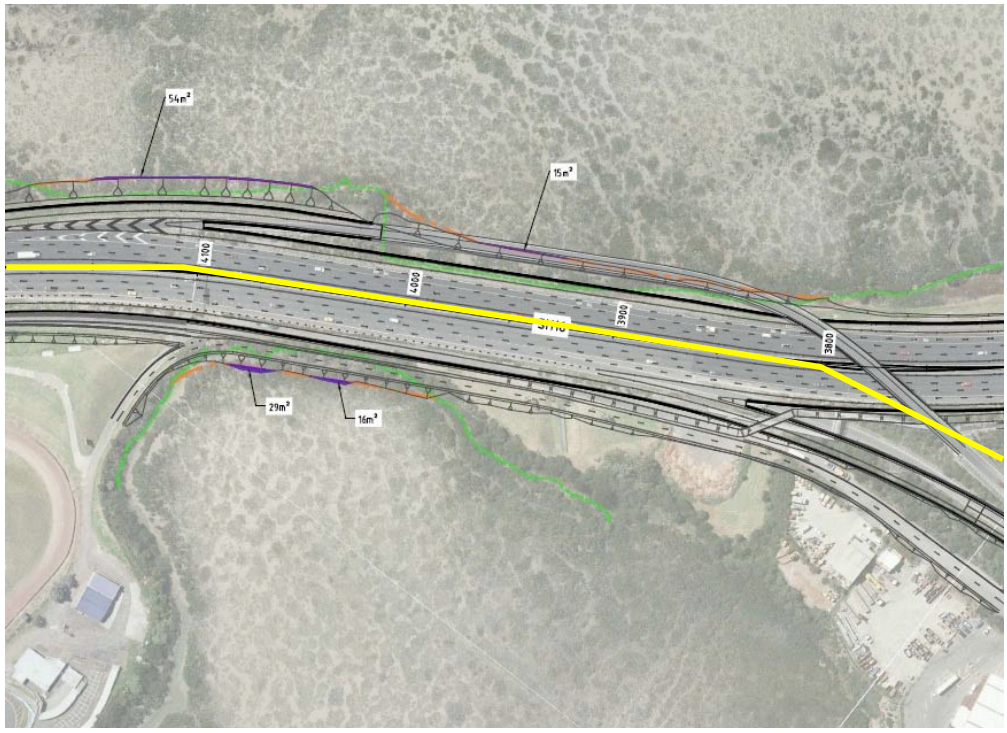

Figure 3a. *Area of CMA to be permanently affected by Sector 3. Green dotted line denotes the limit of the CMA. Yellow line marks the northern boundary of Sector 3.*

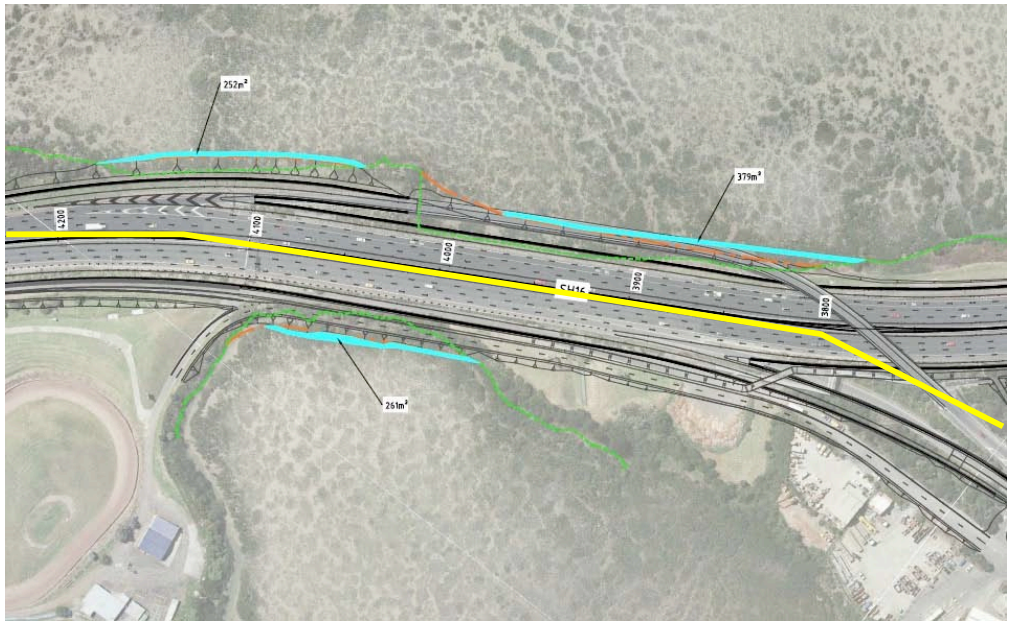

Figure 3b. *Area of CMA to be temporarily affected by construction activities in Sector 3. Green dotted line denotes the limit of the CMA. Yellow line marks the northern boundary of Sector 3.*

4.32 All construction works and erosion and sediment control structures, apart from the above mentioned access realignment, are outside the CMA in Sector 3. However, activities that have the potential to adversely affect marine ecological values include discharges into the CMA from construction phase sediment retention ponds and disturbance from noise and vibration (Technical Report No. G.15 Assessment of Stormwater and Streamworks).

Sediment Quality

4.33 No sediment samples were collected in this Sector. However, one assumes that typical stormwater sourced contaminants (copper, lead, zinc) will be found in the area. A rock toe silt fence will be constructed no more than 5m from the seaward edge of the area identified for permanent occupation. The silt fence will be removed at the conclusion of construction.

Vegetation

4.34 There will be permanent reclamation of a small area of mangrove covered intertidal mudflat. Habitat affected is estimated to be in the order of 1000m^2 although it is not clear how much of this will be permanently occupied. The effect of permanent habitat loss is considered to be moderate.

