TRANSMISSION GULLY PROJECT

TECHNICAL REPORT #11

Ecological Impact Assessment

August 2011

Front Cover Photo:
Looking south up Te Puka Valley. The alignment will traverse the steep slopes on the right (west). The existing transmission corridor is visible in the stream bed and a number of these towers will be relocated. The podocarp broadleaf forest of the Akatarawa-Whakatikei Forest Park visible in the distance.

Bibliographic reference:
Boffa Miskell, 2011: Transmission Gully Project Technical Report 11, Assessment Of Ecological Effects. Prepared for New Zealand Transport Agency and Porirua City Council by Boffa Miskell Limited. Report No: W09034E. 183 p.

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EXECUTIVE SUMMARY

INTRODUCTION

This technical report is one of a series that report on ecological investigations carried out as part of the Transmission Gully Project (the "Project"), specifically in relation to NZTA 345PN Phase II Investigations, E&EA; work package "WS-08 Ecological Assessment, Survey, Modelling, and Management (BML, 2009).

The purpose of Work Package 08 is to comprehensively map and describe the values of ecological systems that occur along this route, and associated link roads, and to describe the distribution and abundance of native flora and fauna within or in close proximity to the Project footprint. From this work the potential environmental effects of both the construction and ongoing operation of the proposed Transmission Gully highway can be assessed and measures to mitigate potential or actual adverse effects can be developed.

METHODOLOGY

Terrestrial Flora and Habitats

All vegetation within a 500 m corridor along the alignment was mapped using aerial photographs and field verification to allow quantification of potential habitat loss. A small number of vegetation transects were carried out to better describe indigenous vegetation that is potentially affected.

A desktop review of literature focused botanical investigations on those areas within the proposed Transmission Gully Designation that were most likely to have species or habitats of conservation value. A plant survey was carried out in all habitats likely to contain rare species.

Terrestrial Fauna

Investigations of terrestrial fauna included surveys of birds, bats, lizards and terrestrial invertebrates and the identification of the habitats in which they occur.

Freshwater Habitats and Species

Four "sets" of data were collected for the Project investigations over a period of three years to describe the aquatic habitats and their assemblages; and to allow regional importance and sensitivities to be assessed. The four are:

- physical habitat data, i.e. stream morphology, substrate type, riparian condition etc;
- water quality (collected in the main by SKM);
- water quantity (collected in the main by SKM); and
- flora and fauna (primarily aquatic macro invertebrates, fish and aquatic macrophyte data).

Estuarine Habitats and Species

A desktop review of the numerous reports and publications on Porirua Harbour, Wainui Stream mouth and Whareroa Stream mouth identified two gaps in our current knowledge of the harbour and the likely effects of sediment and stormwater discharge to it. These were the focus of the field investigations.

Intertidal surveys of infaunal and epifaunal invertebrates, sediment grain size, sediment quality, depth of oxygenation of sediment and macroalgal cover were undertaken at the mouths of streams that are likely to receive both construction and operational phase stormwater from the Project. These streams included Pauatahanui, Horokiri, Ration, Porirua, Wainui and Duck Creek.

Subtidal surveys were undertaken adjacent to the stream mouths that currently receive and retain the most terrestrial sediment during storm events. In addition, some central subtidal basin sites were also sampled to confirm movement and deposition of sediments within the harbour.

Assessment of Significance

For all flora, fauna, and habitats assessments of their ecological significance was undertaken. The potential effects of construction on these ecological components were then quantified.

Project Shaping

The various phases of Project shaping are described including:

- Describing the scope and potential effects of the existing designation;
- Describing the design changes that have been made through the Scheme Assessment, and through this Ecological Impact Assessment process, to avoid or minimise effects; and
- Describing the scope of the preferred alignment including the scale of potential effects on terrestrial and aquatic habitats that could not be avoided.

Assessment of Effects

The assessment of effects considered:

- The predicted magnitude of effects of construction and operation of the road;
- The degree of mitigation required to offset these effects, including the methodology and associated monitoring; and
- The significance of any residual effects that remain after mitigation has been applied.

PROJECT DESCRIPTION

The main alignment will extend from the Kapiti Coast (McKays Crossing) to Wellington (Linden). It will be approximately 27 kilometres in length. There are three link roads that connect the alignment to Tawa/Linden, to Whitby, and to Cannons Creek.

The potential extent of physical works including; construction access tracks, disposal sites, site accommodation, lay-down areas, and erosion and sediment control devices, is defined by the designation and is approximately 485 ha in area. The area of the road footprint (sealed width plus cut and fill batters) is 170 ha. The Project will require the excavation of up to 6 million m³ of material, with approximately 600,000 m³ relocated to fill sites. Construction will require extensive erosion and sediment control to protect stream and estuaries.

The Project will require approximately 112 stream crossings, 10 by bridge and 102 by culvert. This will affect 9,959 m of stream. There will also be 6,600 m of diversions.

The project will require the removal of up to 20 ha of mature native forest, up to 47 ha of secondary native forest, and up to 50 ha of regenerating shrubland and scrub.

EXISTING ENVIRONMENT

Context:

The study area lies almost entirely within the Wellington Ecological District. This Ecological District (ED) is characterised by steep, strongly faulted hills and ranges, and the Wellington and Porirua Harbours. The district is windy with frequent NW gales, warm summers, and mild winters. Rainfall is typically between 900 and 1,400 mm p.a.

The Wellington ED was originally forested. Near the coast the forests were dominated by rimu, rata and kohekohe; podocarp forests (kahikatea, totara, matai) dominated on river terraces and low hills; and miro-rimu/tawa forest at higher altitudes. There was a fringe of salt marsh and swamp forest communities around the Porirua Harbour. The Porirua Basin was part of the Wellington beech-gap and what little beech was present (black beech and hard beech) was confined to stands on the eastern fringes of the ED which extended over the ridgelines from the extensive beech forests of the Hutt Valley.

Today the ED is modified by farming and urbanisation, with pasture, gorse and regenerating shrublands throughout. Some small forest remnants occur.

Vegetation, Communities and Habitats

The great majority of the proposed designation lies in a highly modified pastoral landscape. 48% is in pasture, 21% is in plantation forestry or other exotic forest, and 10% is in pioneer shrublands and scrub within pasture.

A further 10% of the vegetation within the designation is in seral scrub and forest dominated by either kanuka or mahoe. Indigenous forest makes up less than 4% (20 ha) of the plant communities potentially affected. The final 10% of the designation is classed as urban.

Terrestrial Fauna (Lizards & Invertebrates)

Three species of common lizard were observed in low numbers within the proposed designation. It is considered that these populations represent relics, reduced by land use change, loss of habitat, and predation. No species of conservation concern were found although they may still be present but in very low numbers.

The key habitats identified for both lizards and Peripatus are the mature forests of the Akatarawa Forests at the Wainui Summit, and the colluvial boulder fields found on steep slopes within the Te Puka, upper Horokiri, and Duck Creek.

Avifauna

37 species of bird were observed during the study. Of these five species are of conservation concern, NZ bush falcon, NI kaka, NZ Pipit, black shag and pied shag.

The mature indigenous forest in the headwaters of the Te Puka and Horokiri catchments had a high diversity and abundance of more common native forest passerines such as kereru and tui. There was good though lesser abundance of native forest species in the regenerating and mature forests of Cannons Creek and Porirua Park Bush. Finally the saltmarsh and tidal flats of Pauatahanui Estuary are known for the presence of uncommon and rare birds including international migrants.

Bats

The only vegetation of sufficient size and maturity to sustain a population of native bats is the mature forests of the Akatarawa Forests. An unconfirmed bat vocalisation was recorded at Wainui Saddle on the margins of this forest during this study. This observation needs to be confirmed.

Freshwater Habitats & Species

A significant portion of the route lies within or very close to the following four streams listed in the Regional Freshwater Plan as providing habitat for nationally threatened indigenous fish:

- Duck Creek
- Pauatahanui Stream
- Ration Creek
- Horokiri Stream

In addition, the stream assessment conducted as part of this Assessment has identified a fifth stream, Te Puka, as having similar high ecological values to those that are listed.

These investigations confirmed the distribution and abundance of native fish species including nine species that are of conservation concern (nationally threatened or at risk).

Estuarine Habitats & Species

The marine assessment considered three areas; the two arms of Porirua Harbour (the Onepoto Arm and Pauatahanui Inlet), and Wainui and Whareroa Stream mouths on the Kapiti Coast.

The two arms of Porirua Harbour have different values, and within the Pauatahanui Inlet the values also vary between the near shore marine environment and the central subtidal basins. The near shore habitat within the Pauatahanui Inlet has a high diversity and abundance of epifaunal and infaunal benthic invertebrates, with many sensitive taxa present. However, the central subtidal basins comprise predominantly anoxic silt and a depauperate invertebrate community. The invertebrate assemblage in the Onepoto Inlet is slightly less diverse than that found in the near shore habitats of the Pauatahanui Inlet and has a higher proportion of tolerant species. However, species that are sensitive to organic enrichment were detected in both Inlets.

Both arms of the harbour showed elevated levels of contamination resulting from historic use of agrichemicals (e.g. dieldrin and DDT). Common stormwater contaminants (copper, lead, zinc and polycyclic aromatic hydrocarbons) were primarily detected at below biological effects concentrations in the Pauatahanui Inlet, but often above biological effects thresholds within the Onepoto Inlet. This pattern is consistent with the current and historic land uses within the catchments which feed into Porirua Harbour, with the Onepoto Inlet having primarily industrial and residential land use and the Pauatahanui Inlet land use being primarily residential and rural.

Both arms show increased deposition of sediments from upstream erosion associated with land-use practices (farming and forestry) and from earthworks associated with residential development.

The only marine receiving environments not within Porirua Harbour are the Wainui and Whareroa Stream mouths. These sites had coarse grain size sediment, negligible contaminant concentrations in intertidal surface sediment, and a naturally depauperate benthic epifaunal and infaunal community consistent with a high-energy beach environment.

ASSESSMENT OF ECOLOGICAL & CONSERVATION VALUE

Terrestrial Flora, Fauna and Habitats

All areas of indigenous vegetation considered to have ecological value that were identified through the above processes were assessed for significance. This process identified key plant communities and habitats that will be potentially affected, and a number that could be avoided during detailed design.

Freshwater Flora, Fauna and Habitats

A combination of fish presence, invertebrate indices, and habitat scores were used to assess the ecological value of each stream that is affected.

At a Regional scale the aquatic fauna and physical habitat of the Duck, Horokiri and Te Puka systems, while apparently deteriorating in the lower reaches and potentially trending down with land use practices, are considered to be Regionally significant. The lower reaches of Ration and Pauatahanui are also considered to be of high value despite their modifications as they retain important fauna species. The Kenepuru, Porirua tributary and Cannons systems are of lower value although they still support an array of values, notably components of the macroinvertebrate fauna.

Harbours and Estuaries

The ecological values of the intertidal marine habitat in Porirua Harbour are considered to be moderate in the Onepoto Inlet and high in the near shore areas of the Pauatahanui Inlet, but low-moderate in the central subtidal basins. The Wainui and Whareroa Stream mouths intertidal habitat is considered to have high ecological values.

For the Onepoto Inlet this is based on moderate to high species richness and diversity of invertebrates, a dominance of tolerant taxa but the presence of sensitive taxa, presence of seagrass, a predominance of finer sediment grain sizes, a high degree of coastal edge habitat modification, limited habitat and feeding areas for birds and fish, and sediment contaminant concentrations above effects thresholds.

In comparison, the near shore habitat within Pauatahanui Inlet is characterised as having a high diversity and abundance of invertebrates, a diversity of sensitive taxa and the presence of tolerant taxa, presence of seagrass, presence of keystone species (i.e. significant cockle beds), variable grain size characteristics, low concentrations of heavy metals, significant areas of unmodified coastal fringe habitat (containing native coastal and saltmarsh vegetation), significant habitat and feeding areas for fish and birds, but elevated concentrations of agrichemicals and PAHs detected in some sediment samples. The central subtidal basins of the Pauatahanui Inlet have low diversity and abundance of invertebrates, a predominance of tolerant organisms, sediment that is almost entirely silt & clay grain sizes and anoxic. As such, the central basin habitats have been assessed as having low-moderate ecological value.

Protected & Identified Natural Areas

The proposed designation crosses nine protected natural areas (reserves, covenants, Regional Parks) and three wetland reserves lie downstream of works. The designation also crosses 13 unprotected sites which have been identified by PNA surveys as having conservation value.

PROJECT SHAPING

The starting point for this investigation is the existing designation. Investigations for this existing designation were carried out in 1994 and these investigations identified a number of significant adverse effects.

There have been two phases of project shaping where ecological issues have been able to influence design to avoid or minimise adverse effects. Project shaping began during the Scheme Assessment stage (SAR), where a number of route alignment options were explored and where ecological considerations were key assessment criteria.

The SAR process resulted in several important changes to the route alignment, the most significant being the decision to move the alignment from the east to the west slopes of the Te Puka and upper Horokiri valleys. This avoided the most significant effects to indigenous vegetation and significantly reduced effects on these two streams.

The stage II investigations, of which this assessment is part, has allowed more detailed investigations of the proposed designation's ecology and continued ecological involvement in design of the route. This has led to continued refinements of the alignment which further reduce effects on streams and high value plant communities and habitats.

The stage II investigations are also the first time that detailed investigations of the sediment and erosion control have been carried out, and the first time there has been an integrated investigation of potential effects on the Porirua Harbour. This information has, for the first time, allowed modelling of effects associated with discharge of contaminants (sediment and stormwater) to streams and the harbour. A number of scenarios have been modelled to identify sensitivities around construction staging and extent to aid in assessment of effects.

ASSESSMENT OF ECOLOGICAL EFFECTS

Effects during construction can be separated into Direct Effects and Indirect Effects. Effects were first assessed without mitigation.

Direct Impacts of Construction

The route lies within a highly modified landscape dominated by farming and rural lifestyle blocks. However, a number of areas of vegetation and habitats of indigenous fauna have been identified that will be lost beneath the project Footprint and this effect will need to be mitigated.

The key effects during construction are:

- Permanent loss of 40 ha of indigenous vegetation (wetlands, shrublands and scrub, seral forest, and mature or maturing forest) and habitat beneath the road footprint;
- Temporary loss or modification to a further 85 ha of indigenous vegetation due to earthworks and construction activities within the wider designation;
- Permanent loss of 5,280 m of freshwater habitat, riparian margins, and resident populations of freshwater flora and fauna, in perennial or intermittent streams due to culverting, diversion and associated stream shortening;
- Modifications to a further 5,130 m of freshwater habitat and riparian margins within perennial and intermittent streams, through bridge construction and diversion;
- Potential loss of sedentary species (e.g. lizards) when their habitat is removed;
- Disturbance and displacement of mobile species (e.g. birds) by construction activity; and
- Potential impact on the movement of migratory fish by streambed modifications and culverts.

Our assessment concluded that the significance of effects on vegetation and terrestrial habitat would range from very low to moderate depending on the Ecological value of the site and the magnitude of effect. Some mitigation is required for adverse effects.

Effects on freshwater systems also varied from very low to moderate, the two streams most affected being Upper and Middle Duck Creek, and Middle and lower Horokiri. Effects on freshwater fauna would be very high due to the permanent loss of significant areas of stream habitat and the expected reduction of habitat values within the extensive diversions required. These effects need to be mitigated.

Effects on terrestrial fauna and avifauna would be very low or low, as most key habitat had be avoided through the SAR changes and subsequent design changes associated with this project.

Indirect Impacts of Construction

The key indirect effects during construction are:

- Increase of sediment within stream habitats above baseline levels with potential impacts on streams and freshwater fauna; and
- Increase of sediment discharging to harbours above baseline levels with potential impacts on habitats, vegetation and species reliant on these waterbodies.

In order to assess these effects, extensive modelling of catchment characteristics, stream flows, and predicted sediment deposition was carried out by SKM (Technical Report 15). Based on the data provided by this modelling, we have concluded the following:

- With no or limited treatment of sediment, estimated increases in sediment yield varied between 30% and 90% which would lead to very high to high affects on all catchments except Pauatahanui and Horokiri which would experience moderate effects.
- It is anticipated there will be equivalent adverse effects with Porirua Harbour.

This scale of effects was considered to be unacceptable, and additional investigation was carried out in order to determine the extent to which they could be minimised.

Operation Impacts

The key effects during operation are:

- Potential discharge of contaminated stormwater from the road surface to local streams, with potential impacts on water and habitat quality, and effects on sensitive taxa;
- Potential increase of stormwater and contaminant discharge to Porirua Harbour with potential impacts on habitats and sensitive fauna; and
- Potential effects of road operation on sensitive bird and/or bat populations.

We concluded that effects of stormwater runoff to streams and the harbour would be low to negligible. In only one case did the change in selected “indicator” contaminants (Copper and Zinc) result in a change to existing levels that would lead to an exceedence of ANZECC trigger levels, that being Ration Stream.

RECOMMENDATIONS FOR MITIGATION

Direct Impacts of Construction

Recommended mitigation for habitat loss takes the form of retirement and revegetation. The quantities of land required to mitigate for habitat loss were calculated using Compensation Ratios that take account of the value of the habitat being affected and the time it takes for recovery of habitats with equivalent value.

In summary, we recommend the retirement of approximately 400 ha of marginal land in the Te Puka and upper Horokiri, combined with existing early retirement planting, and revegetation above Porirua Park Bush, and fish passage improvements to existing culverts in Duck Creek. These sites were selected to provide the widest range of ecological benefit. They lie adjacent to or contain the highest value stream and vegetation habitats, and the highest concentration of species of conservation concern. In addition to these sites the mitigation calculations include 41 ha of land purchase and early retirement planting that has been carried out by NZTA in recent years as part of the existing designation requirements. These sites contain a further 2,000 linear metres of stream and riparian planting.

These mitigation sites contain between them approximately 13.8 km of perennial or intermittent stream. This total includes 2 km of stream and riparian planting carried out as part of early retirement mitigation. The mitigation calculation also includes 8.6 km of diversions which need to be designed and constructed to mirror the sections of reclaimed stream they are replacing. Finally the mitigation calculations include improvements to existing culverts in Duck Creek which will allow fish to return to 8.5 km of headwater stream. These activities combined slightly exceed the required 26km of stream restoration and result in an overall ecological benefit.

These sites provide a surplus of land necessary for the estimated 247 ha of revegetation required to mitigate for loss of terrestrial vegetation and habitat for terrestrial fauna. This results in an overall ecological benefit.

Within these sites, a range of mitigation measures are proposed including revegetation, enrichment planting, land retirement, the remediation of damaged stream bed, innovative fish passage design, and detailed design of stream diversions to match the habitat that is being replaced.

In addition, there are some opportunities to reduce effects on terrestrial vegetation during detailed design and these are identified.

Additional benefits related to land retirement are creation of green and blue corridors extending from the Akatarawa Whakatikei catchment down to the Kapiti Coast to the north and down to Battle Hill Regional Park in the south. Land retirement and revegetation will also lead to reductions in hillslope erosion within these two catchments, reducing in the long term discharges to Pauatahanui Inlet and Wainui Stream mouth.

A number of recommendations are made with regard to fish passage and the capture and transfer of fish during construction of culverts and diversions. The creation of boulderfields at the toe of fill batters in the Te Puka and Horokiri can mitigate for loss of lizard and insect habitat.

Overall it is believed that direct effects on terrestrial and aquatic habitat can be mitigated and that in the medium to long term, effects will be positive.

Indirect Impacts of Construction

Indirect effects largely relate to downstream impacts of sediment from earthworks on streams and the harbour. A range of measures are proposed for the management of erosion, and the capture and treatment of sediment during construction. Treatment devices have been designed to exceed regional guidelines.

With regard to freshwater systems, we anticipate that with the comprehensive erosion control and sediment treatment that has been modelled by SKM (Technical Reports 14), estimated increases in sediment yield will vary between 2% and 43% from stream to stream in a Q10 rainfall event. This is a significant reduction from calculations made with minimal treatment. These levels of increased sediment yield are predicted to lead to high effects in two catchments, the Te Puka and the upper and mid reaches of Duck Creek. Moderate adverse effects are likely in Horokiri stream, with low to very low effects in all other streams.

Increased sediment transfer to Porirua Harbour will have both short term (1-5 yrs) and long term (20 yrs) effects. Short term effects range from negligible (small rainfall events and benign wind conditions) to moderate (10yr rainfall event and adverse wind conditions) where some tidal areas are inundated with sediment and sensitive biota are lost. No further improvements to sediment management can be achieved that would prevent these effects under the circumstances modelled. Over time the deposited sediments will be re-distributed from the high value tidal sites to lower value subtidal basins, and sensitive biota and communities will re-establish.

In the long term sediments will be redistributed to the deep sub-tidal basins which, in their current state, have lower ecological values. This re-sorting will have negligible effects on marine fauna. Cumulatively, it will contribute some additional sediment to the shallowing harbour, but this will be a very small proportion of all contributing discharges from existing land uses. We assess the long term effect to be low.

Harbour modelling was based upon a number of critical assumptions including maximum open earthworked area in each catchment. Based on the various modelling scenarios that have been assessed, it is our opinion that any increase in earth worked area would expose the harbour to significant increases in sedimentation. Our recommendation is that the earthworked areas used in the modelling be set as the maximum allowed in any watershed at any one time.

Operation Impacts

The Project design requires the use of stormwater treatment wetlands where possible. Where this is not possible, proprietary devices are proposed. Combined, these devices are expected to perform such that the levels of contaminants in stormwater discharging to streams and the Porirua Harbour will not increase.

Factors influencing this result are:

- Removal of traffic from Grays Road and SH58 (between 25-35% and 40-60% respectively) where currently vehicle and road contaminants flush, untreated, into the harbour.
- Retirement of erosion prone land within the Horokiri and Duck catchments.

In addition, the stormwater treatment wetlands will also provide additional habitat as mitigation for the minor loss of wetland habitat beneath the Project footprint.

We conclude that the downstream effect of this discharge to the marine ecological values within the Porirua Harbour will be negligible in the short to medium term. Over time, contaminants will continue to accumulate in the fine benthic sediment of Porirua Harbour which will add to the ongoing contributions from the urbanisation of the catchment. In the long term, this Project adds a small proportion of contaminants which in total may exceed the biological effects thresholds in the

Pauatahanui Inlet, and further increase beyond the low biological effects thresholds that are currently recorded in the Onepoto Arm.

MONITORING

A number of recommendations are made for baseline and construction monitoring and for consent conditions that will provide some certainty of outcome from the mitigation proposed.

Attached to this report are a draft revegetation plan, a water quality monitoring and adaptive management plan, and indicative SSEMPs for the Te Puka, Horokiri, and Duck Creek, which describe how environmental management should be identified and carried out.

CONCLUSIONS

The Transmission Gully Project is a major infrastructure project with a large footprint, which traverses a number of sensitive and ecologically significant environments. Considerable work has been carried out in an attempt to avoid or minimise effects on the most important areas through continual refinement of the road alignment. We are comfortable that every opportunity to avoid effects has been explored.

Despite this work, some areas of indigenous vegetation and significant lengths of stream could not be avoided and will be either lost beneath the road or affected by other associated construction activities. This will lead, at least in the short term, to significant and unavoidable impacts on terrestrial and freshwater habitats, communities and species. A comprehensive mitigation package has been developed in response to these losses. If implemented, mitigation will reduce the scale of these effects over time to the point where we believe there will be a range of positive effects.

In addition to direct habitat loss, we have considered the potential effect of sediment discharges to aquatic systems. Guidelines have been developed for comprehensive management of sediment generation, capture and treatment during construction, which modelling shows, will significantly reduce this risk. For streams, we anticipate major effects in only one catchment, Duck Creek, and moderate short to medium term effects in Te Puka and Horokiri streams.

With regard to Porirua Harbour, modelling included the same comprehensive management of erosion and sediment control. This modelling showed that even with the best possible management, there remains a risk during construction of major sediment discharges to parts of Porirua harbour.

The effects of sediment discharges during construction on Porirua Harbour depend on a number of variables, the size of the rainfall event, the direction and strength of winds and associated wave activity. Overall, we conclude that the effects of the discharge of sediment generated by construction earthworks, assessed over a range of rainfall events scenarios, is likely to have between negligible and moderate effects on the ecological values of Porirua Harbour.

Finally we have considered the potential effect of the ongoing operation of the road, in particular contaminants contained within stormwater, on streams and Porirua Harbour and concluded that, given the levels of treatment proposed, any effects will be very low to negligible, and only a small proportion of all contributing discharges from existing land uses.