Invertebrates

4.35 As for vegetation there will be the permanent loss of a small area of intertidal mudflat, but it is assumed that the suite of infaunal invertebrates found here will be similar to that found occupying like habitat elsewhere (i.e. a mudcrab/*Amphibola* community). As above, the effect of permanent habitat loss on the invertebrate community is considered to be moderate.

Fish

4.36 It is unlikely that fish will be affected by the proposed works in Sector 3.

Mitigation of Effects

4.37 The amount of marine environment affected either during construction or during operation of the Project in Sector 3 is relatively small. Adverse effects comprise habitat loss, discharge of treated stormwater, and noise and vibration, with impacts considered to be moderate for habitat loss, and negligible for both discharge of

treated stormwater and noise and vibration. The proposed mitigation measures (stormwater treatment, silt fences) are considered acceptable given the relatively small area involved, likely recolonisation by marine organisms of temporarily disturbed habitat, and the benefits accrued from improved runoff treatment.

Sector Four – Reclamation

4.38 The largest coastal Sector (Sector 4) includes most of the alignment on SH16 from the Whau River Bridges to the Great North Road Interchange, and encompasses marine/estuarine habitats on both the northern and southern sides of the existing Causeway and the mouth of Oakley Inlet.

4.39 The main construction activities in Sector 4 that affect the CMA are the realignment of three sections of low tide channel (two within Oakley Inlet and one within Waterview Estuary adjacent to the southern side of the existing Causeway) to accommodate widening of SH16, raising and widening the Causeway, widening of the Causeway Bridges and construction of a new pedestrian/cycleway bridge. The Causeway embankment between Great North Road Interchange and Rosebank Road is required to be upgraded to accommodate the additional general traffic lanes and bus shoulders (Figures 4a-e).

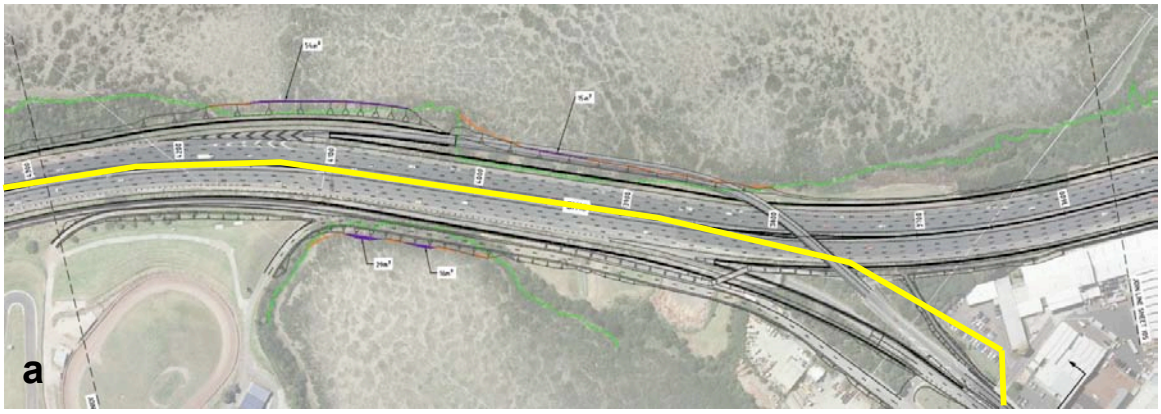

Figure 4. *Area of CMA to be permanently affected by Sector 4. Green dotted line denotes the limit of the CMA. Yellow line in 4a marks the southern boundary of Sector 4.*

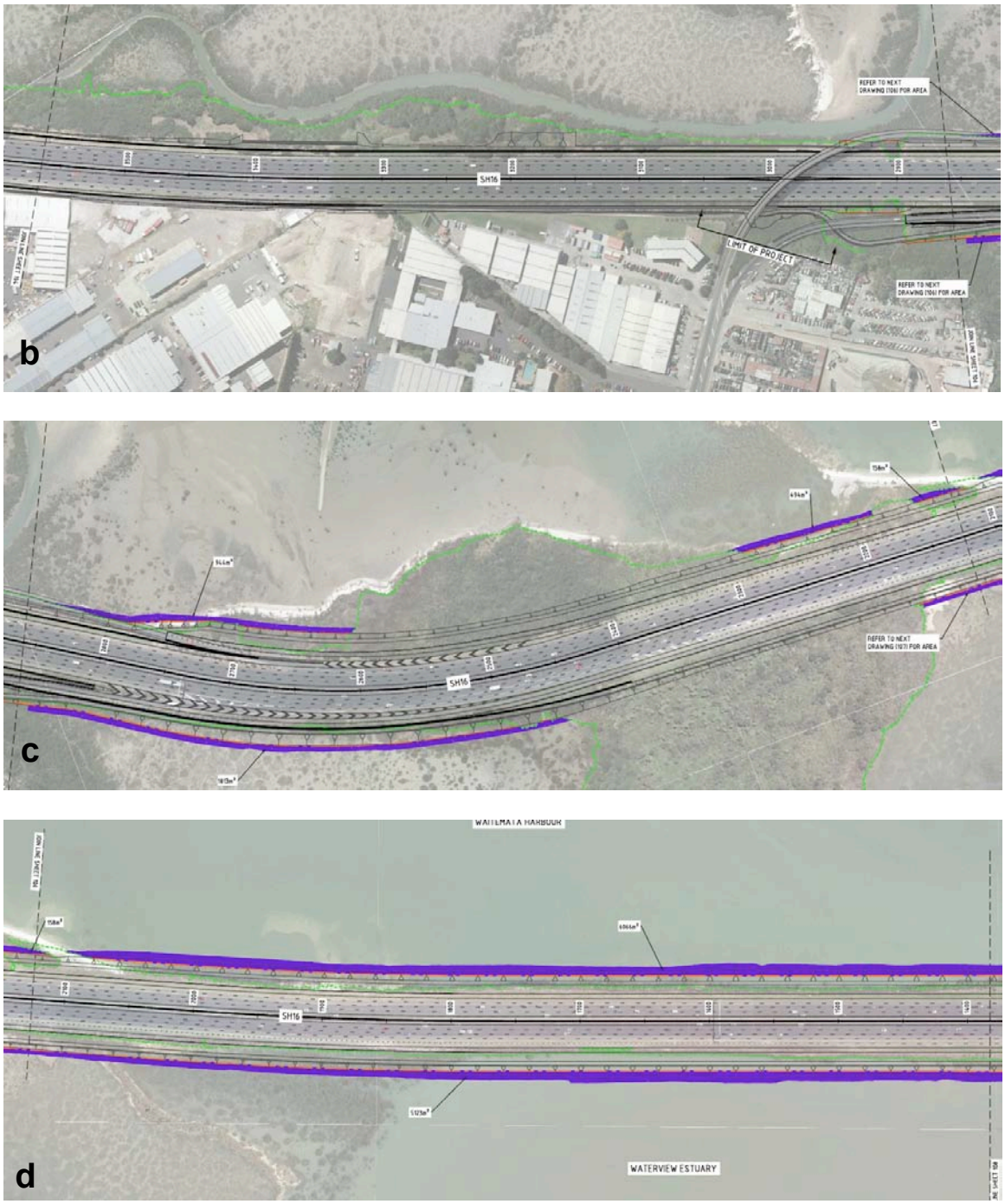

Figure 4 continued. *Area of CMA to be permanently affected by Sector 4. Green dotted line denotes the limit of the CMA. Yellow line in 4a marks the southern boundary of Sector 4.*

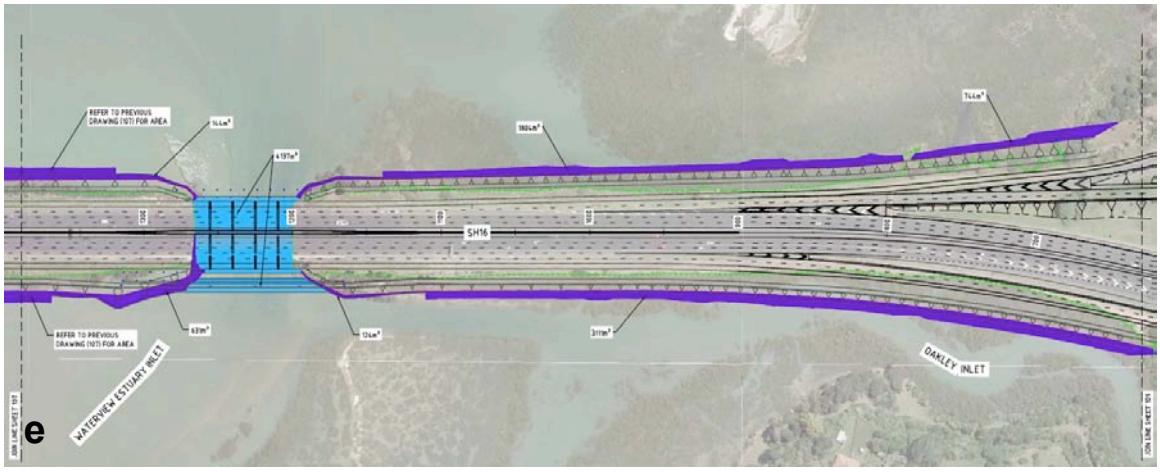

Figure 4 continued. *Area of CMA to be permanently affected by Sector 4. Green dotted line denotes the limit of the CMA. Yellow line in 4a marks the southern boundary of Sector 4.*

4.40 The completion of works in this Sector will result in the permanent loss of approximately 1400m^2 of subtidal habitat and 51,700m^2 of intertidal habitat (Figures 4a-e). Temporary disturbance will affect an area estimated to be approximately 5700m^2 of subtidal habitat and 50,000m^2 of intertidal habitat.

Sediment Quality

4.41 Shellbanks, intertidal mudflats and sandflats, subtidal soft muds and man-made rocky shore (existing rock revetment) comprise the varied substrate found in the area likely to be affected in the proposed works in Sector 4. Chenier shellbanks are present on and around Traherne Island and on the sandflats to the north of the Causeway. Ecological values throughout Sector 4 vary in relation (in part) to sediment grain size, sediment quality and hydrodynamic environment. On the western side of Pollen Island there are ecologically important drainage channels that strongly influence the surrounding resident ecology. Generally speaking, sediment particles are coarser and contaminant levels are lower north of the Causeway, while sediments are finer and contaminant levels higher within the Waterview Estuary. However, there are smaller patches within the estuary, generally where sediment grain size is coarser, that have higher ecological value.

Vegetation

4.42 The ecological values on the northern side of the Causeway within Sector 4 are considered high to moderate. The interface between the mown grass edge seaward of the existing Causeway and the saline habitat comprises a mixture of native and

exotic vegetation. Seaward of this interface area, dependent on the hydrology of the area and the sediment characteristics, the vegetation often grades into coastal marsh species and then into mangroves. Vegetation on the southern side of the causeway grades from grass (containing a mix of native saltmarsh and shrub species and exotic/weed species) to saltmarsh species at the base of the slope/rock armouring, through to low stature mangroves.

Invertebrates

4.43 On the northern side of the Causeway there is higher diversity of marine invertebrates in the immediate estuarine environment due to the more diverse habitats in this area, thus resulting in high to moderate ecological values. The southern side of the Causeway, between the Whau River Bridge and eastern end of Traherne Island, also has high to moderate ecological values, despite a slightly lower invertebrate faunal diversity. Estuarine inverterbrates in this area comprise predominantly mud crabs, mud snails, polychaete and oligochaete worms. High sedimentation loads may have an effect on feeding patterns of some invertebrates, but proposed mitigation measures, and the fact that effects will be temporary, should mean adverse effects will be negligible or, at most, minor.