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1. INTRODUCTION

1.1 BACKGROUND

This technical report is one of a series that report on ecological investigations being undertaken as part of the Transmission Gully Project (the "Project"), specifically in relation to NZTA 345PN Phase II Investigations, E&EA; work package "WS-08 Ecological Assessment, Survey, Modelling, and Management (BML, 2009). It provides an assessment of potential adverse effects of both the construction and ongoing operation of the proposed Transmission Gully highway; and measures to mitigate potential or actual adverse effects be developed.

The Transmission Gully Project (the Project) consists of three components:

1. The Transmission Gully Main Alignment ("the Main Alignment") is the construction and operation of a State highway formed to expressway standards between Linden (in Wellington City) and McKays crossing on the Kapiti Coast. The Main Alignment is 27 km in length, running north between Wellington (Linden) and the Kapiti Coast (McKays crossing).
2. The Kenepuru Link Road involves the construction and operation of a State highway (limited access road) from Kenepuru Interchange (on the Main Alignment) to Kenepuru Drive
3. The Porirua Link Roads involves the construction and operation of two local roads connecting the Main Alignment to Porirua Township.

The concept of an inland, alternative route to bypass the existing SH1 coastal route and communities north of Wellington was first raised in the early 1940s and has been under consideration by various parties ever since.

In 2008 more detailed assessments of alignment options in Transmission Gully started and a Scheme Assessment Report (SAR) prepared; this was followed up in 2009-2010 by more detailed engineering and environmental work to feed into optimise the preferred alignment and prepare documentation to lodge with the Environmental Protection Authority (EPA).

As results became available from the more detailed investigations during 2010, a series of "project shaping" workshops were held. At these decisions were made on alignment and structures to take into account ecological (and a range of other) constraints and opportunities that arose. Through these changes, many potentially adverse effects on ecological values were avoided.

1.2 SUMMARY OF ENVIRONMENTAL ISSUES

The proposed Transmission Gully route has been studied extensively over the last forty years and there is a good general understanding of the key environmental issues. The main alignment and three link roads traverse a wide range of habitats from improved pasture, plantation forestry, shrublands, and scrub, to forest remnants. It ranges from sea level to 280m in altitude.

While much of the landscape along the Project route has been highly modified by farming, the proposed alignment will potentially affect many areas of vegetation of ecological value including protected and unprotected forest remnants and areas of secondary regeneration. The scale of effects will vary for each site. For some, small areas of marginal vegetation may be removed. Some sites will be permanently affected, losing vegetation beneath the road footprint. Other sites will be affected during the construction period but there will be opportunities for restoration following completion of works.

The Transmission Gully alignment crosses eight catchments, seven of which discharge to Porirua Harbour, a nationally significant estuary. Porirua Harbour contains two shallow tidal inlets: the Onepoto Arm and the Pauatahanui Inlet. Four streams (Horokiri, Ration, Pauatahanui, Duck) discharge into the Pauatahanui arm, while two (Kenepuru/Cannons and Porirua) discharge into the Onepoto Arm of the harbour. The eighth catchment (Wainui/Te Puka) discharges to the Kapiti Coast north of Paekakariki. The waterways include permanently flowing streams and rivers as well as intermittent and ephemeral headwaters.

Each of the streams that lie along the Transmission Gully route has high natural and fisheries value. Significant lengths of stream habitat will be lost due to culverting and fill sites. Similar lengths of the stream will suffer from temporary or permanent diversion.

Porirua harbour and its associated reserves and wildlife refuges are identified in the Regional Policy Statement as 'Sites of National or Regional Significance for Indigenous Vegetation or Significant Habitats for Indigenous Fauna'. Porirua Harbour is also identified in the Regional Policy Statement as a 'Landscape and Seascape of National or Regional Significance'. The Department of Conservation considers Pauatahanui Inlet to be of international significance given our obligations to the RAMSAR Convention on Wetlands, and the Bonn Convention on Migratory Species.

The major concern identified by WRC and DOC for construction of this route is the risk of sediment discharge to the Harbour during construction and the long term discharge of contaminants from the road surface once operational. This potential impact will be an area where high levels of control are expected to be required as Conditions of the Resource Consents. The level of risk has not previously been quantified.

The proposed Transmission Gully route passes through of two of the five regional parks, Battle Hill Farm Forest Park and Belmont Regional Park. GWRC has prepared management plans for both Parks. Both plans are currently being reviewed. The management plans recognize the reality of the Transmission Gully Project and that the impacts will be significant. Both of the management plans also state that the impacts need to be mitigated.

1.3 STUDY OBJECTIVES AND REPORT STRUCTURE

Except where a specific technical matter required otherwise, the "study area" comprises all the catchments through which the proposed Main Alignment passes. The "design footprint" or "project footprint" is the area of land/waterway which lies under the road and associated earthworks as currently designed. This is smaller than the designation envelope.

The purpose of this Ecological Impact Assessment (EcIA) is to take the findings of the investigations reported in the Technical Reports (in terms of ecological values) and assess the potential and actual effects on the ecological values described. From this, the EcIA then sets out the mitigation recommended to address adverse effects and monitoring to ensure that desirable outcomes are achieved.

This assessment of effects draws on the findings of five separate Technical Reports, each exploring and describing a different aspect of the local ecology. These reports record site and desktop investigations and provide information about the existing environment together with an evaluation of habitats, species and their interactions, as appropriate to the topic. The scope of these technical reports is described in Section 2.4.

Section 2: summarises the methods used in the Technical Reports to evaluate the ecological components; and the method of ecological impact assessment used in this report.

Section 3: provides an overview of the planning context in which the assessment is carried out. For the purposes of this report, the statutory planning documents provide the community or society's assessment of "value" of ecological components (for example, through methods associated with indigenousness of vegetation), the sites where they occur (for example, through compilation of lists of "sites of significance"), and the levels of adverse effect considered acceptable (for example, through the mitigation hierarchy).

Section 4: gives a description of the Project scope, activities, quantities and areas.

Section 5: gives a description of the existing environment, by summarising the findings of the Technical Reports and providing an account of the important interactions and sites at which they occur.

Section 6: assesses the ecological significance of species, habitats.

Section 7: describes the shaping of the Project that has occurred as a result of ecological involvement, in particular areas where design changes have led to the avoidance or reduction of identified adverse effects, and where design has led to potential positive ecological effects.

Section 8 & 9: assesses the potential positive and adverse effects of the Project. The proposed activities are superimposed on components in specific places and potential effects predicted. This is quantified and evaluated. Cumulative effects are also discussed. This section is divided into Construction Effects and Operational Effects.

Section 10 & 11: sets out the proposed mitigation for potentially significant adverse effects of construction and operation and re-assessed the magnitude of adverse effects with mitigation.

Section 12: summarises the ecological values, predicted effects and proposed mitigation and provides a final conclusion.

1.4 DEFINITION OF TERMS

"**Footprint**" refers to the earthworks extent for the road including both the road surface and associated cuts and fills, but does not involve subsidiary works such as fill sites and sediment treatment devices which have not yet been designed. The Transmission Gully Footprint has an area of 172ha.

"Designation" refers to the designation being sought by this application. Any reference to the existing designation is specified.

For the purpose of this assessment the designation defines the maximum extent of direct effects on the site's ecology. This is on the understanding that, except where noted, the extent of the designation has been determined to enclose all necessary construction activities, including the road and all subsidiary work such as sediment treatment and fill disposal. The Transmission Gully designation has an area of 483ha.

"**Study Area**" refers to all land, water bodies and receiving environments that could be potentially affected by the Project (also called **Zone of Influence**). To provide consistency between this and the other ecology technical reports (including Technical Report 9 Estuarine habitat and species) the study area includes all catchments that are crossed by the main Alignment or which feed into either arm of Porirua Harbour. It has a total area of 20,699 ha.

"**Porirua Harbour**" refers to both arms of this harbour, commonly referred to as the Onepoto Inlet and Pauatahanui Inlet.

Boffa Miskell NZ TRANSPORT AGENCY WAKA KOTAHI

TRANSMISSION GULLY

STUDY AREA & TERRITORIAL BOUNDARIES 11.1

2. METHODOLOGY

2.1 OVERVIEW

This Section comprises:

- A summary of the investigation and assessment process;
- A summary of the scoping process to determine places/sites of potential ecological value and the envelope within which potential effects might occur;
- A summary of the methods used for field investigations;
- A description of the project shaping process used to "avoid" some potential adverse effects;
- Methodologies used to ascribe ecological value to places/sites based on species, habitat and ecological processes (drawn from Technical Reports);
- A method for assessing potential effects;
- Methods for determining mitigation requirements.

2.2 INVESTIGATION AND ASSESSMENT PROCESS

The process for carrying out an ecological impact assessment is well understood and would normally include the following steps (Treweek, 1999), (IEEM, 2006):

Scoping

- Determine the extent of matters that should be covered in the assessment of effects;
  - The statutory context; environmental legislation, plans and policies (see section 3).
  - The range and scale of activities that could affect the environment (see section 4).
  - The area to be assessed, the project's "zone of influence" (see section 2.3).
  - Preliminary investigations to determine the ecological resources potentially affected;

Ecological Investigations and Assessment of Ecological Value

- Carry out appropriate desktop studies and field investigations to accurately describe the presence, distribution and abundance of flora and fauna, and to understand the underlying ecology, habitats, corridors, and natural processes (see section 5).
- From the desktop and field investigations assess the values and current condition of the ecological features/biodiversity components including their ecological and conservation importance (see section 6).

Impact Assessment

Once value has been determined the steps for assessing effects on ecological values are:

- Assessment of the magnitude of the effects that may occur on those populations.
- Integration of value and magnitude into an overall assessment of effects
- Determine the likely effects of each activity on the ecological components, their scale, duration and severity
- Reach conclusions on the significance and acceptability of the predicted effects (see section 8 and 9).

Impact Mitigation

- Refinement of the project to avoid or minimise effects, or maximise potential benefits (See section 10).
- Determine whether all reasonable steps have been taken to avoid or minimise adverse effects and identify what additional mitigation actions are necessary or achievable.

Monitoring & Reporting

- Recommendations for additional pre construction monitoring to improve baseline understanding
- Recommendations for construction and post construction monitoring to assess implementation and compliance (see section 10.3).

Impact Evaluation

- Assessment of the refined project. Determine the significance and importance of predicted residual effects once project shaping has been carried out and with the recommended mitigation in effect (see section 11.

2.3 THE STUDY AREA

For the purpose of this assessment the "Study Area" has been defined as all land, water bodies and receiving environments that could be potentially affected by the Project (also called Zone of Influence).

The study area was defined to encompass all ecological components likely to be directly affected, mobile populations whose ranges may extend some distance beyond the areas directly affected, and any receiving environments that are at some distance from the Project footprint but which may be indirectly affected.

The study area includes all catchments that are crossed by the main Alignment, or which feed into either arm of Porirua Harbour. It has a total area of 20,699 ha. It is shown in Figure 11.1.

In addition the Avifauna study included five 10 km square grids (based on OSNZ field sheets) that encompass the alignment and study area.

2.4 TECHNICAL REPORTS

The ecological values are described and mapped in the separate Technical Reports (TR) and have been summarised and integrated in this report. The five technical reports are:

- TR 6: Terrestrial Vegetation & Habitats: Description and Values
- TR 7: Herpetofauna & Terrestrial Macro-Invertebrates: Description and Values
- TR 8: Avifauna & Bats: Description and Values
- TR 9: Freshwater Habitat & Species: Description and Values.
- TR 10: Marine Habitat & Species: Description and Values

This EcIA and an attached Mitigation Report make up the concluding sections of the ecological assessment of the transmission gully route.

- TR 11: Ecological Impact Assessment (EcIA) – This report.
- TR 12: Mitigation Plans - Appended

The study methodologies describe their methodologies in detail. In summary the technical reports cover the following:

TR 6: Terrestrial Vegetation & Habitats

Desktop Studies

The study began with a desktop review of literature relevant to the botany of the study area. This included all known published and unpublished reports, papers, species lists, and maps. It involved the identification of protected natural areas and the identification of other significant natural areas (unprotected) identified by PNA surveys. It also involved a compilation of any existing GIS mapping resources.

Base maps of the historical vegetation and current vegetation of the study area were produced from national data sets. This helped to identify vegetation communities now locally rare. The desktop study also identified a number of climatic, soils, and geological limitations to land use which can guide site selection and restoration activities for future mitigation. A range of rare plants that could potentially be found along the route was compiled, and their preferred habitats were identified, to guide field investigation.

Field Investigations

Field investigations were then undertaken to map vegetation and confirm the presence or absence of rare plants. Three sampling methods were used:

1. **Vegetation Mapping**: A detailed map of plant communities was prepared covering a corridor extending a minimum of 250 m either side of the centreline of the TG alignment. This was done to provide a reasonable limit to the area that needed to be studied and mapped. Beyond this corridor vegetation shown in maps is based on a national dataset (LCDBII). The area of the mapped corridor is 2,089 ha. A base map was first prepared using high-resolution aerial photography to identify changes in colour and texture that indicated transitions between vegetation communities. These maps were verified in the field and each vegetation community that was identified was briefly described noting the dominant canopy species, the height and structure of the vegetation and other relevant matters.
2. **Vegetation Transects:** Transects were carried out in six forest communities to refine the vegetation descriptions and assess the age and condition of the communities.
3. **Botanical surveys:** Species lists were compiled at sites identified by the desktop studies as potential habitat for plant species of conservation interest.

Assessment of ecological value

The significance of all terrestrial plant communities along the route was then assessed and the areas potentially affected by construction were quantified. Several areas of vegetation with ecological value, that have not been previously described, were located and added to the list of sites for assessment.

All areas of indigenous vegetation considered to have ecological value that were identified through the above processes were listed and assessed for significance. This process identified key plant communities and habitats that will be potentially affected, and a number that could be avoided during detail design.

The report concluded with several recommendations for assessment of potential effects and mitigation.

TR 7: Herpetofauna & Terrestrial Invertebrates

Desktop Studies

The first phase of investigations of the Project's herpetofauna communities involved querying the Department of Conservation's Herpetofauna database for all records of herpetofauna detected within 10 km of the alignment since 1980.

Additional desktop studies included a review of high resolution aerial imagery and preliminary vegetation maps to assist in determining where field-based investigations should be targeted (subsequently verified during the on-site habitat assessment).

Field Investigations

Initial on-site investigations commenced by driving/walking the Main Alignment to assess herpetofauna habitat quality. Areas considered to represent marginal or better herpetofauna habitat were subsequently targeted with the herpetofauna sampling methodologies. Three sampling methods were used:

1. **Manual Searches** (diurnal). The manual searching methodology followed that of Whitaker's (1994) 'searching by day' methodology. Search effort was targeted towards bush and shrubland edges, rocky areas, and debris such as logs and corrugated iron which could be lifted by hand. In accordance with the availability of suitable lizard habitat, searches were concentrated towards the northern end of the Main Alignment,
2. **Spotlighting** (nocturnal) Nocturnal searches for arboreal geckos were conducted along the northern section of the route using spotlights on the evening (21:00-23:00 hrs) over two nights. Spotlighting was targeted towards areas where woody vegetation (especially native shrubland or forest) was present (i.e. the northern section).
3. **Artificial Retreats** (ACOs); 75 were placed in habitat that was considered to represent the best of the lizard habitat present within the alignment (rank grassland, forest/shrubland-grassland interfaces, stone fields within pasture, and scree slopes) and were left for between 6 and 11 weeks and then checked for inhabitants.

Analysis

The report discussed the species that were found and their relative abundance. It discusses the habitats lizards were found in, with particular regard to those habitats potentially affected by the Alignment. It then provides some recommendations for issues for the EcIA to address in its consideration of effects, and identifies some opportunities for mitigation.

TR 8a: Avifauna

Desktop Studies

Data from the recent Ornithological Society of New Zealand's atlas (Robertson et al 2007) were collated from the five 10 km x 10 km grid squares (266,600; 266,601; 267,600; 267,601; 267,602) that encompass the Main Alignment and surrounding area. The primary habitat for each of the species recorded within these five grid squares was then obtained from Heather & Robertson (2000), along with each species' New Zealand threat status according to Miskelly et al. (2008).

Further literature (published and unpublished) and websites searches were undertaken to obtain additional information regarding bird species occurring at Pauatahanui Inlet and Porirua Park Bush.

Field Investigations

The avifauna was surveyed within three areas along and adjacent to the Main Alignment: (1) Te Puka and Horokiri catchments; (2) Along Flighty's Road within the Ration catchment; and (3) within and adjacent to Porirua Park Bush. These areas were chosen as they provide representative avifauna habitats occurring along the length of the alignment. Three methods were used:

1. **Point Counts:** Five-minute point counts, whereby all avifauna species seen and heard during the count period were recorded (Dawson & Bull, 1975), were undertaken within each of the three survey areas. Each area was surveyed in summer (January/February) and autumn (March). Counts were replicated by visiting the areas on two consecutive days (due to bad weather the March Ration counts were two days apart). Over the course of the two days of surveying within each area, the order of point count stations was reversed, thus undertaking a count at each station at a different time of the day.

2. **Incidental Observations:** In addition to the above mentioned counts, all incidental observations were recorded while walking between the point count stations. Such records consisted of any significant observations made outside of the formally defined methods of data collection and included observation of birds within or adjacent to the site, as well as unusually large numbers of a common or exotic bird species, or any unusual and noteworthy behaviour. Similar such notes were taken by other Boffa Miskell ecologists undertaking other ecological surveys along and adjacent to the Main Alignment at the same time as the avifauna surveys.
3. **Nocturnal Observations:** All birds heard vocalising at night while undertaking the bat surveys were recorded. The nocturnal bat surveys were conducted on 25 January (21:10-22:15; full dark recorded at 21:51) along the forest margin and farmland on the Wainui Saddle, and on 26 January (21:00-22:10; full dark recorded at 21:30) along the forest margin and the access road adjacent to the Te Puka Stream.

Analysis

The report describes the results of this survey and provides some recommendations for matters that the impact assessment needs to consider.

TR 8b: Bats

Desktop Studies

Desktop studies confirmed that there has not been any recorded bat activity within the study area but that the long-tailed bat is known to occur nearby.

Field Investigations

Initial on-site investigations confirmed that the only likely habitat for native bats were the remnant forests of the Akatarawa – Whakatikei Regional Forest. Investigations were therefore targeted at forests within the designation that are contiguous with these forests. Three sampling methods were used:

1. **Bat Boxes** (nocturnal): Two transects were walked on consecutive nights commencing 30 minutes after official sunset. Both nights were clear, windless and warm. Transects were on either side of the Wainui Saddle and followed the bush margin. Each transect consisted of 10 points (50 paces apart). At each of the 10 transect points; two hand-held bat boxes set to 40 kHz were deployed for 5 minutes.
2. **Bat Recorders**; In March 2010, six automated bat boxes were left on site from 8-12 March 2010. The boxes were located from the Wainui Saddle down into the Te Puka catchment (situated at vegetation interfaces) and set to record at 28 and 40 kHz from 19:45 to 07:00 over the four consecutive nights. These two frequencies were recorded as they correspond to the peak amplitude of short- and long-tailed bats respectively
3. **Manual Searches** (diurnal): In addition to using the acoustic devices, opportunistic observations were made of any potential roosting trees encountered during the vegetation surveys. No dedicated bat roost search was undertaken.

Results

The report describes the results of this survey and provides some recommendations for matters that the impact assessment needs to consider.

TR 9: Freshwater Habitat & Species

Due to the complexity of issues and scale of effects surrounding freshwater, the study has been divided into two reports, a description of the habitats, species and physical environment (9a) and a preliminary assessment of ecological effects and mitigation (9b).

Field Investigations

A range of survey methodologies have been used including various national protocols and industry standard practices and modified variations of commonly used methods. Each method was tailored to the Project, the site and to the purposes of the data collection.

Sampling and analysis methods were chosen that would:

- Describe the existing aquatic physical habitat (including water parameters);
- Differentiate between the basic aquatic habitat types in the Project area;
- Identify similarities and differences between reaches within streams and across the main waterways in the Project area;
- Supplement the existing data in describing the fish communities in the Project area;
- Describe the existing aquatic macro invertebrate communities;
- Identify rare and threatened species within the waterways;
- Assess the conservation/Regional significance of the species and communities present;
- Allow an evaluation of loss and change of aquatic habitats; and
- Enable identification of potential effects from mitigation proposals that could be developed if the Project were to proceed.

Field investigations were carried out over three years and included electric fishing at 31 sites, macroinvertebrate surveys at 15 sites, full SEV protocol sampling in 15 representative stream reaches, 2.4km of stream geomorphology descriptions, and investigations of existing culverts and fish passage issues. Four broad "sets" of data were collected to describe the aquatic habitats and their assemblages; and to allow regional importance and sensitivities to be assessed. The four are:

- physical habitat data, i.e. stream morphology, substrate type, riparian condition etc;
- water quality (collected in the main by SKM);
- water quantity (collected in the main by SKM); and
- Flora and fauna (primarily aquatic macro invertebrates, fish and aquatic macrophyte data).

BML has also relied for this assessment on related reports produced by others, in conjunction with BML or separately, including a range of water quantity and quality reports and research undertaken by SKM (Combined into Technical Reports 14 and 15). These include:

- Baseline Water Quality Monitoring Report (Malcolm & Wiseman 2009);
- Sediment Yield Calculations (Malcolm 2010);
- Construction Erosion & Sediment Control (Martell/ Adams/ Albrecht 2009);
- Generation of Daily Stream flow : time series for Selected Catchments (Hansford / Malcolm 2009);
- Modelling of Sediment in the Streams & Harbours (B. Fountain);
- Stormwater Management Devices (Albrecht/ Martell 2010);
- Peak flow Analysis for Culvert and Bridge Design (Martell/ Fountain/ Adams/ Heinemann 2009);
- Assessment of Hydraulic Effects on Critical Streams (Fountain/ Adams/ Martell 2010).

Analysis

From these studies a detailed description of the freshwater ecology, species, habitats and physical environment has been produced, and an assessment of ecological value has been carried out to support the assessment of effects.

TR 10: Estuarine Habitat & Species

Desktop Studies

Data and information on the ecological values (invertebrates, fish, sediment grain size, sediment quality and water quality) was collated from a large number of sources. The concentration of key contaminants in surficial sediment was mapped and indicated significant heavy metal and hydrocarbon contamination in the Onepoto Inlet and elevated concentrations of agrichemicals in both Inlets. Gaps in our current understanding of the ecological values that have the potential to be adversely affected by the proposed TG road were identified and used to inform the field surveys.

The above literature review revealed a paucity of information on the intertidal and subtidal invertebrate assemblages around the stream mouths entering into the Onepoto Inlet and the Pauatahanui Inlet. In addition, there was little sediment quality data in at these specific sites. Beyond the stream mouths in the adjacent subtidal habitat, invertebrate assemblage and sediment quality data was also lacking. A lack of information on ecological values at the mouth of the Wainui Stream was also identified.

Field Investigations

4. **Intertidal estuarine sampling:** Intertidal surveys of infaunal and epifaunal invertebrates, sediment grain size, sediment quality, depth of oxygenation of sediment and macroalgal cover were undertaken at the mouths of streams that are likely to receive both construction and operational phase stormwater from TG. These streams included Pauatahanui, Horokiri, Ration, Kakaho, Porirua and Wainui Streams, and Duck Creek. Sampling was carried out. Data were plotted to determine the presence of outliers, and then initially analysed using basic descriptive statistics such as averages and proportions. Invertebrate community composition data was further analysed using multivariate analyses (Primer-v6 software).
5. **Subtidal sampling:** Subtidal surveys were undertaken adjacent to the stream mouths that currently receive and retain the most terrestrial sediment during storm events and within the central subtidal basins. A total of 22 sites within Porirua Harbour were sampled, 16 sites within the Pauatahanui Inlet and six sites within the Onepoto Arm. At each site replicate quadrats were sampled to assess epifaunal abundance and diversity and replicate core samples were obtained to assess infaunal abundance and diversity. Surficial sediment samples were also obtained for sediment grain size and sediment contaminant analysis.
6. **Assessment of Ecological Value**: Ecological values are described as being low, moderate or high. A number of characteristics were used to assess the predominant ecological values of parts of the marine environment, based on a weight of evidence approach.

Results

The technical report describes the results of this survey and provides recommendations for matters that the impact assessment needs to consider.

2.5 PROJECT SHAPING

A fundamental component of ecological involvement in the impact assessment process is project shaping, that is, the cooperative identification and design of alternatives which allow for identified effects to be avoided or reduced.