Fish

4.44 Quite large tracts of intertidal habitat and significant lengths of open water will be affected by the Project in Sector 4. Being generally highly mobile, fish will likely move away from areas where there is disturbance of habitat, disturbance due to noise and vibration, and excessive suspended sediment. There will also be changes to tidal flow regimes during construction and some flows will remain altered at the conclusion of construction where drainage channels have been realigned.

Mitigation of Effects

4.45 The main potential effects on marine ecology during construction and operation of the Project are considered to be as a result of noise and vibration, land disturbance, reclamation and of stormwater and sediment discharges from construction activities and from SH16. Such discharges may contain elevated levels of suspended sediments and other contaminants.

4.46 During construction, bridge piling and vibratory rollers for road consolidation will be the primary source of vibration disturbance in this Sector. Given the temporary nature of bridge piling works, disturbance from vibration on marine organisms is considered to be negligible. Noise disturbance will occur both night and day but, recognising that the marine organisms adjacent to the existing Causeway already tolerate a noisy motorway, it is considered that the effects of noise disturbance on marine organisms will be negligible.

4.47 Upon completion, road traffic will be closer to the marine environment in some sections of the alignment in the operational phase and therefore has the potential to increase disturbance to marine organisms, primarily from noise and vibration. However the adverse effects of this are considered negligible and mitigation is considered necessary for noise and vibration.

4.48 Construction activities in this Sector have the potential to disturb the seabed and result in increased suspended solids in the water column. In addition, contaminants that are bound to fine sediment particles may be disturbed during some construction activities, primarily by the channel excavation and realignment works and installation and removal of the coffer dams.

4.49 Construction activities that may generate suspended sediment include:

- Pile driving for both the temporary staging platforms and the permanent Causeway bridges;
- Ground improvement works to support the widened Causeway Bridges abutments. This will be undertaken using Marine Deposit Displacement (MDD), which includes the placement of rock onto the marine mud (with a geotextile separator) and tamping using an excavator. Tamping will be undertaken at low tide to minimise the generation of suspended sediment;
- Ground improvement works for the reclamation works. It is proposed to undertake this work within coffer dams, which will minimise the potential for suspended solids to be discharged to the environment;
- Installation and removal of the coffer dams. While the coffer dams will be used around the active work areas to allow works to be undertaken in the dry, their installation and removal may generate suspended sediment;
- Channel realignment.

4.50 Portable water filled temporary dams are the preferred option along most of Sector 4 as the depth of soft sediments excludes the use of sheet piling. The removal of temporary dams will result in a temporary increase in suspended sediment. Interlocked sheet piles will be used as watertight coffer dams where the sediment does not comprise deep soft mud.

4.51 It is considered that the adverse effects of the placement and removal of the coffer dams are likely to be negligible, given that they are to be used temporarily and mitigate potential discharge of sediment and cement that may cause significant adverse effects on marine ecological value.

4.52 Channel realignments of the Waterview Estuary and the Oakley Inlet are required to move the low tide channels away from the permanent reclamation. It is proposed to use temporary storage lagoons at each location to contain the excavated material so that there is no loss of sediment or water from the area into the adjacent CMA.

4.53 Given the location of the works, it is anticipated that any suspended sediment generated during construction works will be readily diluted in the wider marine system, and unlikely to have any effect on marine ecology. As noted above, specific construction methods (such as the use of coffer dams and temporary storage lagoon) have been designed to minimise loss of suspended solids beyond the area of temporary occupation.

4.54 Contaminants that are bound to fine sediment particles may be disturbed during some construction activities, primarily by the channel excavation works and installation and removal of the coffer dams. However, the potential to re-suspend contaminants such as heavy metals, during disturbance of the seabed is considered to be low, given the proposed construction methods, and the large dilution provided by the Waterview Estuary and wider harbour. As such it is considered that the adverse effects of mobilisation of existing sediment-bound contaminants from marine sediment disturbance are likely to be negligible. This is a moot point and is discussed further in Section 8.

4.55 Several different ground improvement methods are proposed for the various parts of the widening of the embankment. The main method proposed is in-situ mudcrete, which involves reworking sediment with cement to strengthen the material. The use of cement within the marine environment poses a potential risk should cement be accidentally discharged during placement, causing an alteration the ambient pH levels.

4.56 However, the use of coffer dams around the work areas will mitigate the potential adverse effects from air borne and water borne cement. Any water contained within the coffer dams that is considered to be contaminated as a result of works will be removed by a suction truck, treated and disposed off-site.

4.57 Permanent loss of habitat will arise from:

- Reclamation and permanent occupation of the CMA for the widened Causeway, and the widened abutments of the Causeway bridges; and
- New piles required to support the widened Causeway bridges and the new pedestrian/cycleway bridges.

4.58 The adverse effects on marine ecological values arising from the permanent habitat loss are considered to be moderate.

4.59 Temporary loss of habitat will arise from:

- The works needed to construct the widened Causeway. These works can only be carried out while the work area is free of standing water. As such a coffer dam needs to be installed in each work area to keep out seawater. The area beneath each coffer dam, and contained within each dam that is outside of the permanent reclamation area, is considered as a temporary loss of habitat;
- Channel realignments of the Waterview Estuary and Oakley Inlet. This will involve the establishment of a temporary storage lagoon at each location to store excavated material and minimise the loss of suspended solids to the marine environment; and
- Temporary occupation of the CMA by piers to support the staging platforms.

4.60 While temporary habitat loss is considered to be a minor (and acceptable) effect, permanent habitat loss is considered to have a potentially moderate adverse effect requiring avoidance or mitigation. While it is difficult to directly avoid or mitigate these effects, the following measures are considered to off-set these effects:

- Providing a habitat remediation zone on either side of the reclamation revetments. It is proposed to construct this area by remediating a 3m wide area of intertidal habitat by providing a 0.5m (approx) layer of marine mud above the ground improvement layer of the toe of the revetment (refer Coastal Works Report G.23). This will allow marine organisms to recolonise the remediation zone over time as the replaced sediment depth (>500mm) is more than sufficient to support infaunal and burrowing organisms, as well as vegetation such as mangroves;
- Restoration of coastal fringe habitat; and
- Removal of litter and debris from within and adjacent to the CMA.

4.61 I believe further mitigation measures are perhaps warranted in this Sector and will discuss such measures in Section 8.

4.62 As construction progresses and greater areas of impervious surface are completed there is potential for road runoff to be discharged into the marine environment. However, temporary stormwater treatment has been proposed for construction. This will include a combination of sand filter trenches and grassed filter strips. It is considered that the adverse effects on marine organisms arising from the discharge of treated stormwater during construction are likely to be negligible.

4.63 Upon completion, stormwater will be treated using a combination of cartridge filters and biofilter treatment devices. All stormwater treatment devices have been designed in accordance with ARC TP10, with at least 80% treatment efficiency for both the removal of suspended solids and heavy metals. Given the proposed treatment, the effects of the discharge on marine ecological values are considered to be less than the current situation, bearing in mind that contaminants will continue to accumulate in the marine environment, albeit at a reduced rate.

4.64 A number of dry shell banks (chenier ridges) are located on the northern side of the existing Causeway within the area of permanent reclamation. It is intended that these be removed, temporarily stockpiled and reinstated at the toe of the new Causeway embankment following completion of the works. It is predicted that wave action will reform the shell deposits into a natural profile in a relatively short period of time. While I believe the mitigation measures here are adequate, the importance of these chenier ridges is explored further in Section 7.

4.65 Monitoring of the marine environment is proposed to ensure that the suggested construction mitigation measures are effective in protecting the marine ecological values. This will include suspended sediments, pH and benthic invertebrate community composition. Details of the proposed monitoring are set out in the Ecological Management Plan (ECOMP) contained in Technical Report no. 21 *Construction Environmental Management Plan,* Appendix H.

Sector Five – Great North Road Interchange

4.66 The works within Sector 5 that impinge on the marine environment are the construction of new ramps to connect SH20 to SH16 west- and east-bound, and the upgrading of the cycleway/footpath between Great North Road (GNR) and the Causeway. Some of the ramps bridge over the Oakley Inlet downstream of GNR, and piers will be positioned within the CMA. In addition, temporary staging platforms will be required to be constructed. The area of permanent intertidal habitat loss has been calculated to be in the order of $20m^2$, while temporary habitat loss should be ~$15m^2$. Approximately $5m^2$ of subtidal habitat will also be temporarily occupied.

Sediment Quality

4.67 Sediments in Sector 5 are generally fine, comprising more than 60% of particles <63µm in diameter. Contaminant concentrations reflect light industrial use and heavy urbanisation upstream of Oakley Inlet with elevated levels (within ARCs red range) of copper, lead and zinc.

4.68 Spoil generated from pile boring equipment will be removed off site and disposed of at an appropriate facility. Mitigation measures are proposed to treat stormwater and sediment runoff during construction and operational phases.

Vegetation

4.69 The intertidal banks of Oakley Inlet are inhabited by mangrove stands and coastal fringe vegetation is present between the Inlet and the existing SH16 alignment. There will be some removal of vegetation, including mangroves, to construct piles and temporary staging platforms. There will also be shading of saline vegetation from staging platforms and the completed ramps. It is expected that the temporary shading will have a transitory and negligible effect, while permanent shading may inhibit plant growth somewhat. Overall, however, effects on vegetation are expected to be negligible.

Invertebrates

4.70 As expected for the type of substrate, there is high abundance of invertebrates in Oakley Inlet, but moderate to low diversity. None of the species encountered here are particularly rare or significant with a preponderance of polychaete and oligochaete worms, amphipods and estuarine snails. Effects on invertebrates are expected to be from noise and vibration, disturbance of substrate, minor flow regime changes, and discharge of sediments. On completion of the works it is anticipated that disturbed habitat will be recolonised and adverse effects will be negligible.

Fish

4.71 Fish in Sector 5 will likely move away from areas where there is disturbance of habitat, disturbance due to noise and vibration, and excessive suspended sediment. Slight changes to tidal flow regimes during construction will be expected to have a negligible effect.

Mitigation

4.72 Mitigation of the key effects associated with the operation and construction phases of the Project (i.e. potential sediment and contaminant discharges, road runoff etc.) in Sector 5 will be managed through the installation of erosion and sediment control devices and temporary stormwater devices. Such mitigation measures are considered appropriate and will result in an overall negligible adverse effect from stormwater and sediment runoff.

4.73 While the temporary habitat loss is believed to be negligible/minor and an acceptable adverse effect, the permanent habitat loss is judged to be a moderate adverse effect

requiring mitigation. While it is difficult to directly mitigate these effects, opportunities exist to off-set these effects through:

- Improving the efficiency of the removal of contaminants from the operational phase of stormwater discharge (e.g. to 80% efficiency), which reduces the rate of accumulation of contaminants in the marine environment, and therefore has benefit to marine ecological values;
- Treating the runoff from the currently untreated existing State highway at the GNR Interchange (for the reasons identified above);
- Restoring coastal fringe habitat (e.g. as per the plans in F.16 Urban Design and Landscape Plans). Vegetating the faces of the ground improvement work areas provides an opportunity to increase ecological values at the interface of the terrestrial and coastal habitats. Restoring the coastal fringe (weed control and revegetation with appropriate native species) along the alignment also provides benefit to the marine ecological values through increasing biodiversity; and
- Removal of gross litter and debris from within and adjacent to the CMA.

4.74 It is considered that the implementation of the mitigation opportunities identified above sufficiently offset the adverse effects on marine ecological values arising from permanent marine benthic habitat loss.

4.75 In addition, ecological monitoring is proposed for pre, during and post construction for Sector 5. Monitoring of suspended sediments, pH and benthic invertebrate community composition are proposed as part of the Ecological Management Plan. This monitoring assists in ensuring that construction mitigation measures proposed are effective in protecting the marine ecological values.