For this Project the process of project refinement has occurred twice;

- Transmission Gully Phase I Investigations – Investigations and Preliminary Design (SAR)
    - Initial project design;

- Preliminary ecological assessment based primarily on desktop reviews and rapid site inventories;
- Scheme assessment process including ecological implications of alternatives;
- Refined project design;
- Preliminary assessment of effects and of required mitigation.

- Transmission Gully Phase II Investigations - Engineering and Environmental Assessments
  - Detailed site investigations;
  - Further refinement of alignment taking into account the findings of investigations;
  - Final project design;
  - This assessment.

This process is described in more detail in Section 7.

2.6 ASSESSING ECOLOGICAL VALUE

Different methods for assessing value were used for terrestrial habitats and flora, freshwater habitats, and the coastal estuaries, and species of conservation concern as follows:

2.6.1 SPECIES OF CONSERVATION CONCERN

Threat Classification - General

All species are assessed against a standard set of criteria which is described in "Townsend, et.al (2008): New Zealand Threat Classification System Manual. Wellington: Department of Conservation". In summary:

Table 11-1: New Zealand Threat Classification System (Summarised from Townsend et al 2008)

Criteria for Threatened taxa	1. Nationally Critical
	2. Nationally Endangered
	3. Nationally Vulnerable
Criteria for At Risk taxa	1. Declining
	2. Recovering
	3. Relict
	4. Naturally Uncommon
Not Threatened	

The national threat status of groups of flora and fauna were classified according to the following national assessments.

- PLANTS: de LANGE, et al. 2009: Threatened and uncommon plants of New Zealand (2008 revision). New Zealand Journal of Botany 47: 61-96.
- BIRDS: Miskelly, C., Dowding, J., Elliot, G., Hitchmough, R., Powlesland, R., Robertson, H., et al. (2008). Conservation status of New Zealand birds, 2008. Notornis , 55, 117-135.
- HERPETOFAUNA: Hitchmough R., et al, 2009: Conservation status of New Zealand reptiles, 2009. New Zealand Journal of Zoology, 37: 3, 203 — 224.
- TERRESTRIAL INVERTEBRATES: Hitchmough, R., Bull, L. and Cromarty, P. (2007): New Zealand threat classification systems List 2005. Department of Conservation, Wellington
- FRESHWATER FISH: Allibone, et.al. 2010: 'Conservation status of New Zealand freshwater fish, 2009', New Zealand Journal of Marine and Freshwater Research, First published on: 27 September 2010
- BATS: O'Donnell, C.F.J., Christie, J.E., Hitchmough, R.A., Lloyd, B., Parsons, S. 2010. The conservation status of New Zealand bats 2009. New Zealand Journal of Zoology 37: 297–311.

2.6.2 TERRESTRIAL VEGETATION AND HABITATS

In the absence of a national standard for the assessment of ecological value of vegetation and terrestrial habitats an assessment was carried out using the following inputs (Technical Report 11, Section 6.1):

- Criteria established by recent Case Law for assessing ecological significance;
- District and Regional Council assessments of significance (PNA style surveys);
- National Priorities for Protecting Rare and Threatened Indigenous Biodiversity;
- LENZ threat classes for indigenous vegetation and habitats; and
- Priority habitats described in the Wellington Conservancy CMS;

Assessment Criteria

The criteria used for assessment of "ecological value" of a place/site/area in this report are:

Table 11-2: Assessment Criteria for assessing ecological significance

Value	Description
Ecological context	• A role in protecting adjacent ecological values, including adjacent and downstream ecological and hydrological processes, indigenous vegetation, habitats or species populations; or • A habitat for critical life history stages of indigenous fauna including breeding/spawning, roosting, nesting, resting, feeding, moulting, refugia, migration staging points (as used seasonally, temporarily or permanently); or • It contributes to ecological networks (such as connectivity and corridors for movement of indigenous fauna).
Representativeness	• Contains indigenous vegetation types or indigenous fauna assemblages that were typical for, and have the attributes of equivalent communities that would have existed prior to 1840.
Rarity	• Nationally threatened species are present ; or • Nationally at risk species or uncommon communities or habitats are present and the population at this site has an important contribution to the national population and distribution of a species or number of at risk species or distribution and extent of threatened or uncommon communities or habitats. • Regionally uncommon species are present; or • Is a member of a plant community that is now less than 30% of its original extent as assessed at the ecological district and the freshwater bio-geographic unit scales; or • Contains ecosystems that are identified as historically rare by Williams et al (2007).
Distinctiveness	• Has special ecological features of importance at the international, national, or ecological district scale including: a. intact ecological sequences; or b. an unusual characteristic.

Modified from Shearer Swamp Incorporated v West Coast Regional Council (NZEnvC 345).

For a site, each of the four criteria are subjectively scored "high", "moderate", "low" or "nil", based on the assessor's experience and knowledge of the site. The four scores are then combined to provide a single site score which ranges from "Very High" to "Low" based on the following system.

Table 11-3: Assessment Scoring for Terrestrial vegetation and habitats

Value	Description
Very High	• Rates High for all or most of the four assessment criteria. Likely to be nationally important and recognised as such.
High	• Rates High for at least one of the assessment criteria and moderate for the majority of the others. Likely to be regionally important and recognised as such.
Moderate	• Rates moderate for the majority of assessment criteria. Important at the level of the Ecological District.
Low	• Rates Low or Nil for all assessment criteria. Limited ecological value other than as local habitat for a tolerant native species.

2.6.3 FRESHWATER HABITATS AND SPECIES

The Freshwater Habitats and Species Technical Report, TR 9, assesses the values of habitats in relation to a number of factors and components.

Two primary methods have been used to test the regional value of the reaches and streams affected by the proposal. The fish IBI has been calculated for the sites sampled and compared to the general condition of other waterways in the Region.

A comparison has also been made of how the %EPT, QMCI and MCI values rank relative to the data on these same factors published by GWRC as part of their SOE programme.

There are no comparative metrics for the physical habitat. However, the SEV outputs have been examined in relation to the project reference sites. Project reference sites had to be established since currently there are no recognised or "designated" Regional Council reference sites.

In addition water quality parameters have been considered.

Within a number of reaches (or groups of reaches) in 8 waterways, each factor has been measured to provide an assessment of value for each factor/attribute in each reach or group of reaches. These have then been integrated to provide a single overall value (Very High, High, Moderate or Low) for parts of the waterways.

Table 11-4: Assessment Scoring for Freshwater Systems

Value	Explanation
Very High	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants for human induced activities.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers etc, and stock access or similar, to the extent it is no longer reference quality.
Moderate	A watercourse which contains fragments of relatively unmodified habitat, but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues.

2.6.4 ESTUARINE HABITATS AND SPECIES

Marine ecological values are described in this report as being low, moderate or high. Table 11-5. lists the characteristics which have been used to assess the predominant ecological values of parts of the marine environment within the Project area, based on a weight of evidence approach. Not all characteristics listed within each ecological value category need to be present in order to assess ecological value. Consideration of low, moderate and high benthic invertebrate species richness and diversity is based on expert judgment and experience.

Table 11-5: Characteristics of estuarine site with low, moderate and high ecological values.

Ecological Value	Characteristics
Low	• Benthic invertebrate community degraded with low species richness and diversity. • Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with few/no sensitive taxa present. • Marine sediments dominated by smaller grain sizes. • Shallow depth of oxygenated surface sediment. • Elevated contaminant concentrations in surface sediment, above ISQG-high or ARC-red effects threshold concentrations[1]. • Invasive, opportunistic and disturbance tolerant species dominant. • Minimal habitat and feeding areas for fish and birds present. • Seagrass beds not present. • Saltmarsh habitat disconnected, absent or highly modified. • Habitat highly modified.
Moderate	• Benthic invertebrate community typically has moderate species richness and diversity. • Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present. • Marine sediments typically comprise approximately 50-70% smaller grain sizes. • Depth of oxygenated surface sediment typically >0.5 cm. • Contaminant concentrations in surface sediment generally below ISQG-high or ARC-red effects threshold concentrations. • Few invasive opportunistic and disturbance tolerant species present. • Habitats and feeding areas for birds and fish present but modified or small. • Seagrass areas patchy or small. • Connection to saltmarsh habitat limited or modified • Habitat modification limited.
High	• Benthic invertebrate community typically highly diverse with high species richness. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud. • Marine sediments typically comprise <50% smaller grain sizes. • Depth of oxygenated surface sediment typically >1.0 cm. • Contaminant concentrations in surface sediment rarely exceed low effects threshold concentrations. • Habitats and feeding areas for birds and fish present and largely unmodified. • Keystone species present (e.g. significant cockle beds). • Seagrass beds present. • Natural connections to saltmarsh habitat present. • Habitat largely unmodified.

2.6.5 OTHER ASSESSMENT RESOURCES

Council Assessments

A number of sites have been identified in Wellington City, Porirua, or Kapiti Coast and Greater Wellington Regional Council through SNA style surveys. In the case of Kapiti Coast have been scheduled in the District Plans.

National Priorities for Protecting Rare and Threatened Indigenous Biodiversity

In making the assessment of ecological value of sites or habitats the following have been considered.

[1] ANZECC (2000) Interim Sediment Quality Guideline (ISQG) High contaminant threshold concentrations or Auckland Regional Council's Environmental Response Criteria Red contaminant threshold concentrations (Auckland Regional Council, 2004).

- **National Priority 1:** To protect indigenous vegetation associated with land environments (defined by Land Environments of New Zealand at Level IV), that have 20% or less remaining in indigenous cover.
- **National Priority 2:** To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.
- **National Priority 3:** To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.
- **National Priority 4:** To protect habitats of acutely and chronically threatened indigenous species.

These are considered in more detail in TR 6.

Wellington Conservation Management Strategy

In making the assessment of ecological value of site or habitats the following have been considered.

Within the Wellington Hawkes Bay Conservancy the ten highest priority ecosystems and habitats managed by the Department of Conservation in the Wellington Hawkes Bay CMS area (DOC 2010) are:

- indigenous forests;
- shrublands;
- freshwater wetlands;
- rivers and lakes;
- estuaries;
- dunes and dune wetlands;
- cliffs;
- herbfields and grasslands; and
- marine environment.

2.7 ASSESSING SIGNIFICANCE OF EFFECTS

The proposed development was considered in relation to known ecological values determined from investigations and published material (See Technical Report 13) and the plans and policies that exist for the area (e.g. GWRC Regional Freshwater Plan, Porirua City District Plan). The significance of effects has been considered based upon the following;

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

Table 11-6: Criteria for describing impact magnitude (Modified from Regina 2002)

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

Table 11-7: Matrix combining magnitude and value for determining significance of ecological impacts (from Regina 2002)

SIGNIFICANCE		Ecological &/or Conservation Value			
		Very High	**High**	**Moderate**	**Low**
Magnitude	**Very High**	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Low	Very Low
	Low	Moderate	Moderate	Low	Very low
	Negligible	Low	Low	Very Low	Very Low

This significance is used to determine whether a predicted impact is acceptable or not. For example:

- **Very high** and **high** represent a highly significant impact on ecological or conservation values and would warrant refusal of a planning proposal.
- **Moderate** represents a potentially significant impact that requires careful individual assessment. Such an impact could warrant planning refusal, but it may be of a scale that can be resolved by revised design or appropriate mitigation.
- **Very low** and **low** should not normally be of concern, though normal design care should be exercised to minimise impacts.

2.7.1 DURATION

When referring to the duration of an effect, whether positive or negative, the following criteria are used.

Table 11-8: Scales of temporal magnitude

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

2.7.2 BENEFICIAL EFFECTS

Beneficial effects on ecological values include a range of outcomes that improve the quantity and quality of indigenous biodiversity and ecological processes within the area affected by the Project. Benefits may extend into the wider area over time.

Beneficial effects include:

- the extension of cover of indigenous vegetation through restoration and natural regeneration following stock removal;
- contribution to the improvement of water quality and aquatic habitat conditions through removal of stock grazing and re-vegetation in upper catchments; and
- improved knowledge of local plant and animal populations through site investigations.

2.8 REPORT LIMITATIONS

The Technical Reports identify limitations to the ecological data collected and analysed and some of these limitations flow through to this assessment. In particular the assessment is affected by:

- Timing of botanical work. Vegetation survey work was undertaken during late summer to early autumn, so missed the potential to detect the presence of a number of plant species whose identification is limited to the flowering period (especially early spring, summer flowers). It is possible that plant species that could add to the "ecological value" of a site may have been overlooked.
- Timing of terrestrial fauna work. Access issues meant that bird surveys were confined to late summer and early autumn, thus missing the opportunity to detect possible seasonal variations. Species that could add to the "ecological value" of a site may have not been recorded. Options for addressing gaps prior to construction are identified in Technical Reports and as part of mitigation proposed here.
- Grazing/browsing. Many of the lower stature shrublands and wetlands along the route are heavily browsed and this limited the identification of a small number of rushes, sedges and orchid species.
- The identification of a single bat vocalisation on one bat recorder occurred too late in the study to carry out follow-up study to confirm species and distribution. This is now planned for spring summer 2011.
- In the preparation of the analysis of sediment and stormwater effects on both freshwater ecology and estuarine ecology, we have relied upon the technical reports and hydrodynamic modelling carried out by SKM (Technical Reports 14 and 15). The assumptions that informed the modelling variables are contained in Appendix 11..

The alignment and design will continue to be reviewed and revised in the light of on-going engineering and environmental investigations and analysis. However, for the purposes of the ecological and other investigations, the designation envelope has been fixed as described in TRs 1 & 2 and is the basis of all Technical Reports and the Project Assessment of Effects on the Environment.

3. PLANNING CONTEXT

The following section summarises relevant plans and strategies together with any policies, objectives and rules directed at the protection and enhancement of this catchment.

3.1 LEGISLATION

3.1.1 RESOURCE MANAGEMENT ACT 1991

This report comprises an assessment of the ecological effects of this proposal with particular regard to the ecological matters identified in sections 5, 6 & 7, and the 4th Schedule to the Resource Management Act.

3.1.2 FRESHWATER FISHERIES REGULATIONS 1983

Many indigenous freshwater fish are migratory and must spend part of their lifecycle in the sea (diadromous). They require streams and rivers that are relatively unmodified from their mouth to their headwaters. If passage along a stream is prevented, populations of some species upstream of the barrier will eventually die out.

The Freshwater Fisheries Regulations require that passage must be provided for indigenous fish.

3.1.3 WILDLIFE ACT 1953

While the presence of Threatened and/or At Risk animals is one of the factors taken into consideration when undertaking ecological assessments, it is important to note that all native animals other than those outlined in Schedules 1-5 of the Act are protected under the Wildlife Act (1953). This includes terrestrial or freshwater invertebrate declared to be an animal under Schedule 7 of the Act and Marine species declared to be animals under Schedule 7A of the Act.

3.1.4 CONSERVATION MANAGEMENT STRATEGY (CMS)

The CMS is the key strategic document of the Wellington Conservancy of DOC. Duck Creek Scenic Reserve (R27001) is identified in the CMS as are the three protected sites within Pauatahanui Inlet (R26007, R26053, & R27056). The inlet is considered a priority site for DOC which considers it to be of international significance given that New Zealand is a signatory to the RAMSAR Convention on Wetlands of International Importance (RAMSAR 1971), and the Convention on Migratory Species (Bonn 1979). The proximity of the study area to this inlet requires consideration of DOC's role.

DOC identifies key threats to the inlet as siltation, eutrophication, pollution, road development, and depletion of fish stock.

An objective of the CMS is:

> *"(4) Conservation of the natural and historic resources of Pauatahanui Inlet and its catchments,"*

Implementation of its objectives includes:

> *"(6) Seek opportunities to protect land around Pauatahanui Inlet containing other natural and historic resources."*

3.1.5 NEW ZEALAND COASTAL POLICY STATEMENT

Policies 1.1.2, 1.1.4 and 1.1.5. identify the importance of:

- Indigenous flora, fauna or their habitats
- outstanding or rare indigenous communities

- rare species
- ecological corridors
- areas important for migratory species
- natural biodiversity
- intrinsic values of ecosystems.

3.1.6 PROPOSED NATIONAL POLICY STATEMENT ON INDIGENOUS BIODIVERSITY (NPSIB)

While the NPS has not yet been enacted and may change based on consideration of submissions, for completeness we have treated this as an "other matter". We have accordingly considered each of these criteria in this assessment. Its key assessment criteria are:

Principles to be applied when considering a biodiversity offset include:

- No net loss
- Additional conservation outcomes
- Adherence to the mitigation hierarchy
- Limits to what can be offset
- Landscape context
- Long-term outcomes
- Transparency.

3.2 REGIONAL PLANS & STRATEGIES

3.2.1 REGIONAL POLICY STATEMENT (Operative)

Pauatahanui Inlet and its three Wildlife Refuges and Wildlife Management Reserves are identified in the Regional Policy Statement (RPS) as sites of national significance for indigenous vegetation and as significant habitats for indigenous fauna (RPS Table 8). Pauatahanui Inlet is also identified in the RPS as a Landscape and Seascape of National or Regional Significance (RPS Table 9).

The Wellington Regional Council refers to this estuary and its protection in the Regional Policy Statement. It also raises concerns over continued impacts upon it.

> *"…the development phase of urban subdivisions, such as those surrounding the Pauatahanui Inlet, can cause deposition of soil and debris in watercourses and estuaries. This may destroy natural habitats and ecosystems and increase the risk of surface flooding, water pollution and disruption of services."*

> *"A variety of human activities, in the coastal environment and further inland, are causing degradation of coastal water quality, contamination of sediments and biota, and disruption to natural processes. Specific examples include . . . degradation of water quality in the Pauatahanui Inlet as a result of silt discharge from upstream subdivisions. Silt from catchments surrounding Pauatahanui has smothered filter feeders and exacerbated infilling of the inlet. There is potential for this to continue where land development occurs without careful run-off management."*

The RPS also raises concerns regarding loss of freshwater habitat and the effect of subdivision on streams that lie within the watershed. Chapter 5 contains objectives and policies that relate to protection and enhancement of streams and freshwater habitat (Specifically Objective 3, Policies 8 and 11).

> *To promote the retirement and planting of riparian margins for the purposes of maintaining or improving the structural integrity of the beds and banks of water bodies, flood management,*

maintaining or enhancing water quality, and encouraging the healthy functioning of aquatic and riparian ecosystems (Policy 8).

To ensure that, in respect of all water bodies not covered by Fresh Water Policy 10 (regionally significant), any adverse effects on amenity values or the intrinsic values of ecosystems which may result from any use and development, and on any natural or near natural areas, are avoided, remedied, or mitigated (Policy 11).

3.2.2 REGIONAL POLICY STATEMENT (Proposed)

The proposed 2009 Regional Policy Statement identifies Horokiri Stream, Duck Creek, Pauatahanui Stream, and Porirua Stream in Appendix 1 (Rivers and lakes with values requiring protection), Table 16 (Rivers and lakes with significant indigenous ecosystems), noting that this stream provides "Habitat for threatened indigenous fish species", "Habitat for six or more indigenous fish species" and "Inanga spawning habitat".

Within the proposed RPS protection of streams listed in this Appendix are addressed by policies 17, 23 and 42. These policies cover:

- Policy 17: Protecting significant values of rivers and lakes – regional plans
- Policy 23: Protecting indigenous ecosystems and habitats with significant indigenous biodiversity values – district and regional plans
- Policy 42: Protecting aquatic ecological function of water bodies – consideration

In particular, Policy 42 requires that when considering an application for resource consent, notice of requirement, or a change, variation or review of a district or regional plan, particular regard shall be given to:

- *maintaining or enhancing the functioning of ecosystems in the water body;*
- *maintaining or enhancing the ecological functions of riparian margins;*
- *minimising the effect of the proposal on groundwater recharge areas that are connected to surface water bodies;*
- *maintaining or enhancing the amenity and recreational values of rivers and lakes, including significant amenity and recreational values of rivers and lakes listed in Table 15 of Appendix 1;*
- *protecting the significant indigenous ecosystems and habitats with significant indigenous biodiversity values of rivers and lakes, including rivers and lakes listed in Table 16 of Appendix 1;*
- *retaining natural flow regimes;*
- *maintaining fish passage;*
- *protecting and reinstating riparian habitat, in particular riparian habitat that is important for fish spawning;*
- *discouraging stock access to rivers lakes and wetlands; and*
- *preventing the removal or destruction of indigenous wetland plants in wetlands.*

3.2.3 REGIONAL FRESHWATER PLAN

The Regional Freshwater Plan identifies Pauatahanui Stream, Horokiri Stream, and Ration Stream in Appendix 2, Part B as "Surface water to be managed for aquatic ecosystem purposes."

It also identifies Horokiri Stream and Ration Stream, Pauatahanui Stream, Duck Creek, Wainui Stream and their tributaries, in Appendix 3, Part A as waterbodies having "Nationally Threatened Indigenous Fish recorded in the Catchment."

Specific policies and rules relate to this category of waterbodies requiring that their management should be consistent with Policy 4.2.10, which is "to avoid adverse effects on wetlands, and lakes and rivers and their margins".

Policy 4.2.13 relates to Appendix 3, Part A. Its purpose is "To protect nationally threatened freshwater fauna, in the water bodies identified in Part A of Appendix 3 by":

- *managing water quality so that Policies 5.2.1 to 5.2.7, whichever is (are) relevant, is (are) satisfied; and*
- *managing the flows and levels of water bodies so that Policies 6.2.1, 6.2.2, 6.2.12, and 6.2.13, whichever is (are) relevant, is (are) satisfied;*

and

- *maintaining migratory and dispersal pathways for fish; and*
- *avoiding adverse affects on habitats that are important to the life cycle and survival (including spawning areas) of fish and birds; and*
- *promoting landowner and user knowledge of nationally threatened species, the sites where they are present, and how they can be protected.*

Policy 5.2.1 relates to protecting water quality within waterbodies identified in Part A of Appendix 2.

NZTA has applied for a Plan Change relating to Policy 4.2.10, to introduce a new policy 4.2.33A and amend policies 4.2.10, 7.2.1, 7.2.2, and introduce some new definitions.

3.2.4 REGIONAL COASTAL PLAN

Pauatahanui inlet is identified in the Regional Coastal Plan as an "Area of Significant Conservation Value" (App 2). Its values are described as:

> *"Natural, conservation, geological and scientific values. A wildlife reserve with a diverse waterfowl and wading bird habitat (local and migratory), threatened fish species (including Galaxias spp.) and endangered vegetation. The reserve contains significant salt marsh vegetation."*

3.2.5 REGIONAL SOIL PLAN

Pauatahanui Inlet is also mentioned in the Regional Soil Plan:

> *"Sediment-laden runoff into shallow marine environments, such as Pauatahanui Inlet, may also cause in-filling of the receiving environment. Such in-filling, and any reduction in the aesthetic and biotic qualities of shallow marine environments, is undesirable."*

> *"While these adverse effects of sediment-laden runoff occur in the coastal marine area or in rivers and lakes, the activities which cause those effects are land based and thus are managed through this Plan."*

3.2.6 REGIONAL RIPARIAN STRATEGY

This strategy, together with a number of information brochures, is seeking to improve water quality, aquatic habitat, and ecological links through urban and rural land. The key methods are retirement and planting to remove the impacts of stock, enhance habitat and buffer the stream and wetlands from overland runoff.

One of the methods considered for encouraging better management of riparian zones is through consent conditions to mitigate the effects of some activities. The council has also produced information packs such as "Mind that Stream", "Restoration Planting," "A Beginners Guide to

Wetland Restoration" and "Controlling Problem Weeds in Riparian Zones", that support the key message of the strategy and provide guidance to landowners.

3.3 SUMMARY OF STATUTORY CONSIDERATIONS

In summary, we have taken into consideration the range of national and regional policy statements, strategies and plans. In summary these policies, objectives and regulations required us to consider the following:

- Protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna
- Outstanding or rare indigenous plant communities;
- Areas containing nationally vulnerable species;
- Areas and habitats important to the continued survival of indigenous species;
- Areas important for migratory species;
- Areas important to vulnerable life stages of common indigenous species;
- Ecological corridors;
- Protection of ecosystems vulnerable to modification, including estuaries and wetlands;
- Areas of scientific value;
- The quality of freshwater entering the coastal marine area;
- The potential for restoration and rehabilitation of natural character; and
- Cumulative effects.

4. PROJECT DESCRIPTION

The various aspects of the Project are described in detail in other Technical Reports and the AEE. Those aspects that are relevant to the assessment of ecological effects are:

4.1 TRANSMISSION GULLY MAIN ALIGNMENT

The main alignment will extend from the Kapiti Coast (McKays Crossing) to Wellington (Linden). It will be approximately 27 kilometres in length and will involve land under the administrative jurisdiction of four separate territorial authorities: Wellington City Council, Porirua City Council, Upper Hutt City Council, and Kapiti Coast District Council.

The key design features of the Main Alignment are:

- Four lanes (two lanes in each direction with continuous median barrier separation);
- A sealed width of 21 m
- An earth worked footprint width, including berms, drainage, cuts, and fill batters, of up to 160 m, and averaging along the alignment 55 m.
- A designation with an average width of 155 m, and in some cases up to 300 m, within which all associated construction activities including erosion and sediment management will be carried out.

The SAR and AEE divide the route into nine “manageable” sections for the purpose of description. These sections are:

Table 11-9: The Main Alignment consists of nine sections:

Section number	Section name	Station value (m)	Length (km)
1	McKays Crossing	00000 – 03500	3.5
2	Wainui Saddle	03500 – 06500	3.0
3	Horokiri Stream	06500 – 09500	3.0
4	Battle Hill	09500 – 12500	3.0
5	Golf Course	12500 – 15500	3.0
6	State Highway 58	15500 – 18500	3.0
7	James Cook	18500 – 21500	3.0
8	Cannons Creek	21500 – 24900	3.4
9	Linden	24900 – 27700	2.8

Section 1: McKays Crossing

This section is approximately 3.5 km long, and extends from the tie-in at the existing McKays Crossing Interchange on SH1 to the lower part of the Te Puka Stream valley.

Section 2: Wainui Saddle

Section 2 starts at approximately 03500m and climbs for about 2km to the top of the Wainui Saddle at approximately 262m above sea level (at about 05500m). This will be the highest point of the Main Alignment

Section 3: Horokiri Stream

This section is approximately 3km long and extends from the southern end of the Wainui Saddle to the northern end of Battle Hill Farm Forest Park. For the entire length of this section, the Main Alignment will run generally parallel to the Horokiri Stream. From 06500m to approximately

08550m the Main Alignment will be to the west of the Horokiri Stream, while from 08550m to 09500m it will be to the east of the stream. As the Main Alignment runs parallel to the stream it will cross a number its minor tributaries which generally run perpendicular to the Horokiri Stream and the Main Alignment.

Over this section, the Main Alignment will cross the Horokiri Stream once with a bridge at 08540m (BSN 4). The section finishes towards the northern boundary of the Battle Hill Farm Forest Park (BHFFP) at approximately 09500m.

Section 4: Battle Hill

This section is approximately 3km long and extends from the northern boundary of the BHFFP to the Pauatahanui Golf Course. Shortly after the Main Alignment enters the BHFFP from the north, it crosses over the Horokiri Stream with a bridge at approximately 09720m (BSN 5). Over the remainder of this section, heading south the Main Alignment will follow the Horokiri Valley floor, which widens from north to south through the BHFFP.

At about 11750m it will crosses an unnamed stream with a bridge (BSN 7). Access across the Main Alignment will be available underneath this bridge.

Section 5: Golf Course

This section is approximately 3km long, and extends from north to south through rural land adjacent to the Pauatahanui Golf Course and Flighty's Road. The Main Alignment will cross a number of small tributaries along this section but there will be no major stream crossings requiring bridges.

Section 6: State Highway 58

This section is approximately 3km long and starts at 15500m. The SH58 / Pauatahanui Interchange will be located at approximately 17500m. At this interchange, the Main Alignment will be elevated above a roundabout which will provide access to and from the Main Alignment for traffic travelling in both directions on existing SH58. Immediately south of this interchange, at approximately 17660m, there will be a bridge (BSN 14) across the Pauatahanui Stream.

Section 7: James Cook

This section starts just south of the State Highway 58 / Pauatahanui Interchange, at approximately 18500m and climbs up to the James Cook Interchange at approximately 19500m. From the James Cook Interchange, the Main Alignment continues southwards for a further 2km. This section finishes at approximately 21500m.

Section 8: Cannons Creek

This section begins at 21500m and is approximately 3.4 km long. Throughout this section the Main Alignment will run along the eastern side of Duck Creek valley, and across an undulating, weathered greywacke plateau between Duck and Cannons Creeks.

There will be four bridges in this section.

Section 9: Linden

This southernmost section is approximately 2.8km long. From the start of the section at approximately 24900m, a third lane will be provided in the northbound carriageway heading uphill.

There will be two bridges in this section.

The Kenepuru Interchange will be located at approximately 26700m. This interchange will involve the Main Alignment being elevated above a roundabout which will connect to the Kenepuru Link Road.

South of the Kenepuru Interchange, the Main Alignment will continue downhill to where it will tie into the existing SH1 along the Tawa straight.

THE KENEPURU LINK ROAD

The Kenepuru Link Road will connect the Main Alignment to western Porirua. The Kenepuru Link Road will provide access from Kenepuru Drive to the Kenepuru Interchange. This road will be a State highway (limited access road) with two lanes (one in each direction).

PORIRUA LINK ROADS

The Porirua Link Roads will connect the Main Alignment to the eastern Porirua suburbs of Whitby (Whitby Link Road) and Waitangirua (Waitangirua Link Road). The Porirua Link Roads will be local roads designed to the following standards:

The Waitangirua Link Road will be approximately 2.5km long and will run from the James Cook Interchange to the existing intersection of Niagara Street and Warspite Avenue. This will be a signalised intersection. The Waitangirua Link Road will cross five waterways. The most significant of these will be a crossing of Duck Creek requiring a culvert (BSN 16). The Waitangirua Link Road will link into the western side of the James Cook Interchange.

The Whitby Link Road will be 0.9km long and will run from the existing roundabout at the intersection of James Cook Drive and Navigation Drive to the Waitangirua Link Road.

5. DESCRIPTION OF EXISTING ENVIRONMENT

5.1 INTRODUCTION

In this section, the findings of desktop and site surveys carried out as part of the Transmission Gully Project, and reported in full in the Technical Reports, are summarised, with a focus on the values that are potentially affected by the proposed activities.

5.2 ENVIRONMENTAL CONTEXT

5.2.1 ECOLOGICAL DISTRICTS

The study area lays entirely within the Sounds-Wellington Ecological Region (39) and the Wellington Ecological District (39.01). The Wellington Ecological District (ED) is characterised by steep, strongly faulted hills and ranges, and the Wellington and Porirua Harbours. The district is windy with frequent NW gales, warm summers, and mild winters. Rainfall is typically between 900 and 1400 mm p.a. (McEwen, 1987).

The ED was originally forested with fringes of salt marsh vegetation around the harbours. Near the coast rimu-rata/kohekohe forest dominated; podocarp forests (kahikatea, totara, matai) dominated on the river terraces and lower slopes; and miro-rimu/tawa forest dominated at higher altitudes. The Porirua Basin was part of the Wellington beech gap. What little beech was present (black beech and hard beech) was confined to stands which extended over the ridgelines from the extensive beech forests of the Hutt Valley on the eastern fringes of the ED.

Today this ED is almost entirely modified by farming and urbanisation, with pasture, plantation pine, gorse and regenerating shrublands throughout. Some small forest remnants occur. The vegetation includes a number of Cook Strait endemics typically along or near the coastal fringe.

The section of the study area within Horokiri and Te Puka valleys lies on the margins of the inland Tararua Ecological District (38.01). The steep, high, dissected hills and mountains of this ecological district are apparent east of Wainui Saddle. This ED is characterised by high winds, long periods of low cloud, high rainfall ranging from 1,600 mm p.a. at low altitudes to 2,400 mm on the summit of the western summit of the Akatarawa Ranges above the Kapiti Coast, increasing to 8,000 mm in the Tararua Ranges. These high intensity rainfalls occasionally lead to flash flooding and, in winter, to small snowfalls. The steepland soils in the Tararua ED are derived from greywacke and are mainly shallow, stony and somewhat leached. In the low-altitude foothills such as those seen around Wainui Saddle, there are less leached and more fertile steepland soils. On these soils, scrub reversion is rapid and often dominated by tauhinu.

5.2.2 GEOLOGY AND TOPOGRAPHY

Transmission Gully traverses a diverse range of the Region's topography. Along sections of the route, the topography is particularly rugged and poses a number of challenges to selecting an alignment and designing a major road. Approximately 36% of the site exceeds 25° in slope.

The great majority (60% or 288 ha) of the designation lies in Greywacke hill country (strongly rolling to steep greywacke hill country of Te Puka, the upper Horokiri, Duck, and Kenepuru/Porirua Catchments). The next largest proportion of the route (33% or 160 ha) lies on rolling to strongly rolling alluvial plains and terraceland within the lower Horokiri, Ration, and Pauatahanui catchments. Small areas of the route (1.5% or 7 ha) lie on sand country and associated swamp lands (around McKays crossing), or on excessively steep and erosion prone mountainlands in the upper Horokiri and Te Puka (3% or 16 ha).

The route topography is characterised (from north to south) as:

- Low lying flat plains at McKays Crossing comprising peatlands, dune depressions, and low dunes
- An elevated alluvial terrace with adjacent incised stream (Te Puka Stream) within bedrock to the west and an ancient landslide to the east.
- The relatively linear northward flowing Te Puka Stream valley (north of Wainui Saddle), with steep greywacke side slopes (forested on the eastern flank and in pasture on the western slopes) and a number of alluvial fan deposits at the mouth of main tributary streams
- The relatively linear southward flowing Horokiri Stream valley (south of Wainui Saddle), with steep bedrock side slopes (forested on the eastern flanks and in rough pasture on the western slopes and valley floor) and alluvial fan deposits at the mouth of steeply incised tributary streams
- A wide, gently sloping alluvial basin section of the Horokiri Stream in the Battle Hill area, with relatively steep side slopes planted in pine forest on the eastern flank and in improved pasture on the valley floor and western hills
- Variably undulating river terraces, gullies and subdued hilltops in pasture and plantation pine, lying between Horokiri Stream and SH58 (in the vicinity of the Pauatahanui Golf Course)
- A 300 m long section of low lying plain at Pauatahanui Stream
- The flanks of a significant tributary stream rising to a saddle with Duck Creek, thence traversing south along the (recently deforested) west facing flank of the Duck Creek valley, crossing a number of steep incised tributary streams
- An undulating plateaus between Duck Creek and Cannons Creek, south to a crossing of the deeply incised and forested Cannons Creek gorge. Then moderately steep northeast and then northwest facing flanks of a broad ridge top crossing a number of deeply incised gullies (in rough pasture and scrub to plantation pine at the southern end) culminating at the gentle slopes of Porirua Stream valley at SH1 Linden.

5.2.3 SOILS

The ED includes a range of soils derived from greywacke and loess on slopes and areas of alluvial, peaty and stony alluvial soils in the valleys. Soils in the valleys range from sandy and silty well-drained soils of levees, through poorly drained heavier textured soils on the toe slopes and fans, to peaty soils in swamps. On the hilly rolling and flattish slopes, soils are moderately deep and formed from varying thicknesses of loess over greywacke. On the steep slopes, there are shallow, moderately leached, steepland soils, mainly used for pastoral farming.

The NZLRI identifies 24 different soil types within the route. These are described in TR6, in terms of both the total extent within the wider study area and the proportion contained within the designation.

In summary, the majority of the route (over 90%) lies on five soil groups:

- Makara steepland soils (19%): The steepest sides of some of the valleys, typically in the upper Horokiri and Te Puka have thin Makara Hill Soils susceptible to slip and scree erosion.
- Korokoro hill soils (40%) The upper slopes of the Horokiri and Te Puka and Upper Duck catchments carry shallow Korokoro Hill soils. These soils are derived from greywacke drift and colluvium on weathered greywacke bedrock. This soil type has a high risk of sheet collapse of exposed cuts.
- Judgeford hill soils (16%) The lower slopes of the Duck, Ration and Porirua catchments are gentle to rolling slopes with Judgeford Hill Soils derived from weathered greywacke and loess and drift soil parent materials.
- Heretaunga silt and clay loams (10%) on the terraces and basins of the lower Horokiri, Ration, Pauatahanui.

- Waiwhetu sandy and silty loams (5%) on the terraces and basins of the lower Horokiri, Ration, Pauatahanui.

A variety of other soils have small representations but no others exceed 5% or 12 ha of the total designation areas.

5.2.4 CLIMATE

The normal annual rainfall for the catchment has been estimated at around 1200 mm. The number of rainy days with over 1 mm in 24 hours has been estimated at 177 (1980), or roughly half the year. The mean air temperature is around 13°C with a recorded minimum of 5.5°C in July and maximum of 22°C in January.

Solar radiation in the Pauatahanui catchment is higher than other Wellington catchments (Kelburn), measured at a mean daily total of 341 calories per square centimetre. The Pauatahanui area receives typically more sun shine hours than other southern parts of Wellington.

5.2.5 LAND USE

The 1980 capability study (Healy, 1980) shows most of the land as being class IV land, not suitable for cropping, of moderate potential for grazing and of high potential for forestry. The Horokiri valley and Ration area have land class III areas; these are of moderate potential for cropping, and high potential for grazing and forestry.

Despite these capability classes most of the landscape is in pasture and variously grazed on small-scale farmlets which include exotic shelterbelts or are in pine forest, such as the large regional forest in the hill country of the Horokiri catchment east. Few indigenous vegetation areas persist.

Table 11-10 shows changes in vegetation cover in the 30 years since it was last mapped (Healy, 1980). The table suggests that arable and pastoral farming has diminished to be replaced by forestry or other exotic forest types associated with the subdivision of larger farms into lifestyle blocks. The table also suggests there has been a reduction in indigenous forest within the Pauatahanui watershed over the last 30 years.

Table 11-10: Changes in vegetation cover of the Pauatahanui Watershed (Healy 1980 & LCDBII 2003)

Sort	Description	Healy (%)	LCDB II (%)
1	Pasture, cropland, open ground	67%	57%
2	Shrublands and Scrub	24%	25%
5	Indigenous Forest	6%	2%
6	Exotic vegetation / Plantation Pine	3%	17%
TOTALS		**100%**	**100%**

5.3 TERRESTRIAL FLORA AND VEGETATION (TR#06)

5.3.1 VEGETATION/ PLANT COMMUNITIES

Vegetation communities are identified within the study area (20,699 ha), the designation (an area of 483 ha), and communities beneath the project footprint (an area of 172 ha including cut and fill batters). It is assumed that most vegetation that lies outside the footprint but within the designation is at risk through associated construction activities. However while vegetation beneath the road footprint will be lost, in some cases it will be possible to avoid and protect identified areas of value within the designation.

Table 11-11 compares vegetation within the wider study area (based on LCDBII), and within the designation and footprint (based on field survey).

Table 11-11: Vegetation communities at different scales of the study area

N°	Description	Footprint (ha)	Designation (ha)	Study Area (ha)
1	Pasture, cropland, open ground	78	227	9,287
1	Wetlands	2	6	813
2	Gorse, broom and fernlands	16	51	1,631
3	Manuka or kanuka low forest	4	10	747
4	Regenerating native forest	12	37	2,006
5	Mature native forest	6	20	340
6	Exotic vegetation	37	104	3,017
7	Urban	17	29	2,859
TOTALS		**171**	**483**	**20,699**

Table 11-12 provides additional detail of the 21 plant communities that were described within the designation. The vegetation communities range from largely unmodified montane podocarp broadleaf forests, small fragmented forests in rural landscapes, and regenerating shrubland communities, to large areas of exotic forestry and croplands.

Table 11-12: Summary of vegetation communities within the Designation of the proposed Transmission Gully Project.

	Description	Footprint		Designation	
		Area (ha)	% of Total Designation	Area (ha)	% of Plant Community
Grassland, shrublands, rushland and wetlands					
1.01	Improved pasture	62	36%	182	38%
1.02	Rough pasture and shrublands	10	6%	30	6%
1.03	Cropland	3	2%	4	1%
1.04	Stony streambed in pasture	3	2%	10	2%
1.05	Riparian margins in rushland	2	1%	4	1%
1.06	Indigenous wetland	0	0%	2	0%
Pioneer shrublands and low scrub					
2.01	Gorse dominated scrub (closed canopy)	9	5%	31	6%
2.02	Tauhinu dominated scrub (closed canopy)	6	3%	16	3%
2.03	Riparian margins beneath scrub	1	1%	3	1%
Seral manuka/kanuka forest					
3.01	Secondary native forest (kanuka)	4	2%	10	2%
Seral broadleaved forest					
4.01	Transmission Gully restoration planting	6	3%	16	3%
4.02	Secondary native forest (mahoe)	5	3%	15	3%
4.03	Riparian margins with 2° native forest	2	1%	6	1%
Mature or maturing indigenous forest					
5.01	Lowland tawa forest	0	0%	4	1%
5.02	Coastal kohekohe forest	5	3%	12	2%
5.03	Remnant sub-montane hardwood forest	0	0%	1	0%
5.04	Riparian margins with indigenous forest	1	0%	3	1%
Exotic vegetation					
6.01	Plantation pine	14	8%	47	10%
6.02	Plantation pine – harvested	17	10%	43	9%
6.03	Exotic trees (shelterbelts, gardens)	5	3%	12	2%
6.04	Riparian margins with exotic trees	1	0%	2	0%
Undefined					
7.01	Built-up area	17	10%	29	6%
TOTALS		**171**	**100%**	**483**	**100%**

In summary, the great majority of the Project footprint lies in a highly modified pastoral landscape. Indigenous forest makes up less than 4% (20 ha) of the plant communities potentially affected. A further 10% of the vegetation within the designation is in seral scrub and forest dominated by either kanuka or mahoe.

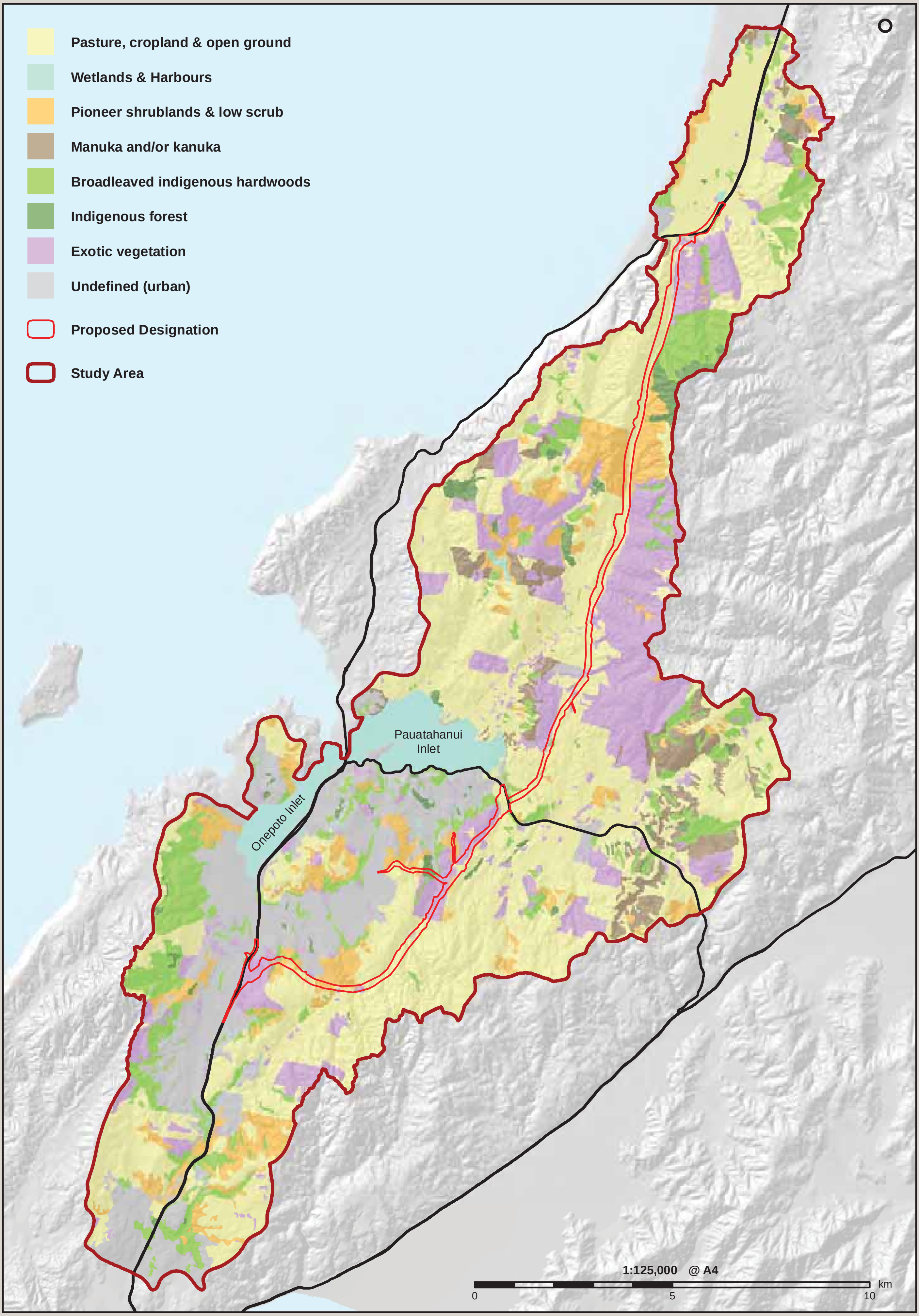
Of the remaining vegetation, 48% is in pasture, 21% is in plantation forestry or other exotic forest, and 10% is in pioneer shrublands and scrub within pasture. The final 10% of the designation is classed as urban.

Table 11-13 describes the vegetation communities found within each of the catchments crossed by the designation. Of note is that the majority of mature indigenous forest lies within the Te Puka valley. Wetlands are only found within the designation in the Whareroa catchment and the Horokiri Stream.

Table 11-13: Vegetation communities within the proposed Transmission Gully designation by catchment.

Description		Whareroa Stream	Wainui Stream	Te Puka Stream	Horokiri Stream	Ration Creek	Pauatahanui Stream	Duck Creek	Kenepuru Stream	Porirua Stream	TOTAL
Grassland, shrublands, rushland and wetlands											
1.01	Improved pasture	21	5	22	73	21	14	34	10		182
1.02	Rough pasture and shrublands			4	13		9	2	3		30
1.03	Cropland		4								4
1.04	Stony streambed in pasture			2	5		1	1			10
1.05	Riparian margins in rushland					1	2	1			4
1.06	Indigenous wetland	1			1						2
Pioneer shrublands and low scrub											
2.01	Gorse dominated scrub (closed canopy)				10	3	3		13	3	31
2.02	Tauhinu scrub (closed canopy)			8	8						16
2.03	Riparian margins with low scrub				2	1					3
Regenerating kanuka scrub & forest											
3.01	Secondary native forest (kanuka)			1			3	5	1		10
Regenerating broadleaved scrub & forest											
4.01	Transmission Gully restoration planting					7	4	5			16
4.02	Secondary native forest (broadleaf)			1	2	1			10		15
4.03	Riparian margins with 2° native forest			1	3			1			6
Mature or maturing indigenous forest											
5.01	Lowland tawa forest			1					1	1	4
5.02	Coastal kohekohe forest		1	11							12
5.03	Remnant sub-montane hardwood forest			1							1
5.04	Riparian margins with indigenous forest			3							3
Exotic vegetation											
6.01	Plantation pine		3	8	3	7		5		19	47
6.02	Plantation pine - harvested						8	35			43
6.03	Exotic trees (shelterbelts, gardens)			1	1	1	3	2	4		12
6.04	Riparian margins with exotic trees				1						2
Undefined											
7.01	Built-up area	1	5				4	1	1	16	29
TOTAL		**5**	**19**	**65**	**124**	**44**	**51**	**91**	**44**	**41**	**483**

Note: Areas are rounded up to the nearest hectare and may not total precisely



Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY

CURRENT VEGETATION PATTERN & LANDCOVER

(derived from LCDB2)

11.2

Key points from the vegetation survey are:

- Indigenous wetlands are only present in two catchments, Whareroa (McKays Crossing wetland) and Horokiri Stream – a small area of sphagnum wetland in pasture identified in this study.
- The largest areas of seral kanuka forest and scrub that will be affected are in the Pauatahanui (3 ha) and Duck (5 ha) catchments. The total area of potentially affected kanuka forest is 10 ha.
- The largest potentially affected areas of regenerating broadleaved scrub are the early retirement plantings in the Duck, Pauatahanui, and Ration catchments (16 ha)
- The largest area of unplanted regenerating broadleaved scrub and forest is 10 ha of mahoe dominated low forest regenerating through gorse above Cannons Creek
- Small areas of lowland tawa forest lie within the designation in three catchments: Te Puka SNA site K222 (1 ha); Kenepuru – a small fragment located as part of this study (1 ha), and Porirua SNA site PCC88 (1 ha)
- Coastal kohekohe forest is only potentially affected in one catchment, the Te Puka, where 11 ha of kohekohe remnants lie within the designation.
- A small area of sub-montane podocarp-broadleaved forest (1ha) lies within the designation at Wainui Saddle.