5. Other Issues

5.1 An omission is the detailing of the depth of sediment sampled during the NIWA surveys (2003 and 2004) and the Bioresearches surveys (2007 and 2009). It is clearly stated that the Boffa Miskell and ARC surveys sampled surficial sediments (top 20mm) and the assumption is that the other surveys sampled similar sediments. However, Bioresearches used a box dredge sampler that is likely to have recovered sediments from the surface down to perhaps 100mm or more. Consequently,

samples are not directly comparable. Given the timeframe over which sampling has occurred and the locations of samples I believe the results do give a reasonable picture of current contamination in surficial sediments. However, for Oakley Inlet, other technical assessments refer to the fact that Garrett Brother tannery operated close to Oakley Creek from 1879 until 1890 and stood until c1912 (Clough *et al.* 2010). As stated in Section 3.1.1, likely contaminants that will have been discharged from the tannery include arsenic, cadmium and chromium. These will likely still exist buried at some undetermined depth. Some deeper, stratified samples could perhaps have been collected here and analysed for a full suite of heavy metals. Extra mitigation for this Sector is suggested in Section 8.

5.2 Some other points noted in the Assessment of Ecological Effects that, although not critical, need some clarification are:

- Saltmarsh and intertidal mud/sand flats appear on aerial photographs in Sector 2, which, from my understanding, stretches from Ch4400 to ~Ch4880. There appears to be some confusion as to which Sector this should be considered under as both Marine Ecology and Terrestrial Vegetation Assessments refer to this habitat under Sector 3.

- Likewise, the reclamation of mangrove covered tidal mudflats for the realignment of access to the Rosebank Domain is discussed under Sector 2 in the Marine Ecology Assessment while it appears to be actually located in Sector 3.

6. Submissions

6.1 The marine environment is an area of concern for many New Zealanders. This is evidenced by the fact that, of the 232 submissions received on the Project, 87 (37.5%) cited concerns about likely effects on one or more aspects of the marine environment in the vicinity of Sections 1-5 (Table 5). Sixty one submitters specifically had concerns about adverse effects on the coastal marine area with reference to the Motu Manawa Marine Reserve (MMMR), with a little over half of these concerned about reclamation inside the reserve. A further 5 out of 87 submissions (5.7%) cited concerns regarding the chenier ridges.

6.2 Fifteen submitters asked for a reduction in the size of the footprint of the proposal where it impinges on the Motu Manawa Marine Reserve and 18 submitters asked that the Reserve be increased in size as compensation for the loss of habitat within the Reserve and/or that Traherne Island be afforded similar conservation status as that afforded Pollen Island.

Table 5. *Summary of submissions that mention effects on the marine environment.*

Category	Number	As percentage of total submissions (232)	As percentage of submissions with concerns about marine ecology
Submissions with concerns about marine ecology	87	37.5	100.0
Submissions with concerns about adverse effects in the Coastal Marine Area	22	9.5	25.3
Submissions with concerns regarding effects on Motu Manawa Marine Reserve	61	26.3	70.1
Submissions with concerns about reclamation in Motu Manawa Marine Reserve	31	13.4	35.6
Submissions requesting the Motu Manawa Marine Reserve be expanded as compensation	18	7.8	20.7
Sbumissions with concerns about water quality as a result of stormwater runoff	27	11.6	31.0
Submissions requesting improvement in tidal flow in Waterview Inlet	22	9.5	25.3
Submissions expressing concerns about sediment build-up/quality	6	2.6	6.9
Submissions requesting a reduction in the footprint of the proposal along all or part of SH16	15	6.5	17.2
Submissions requesting bridging of Motu Manawa Marine Reserve	2	0.9	2.3
Submissions requesting protection/mitigation for chenier spits	5	2.2	5.7
Submissions requesting better access/signage for Motu Manawa Marine Reserve	4	1.7	4.6
Submissions requesting monitoring of CMA during and after construction	3	1.3	3.4

6.3 A small number of submitters (3) requested that monitoring be carried out during and after construction and 4 submitters requested an improvement in access and/or signage associated with the Reserve. Given the sensitive nature of some to the habitat within the reserve, however, I do not totally support unlimited access to the reserve without some protection for such habitat.

6.4 Stormwater runoff and resultant water quality effects were an issue for 27 submitters, with 6 submitters also expressing concerns about sedimentation and sediment build-up.

Reduced tidal flows in Waterview Estuary as a result of historic reclamations and the proposed works were a concern for 22 submitters.

7. Issues Raised by Assessment and Submitters

7.1 Perhaps the most contentious issue affecting the marine environment in the vicinity of Sectors 1 to 5 of the Project is the permanent loss to reclamation of intertidal habitat, especially within the Motu Manawa Marine Reserve (MMMR). The Assessment of Ecological Effects recognises that this is an area of concern and affords the effect an overall "moderate" significance, based on ecological values impacted and the magnitude of the effect. However, I believe the magnitude is slightly underestimated in terms of area affected.

7.2 The Marine Ecological Assessment states that the area lost to reclamation within the MMMR is 5.87ha or approximately 1% of the total reserve area of some 500ha. While true, this does not take account of the fact that the MMMR comprises a number of different habitats, the two most affected by the proposal being mangroves/mudflats and saltmarsh. I have calculated the rough area of these habitats in the reserve using a crude areal mapping tool and found that their areas are approximately 33ha and 147ha respectively. Thus, the amount of habitat loss is more likely around 3-4%, and will be higher if mangrove habitat is considered on its own.

7.3 Mangrove habitat is not rare in the Waitemata Harbour or the wider Hauraki Gulf and the loss of a relatively small area of such habitat is of little consequence in the wider context of coastal northern New Zealand. However, while I would not advocate the changing the description of adverse effects from "Moderate" significance to "Major" significance, cognisance must be taken of the fact that a marine reserve is being impacted and any loss of habitat within such areas is a matter of concern.

7.4 Chenier ridges are described in the Assessment of Marine Ecological Effects and are mentioned as an area of concern by a small number of submitters. A chenier ridge (or plain) is a prograded shell barrier beach comprising shell fragments and coarse sand that is moved by longshore drift and carried landwards through swash action to form bars on the foreshore (Woodroffe *et al*. 1983). There are purportedly only

about 12 of these shell plains in the world. The largest in New Zealand, at Miranda, is the only one in the world still aggrading. The shells are mainly those of cockles or, more properly, little neck clams (*Austrovenus stutchburyi*) but other molluscs may be present. The chenier ridges on the MMMR are arguably the most accessible anywhere. Thus, the chenier ridges in the MMMR are very significant habitat and due care must be taken in their preservation. The mitigation measure proposed for these ridges appear to be adequate, but monitoring of the ridges post construction will be essential.

7.5 Six submitters expressed concern at historic changes to the tidal drainage of Waterview Estuary and the subsequent build up of fine sediments and associated contaminants. This is a very real concern but mitigation of these historic effects likely fall outside the scope of the Project under consideration. However, care should be taken to not impair tidal flushing any more than is already the case. Perhaps the clearing of the currently blocked culvert under SH16 should be revisited.

7.6 A number of submitters asked that extensive monitoring be carried out during construction and operational phases of the Project. I believe the proposed Ecological Monitoring Plan addresses their concerns.

7.7 Two submitters have asked that the MMMR be bridged, rather than reclaiming habitat within the reserve. While this option has some merit and, although it would still require disruption of the MMMR during the construction phase, it may go some way to addressing concerns about footprint.

8. Further Suggested Mitigation Measures

8.1 Permanent habitat loss within the intertidal zone is a concern in all Sectors, with permanent habitat loss within the subtidal zone also occurring in three Sectors, but to a much lesser extent. While temporary habitat loss is considered to be a minor (and acceptable) adverse effect, permanent habitat loss is considered to have a potentially moderate adverse effect requiring avoidance or mitigation. Proposed mitigation includes habitat remediation, improved treatment of stormwater, restoration of coastal fringe habitat, removal of litter and debris and ongoing monitoring. I believe these measure go some way to addressing the issue, but, given the level of concern

expressed by submitters and the fact that habitat will be lost from a marine reserve, I would suggest that further mitigation be investigated.

8.2 A number of submitters request that the footprint of the widened causeway be reduced and one submitter suggests that this could be achieved to a certain extent by using vertical concrete walls for the causeway rather than the proposed sloping rock revetments. This would certainly reduce the size of the causeway footprint and thus loss of habitat.

8.3 Eighteen submitters suggested that an expansion of the MMMR would compensate for habitat lost from the reserve and I would suggest that this may be a measure that would be palatable to most parties. Similar habitat to that which will be lost occurs on the Te Atatu Peninsula on the true left bank of the Whau River downstream of the SH16 bridge, and further north, and it would be worthwhile investigating the merits of expanding the reserve in this direction. It is appreciated that such an expansion would, of necessity, have to be carried out after due consultation and in accordance with the provisions of the Marine Reserves Act 1971.

8.4 At present, Pollen Island, which lies within the MMMR is gazetted as a scientific reserve, having passed into Department of Conservation ownership in 2005. Neighbouring Traherne Island also lies within the MMMR, but is crown land owned by NZTA/LINZ. Another mitigation option that could be explored is for NZTA/LINZ to pass Traherne Island, excluding the portion used by SH16, into DoC ownership for conservation purposes.

8.5 With regard to mitigation of sediment discharges in Sectors 4 and 5, the possibility of high levels of arsenic, cadmium and chromium in historic sediments in Oakley Creek as a result of operation of the now defunct Garrett Brothers tannery is a concern. The proposed mitigation measures state that excavated sediments will be analysed before being returned to the environment and, if contaminants are found, the sediment will be taken to a licensed landfill. This is an acceptable measure but the likelihood that these particular sediments may contain contaminants outside the suite of usual stormwater contaminants monitored needs to be recognised. I would suggest a number of 0.5m deep sediment cores (perhaps 4 to 6) be taken at the sites identified as 1-6 in the Assessment of Marine Ecological Effects and analysed for the

full suite of heavy metals at perhaps 100mm depth increments before any construction commences. Proposed mitigation measures, such as removal of sediments, removal of water by suction trucks, installation of coffer dams and so on, can then be amended accordingly if necessary.

9. Conclusion

9.1 It must, at all times, be remembered that the marine environment that has been assessed is by no means pristine. The reclamation required for this Project needs to be considered within the context of the cumulative effects of historical and current works that permanently reduce marine benthic habitat in the Waitemata Harbour and the MMMR. As stated in the Assessment of Marine Ecological Effects, it is difficult to quantify the area of historical marine benthic habitat loss in the Project area. The margins of the Waterview Estuary have been modified by industrial and residential land use and the establishment of roading and the original construction of the Causeway in the 1950s. It can be concluded that the marine habitat has been significantly modified with some benthic habitat loss and/or degradation.

9.2 That being said, the Motu Manawa Marine Reserve is an area of special interest, Pollen Island purportedly being one of the few unmodified estuarine mangrove areas remaining in the Upper Waitemata Harbour (Forest and Bird 2010). Traherne Island is significant due to the presence of extremely dense wetland scrub and the rare chenier shell ridges.

9.3 If the Project proceeds the adverse effects from many activities will be temporary with negligible significance. Such activities include temporary occupation, land disturbance, noise and vibration, sediment runoff, and minor tidal flow alterations and the significance of these adverse effects is, quite rightly in my opinion, identified as negligible.