5.3.2 PLANTS OF CONSERVATION CONCERN

During this study only one species that has a national threat classification, Leptinella tenella, was found within the Project corridor. This species was ranked by de Lange et al (2009) as At Risk (Declining with the qualifiers of Data Poor, Range Restricted and Sparse). *Leptinella tenella* is endemic to the North Island and northern South Island. It is a lowland species whose habitat usually on stream margins where they enter estuaries, on lake margins or on the margins of freshwater swamps and wetlands bordering saltmarsh. This species is sometimes found on cattle pugged swampy ground bordering saltmarshes (as in the Transmission Gully Project location).

Leptinella tenella is intolerant of much shading and grass competition. It favours sites that are kept open through periodic disturbance from high tides and flooding. During this study it was located in an area of heavily grazed, sphagnum dominated wetland within the Horokiri Valley. This wetland is otherwise unremarkable; however, the presence of this species elevates its significance slightly.

A number of other species that are considered to be locally uncommon are located within the area, the majority within the lowland podocarp/tawa forest and sub-montane podocarp broadleaf forest of the Akatarawa Forest Park. The presence of these species contributes to our assessment of significance of this forest block.

5.4 BIRDS/AVIFAUNA (TR#08)

The avifauna is described in detail in Technical Report 8: Avifauna and bat studies: Ecological valuation and only a summary is repeated here. Table 11-14 lists the birds recorded during current surveys and gives an indication of their habitat preferences. Darker green cells indicate primary habitat.

Table 11-14: Avifauna species recorded in January, February and March 2010 along and adjacent to the Transmission Gully Main Alignment and the habitat types they are known to occur in.

SPECIES		CONSERVATION STATUS	Native forest	Exotic Forest	Scrub \ Shrubland	Farmland \ Open country	Freshwater \ Wetland	Coastal \ Estuary	Urban\Residential	Point counts	Non-standardised obs
Bush falcon	*Falco novaeseelandiae "bush"*	Nationally Vulnerable DP St								✓	
Kaka	*Nestor meridionalis*	Nationally Vulnerable									✓
Bellbird	*Anthornis m. melanura*	Not Threatened								✓	
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened CD								✓	
Pied tomtit	*Petroica macrocephala toitoi*	Not Threatened									✓
Tui	*Prosthemadera n. novaeseelandiae*	Not Threatened St								✓	
Fantail	*Rhipidura fuliginosa placabilis*	Not Threatened								✓	
Morepork	*Ninox n. novaeseelandiae*	Not Threatened									✓
Grey warbler	*Gerygone igata*	Not Threatened								✓	
Silver-eye	*Zosterops l. lateralis*	Not Threatened SO								✓	
Californian quail	*Callipepla californica*	Introduced & NaturalisedSO								✓	
Eastern rosella	*Platycercus eximius*	Introduced & NaturalisedSO								✓	
Blackbird	*Turdus merula*	Introduced & NaturalisedSO								✓	
NZ Pipit	*Anthus n. novaeseelandiae*	Declining								✓	
Swamp harrier	*Circus approximans*	Not Threatened SO								✓	
Welcome swallow	*Hirundo tahitica neoxena*	Not ThreatenedInc SO								✓	
Spur-winged plover	*Vanellus miles novaehollandiae*	Not ThreatenedSO								✓	
Skylark	*Alauda arvensis*	Introduced & NaturalisedSO								✓	
Gold finch	*Carduelis carduelis*	Introduced & NaturalisedSO								✓	
Green finch	*Carduelis chloris*	Introduced & NaturalisedSO								✓	
Redpoll	*Carduelis flammea*	Introduced & NaturalisedSO								✓	
Rook	*Corvus frugilegus*	Introduced & NaturalisedSO									✓
Yellow hammer	*Emberiza citrinella*	Introduced & NaturalisedSO								✓	
Chaffinch	*Fringilla coelebs*	Introduced & NaturalisedSO								✓	
Magpie	*Gymnorhina tibicen*	Introduced & NaturalisedSO								✓	
House sparrow	*Passer domesticus*	Introduced & NaturalisedSO								✓	
Dunnock	*Prunella modularis*	Introduced & NaturalisedSO								✓	
Starling	*Sturnus vulgaris*	Introduced & NaturalisedSO								✓	
Song thrush	*Turdus philomelos*	Introduced & NaturalisedSO								✓	
Pied shag	*Phalacrocorax varius varius*	Nationally Vulnerable								✓	
Black shag	*Phalacrocorax carbo novaehollandiae*	Naturally UncommonSO Sp									✓
Paradise shelduck	*Tadorna variegata*	Not Threatened								✓	
White-faced heron	*Ardea novaehollandiae*	Not ThreatenedSO								✓	
Pukeko	*Porphyrio melanotus*	Not ThreatenedInc SO								✓	
Kingfisher	*Todiramphus sanctus vagans*	Not Threatened								✓	
Mallard	*Anas platyrhynchos*	Introduced & NaturalisedSO								✓	
Feral goose	*Anser anser*	Introduced & NaturalisedSO								✓	
Black-backed gull	*Larus d. dominicanus*	Not ThreatenedSO								✓	

A total of 37 species were recorded along the Main Alignment; these comprised 17 introduced (exotic), 20 native but Not Threatened species, two Threatened and two At Risk species.

This represents 48% of the 77 bird species (57 native and 20 introduced species) recorded in the OSNZ atlas data (Robertson, Hyvonen, Fraser, & Pickard, 2007) over the period 1999-2004 within five 10 km x 10 km grid squares that encompass the Main Alignment and surrounding area. However, the OSNZ species list must be viewed in the context of which the data was collected: over a five-year period (1999-2004) and from an area of 500 km² encompassing a number of sites and habitats (e.g. estuaries, Mana Island) that are not represented along the Main Alignment. Consequently, this list contains a number of species that were never expected to be recorded as part of the Project avifauna surveys undertaken in 2010.

Rook was the only species recorded in 2010, which was not recorded in OSNZ surveys. Conversely, shining cuckoo is on the OSNZ list, but was not recorded in 2010. Given the large extent of suitable habitat for shining cuckoo, it is likely that they are present, but were missed due to the late summer/early autumn timing of surveys in 2010.

Also absent from the 2010 survey, but known to be present in the wider area was the native whitehead (Not Threatened). If present, it is most likely to be found within the forest in the Te Puka/Horokiri area.

5.4.1 HABITAT VALUES

The majority of habitat along the Main Alignment is pasture and farmland. The greatest number of species (16) was recorded in this habitat type, and 75% of these were introduced species.

In comparison, the forest provides primary habitat for fewer species, but all of these were native species and include the Threatened bush falcon. The freshwater habitats are utilised by introduced, native, Threatened and At Risk species.

Thus in terms of ecological values, the forest, scrub and freshwater habitats are of greater value than the farmland in terms of providing feeding and nesting resources for native species, including Threatened and At Risk species. Forest, scrub and freshwater habitat types are poorly represented within the Main Alignment. Only one At Risk species recorded during the avifauna surveys utilises farmland as its primary habitat (the New Zealand pipit).

Specific habitats and areas of importance for birds are:

- Ration survey area: the high mean bird abundances and species diversity per count recorded are likely to be due to the variety of land-uses within this area (rural residential, hobby farms, exotic plantation) rather than a reflection of high habitat quality.
- Te Puka survey area: the habitat with the highest ecological value was found here, notably the forest remnants within the Te Puka catchment. The occurrence of large trees (including emergent podocarps) together with important fruiting species within these remnants provides suitable nesting and feeding habitat for a variety of native, Threatened and At Risk species.
- Porirua Park Bush survey area: while no Threatened or At Risk species were recorded within the area, a relatively high diversity of native species was recorded, most notably in the older-growth forest which had a greater diversity in vegetation than found elsewhere.
- Given the lack of wetlands, streams constitute the main freshwater habitat along the Main Alignment and are likely to provide some feeding opportunities for native bird species (especially shags and waterfowl), while generally lacking in nesting habitat.
- Petrel habitat: most breeding colonies are located on islands (e.g. Kapiti and Mana) with the few mainland populations largely confined to coastal forested hilltops, such as at the northern end of the Transmission Gully Project. Petrels may occur at very northern section

of the Main Alignment, but that habitat will not be directly or indirectly impacted upon by the Project.

5.4.2 SPECIES OF CONSERVATION CONCERN

Overall, introduced species made up the greatest proportion (68.6%) of all birds recorded during the point counts along the alignment. Of the 37 bird species recorded during the avifauna survey period, 20 were native with the following classifications:

- 16 are Not Threatened,
- Three are Threatened (bush falcon, kaka and pied shag) and
- Two are At Risk (black shag and New Zealand pipit) (Miskelly, et al., 2008).

Thus, Threatened and At Risk species were present along the alignment but were recorded in very low numbers.

5.5 BATS (TR#08)

5.5.1 INTRODUCTION

Bats studies are described in detail in Technical Report 8.

New Zealand has three species of bats: the long-tailed bat (Chalinolobus tuberculatus), the lesser short-tailed bat (Mystacina tuberculata), and the presumed extinct greater short-tailed bat (Mystacina robusta) (Daniel 1998). Threats to both extant species include predation, habitat loss and disturbance of roosts (Molloy 1995, Lloyd 2001, O'Donnell 2001). Both species are threatened: long-tailed bat is considered Nationally Vulnerable (Data poor, Human Induced qualifiers) and the Southern North Island short-tailed bat is Nationally Critical (Human Induced qualifier).

A population of short-tailed bats found in the Wairarapa in 1999 is believed to be the last remaining population of this species in the south of the North Island, while long-tailed bats are known to occur around Wellington and on Kapiti Island. Given the difference in distribution of the two species, it was considered that long-tailed bats would be the more likely of the two extant species to potentially occur within or adjacent to the Transmission Gully Project.

5.5.2 BATS OCCURRENCE AND HABITATS

Bat surveys were concentrated at the end of January (which is peak activity period for bats) around the Wainui Saddle (between Te Puka/Horokiri catchments).

While there were no confirmed recordings of bats, one recording of interest was detected from the bat box located in the upper Te Puka site in kohekohe forest. This record could potentially be either a short- or long-tailed bat. Further surveys are recommended – to be undertaken in winter and spring - to more confidently determine if bats occur around the Wainui Saddle area.

5.5.3 HABITAT VALUES

The only habitat with sufficiently large area of old growth native forest likely to contain the long-tailed bat is the Akatarawa Forest which extends into the upper Te Puka and upper Horokiri.

5.6 HERPETOFAUNA (TR#07)

5.6.1 INTRODUCTION

Based on known distributions and preferred habitat types ten species of endemic lizard could potentially occur within the Project Designation. They are:

Table 11-15: Conservation status and habitat preferences of herpetofauna potentially occurring along the Main Alignment.

Family	Common Name	Conservation Status2	Habitat Preferences
Skink	Copper skink	Not Threatened PD	Open and shaded areas where sufficient cover is available (e.g., rock piles, logs, dense vegetation, etc).
	Spotted skink	Relict CD,PD	Open grassland, scrub and stone fields.
	Common skink	Not Threatened	Dry open areas with low vegetation or debris such as logs or stones for cover.
	Ornate skink	Declining CD,PD	Open and shaded areas where sufficient cover is available (e.g., rock piles, logs, dense vegetation, etc).
	Brown skink	Not Threatened Sp	Forest or densely vegetated and damp areas in forest, scrub, grassland, gardens and coastlines.
Gecko	Common gecko	Not Threatened PD	Forest, scrub, grassland and coastal areas
	Pacific gecko	Relict CD,PD	Forest, scrub, grassland, coastal areas and creviced clay banks
	Marlborough mini gecko	Not Threatened	Forest, scrub, grassland and coastal areas
	Southern forest gecko	Not Threatened	Forest and scrub, especially kanuka / manuka, and creviced clay banks
	Wellington green gecko	Declining	Forest and scrub, especially kanuka / manuka.

5.6.2 DISTRIBUTION & ABUNDANCE

The Main Alignment provides habitat for at least three endemic lizard species: common gecko, copper skink and common skink. In total this study found four lizards and nine skin sloughs.

Two common skink were located at the southern end of the alignment under a cover object in ungrazed pasture. In comparison, the two copper skink were found under a cover object in stone fields within the northern section.

Manual searches located a juvenile and two female common geckos. All were found beneath rocks within a stone field in grazed pasture near the northern end of the alignment in the Horokiri and Te Puka. Also in the Te Puka nine gecko (probably common gecko) skink sloughs were found among the screes.

5.6.3 SPECIES OF CONSERVATION CONCERN

No species of conservation concern were located during the survey. It is possible that additional lizard species occur along the Main Alignment but were not detected. However, given the variety and intensity of the surveys, if any species were missed they are unlikely to be present in any abundance. The restriction to three species within and adjacent to the Project footprint (from the 10 potential species listed in Table 11-15) suggests both a lack of suitable habitat for the majority of these additional species together with high predation pressure from introduced mammals.

However, while this study did not detect any uncommon or threatened species of lizard, the suite of three common native lizard species present has ecological value; it is most probably representative of the lizard communities occurring across much of the inland Wellington Region – especially in agricultural landscapes with remnants/patches of forest and shrubland and/or deep scree slopes. Key habitats where lizards were found are:

[2] According to Hitchmough et al. (2010) with qualifiers: CD=Conservation Dependent; PD=Partial Decline; Sp=Sparse.

5.6.4 HABITAT VALUES

Much of the Main Alignment represents poor to marginal (low value) habitat herpetofauna habitat, in particular the grazed pasture. Where lizards were recorded in grazed pasture, they are usually found sheltering beneath rocks, log and debris in the pasture and represent a relict (as opposed to thriving) population.

Rank grassland represents a better quality habitat (moderate value), but this is rare within the Main Alignment which is almost entirely grazed.

The highest quality herpetofauna habitats within the Designation are the stone fields and scree slopes located towards the northern end of the alignment. The two deep scree slopes located here probably represent the best habitat for common gecko within the Main Alignment. These stone fields also supported the copper skink and the unidentified skink. This supports the conclusion that the Project's northern stone fields and scree slopes represent the site's most important herpetofauna habitat within the designation.

The native forest in the Wainui Saddle area (also located within the northern end of the Project footprint) may provide habitat for arboreal gecko species such as forest gecko and Wellington green gecko. However, the survey programme revealed no herpetofauna occurring within the native forest habitats. They may be present but undetected due to the inherent difficulties in surveying for gecko and/or low population densities. Regardless, given that the vast majority of forest habitat in the area lies outside the Main Alignment, the small areas of native forest that are located within it are unlikely to represent significant herpetofauna habitat.

5.7 TERRESTRIAL INVERTEBRATES (TR#07)

5.7.1 INTRODUCTION

A wide variety of common terrestrial invertebrates were detected, though none of conservation concern. However, the area around Wainui saddle appears to be a stronghold for *Peripatus novaezealandiae* which was located in a variety of habitats beneath logs and within boulderfields. While this species does not currently have a threat status, their taxonomy is under review.

5.8 FRESHWATER HABITATS AND SPECIES (TR#09)

5.8.1 HYDROLOGY

There are three watersheds affected by this proposal. They are:

The Wainui watershed which discharges to the Kapiti Coast through Queen Elizabeth Regional Park. It includes Wainui Stream and Te Puka Stream, both of which would be crossed by this proposal. This watershed has a combined area of 670 ha (6.7 km^2).

The Pauatahanui watershed. This includes six named sub-catchments, Kakaho Stream, Horokiri Stream West Branch, Horokiri Stream East Branch, Ration Stream, Pauatahanui Stream, and Duck Creek, all of which discharge into Pauatahanui Inlet. Of these the Horokiri East Branch, Ration, Pauatahanui, and Duck catchments would be traversed by this proposal. This watershed has a combined area of 10,640 ha (106 km^2).

The Porirua watershed. This includes Kenepuru Stream and its smaller tributary Cannons Creek which combine and flow into Porirua Stream a short distance upstream of the stream mouth on the shores of Porirua Harbour. Cannons Creek and several small tributaries of Porirua Stream would be crossed by the proposal. This watershed has a combined area of 5,325 ha (53 km²).

These watersheds and streams are shown in Figure 11.3.

5.8.2 WATERWAY SYSTEM DESCRIPTIONS

Te Puka Stream

- Te Puka Stream has a catchment area of 3.7 km² (372 ha) and drains through a very steep gradient from above and to the north of the Wainui saddle over 3 km to the South under the state highway and across the coastal plain through the Queen Elizabeth Park Reserve to the coast.
- The waterway in its headwaters in the Wainui saddle area is a poorly defined cobble and boulder base stream under a full forest canopy (the true right branch) or a narrow channelised, intermittent creek. The larger perennial true right branch represents a very natural aquatic habitat type with sub-surface flows, appropriate organic matter and complex and simple habitat areas. These are ideal habitat for koaro and banded kokopu but less so for shortjaw kokopu.
- Below the headwater and out of the forest the stream widens and becomes semi-braided on a course cobble base with a relatively undefined channel set in wide banks. The habitat is very simple and relatively uniform. As the stream reaches the lower-middle portion it cuts through an old ridge and this cut forms a deep and enclosed gorge section (around 500 m). This adds substantively to the habitat diversity of the creek. Below the gorge the stream falls a further 500 m to the State Highway were the gradient falls to the coastal plain. This lower stream section is narrower, single channel and provides greater evidence of disturbance by farming activities.
- Average velocities in the middle to upper reaches range from 0.3 to 0.5 ms-1 with water depths typically around 0.05 to 0.1 m (very shallow). These are in undefined wetted channels of around 3 to 4 m, often in two channels and a bank to bank width of 9 to 15 m.
- Riffle habitat makes up around 40% of the aquatic habitat with cascades, stepped riffles, and stepped pools making up equally the remaining general aquatic habitat types, all represent relatively shallow “fast” water habitat.

Horokiri Stream

- Horokiri Stream has a catchment area of 34 km² (3,380) and drains from north to south from a high point above Wainui saddle (at around 560 m a.s.l) down into the Pauatahanui Inlet at sea level.
- The upper headwater/catchment of the East Branch of the Horokiri is largely in rough pasture with the larger, eastern tributaries in native regenerating shrublands. The typical water velocity in the headwaters is around 0.2 ms-1 but around 0.5 m-1 in some of the steeper reaches. The water is clear, the substrate cobble and relatively clean but the riparian areas largely exotic pasture species and unprotected from stock.
- The upper-middle reaches are characterised by a narrowing of the valley and an increase in native shrubland riparian vegetation (mahoe) on steep banks and small terraces over an incised stream. Despite the vehicle and stock crossings, the substrate and general form of the stream in this upper-middle section is relatively unmodified, but with little evidence of former forest habitat.
- The middle and lower-middle reach is deeply incised with native herbs and grasses on the steep, high banks and pastoral grasses on the bank tops. The water generally runs clear in a wide deep set channel as a shallow run and riffle system. The lowest reaches are much flatter and the river is larger and deeper with frequent pools and long runs. Here, the water

is often slightly coloured by sediment, and sands and sediment are common on the benthos. The banks are largely exotic and mixed weeds (willow), shrubs and grasses.

- In the lower reaches the waterway runs along an alluvial flat between steep and unstable hills for most of its 12.9 km length. As the alluvial plain opens into the Battle Hill Regional Park the surrounding hills recede. The East Branch meets the West branch at about the Paekakariki Hill Road, doubling the size of the waterway. Downstream the river flows to the Pauatahanui Inlet as a relatively slow and large lowland river type.

Ration Stream

- The Ration system is one of the shorter waterways of the eight affected. It has a total catchment area of around 6.13 km² (nearly 20% of that of the Horokiri), originates at around 260 m .a.s.l. and is only 4.8 km long. It discharges into Pauatahanui Inlet off Ration Point through a small oioi reed land.
- This is a generally flatter catchment than others in the study area. The majority of the upper reaches are in beef and sheep pasture, the middle reach in plantation forestry (which is likely to be having an adverse effect on the hydrology of the system), and the lower reaches in life style farming.
- The system has numerous intermittent or ephemeral tributaries that are largely covered in macrophytes (monkey musk, watercress, water pepper) and/or rushes and sedges in pasture (*Juncus effusus*, *Carex* sp). Water in this system is not always flowing and often only found underneath long grass swards and wetland plants. An open channel with water flow is only obvious in the middle to lower reaches under pine plantation or through the farmlands near the inlet.
- The water is often clouded, and nutrient and recorded sediment levels are very high. Unlike the Horokiri, there is a relative consistent and slow velocity of water (~0.2 ms-1).

Pauatahanui Stream

- The Pauatahanui catchment is the largest of the Project area at around 43.4 km² (4200 ha). The majority of the feeder tributaries arise in the south of the catchment from the hills at an altitude of around 430 m a.s.l. The main stem is around 9.6 km long.
- The upper catchment area has pockets of bush and shrubland, the middle and lower catchment is largely in exotic shelter belts and pasture.
- Typically the riparian condition is one of rough pasture, pasture weeds and mixed exotic trees (willow being common) and in general there is a strong vegetative riparian cover in the middle and upper reaches. Generally the banks are unprotected and stock has free access to most areas.
- At and below the area subject to the designation, the Pauatahanui Stream is a typical lowland stream with a relatively natural meander path, hydrologically natural flows and a substrate that, while affected by sediment, exhibits a reasonably natural condition. Flows are reported at anywhere from 55 L/s to 25800 L/s with an average around 940 L/s.
- The lower reaches, prior to discharge into the Pauatahanui Inlet, are wide and relatively deep with sand, gravel and small cobble reaches typical of lowland streams. Over-hanging willows are associated with pools and deep runs. The river exits to the inlet through a large well-formed oioi wetland.

Duck Creek

- Duck Creek has a catchment area of 10 km² (1000 ha) and drains west on a very steep gradient from 490 m a.s.l to sea level over a distance of around 7.2 km.
- The upper catchment is generally in pasture, with the headwaters (4-5 tributaries) lying in scattered riparian native shrubland and pasture. The catchment contributing to the middle-lower section is in plantation forest (Silverwood Forest) down to the Whitby Coastal Estate

urban area. The catchment comprises roughly 50% steep to very-steep pastoral lands and 50% forest of mixed age and type.

- The stream system includes narrow tributaries that have extensive and near vertical drops into the main stem (and thus are restricted to climbing fish only). The main stem has "steps" of flatter, shallow, slow meanders between steeper, straighter sections.
- Generally the substrate is dominated by coarse gravel/cobble with little fine sediment. Depths vary from shallow upper areas around 0.1 m and 3 to 4 m wide to lower reaches of over 1 m deep and 10 m wide. Flow velocities in the main stem average at 0.3 ms-1 while Flows are recorded in Healy (Healy, 1980) as being from 16 L/s to 5890 L/s and averaging 230 L/s.
- In many lower and middle reach areas the stream has good in-stream habitat and varied riparian and wetland edge habitat. However, the upper stream is currently modified through six perched culverts which prevent continuous upstream fish passage.

Porirua Stream

- At its southern end, the proposed alignment traverses the top end (head water) of an un-named tributary of Porirua Stream. This short steep tributary is intermittent but has a good cover of indigenous secondary forest (dominated by mahoe) below the road alignment within the gully. Sections above the mahoe gorge are choked with gorse and monkey musk and generally aquatic habitat decreases upstream. Downstream of the mahoe gorge, it is surrounded by the pine forest plantation that covers the majority of the sub-catchment of this tributary. Site investigations focused on the mahoe gully reach.
- While physical habitat appeared good, the aquatic macroinvertebrate fauna was very poor.
- The Porirua Stream width is typically 1 to 1.5m across and shallow (in the mahoe section less than 0.1m.) Flows are small and total flow estimated at less than 10 L/s.