9.4 Some 6ha of marine intertidal and subtidal habitat will be permanently lost. The proposed measures (habitat remediation, improved treatment of stormwater, restoration of coastal fringe habitat, removal of litter and debris and ongoing monitoring) go some way towards mitigating this loss, and many submitters recognize this fact. However, such is the interest in the marine environment likely to be affected by the Project, especially the MMMR, that I believe there is a need to take mitigation a step of two further. While there are those who totally oppose the Project, for whatever reason, I believe the expansion of the MMMR, in some form or other, or reduction in the amount

of habitat loss in the reserve, would make the Project more acceptable to many of the submitters.

10. References

Australian and New Zealand Environment and Conservation Council (ANZECC), 2000. Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic Ecosystems.

Auckland Regional Council (ARC) (2004). Blueprint for monitoring urban receiving environments. Auckland Regional Council Technical Publication No. 168.

Beasley, G. and Kneale, P. (2002). Reviewing the impact of metals and PAHs on macroinvertebrates in urban watercourses. *Progress in Physical Geography* 26(2) 236-270.

Belan, T. 2000. Changes in benthic communities along a presumed pollution gradient in Vancouver Harbour. Report 16, Scientific Reports of the University of Vancouver.

Bryan, G. W. (1971). The effects of heavy metals (other than mercury) on marine and estuarine organisms. *Proc. Roy. Soc. Lond.* B 177: 389-410.

Clough, R, Macready, S and Bickler, S. (2010). Western Ring Route – Waterview Connection: Assessment of Archaeological Effects. A report prepared by Clough and Associates Ltd for NZTA.

de Luca, S (2010). Western Ring Route – Waterview Connection: Assessment of Marine Ecological Effects. A report prepared by Boffa Miskell for NZTA.

Etter, R. J. and Grassle, F. J. (1992). Patterns of species diversity in the deep sea as a function of sediment particle size diversity. *Nature* 360: 576-578.

Fisher, T., Moulder, T. and Mackay, K. (2010). Western Ring Route – Waterview Connection: Assessment of Stormwater and Streamworks Effects. A report prepared by Tonkin and Taylor and Aurecon Group for NZTA.

Forest & Bird (2010). http://www.forestandbird.org.nz/what-we-do/branches/central-auckland/pollen-island-/-motu-manawa-marine-reserve

Gardner, R. (2010). Western Ring Route – Waterview Connection: Assessment of Terrestrial Vegetation Effects. A report prepared by Bioresearches Group Ltd for NZTA.

Kingsford, M. and Battershill, C. (1998). Studying Temperate Marine Environments - A Handbook for Ecologists. Canterbury University Press. pp. 335.

Long, E.R., MacDonald, D.D., Smith, S.L. and Calder, E.D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environment Management* 19:81-97.

Malins, D.C., McCain, B.B., Landahl, J.T., Myer, M.S., Krahn, M.M., Brown, D.W., Chan, S. and Roubal, W.T. (1988). Neoplastic and other diseases in fish in relation to toxic chemicals: an overview. Aquatic Toxicology, 11, 43-67.

MPMMG (Marine Pollution Monitoring Management Group). (1998). National Monitoring Programme Survey of the Quality of UK Coastal waters. Marine Pollution Monitoring Management Group, Aberdeen, ISBN 0 9532838 36.

Morrisey, D. J. Turner, S. J., Mills, N. M., Williamson, R. B. and Wise, B. E. (2003) Factors affecting the distribution of benthic macrofauna in estuaries contaminated by urban runoff. *Marine Environmental Research* 55: 113-136.

Pearson, T.H. and Rosenberg, R. (1978). Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: an annual review 16: 229-311.

Robertson, B.M.; Gillespie, P.A.; Asher, R.A.; Frisk, S.; Keeley, N.B.; Hopkins, G.A.; Thompson, S.J.; Tuckey, B.J. (2002). Estuarine Environmental Assessment and Monitoring: A National Protocol. Part A. Development, Part B. Appendices, and Part C. Application. Prepared for supporting Councils and the Ministry for the Environment, Sustainable Management Fund Contract No. 5096. Part A. 93p. Part B. 159p. Part C. 40p plus field sheets.

Smith, F. (1998). Subtidal landscapes of a New Zealand fjord: Patterns of species diversity, community structure and recruitment processes. Unpublished PhD thesis. Dept. of Marine Science, University of Otago. pp 134 plus appendices.

Stevenson M. (1998). Otago Harbour: An investigation of sediment in the Upper Harbour Basin and Andersons Bay Inlet. Report prepared for the Otago Regional Council.

Stewart B.G. 2009. Peninsula Road Improvements Project: Post Construction Ecological Assessment. Report prepared for MWH Ltd by Ryder Consulting Ltd.

Stewart, B. 2010a. Tahuna WWTP Offshore Outfall: Offshore sediment survey, February 2010. Prepared by Ryder Consulting Ltd for Dunedin City Council.

Stewart B.G. 2010b. Peninsula Road Improvements Project: 2nd Post Construction Ecological Assessment. Report prepared for MWH Ltd by Ryder Consulting Ltd.

Thrush, S.F. and Roper, D.S., (1988). Merits of macrofaunal colonization of intertidal mudflats for pollution and monitoring: preliminary study. Journal of Experimental Marine Biology and Ecology 116: 219-233.

Vasques, J. (1999). Patterns of diversity, distribution, and resource partitioning among a group of sympatric tripterygiids in New Zealand's Fiords. Unpublished MSc thesis, University of Otago.

Vethaak, A.D. and ap Rheinhallt, T. (1992). Fish disease as a monitor for marine pollution: the case of the North Sea. *Reviews in Fish Biology and Fisheries*, 2, 1-32.

Warwick, R.M., Platt, H.M., Clarke, K.R., Agard, J., and Gobin, J. (1990). Analysis of macrobenthic and meiobenthic community structure in relation to pollution and disturbance in Hamilton Harbour, Bermuda. Journal of Experimental Marine Biology and Ecology 138: 119-142.

Woodroffe C.D., Curtis R.J. and McLean R.F. (1983). Development of a Chenier Plain, Firth of Thames, New Zealand. *Marine Geology* 53: 1-22.