Cannons Creek / Kenepuru Stream

- Cannons Creek is a tributary of Kenepuru Stream (total catchment area of around 13km² or 1300 ha and sub-catchment of around 390 ha). Its headwaters lie in Belmont Regional Park at an altitude of approximately 400m. The stream descends through farmland and regenerating bush for 3.6 km until it joins Kenepuru Stream.
- While the majority of the upper catchment consists of regenerating native vegetation and small areas of primary forest, the upper area of the catchment above the Takapu Road electricity substation is almost entirely in improved pasture managed by Landcorp. Aquatic habitat in this upper reach is intermittent.
- The Cannons Creek system includes the Cannons Creek Lake Reserve which is a small narrow 7.5ha reserve situated at the point Cannons Creek enters Porirua East. The Lakes Reserve contains two artificial lakes, which are also fed by springs and stormwater drains and were formed in the 1950s to act as flood detention ponds. The eastern perimeter of the lower lake is lined with stone. The upper lake is fringed by flax, wetland grasses and native tree and shrub. Both lakes are surrounded by mown lawns and beyond this with a band of native shrubs and trees along the gully slopes.
- Below the Lakes Reserve, the Creek flows in a concrete-lined channel for 1.4 km before dropping steeply down a series of large stepped concrete structures to join Kenepuru Stream. Kenepuru Stream eventually enters Porirua Harbour approximately 3.0 km from the Cannons Creek Lakes Reserve.

5.8.3 FRESHWATER FISH

Seventeen species of fish have been recorded in the FFDB from the seven catchments of the Project area. Four of these species are tidal and only found in the lowest reaches (smelt, flounder, mullet, triple fin) were not targeted by the sampling regime for this Project and are assumed to be present permanently or periodically in all of the tidal reaches of the streams of the study area.

Of the remaining 13 species, the sampling programme for this Project has recorded nine.

Those not recorded by EFM sampling were lamprey, torrent fish, shortjaw kokopu and giant bully. The freshwater fish species recorded in the study area catchments are shown in Table 11-16.

Table 11-16: Summary of species caught within each river system sampled by EFM.

Catchment	Fish species (with threat status indicated)
Te Puka	Koaro*, red fin bully*, long fin eel*
Horokiri	Banded kokopu, koaro*, red fin bully*, common bully, long fin eel*, short fin eel
Ration	Giant kokopu*, long fin eel*, short fin eel, white bait (?)
Pauatahanui	long fin eel, short fin eel, inanga*, common bully
Duck	Banded kokopu, koaro*, Giant kokopu*, Inanga*, red fin bully*, common bully, long fin eel*, short fin eel
Cannons	Banded kokopu, Giant kokopu*, Inanga*, red fin bully*, long fin eel*, short fin eel

*-"At Risk" (Townsend et al 2008) "Declining" (Alibone et al 2010)

Based on both FFDB and sampling as part of this study, the two species of eel and red fin bully are, by far, the most frequently encountered freshwater fish in the waterways. Lamprey, torrent fish, shortjaw kokopu and giant bully are infrequently found (that is, in less than 1% of records).

5.8.4 AQUATIC MACROINVERTEBRATES

Species richness

In total 81 different aquatic invertebrate taxa were sampled from the seven catchments of the Project area. These were identified to levels which provide "taxa richness" information.

Sites returned consistently around 30 taxa across all of the sampling sites, (taking an average of the three samples).

All sample sites have over 10 EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa and a typical range of between 15 and 20 taxa with 5 stream sites having over 25 EPT taxa. Ten taxa of mayfly (Ephemeroptera) were recognised. *Deleatidium* are the mostly commonly encountered mayfly (100%) along with *Coloburiscus*. These two taxa are caught in over 80% of the 63 samples. Around 41% of the mayfly fauna caught across the seven catchments was either *Deleatidium* or *Coloburiscus* species.

Six taxa of stonefly (Plecoptera) were recognised. *Zelandoperla*, *Zelandobius* and *Stenoperla* stonefly were caught from around 50% of the samples, with the other taxa much less commonly present. Furthermore over 80 % of the records of stonefly are in these three taxa and these three taxa typify the stonefly community in the wider catchment.

Caddisfly (Trichoptera) were the most taxa-rich group of the EPT with 20 taxa recognised. Eight taxa were found in over 50% of sampled and five in over 70%. Olinga was the most commonly found taxa along with *Pycnocentrodes*, *Aoteapsyche*, *Psilochorema* and *Hydrobiosella*. However, no single taxon within the group dominated in terms of proportion of recordings.

The percentage of a community's richness or abundance that is EPT is an indicator of richness. For most sites in the Project area, over 50% of the community's species belong to one of the three EPT groups. The lowland sites of Duck Creek and Pauatahanui are the only sampled sites that have less than 50% representation. Two Project sites (Horokiri middle and Horokiri upper) and one of the reference sites (Belmont Stream) have over 70% of the taxa present belonging to the EPT groups.

There is also a positive trend in increasing EPT representation in the fauna from lowland to upland reaches

Sensitivity indices

Stark & Maxted's (2004) Macroinvertebrate Community Index (MCI) scores were calculated.

Mean MCI scores in the Project area sites were generally high. All sites measured qualify as being "Good" quality with only "possible mild pollution" (score >100), while the majority of sites (> 17) have score which indicate "excellent" quality in terms of their MCI scores (i.e. > 120, clean).

There is also a distinct trend of lower reach sites having lower MCI scores than upper reach sites.

The SQMCI accounts for the bias effect of a single (or low number of) taxa of very high or very low MCI scores on the final score. The range is from 4 ("fair" - probable moderate pollution) through to >8.

Only 4 sites produced a score of < 6. Scores > 6 are interpreted as "Excellent" quality, clean sites.

Both sensitivity indices strongly suggest the aquatic benthic macroinvertebrate fauna across and throughout the seven catchments are in very good to excellent condition with sensitive taxa prominent or dominant in the benthos of those streams.

5.8.5 SPECIES OF CONSERVATION CONCERN

The conservation value of fish species are listed in TR13. They are:

Table 11-17: Aquatic species and habitat values

FFDB analysis1	Common name	Threat Status	Found in this study
Anguilla australis	Short fin eel	Not threatened	Y
Anguilla dieffenbachii	Long fin eel	Declining C(2)	Y
Cheimarrichthys fosteri	Torrent fish	Declining C(1)	N
Galaxias argenteus	Giant kokopu	Declining B(1) PD	Y
Galaxias brevipinnis	Koaro	Declining C(1)	Y
Galaxias fasciatus	Banded kokopu	Not threatened	Y
Galaxias maculatus	Inanga	Declining C(1) CD, DP	Y
Galaxias postvectis	Shortjaw kokopu	Declining A(1) DP	N
Geotria australis	Lamprey	Declining B(1) DP	N
Gobiomorphus cotidianus	Common bully	Not threatened	Y
Gobiomorphus gobioides	Giant bully	Not threatened	N
Gobiomorphus huttoni	Red fin bully	Declining C(1)	Y
Salmo trutta	Brown trout	Introduced	Y

5.8.6 FRESH WATER QUALITY

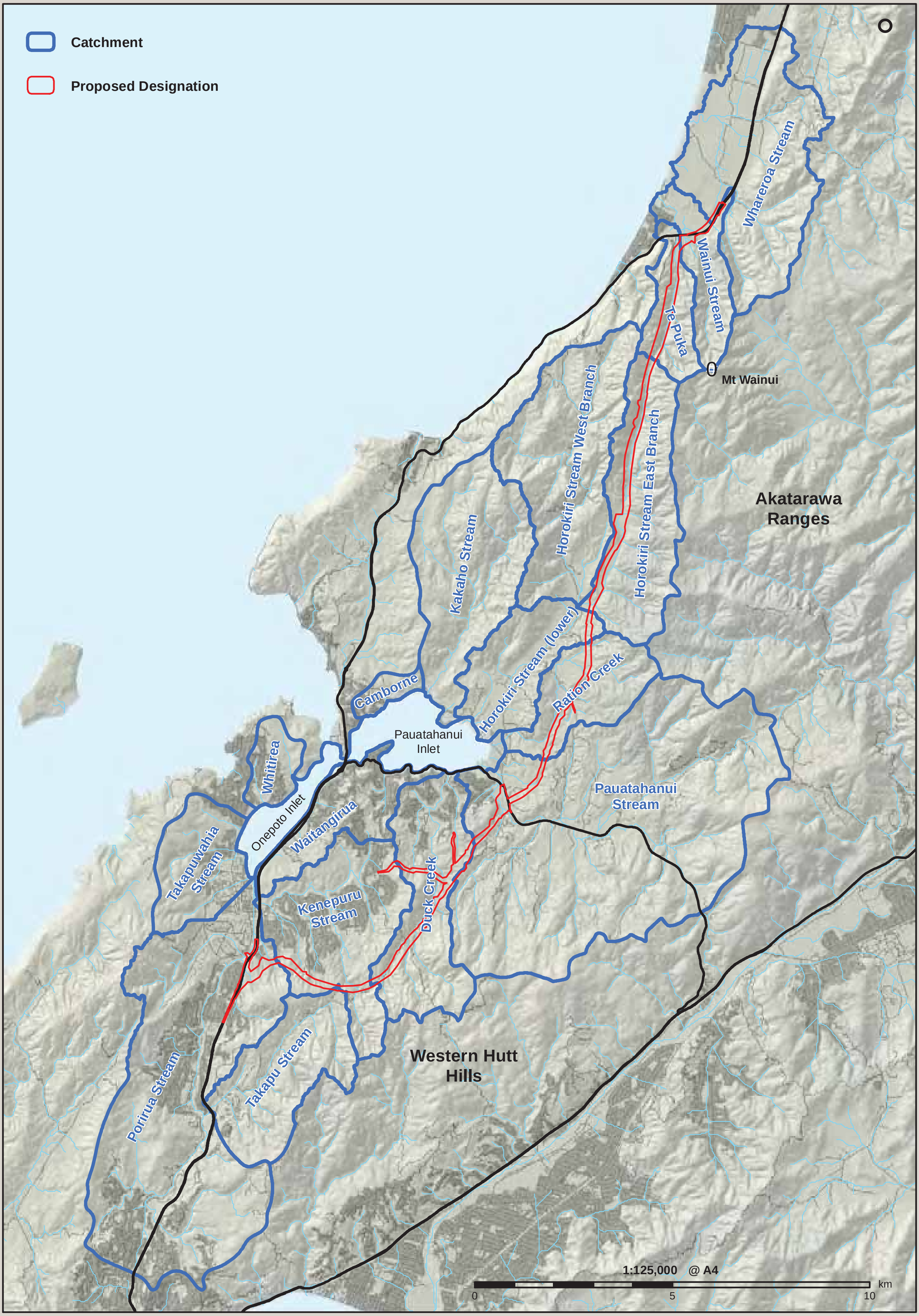
The water quality data illustrates that several catchments have heavy metal issues and that most catchments currently have nutrient enrichment. The catchments most contaminated (with Copper and /or Zinc) are Porirua, Cannons, Kenepuru, Duck, Pauatahanui, Ration, Horokiri and Wainui i.e. most of the waterways. However only the Kenepuru and Cannons have notable high Dissolved

Copper contaminant and it is the dissolved material that is most ecologically of issue. Again it is the Kenepuru-Cannons and Pauatahanui systems that have the greatest nutrient enrichment[3].

The TSS data gathered suggests that all of the streams in the Project area experience a number of raised TSS conditions throughout each year. In the Horokiri Stream, events can be very large (>1000 gm^3) and quite frequent, whereas in other catchments events are more typically 50-100 gm^3.

In all cases it appears that benthic macroinvertebrate fauna and fish indicative of good waterway quality persist with this current level of contaminant. However, in the absence of data over a prolonged period of time, it is not known whether these conditions and values are trending downwards.

[3] See SKM Technical Report #15


Catchment
Proposed Designation
Whareroa Stream
Wainui Stream
Te Puka
Mt Wainui
Horokiri Stream West Branch
Horokiri Stream East Branch
Akatarawa Ranges
Kakaho Stream
Horokiri Stream (lower)
Ration Creek
Camborne
Pauatahanui Inlet
Pauatahanui Stream
Whitirea
Onepoto Inlet
Waitangirua
Takapuwahia Stream
Kenepuru Stream
Duck Creek
Western Hutt Hills
Takapu Stream
Porirua Stream
1:125,000 @ A4
0
5
10
km

5.9 HARBOURS AND ESTUARIES (TR#10)

5.9.1 PORIRUA HARBOUR

Catchment

Porirua Harbour (867 ha) contains two shallow tidal inlets: the Onepoto Inlet (283 ha) and the Pauatahanui Inlet (524 ha). The catchment area for Porirua Harbour is approximately 600 km² (Glasby et al. 1990).

Hydrological Characteristics

The Onepoto Inlet and the Pauatahanui Inlet have a common access to the sea via a narrow 0.1 km wide entrance (Glasby et al. 1990). Maximum water depth in both inlets is approximately 3.0 m. Approximately 80% of the Onepoto Inlet is subtidal, whereas 60% of the Pauatahanui Inlet is subtidal (SKM, 2010). The ratio of subtidal to intertidal habitat is relatively high compared to other estuaries and tidal inlets. This latter characteristic has important implications for sedimentation and eutrophication patterns (Robertson & Stevens 2009).

Both tidal inlets have dynamic features, modified by tides, waves and littoral sediment transport. Typically, tidal inlets are characterised by narrow deep throats through which strong currents flow, flood tidal deltas (sand bodies within the estuary bay) and ebb tidal deltas (immediately seaward of the throat (Goff et al. 2003). The larger streams that enter into Porirua Harbour have complex flood tide deltas, with dynamic and often multiple channels at the stream mouths (SKM, 2010).

Circulation eddies occur in both Inlets, and are likely to contribute to accumulation of fine sediment in the central basins. Within Pauatahanui Inlet, most deposition occurs in the western and eastern parts of the central basin, where currents and circulation eddies are weakest (SKM, 2010).

The primary driver for the movement of water into and out of Porirua Harbour is tidal exchange. Approximately 60% of the incoming tide flows to the Pauatahanui Inlet, with 40% to the Onepoto Inlet. Winds, waves and freshwater inflows also influence the movement of water.

Sediment Characteristics

Between 1974 and 2009 a net average deposition rate of 27.1 mm/year of fine sand has occurred within the harbour throat. Since 1980, much of this fine sand has been trapped against the breakwaters and Mana Marina entrance. The predominant source of sediment entering the Porirua Harbour is from both bed load and suspended load from the Porirua, Kakaho, Ration, Pauatahanui, Duck, and Brown streams (Gibb & Cox 2009).

Based on the results from the deployment of 15 sedimentation plates, Robertson & Stevens (2009) estimate the mean sedimentation rate in Porirua Harbour to be 0.75–7 mm in a 13 month period. The authors interpreted the sediment rates as very low in the Pauatahanui Inlet and very low to moderate in the Onepoto Inlet.

Recent broad-scale habitat mapping shows that the intertidal areas within the harbour is dominated by poorly sorted firm muddy sands, with a low proportion of soft muds (approximately 1.6% and 4.5% of the total intertidal habitat in the Pauatahanui Inlet and Onepoto Arm respectively) (Stevens & Robertson 2008) (see Figure 11.4 below).

Modelling undertaken for this Project (SKM, 2010) indicates that the terrestrial sediment entering the harbour is deposited initially throughout the harbour including shallow intertidal zones near stream mouths, with long term accumulation in the central subtidal basins . In these intertidal areas total suspended sediment (TSS) is also highest, exacerbated by wave induced suspension of bed material in shallow water. Fine sediment is transported further away from stream mouths and intertidal habitats to the central subtidal basins.

Sediment Contaminants

In a survey of heavy metal concentrations in Porirua Harbour, Glasby et al. (1990) determined that the average concentration of copper and zinc in sediment samples exceeded the Auckland Regional Council (ARC) Ecological Response Criteria (ERC) amber (and in some cases the red) threshold, but lead did not (Auckland Regional Council, 2004).

An intertidal sediment quality survey carried out by Sorenson & Milne (2009) in Porirua Harbour indicated elevated contaminant concentrations in surface sediment samples from Onepoto and Browns streams and Duck Creek. Total DDT exceeded effects thresholds at all stream mouths, in addition to lead at Onepoto and Browns Stream, and zinc and various polycyclic aromatic hydrocarbons (PAHs) at Browns Stream.

5.9.2 PAUATAHANUI INLET

Catchment

The Pauatahanui Inlet is approximately 3.5 km long by 2 km wide and is fed by six major streams (Pauatahanui, Horokiri, Browns, Ration and Kakaho Streams and Duck Creek) covering a catchment of approximately 100 km_2. The shoreline length is approximately 13.24 km (Bellingham 1998; Gibb & Cox 2009). The inlet is a dynamic sedimentary system and is largely subtidal, a feature which is not common for North Island estuaries (Swales et al. 2005). Furthermore, the inlet is small compared to its catchment and is therefore sensitive to the effects of land-use practices, which are primarily rural and residential.

The inlet is a low energy estuarine system with a catchment that has been significantly modified over the past 150 years. The inlet is considered to be a sensitive receiving environment as it is already showing signs of ecosystem change, potentially due to sedimentation and accumulation of contaminants (Page et al. 2004). Urbanisation and ongoing fragmentation of coastal ecological features continue to threaten the inlet ecosystem (Anstey & Blaschke 2004).

The inlet has intertidal flats that fringe the central mud basin, and deltas have formed where streams discharge. The largest intertidal mud/sand flats are associated with the Pauatahanui, Horokiri, Ration, and Kakaho streams. Horokiri Stream enters the Pauatahanui Inlet on the northern side, with the land use in this catchment (33 km_2) being predominantly pastoral farming. The catchment for Pauatahanui Stream is largely rural, but residential land use dominates in the lower reaches of the stream. Saltmarsh vegetation is present, adjacent to the Pauatahanui Stream mouth (Hooper 2002).

The catchment for Kakaho Stream is small (11.3 km_2) and is also agricultural, with the upper stream areas surrounded by native bush. Ration Stream has a small low-lying catchment (6.1 km2), including pastoral land and a golf course. The lower part of Ration Stream is surrounded by saltmarsh contained within a Department of Conservation (DOC) reserve. Duck Creek drains a small catchment (11 km_2) and comprises an eastern and a western branch above the Duck Creek Golf Course. The land-use surrounding the eastern branch is predominantly pastoral and pine forest land, whereas the western branch has a mainly urban catchment. Browns Stream has a small (1.23 km_2), urban catchment. Much of the marsh area around the inlet has been drained for other land-uses such as grazing and roading (BML 2000).

Hydrology and Water Quality

The estuary is characterised by strong tidal flushing, deep low water channels and active sediment transport. Water residence time is estimated at three days (Healy 1980). The bottom sediments range from firm sand and rocks in the northern and middle areas, to soft muddy beds and eel grass on the eastern side (Healy 1980). There is a range of salinities in the estuary as fresh and marine water mix.

Due to the shallow nature of the Pauatahanui Estuary, there is reasonably good mixing of the water column through the action of tides and waves and as a result the salinity throughout the estuary is similar to seawater (Healy 1980; Swales et al. 2005). Stratification of water may occur during storm flow conditions, where the fine catchment sediments are transported in the surface freshwater layer overlying the saline water. These fine particles aggregate as they settle through the water column and deposit on the estuary bed (Swales et al. 2005). Sediments and associated contaminants are reworked through re-suspension and mixing, and through the actions of burrowing and feeding of organisms.

The western and eastern ends of the central basins in the Pauatahanui Inlet accumulate most of the fine sediment, due to the weak tidal currents and circulation eddies. Estimates indicate that between 1974 and 2009 the net average deposition rates within the Pauatahanui Inlet were 9.1 mm/yr, which has reduced the tidal prism by 8.7%. At current sedimentation rates, the Pauatahanui Inlet is likely to infill in the next 145-195 years (SKM, 2010).

5.9.3 ONEPOTO INLET

Catchment

The approximately 4 km long Onepoto Inlet is fed by the Porirua Stream and other small tributaries, draining a total catchment of approximately 70 km_2 (Hooper 2002). Gibb & Cox (2009) estimated the shoreline length to be 9.03 km. This Inlet is smaller and shallower than the Pauatahanui Inlet, with approximately half of the Inlet being exposed at low tide (Healy 1980). The benthic sediment is predominantly muddy, with surrounding land-use predominantly being residential and industrial.

Hydrology and Water Quality

Water quality is frequently compromised, with high concentrations of nutrients, faecal indicator bacteria, and contaminants commonly recorded (BML 2000).

Sediment deposits in the central basin within the Onepoto Inlet. Erosion along much of the Onepoto shorelines occurs most likely as a result of wave reflections from the modified harbour edges. Estimates suggest that between 1974 and 2009 deposition within the Onepoto Inlet has been around 5.7 mm/yr, and the tidal prism has reduced by 1.7%. At current sedimentation rates, the Onepoto Inlet may infill within the next 290-390 years (SKM, 2010).

5.9.4 ECOLOGICAL VALUES OF PORIRUA HARBOUR

Saline Vegetation and Macro-algae

While seagrass was found to be extensive in both inlets, saltmarsh covers approximately 51 ha in the Pauatahanui Inlet but is largely absent in the Onepoto Inlet (Robertson & Stevens 2009). Macroalgae cover on intertidal sediments within the Porirua Harbour was investigated by Stevens & Robertson (2009) and revealed some nuisance macroalgae in both the Pauatahanui Inlet (around the Pauatahanui Stream) and the Onepoto Inlet (around the Porirua Stream). Macroalgae cover increases with increased nutrients and, when the sediment below is smothered, can cause localised areas of rotting algae, poorly oxygenated and sulphide rich sediments. Overall, Porirua Harbour was given a rating of “fair” for macroalgae cover condition and was of sufficient concern for the authors to recommend annual monitoring.

Marine Invertebrates

The invertebrate assemblage, both intertidally and subtidally, based on the existing literature and samples collected specifically for this Project in 2009-2011, indicate that the Pauatahanui Inlet has a high diversity and abundance of epifaunal and infaunal benthic invertebrates, with many sensitive taxa present. The assemblage in the Onepoto Inlet is slightly less diverse and has a higher proportion of tolerant species. However, species that are sensitive to organic enrichment were detected in both Inlets. The number of species that have a strong sand preference was only slightly higher in samples collected in the Pauatahanui Inlet compared to the Onepoto Inlet.

The Wainui and Whareroa Streams discharges to high energy exposed sandy beaches along the Kapiti Coast. As is typical for this type of habitat, the intertidal area adjacent to the stream mouths has highly mobile sand, low concentrations of contaminants in sediment, and naturally low invertebrate community composition.

Intertidal

Species diversity and species richness, whilst high, were lower in the present study compared to that reported by Robertson & Stevens (2009). However, this is likely due to sampling in different parts of the harbour with somewhat different habitat characteristics.

The number of epifaunal species detected in the 2010 field investigations was similar to those reported by Robertson & Stevens (2009), with typically between 1-4 species detected per quadrat. In comparison, the benthic invertebrate species richness was lower in the present study (average of 8-14) compared to Robertson & Stevens (2010) (average of approximately 15-23). However, the sites sampled by Robertson & Stevens (2010) were not at stream mouths, which is likely to influence the species present.

Infaunal invertebrate taxa detected in the present survey are consistent with that reported by Robertson & Stevens (2009, 2010), with both data sets having a dominance of polychaete worms, bivalves, gastropods. In the present survey oligochaete worms were an additional dominant feature of samples collected from both estuary Inlets, and amphipods were abundant in samples collected adjacent to Porirua Stream mouth. As mentioned above, these minor differences in dominant taxa between the two studies could be due to different sampling locations, with the present survey focussing on stream mouths (where sediment characteristics and water physic-chemical parameters may be different to estuarine intertidal areas with less direct freshwater influence), whereas Robertson & Stevens (2009, 2010) sampled in areas of intertidal sandflat not adjacent to stream mouths.

Cockles were detected at all sites sampled in the present survey at a variety of densities. However, cockle density is likely to be higher at sites lower on the intertidal sand- and mudflats and also in subtidal sediment. Sediment grain size and sediment quality are likely to be factors that influence the density and distribution of cockles in the harbour. However, sediment grain size and sediment quality at the sites sampled in the present survey do not fully explain the difference in cockle density among sites.

A high diversity of molluscs (bivalves and gastropods) was detected in the present survey, with Pauatahanui Stream having the highest diversity. Typically this group of organisms is less diverse or absent when the habitat quality is low. This was reflected in the fact that Porirua and Ration Streams (and Horokiri Stream to a lesser extent) which had the lowest proportion of gravel and the highest proportions of the smallest grain size categories, also had the lowest diversity of molluscs.

Subtidal

A study by Milne & Sorensen (2009) indicated diverse subtidal invertebrate communities within both the shallow subtidal near shore habitats within Pauatahanui Inlet and the Onepoto Arm. Dominant taxa included malacostracan crustaceans, bivalves, polychaete worms and amphipods.

The subtidal survey of the Pauatahanui and Onepoto Arms of the Porirua Harbour undertaken for this Project revealed 5 main biological types – cockle (*Austrovenus stutchburyi*) dominated, *Nucula hartvigiana* dominated, polychaete dominated, *Zostera* sp habitat and *serpulid* worm habitat. No subtidal rocky reef habitat was encountered at any of the survey sites, but does occur at the harbour mouth and outer harbour (Blashcke et al. 2010), areas outside of the scope of the present study.

Subtidal surficial sediment types ranged from firm sand, typical of the shallowest sites < 1m depth, to fine soft anoxic mud at sites > 1m depth matching previous descriptions (Blaschke et al. 2010) and reflecting extensions of intertidal habitats presented in Stevens and Robertson (2008). Patches of small pebbles and mud were apparent in the southern part of the Porirua Harbour.. The central subtidal basins in the Pauatahanui Inlet particularly, were characterised as comprising silt and clay sediment grain sizes, anoxic sediment and low invertebrate community diversity and abundance.

Soft sediment epifaunal species described for this study appear typical of those commonly found in North Island estuaries and harbours (Morton and Millar 1968, Gibbs and Hewitt 2004, Hewitt and Funnel 2005). However, epifaunal diversity was low compared to other estuarine/ harbour environments in New Zealand (see Robertson et al. 2002). Shallow-water sites located in the north-eastern area of the Pauatahanui Inlet were generally comprised of firm sandy sediment with smaller patches of mud. The common cockle *Austrovenus stutchburyi*, the nut shell *Nucula hartvigiana* and the wedge shell *Macomona liliana* were associated with this substratum type. Shallow-water sites in the northern and north-western part of the Pauatahanui Inlet were generally dominated by polychaete worms with the surficial sediment comprised of firm sand with larger patches of sandy mud relative to the north-eastern part of the inlet.

The presence of cockles (a keystone species) in the Pauatahanui Inlet are an important biological component as cockles are food source for a variety of organisms, affect the distribution of predator species, affect nitrogen and oxygen fluxes between water and sediment and are an important substrate for the attachment of algae and other molluscs (Gibbs and Hewitt 2004, Morley 2004, this study). Similarly, *Nucula hartvigiana* and *Macomona liliana* affect nitrogen and oxygen fluxes between water and sediment and are important as prey items.

Cockle surveys carried out between 1976 and 2010 within the Pauatahanui Inlet demonstrated a large reduction in numbers between 1976 and 1995 declining from between 400-600 million to around 200 million, thereafter remaining stable, with the population estimated at approximately 280 million following the 2010 survey. Specific mechanisms for the decline between 1976 and 1992 remain unclear; however, increased sedimentation has been suggested to be a principal factor.

Although having low coverage, another biogenic habitat of importance was *Zostera* sp, present in the shallow subtidal at site O4. Unfortunately due to the poor visibility it was not clear as to the exact spatial extent of this habitat. In a recent survey, intertidal *Zostera* habitat in the Porirua Inlet equated to 17.3 ha (described as low-to-moderate abundance) and 45.2 ha in the Pauatahanui Inlet (described as moderate abundance) (Stevens and Robertson 2008). Presently, the extent of subtidal *Zostera* sp habitat across the entire harbour is unknown, but may exist only on the intertidal/subtidal margins given that much of the subtidal substrate consists of fine mud (Stevens and Robertson 2008).

Zostera habitat is considered to be ecologically significant due to its contribution to primary productivity and detrital food webs (trophic linkages) and through its structural complexity, providing habitat for a range of species (Schwarz et al. 2006). Seagrass meadows have also been shown to enhance bottom stability, reduce sediment accumulation, and enhance nutrient cycling (Ruiz et al. 2001, Turner and Schwarz 2006).

Of further note was the occurrence of patches of the colonial serpulid *Spirobranchus cariniferus* (perhaps better known as *Pomatoceros caeruleus*) at Site O3 in the southern Onepoto Arm of the Harbour, loosely attached to small pebbles and the muddy substratum. Again this appears to be an important predominantly intertidal biogenic habitat (see Stevens and Robertson 2008) within the harbour with macroalgae and incrusting invertebrates associated with it.

Studies have suggested that the Porirua Harbour faunal communities are under threat from effects associated with sedimentation (Stevens and Robertson 2008), which was evident at the two deepest sites (P2, P6) surveyed in the Pauatahanui Inlet where the substrate was comprised of soft anoxic mud. Consequently, these sites were largely devoid of common epifaunal taxa observed at many of the other sites. If sedimentation continues to affect the harbour then epifaunal taxa such as *Cominella glandiformis*, *Diloma subrostrata* and *Austrovenus stutchburyi* which have been described as being sensitive to increased sedimentation (muddiness) are likely to be adversely affected (Gibbs and Hewitt 2004). Moreover, habitats such as *Zostera* sp, may also be negatively impacted through direct smothering and increased turbidity.

Estuarine Fish

Jones & Hadfield (1985) detected 24 species, increasing the number of species known to use Porirua Harbour to 43. Jones and Hadfield (1985) detected 14 additional species to that listed by Healy (1980) (Table 11-18).

Table 11-18: Estuarine fish species known to use Porirua Harbour.

Species	Common name
Geotria australis	Lamprey *
Mustelus lenticulatus	Rig
Callorhynchus milii	Elephant fish
Myliobatis tenuicaudatus	Eagle ray
Arripis trutta	Kahawai
Adrichetta forsteri	Yellow-eyed mullet
Sardinops neopilchardus	Pilchard
Engraulis australis	Anchovy
Hemirhamphus ihi	Garfish
Retropinna retropinna	Smelt
Syngnathus norae	Pipefish *
Stigmatophora longirostris	Long-snout pipefish
Hippocampus abdominalis	Seahorse
Scomber australasicus	Blue mackerel
Trachurus novaezelandiae	Jack mackerel
Thyrsites atun	Barracouta
Caranx georgianus	Trevally
Nemadactylus macropterus	Tarakihi
Chrysophrys auratus	Snapper
Latridopsis ciliaris	Blue moki
Seriolella brama	Warehou
Mugil cephalus	Grey mullet
Pseudophysis bacchus	Red cod
Lotella rachinus	Rock cod
Cheilidorichthys kumu	Gurnard
Pseudolabrus celidotus	Spotty
Pseudolabrus fucicola	Banded parrotfish
Rhombosolea plebeia	Sandflounder
Rhombosolea leporina	Yellowbelly flounder
Peltorhamphus novaezeelandiae	New Zealand sole
Peltorhamphus latus	Dwarf common sole
Leptoscopus macropygus	Striped stargazer
Genyagnus novaezelandiae	Spotted stargazer
Forsterygion varium	Cockabully
Trypterygion robustum	Robust blenny
Grahamichthys radiatus	Graham's gudgeon
Salmo trutta	Brown trout
Conger verrauxi	Conger eel
Anguilla australis	Shortfin eel
Anguilla dieffenbachii	Longfin eel *
Galaxias argenteus	)
Galaxias fasciatus	)Whitebait *
Galaxias maculatus	)

*At Risk (see TR10 for more detail)

5.9.5 SEDIMENT

Sediment Grain Size

The proportion of very fine sand plus silt and clay in surficial sediment samples varied significantly among sites within each of the Inlets.

Within Pauatahanui Inlet, the intertidal habitat adjacent to the mouths of Ration and Horokiri Streams comprised approximately 60% very fine sand and silt and clay. Sediment collected from the central subtidal areas of the Pauatahanui Inlet approached 100% of these finest grain size fractions, which aligns with the current knowledge on the hydrodynamic environment.

Within the Onepoto Inlet, the Porirua Stream mouth is characterised by a large proportion of gravel and coarser sand grain fractions. However, the subtidal environment adjacent to this stream mouth comprises a high proportion of very fine sand and silt and clay. It is likely that fine sediment is flushed from the intertidal area to the subtidal habitat in flood flows.

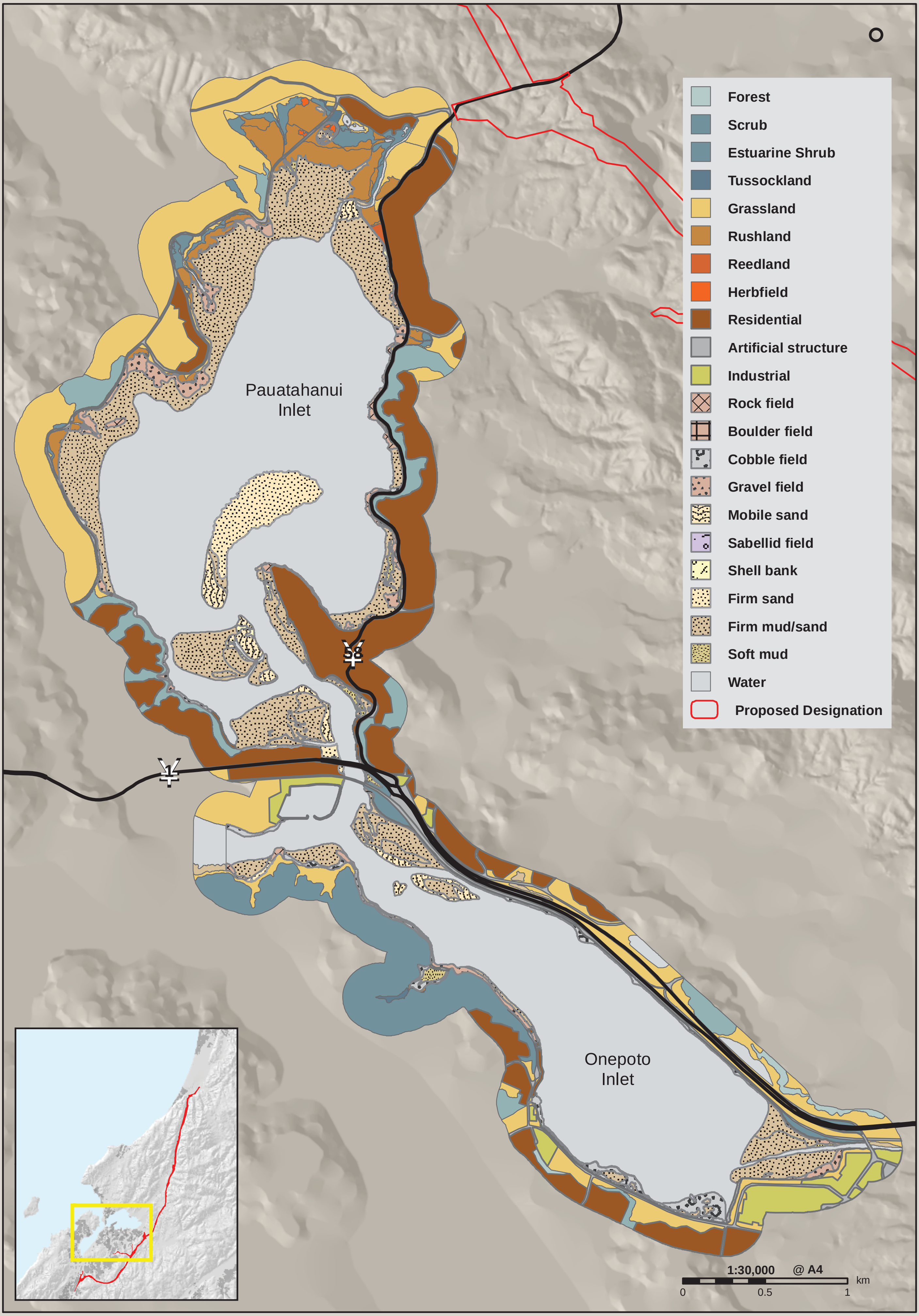
Sediment Quality

In general, based on the results of the 2009-2011 field investigations and those obtained from the literature review, sediment quality is lower in the Onepoto Inlet compared to the Pauatahanui Inlet with regards to the common stormwater heavy metals copper, lead and zinc. While the effects threshold concentrations were commonly exceeded within the Onepoto Arm, this was rarely the case in the Pauatahanui Inlet. This pattern is consistent with the current and historic land-uses within the catchments that feed into these estuaries, with the Onepoto Inlet being primarily industrial and residential and the Pauatahanui Inlet being primarily residential and rural.

The two estuary Inlets have similar patterns for HMW-PAHs, mercury, total-DDT and dieldrin concentration. Subtidally, many of these contaminants are found at higher concentrations compared to intertidal sediment. This may be due to the subtidal accumulation of fine sediment, which is likely to have a higher organic content and therefore a higher concentration of bound contaminants. The presence of DDT (and its derivatives) and dieldrin in sediment, decades after these agricultural chemicals were banned, indicates the persistence of these contaminants. Furthermore, it is possible that these contaminants continue to leach from rural land.

From the sampling carried in 2009 for this Project, sediment grain size analyses suggests that the mouths of Duck Creek, Pauatahanui Stream and Kakaho Stream are dominated by larger grain sizes, whereas Horokiri, Ration and Porirua Streams have a larger proportion of fine and very fine sands, and silt and clay grain sizes. However, the fine sediments at these latter sites are not also associated with higher contaminant concentrations compared to the more coarsely grained sites.

It may be that sediment and associated contaminants entering the Pauatahanui Inlet, given the strong tidal flushing and dominance of subtidal habitat, are removed from the intertidal habitat and deposited subtidally. Some of these subtidal depositions may be removed from the system with tidal flows under certain wind and wave conditions. With respect to the Onepoto Inlet, the fetch may be more constricted which may lead to a higher accumulation of contaminants subtidal in sediment. However, land-use in this catchment is likely to deliver significantly greater contaminant concentrations compared to the Pauatahanui Inlet.



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BROAD SCALE FEATURES OF PORIRUA HARBOUR

(Stevens & Robertson, 2008)

11.4

6. ASSESSMENT OF ECOLOGICAL VALUE

6.1 INTRODUCTION

This section consists of the following:

- Identification of protected natural areas, reserves, covenants, regional parks that have been protected, at least in part, due to their ecological values.
- Identification of other natural areas that have been identified by a PNA process as having ecological value, but which do not have formal protection.
- Identification of Flora and Fauna identified in the previous section as having conservation value

6.2 KEY ASSESSMENT CONSIDERATIONS

6.2.1 NATIONAL PRIORITIES FOR PROTECTING RARE AND THREATENED INDIGENOUS BIODIVERSITY

National Priority 1: To protect indigenous vegetation associated with land environments (defined by LENZ at Level IV), that have 20% or less remaining in indigenous cover.

A LENZ level IV analysis was carried out and provides context to the following assessments. The results of this analysis presented in Figure 11.5. The analysis is based on the following threat classes.

Table 11-19: LENZ Threat Classes

Category	1. Acutely threatened	2. Chronically threatened	3. At risk	4. Not at risk	A. Critically under protected	B. Under protected	C. Protected
Criteria	<10% indigenous cover remaining	10–20% indigenous cover remaining	20–30% indigenous cover remaining	>30% indigenous cover remaining	>30% indigenous cover remaining		
					<10% legally protected	10–20%	>20% protected

- The LENZ map confirms that within the study area the most threatened environments, and the environments that are critically under protected, are the lowlands, in particular the sand country of the Kapiti Coast, and the broad river valleys and terraces in the lower sections of the main streams. These are the areas that were first settled and which are now the most heavily urbanised and the most intensively farmed.
- The areas that are not at risk and where there is adequate protection are the higher steeper lands, typically class VII and VIII land (NZLRI) which is less suitable for land clearance and farming.

National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

- All dunelands and associated wetlands are considered below.

National Priority 3: To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by priorities 1 and 2.

Seventy two "Naturally rare ecosystems" have been identified (Williams et.al. 2007) and are defined as "ecosystems having a total extent less than 0.5% of New Zealand's total area". Many of these ecosystems rely on specific rock and soil types which are not found locally. The only ones of these that have been identified within the mapped corridor and could potentially be affected by this Project are:

- **Cloud Forest:** The forests on the slopes above Wainui Saddle fall into this category.
- **Ephemeral wetlands** (seasonally high water table / depression. Herbfield). We are satisfied that all ephemeral wetlands observed during this study are agricultural in origin (colluviation due to land clearance, over-sowing, grazing and trampling), are therefore not representative of historical communities and so have limited botanical value. Their dominance by exotic grasses and weed species also mean they have limited habitat value. These ephemeral wetlands are therefore not recognised unless another value is present (e.g. recognised habitat values or the presence of rare flora or fauna).
- **Damp sand plains:** There are small areas at the McKays crossing end of the designation, all of which are currently in production farming. No original or unmodified sand plains are present.
- **Dune slacks:** There are small areas at the McKays crossing end of the corridor including the McKays Crossing Wildlife Reserve.
- **Estuaries**: Porirua Harbour:

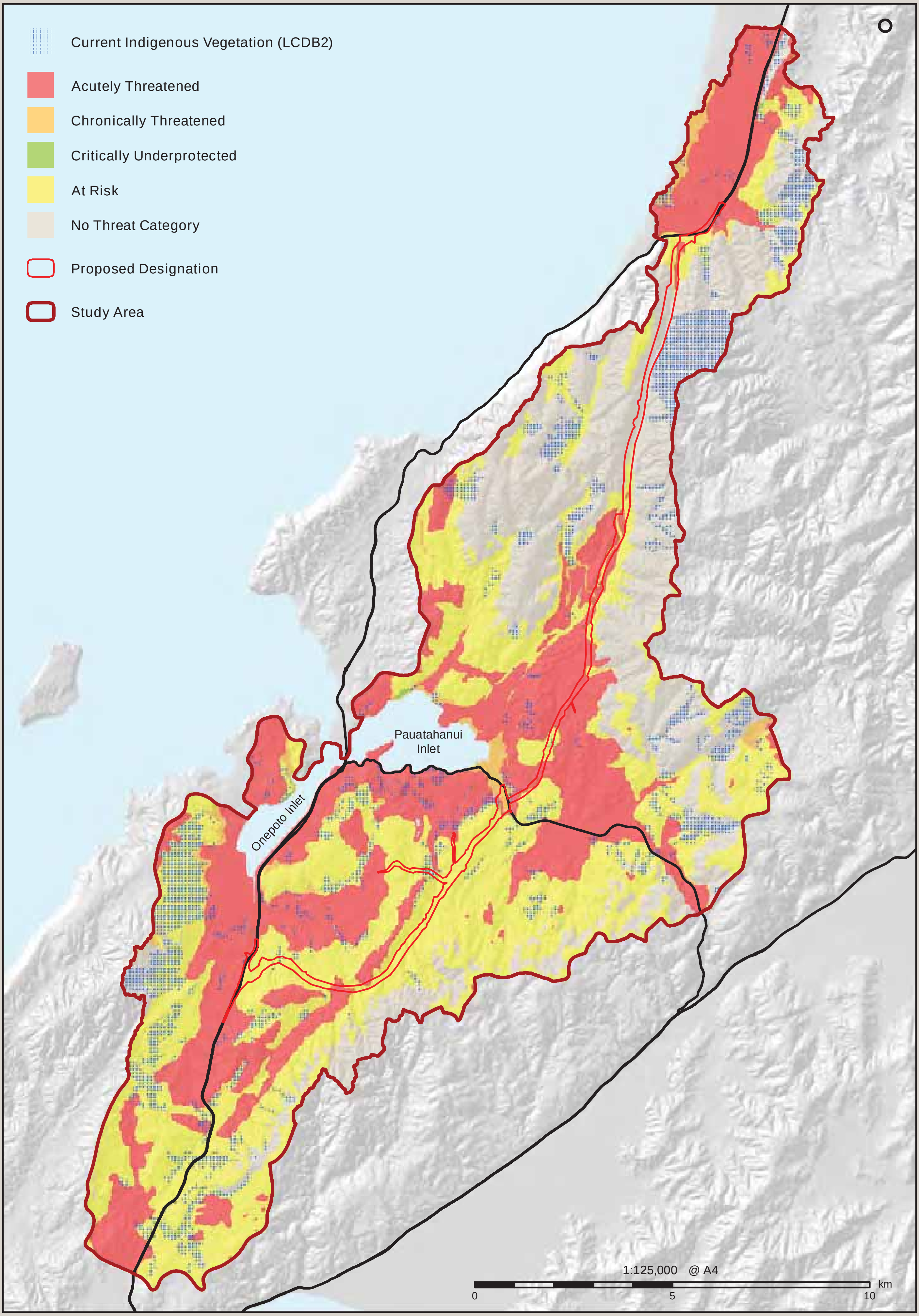
National Priority 4: To protect habitats of acutely and chronically threatened indigenous species.

- This study did not identify any acutely or chronically threatened indigenous plants. It has identified one plant, *Leptinella tenella*, which is At Risk (Declining with qualifiers of Data Poor, Range Restricted and Sparse).
-

6.2.2 WELLINGTON CONSERVATION MANAGEMENT STRATEGY

Within the Wellington Conservancy the 10 highest priority ecosystems and habitats managed by the Department in the Wellington CMS area (DOC 2010) are:

- **Indigenous forests:** A small number of indigenous forest fragments are present within the designation and a number are crossed by the Project Footprint. In almost all instances these fragments have been identified and described in earlier PNA surveys and these descriptions have helped to inform the assessment of significance.
- **Shrublands:** We are satisfied that none of the shrublands contained within the designation are persistent shrublands representative of historical communities. They therefore have limited botanical value. However, we have identified areas where regeneration has advanced to a stage where the shrublands are becoming increasingly important as habitat.
- **Freshwater wetlands:** Only one small freshwater wetland lies within the designation.
- **Rivers and lakes:** There are no lakes within the mapped corridor. A number of listed rivers are affected.
- **Estuaries:** Porirua Harbour lies downstream of the majority of works.
- **Dunes and dune wetlands:** No dunes will be affected. A small portion on MacKays crossing wetland may be affected.
- **Cliffs:** No cliff habitat was identified within the mapped corridor.
- **Herbfields and grasslands:** We are satisfied that all grasslands and herbfields are agricultural in origin, dominated by exotic grasses and weed species, not representative of historical communities, and have limited botanical and habitat value.
- **Islands:** Not relevant to this technical report.
- **Marine environment:** This includes the subtidal portions of Porirua Harbour.



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TRANSMISSION GULLY

LAND ENVIRONMENTS OF THE STUDY AREA

& THEIR THREAT CLASSIFICATION (DERIVED FROM LENZ)

11.5

6.3 PROTECTED NATURAL AREAS (PNAs)

Technical Report 11 lists "Natural Areas" along the Project alignment that have either been protected for their ecological values or which have been protected for other purposes. These sites are shown in Figure 11.6.

Protected means either; a scenic reserve or conservation land protected under the Reserves Act (1977) including local purpose reserves and stewardship areas, a private or QEII National Trust Open Space Covenant attached to the title of the property, or public land which has a management plan (Regional Park).

The sites listed below (Table 11-20) are all crossed by the Designation and a number extend beneath the Footprint of the proposed highway. The second column of the table (Rel^n) identifies the relationship of the PNA's to alignment. The categories used are:

D = all or part within Designation;
F = falls beneath road Footprint; and
DS = downstream of route.

Within the Porirua and Kapiti Districts, RMA-based ecological surveys of significant natural areas have been undertaken and relevant information from these surveys is included.

Table 11-20: Protected Natural Areas beneath or in close proximity to the Transmission Gully Designation.

Name (Sorted by Catchment and listed from North to South)	Rel^n	Description and size	Ecological Value
Whareroa Catchment			
McKays Crossing Wetland and Wildlife Reserve	D	Moderately sized area of raupo reedland wetland which lies in part beneath the designation. Considered to be regionally significant. DOC Wildlife Management Reserve. KCDC Ecosite 106 (9.68ha)	H
Wainui Catchment			
Rowans Bush	D	Partially protected by QEII covenant (QE11 5/07/363). Kohekohe-titoki forest on lowland hill country. Part of a series of fragments that provides links between Kapiti Island and the Tararua Ranges. Eastern half of site is protected in part under QEII covenant. KCDC Ecosite K139: Regionally significant (2.8ha).	H
Te Puka Catchment			
Akatarawa/Whakatikei Forest Park	D	GWRC water collection area and regional forest park. Identified in BRWR[4] as site 19b – Lowland to montane miro-rimu-rata/tawa-kamahi forest. Has a high diversity of native bird life and this area of vegetation has large corridor benefits and wider ecological habitat benefits (15,439ha).	H
Horokiri East Catchment			
Battle Hill Regional Park	F	Much of this park is open space and farmland. There are a number of small wetland and bush fragments that lie within it that are considered to have ecological value however there are no indigenous plant communities within the designation. (502ha)	Nil
Horokiri Wildlife Management Reserve	DS	Wildlife Management Reserve (DoC). Coastal wetlands and saltmarsh. Crown land reserve. PCC Ecosite 30, SES ranking 3 (6.25 ha).	H

4 Biological Resources of the Wellington Region. Wellington Regional Council 1984.

Ration Catchment			
No Sites			
Pauatahanui Catchment			
Pauatahanui Wildlife Management Reserve	DS	Wildlife Management Reserve (DoC). Coastal wetlands and saltmarsh. Mixed private and public ownership. PCC Ecosite 65. SES Ranking 1 (47.4 ha)	H
Scoresby Grove Kanuka Forest	F	Private land with covenant. Small forest remnants within built up areas. PCC Ecosite 70a.SES ranking 4 (4.70 ha).	M
Duck Creek Catchment			
Duck Creek Scenic Reserve	DS	Coastal wetland and saltmarsh. Crown land reserve. PCC Ecosite 22, SES ranking 2 (1.18 ha).	H
Whitby West Bush	D	Small forest remnants within built-up area. Mixed private/public land. PCC Ecosite 155b.SES ranking 4 (9.16 ha)	M
Belmont Regional Park	F	Much of this park is open space and farmland. There are a number of small wetland and bush fragments that lie within it that are considered to have ecological value including: Wellington City Council Prime Bush Remnants (3,446 ha).	Nil
Kenepuru Catchment			
Cannons Creek Bush	F	Seral Forest with maturing tawa podocarp. 13c Lowland tawa-kohekohe-mahoe forest remnant and gorse shrubland Sizeable areas of forest. PCC Ecosite 12. SES ranking 1 (41.66 ha).	H
Porirua Catchment			
Porirua Park Bush	F	Porirua Park Bush is well fenced and surrounded by a combination of farmland, residential areas and school facilities. BRWR site 13d – Regionally representative example of lowland tawa-kohekohe forest remnant. PCC Ecosite 76. SES ranking 1 (16.4 ha).	H

6.4 UNPROTECTED NATURAL AREAS (SNAs)

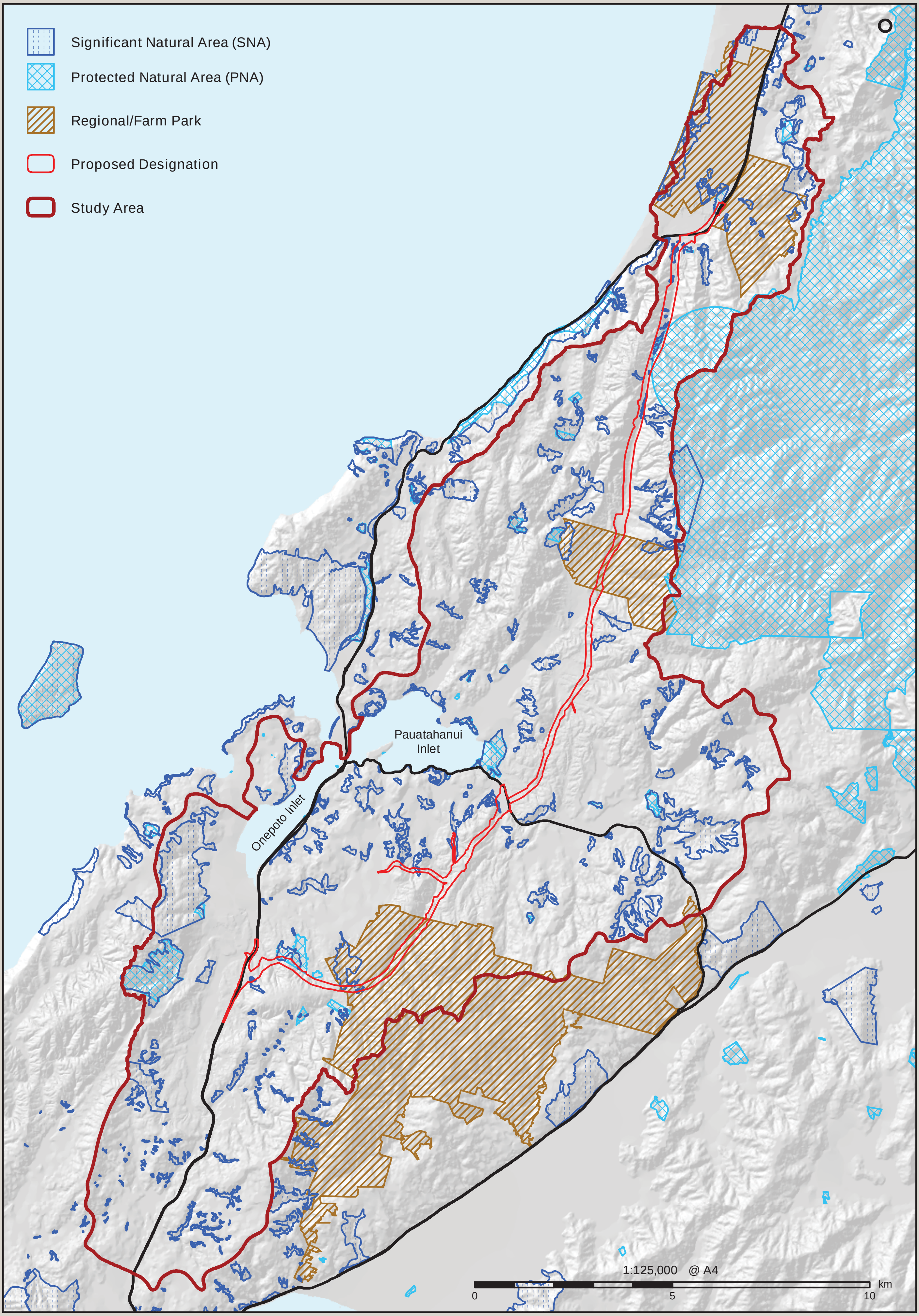
In addition to PNAs listed above, Table 11-21 lists 8 sites along the route that have been identified through district wide or regional survey as having ecological value, and which do not have formal protection such as covenant or reserve status. A number may be protected through rules and schedules in the District or Regional Plans.

These sites have been derived from a number of sources. These sites are shown are shown in Figure 11.6. It should be noted that each of the surveys has used a different set of criteria for establishing the significance of these sites.

Table 11-21: Unprotected sites of ecological value beneath or in close proximity to the Transmission Gully Designation.

Name (Sorted by Catchment and listed from North to South)	Rel^n	Description	Ecological Value
Whareroa Catchment			
No Sites	-	-	
Wainui Catchment			
No Sites	-	-	
Te Puka Catchment			
Paekakariki bush B – I	F	KCDC Ecosite K222 – 229. Eight small fragments of kohekohe forest of varying sizes and conditions. All are unfenced and heavily browsed by stock. They are also typically too small to contain a healthy core. For these reasons the KCDC survey did not recommend them for protection.	L to M
Horokiri East Catchment			
Transmission Gully Saddle	D	Small forest remnant within farmland, PCC Ecosite 172 – SES ranking 6 (0.287 ha)	L
TG Riparian Area	D	Riparian areas within farmland, PCC Ecosite 199 – SES ranking 5 (1.877 ha)	L
Ration Catchment			
No Sites	-	-	
Pauatahanui Catchment			
No Sites	-	-	
Duck Creek Catchment			
James Cook Drive Bush	F	Small forest remnants within built-up areas, PCC Ecosite 33 – SES ranking 3,4 (12.84 ha)	H
Exploration Drive Kanuka	F	Small forest remnants within built-up areas. PCC Ecosite 190 – SES ranking 4 (5.67 ha)	M
Kenepuru Catchment			
Head of Cannons Creek	F	Tawa, mahoe, mapou, porokaiwhiri, mamaku and cabbage tree. WCC 0702.15 (1.06 ha)	M
Head of Cannons Creek	D	Primary forest of tawa, nikau, porokaiwhiri, mamaku, wineberry, mapou and mahoe. Secondary forest of mahoe, porokaiwhiri, lancewood, mamaku and mapou intermixing with primary forest remnant. WCC 0702.16 (1.28 ha)	M
Porirua Catchment			
Roberts Bush	D	Gullies of mahoe forest including small areas of maturing tawa forest within pines adjacent to SH1. PCC Ecosite 88 – SES ranking 4. (3.68 ha)	L

A = adjacent to Designation; D = all or part within Designation; F = falls beneath road footprint; DS = downstream of route.



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PNAs, SNAs & REGIONAL/FARM PARKS 11.6

6.5 TERRESTRIAL VEGETATION & HABITAT

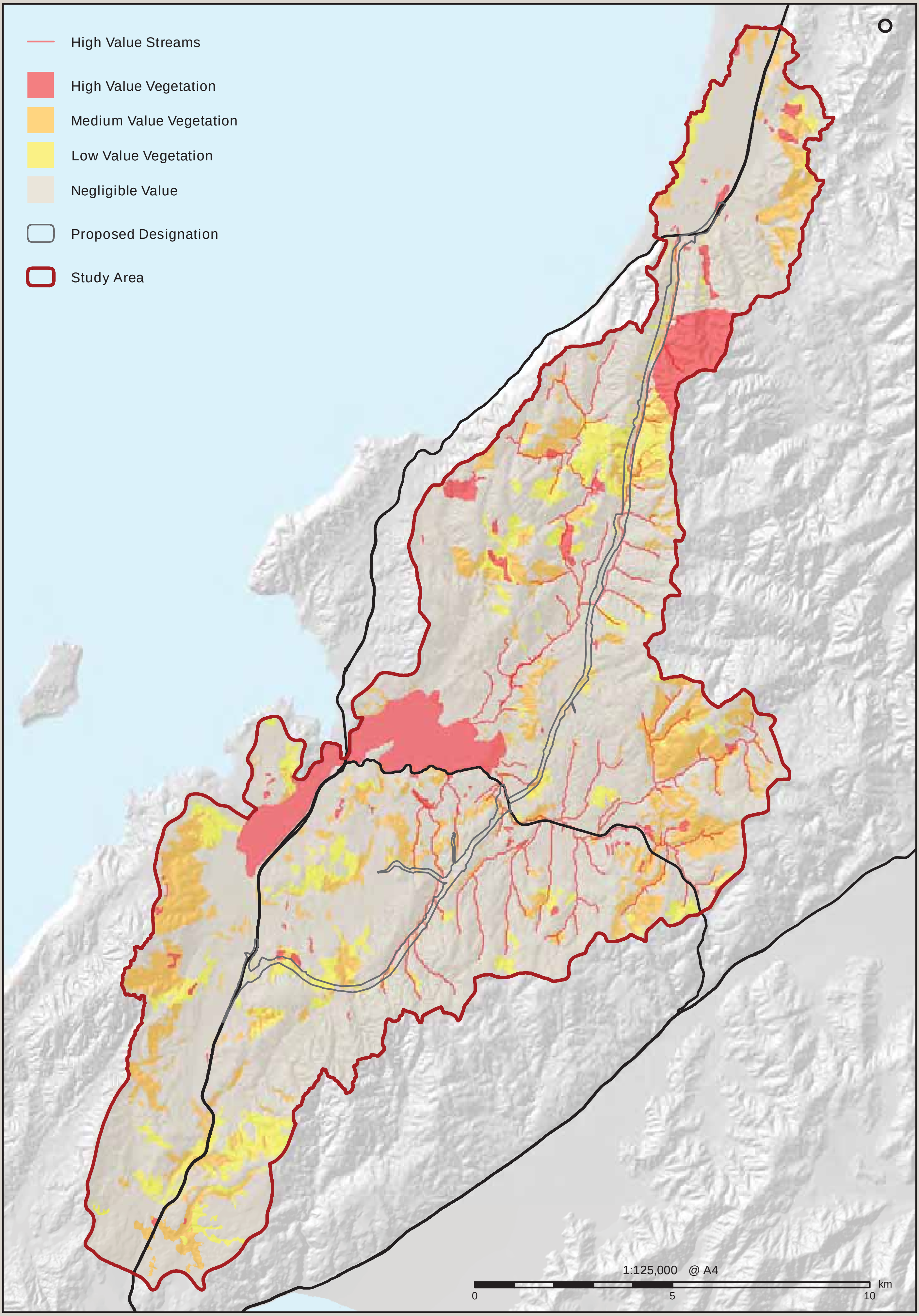
Introduction

The assessment commenced with the development of a GIS layer that took the mapped vegetation communities and assigned each one a value (High, Moderate, Low, and Negligible) as follows.

Table 11-22: Value Classification of Plant Communities.

Grassland, shrublands, rushland and wetlands		**RANK**
1.01	Improved pasture	N
1.02	Rough pasture and shrublands	L
1.03	Cropland	N
1.04	Stony streambed in pasture	L
1.05	Riparian margins in rushland	M
1.06	Indigenous wetland	H
Pioneer shrublands and low scrub		
2.01	Gorse dominated scrub (closed canopy)	L
2.02	Tauhinu scrub (closed canopy)	L
2.03	Riparian margins with low scrub	M
Seral kanuka forest and scrub		
3.01	Secondary native forest	M
Seral broadleaved forest and scrub		
4.01	Transmission Gully restoration planting	M
4.02	Secondary native forest (mahoe)	M
4.03	Riparian margins with 2° native forest	H
Mature or maturing indigenous forest		
5.01	Lowland tawa forest	H
5.02	Coastal kohekohe forest	H
5.03	Remnant sub-montane hardwood forest	H
5.04	Riparian margins with indigenous forest	H
Exotic vegetation		
6.01	Plantation pine	L
6.02	Plantation pine - harvested	L
6.03	Exotic trees (shelterbelts, gardens)	L
6.04	Riparian margins with exotic trees	M

These were used to develop a base map (Figure 11.7).



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VALUED PLANT COMMUNITIES OF THE STUDY AREA (COMPOSITE MAP)

11.7

6.6 FRESHWATER SYSTEMS

Project sampling and limited regional and historical data show that overall the streams of the Project area support fauna that are sensitive to organic water pollution and sensitive to contaminants. This is in spite of a general nutrient enrichment condition, a low background of copper contamination and a discernable copper and zinc contamination in the lower reaches of Kenepuru, Cannons, Duck and Pauatahanui waterways. The absence of systematic data collection over a long time means that it is not possible to identify any trends in fauna communities or condition of the physical environment.

Maintenance of diversity in the lower reaches of the Horokiri and Duck systems is of very high ecological value and importance at the Regional scale. In terms of aquatic habitat most reaches maintain over 75% of the condition they could be expected to have if in "good" condition for the landscape they remain in.

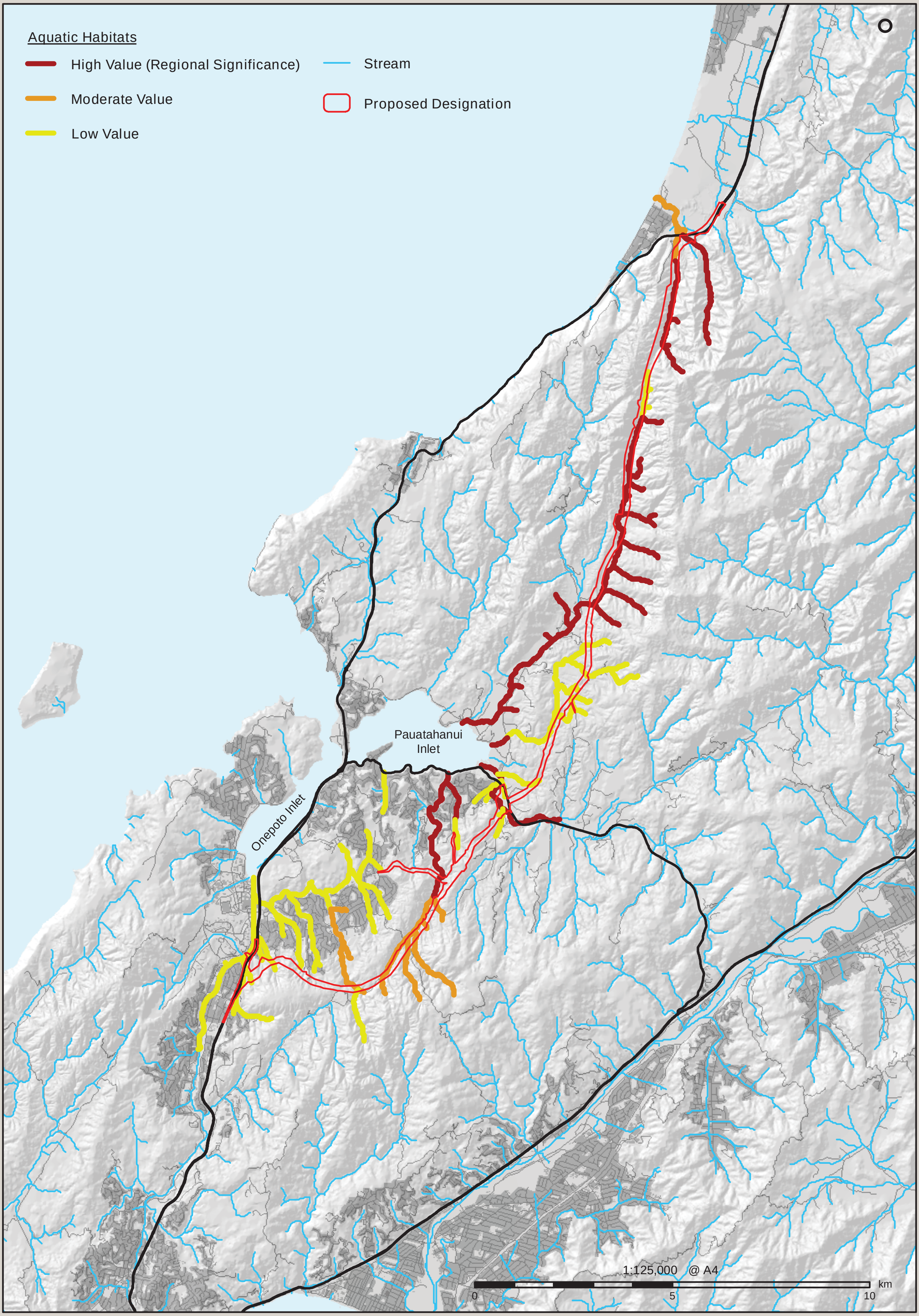
At a Regional scale the aquatic fauna and physical habitat of the Duck, Horokiri and Te Puka systems, while apparently deteriorating in the lower reaches and potentially trending down with land use practices, are considered to be Regionally significant. The lower reaches of Ration and Pauatahanui are also considered to be of high value (although the Ration is not of Regional importance) despite their modifications as they too still retain important fauna species. The Kenepuru, Porirua tributary and Cannons systems are of lower value although they still support an array of values, notably components of the macroinvertebrate fauna.

Table 11-23: Assessment of Ecological Value – Streams

Stream Reach	PHA (SEV)	Fish	Aquatic invertebrates	Compilation and result
High Value Stream Habitat				
Upper Te Puka	H	M	H	H
Lower-middle Te Puka	H	L	H	H
Middle Horokiri (east)	M	H	H	H
Lower Horokiri (east)	M	H	H	H
Upper-Middle Duck	H	L	H	H
Middle Duck	M	H	H	H
Medium Value Stream Habitat				
Upper Horokiri (east)	M	M	H	M
Lower Pauatahanui	L	H	M	M
Lower Duck	M	H	M	M
Upper Kenepuru (Cannon)	M	M	H	M
Low Value Stream Habitat				
Middle Ration	L	L	L	L
Lower Ration	L	M	L	L
Porirua tributary (Linden)	L	L	L	L

The results of this study were:

- The three streams sampled have high fisheries values with Horokiri Stream identified as having very high regional values and Duck Creek having high regional values.
- The eastern tributaries of the Te Puka and Horokiri Streams have their headwaters in native forest and have high habitat and fisheries values. The western tributaries lie predominantly in pasture and have lower habitat and fisheries values.



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ECOLOGICAL VALUE OF STREAMS

11.8

6.7 ESTUARINE SYSTEMS

The ecological value characteristics for each of the Inlets are summarised below (Table 11-24).

Both Inlets contained relatively diverse invertebrate assemblages including some species that are known to be sensitive to organic enrichment and to silt and clay. Within the Pauatahanui Inlet, there were differences in invertebrate diversity and abundance and sediment characteristics between the near shore environment (intertidal and shallow subtidal) and the central subtidal basins. The near shore habitat had higher diversity and abundance of invertebrates and sediment was more coarse grained and had low concentrations of contaminants. The central subtidal basin habitat was characterised by low diversity and abundance of invertebrates, fine grained sediment and higher concentrations of contaminants compared to the near shore habitat.

Significant saltmarsh habitat is present within the northern and eastern parts of the Pauatahanui Inlet. In addition, both Inlets support intertidal seagrass beds. Habitat and feeding areas for fish and birds is extensive in the Pauatahanui, but more limited in the Onepoto Inlet primarily due to coastal edge modification.

Sediment contaminants were significantly higher in the Onepoto Inlet compared to the Pauatahanui Inlet, primarily due to activities occurring within the catchments. Further, habitat modification is more extensive in the Onepoto Inlet, compared to the Pauatahanui Inlet.

Table 11-24: Assessment of Ecological Value – Porirua Harbour

Pauatahanui Inlet

ECOLOGICAL VALUE	CHARACTERISTIC
HIGH	• Benthic invertebrate community typically highly diverse with high species richness. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud. • Significant habitat and feeding areas for birds and fish. • Presence of keystone species (i.e. cockle beds). • Seagrass beds present. • Significant saltmarsh habitat in the northern and eastern areas. • Intertidal surficial sediments typically comprise approximately 50-70% very fine sand and silt/clay. • Depth of oxygenated surface sediment typically >1.0 cm. • Contaminant concentrations in surface sediment rarely exceed low effects threshold concentrations.
MODERATE	• Subtidal surficial sediments typically comprise approximately 50-70% very fine sand and silt/clay (although central basin sites approach 100%). • Habitat modification limited.
LOW	• Central subtidal basin areas comprise almost 100% anoxic silt and clay at most sites surveyed. • Benthic invertebrate diversity and abundance, within the central subtidal basins, is low.

Onepoto Arm

ECOLOGICAL VALUE	CHARACTERISTIC
HIGH	• Marine sediments typically comprise <50% very fine sand and silt/clay.
MODERATE	• Benthic invertebrate community typically has moderate species richness and diversity. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud. • Seagrass beds present. • Depth of oxygenated surface sediment typically >0.5 cm.
LOW	• Elevated contaminant concentrations in surface sediment, above ISQG-High or ARC-red effects threshold concentrations. • Habitat and feeding areas for birds and fish limited and modified. • Habitat highly modified.

Overall, we conclude that the Pauatahanui Inlet has high marine/estuarine ecological values in the intertidal and near shore environment and low/moderate ecological values in the central subtidal basins. Onepoto Inlet has moderate marine/estuarine ecological values intertidally and low to moderate values subtidally.

Wainui and Whareroa Stream mouths cannot be assessed using Table 11-24 as the habitats are open sandy beaches, not quiescent estuaries. We can conclude that whilst the abundance and diversity of organisms is low at these sites, the ecological values are high and the risks of degradation low due to the hydrodynamic environment of the ultimate receiving environment.

6.8 SUMMARY OF ECOLOGICAL VALUES

The following tables summarise the valued ecological components that have been identified and described by this study and detailed in the preceding sections.

Table 11-25: Summary of valued ecological components

Description	Context	Ecological Value
TERRESTRIAL VEGETATION AND HABITAT		
FW Wetlands		
Sphagnum bog	In mid Horokiri Stream	Low
MacKays Crossing wetland	In Wainui Stream (Site K106)	High
Shrublands & Scrub		
Gorse and tauhinu	Throughout designation.	Low
Shrubland containing boulderfields	In Te Puka, Upper Horokiri, Duck)	Moderate
Regenerating indigenous forest		
Kanuka dominated forest communities	including PCC33, PCC155b, Part PCC190, PCC196	Moderate
Regenerating broadleaf forest (mahoe dominant)		
Mahoe dominated –monocultures.	including PCC199	Low
Mahoe dominated riparian margins	including PCC155b	Moderate
Mixed broadleaf low forest	including Part PCC12, PCC76	High
Early Retirement Planting	(Areas 1, 2, 3, 5, 6, 7)	Moderate
Mature or maturing indigenous forest		
Very small modified forest fragments	Including K223-230, PCC88, PCC172	Low
Small forest fragments with a sustainable core or buffered	Including K229, PCC33, Part PCC190	Moderate
Podocarp tawa forest remnants	Including Akatarawa Forest, K139, PCC88, WCC0702.15, W0702.16	High

STREAMS AND AQUATIC HABITAT		
High Value Stream Habitat		
Upper Mid and Lower Te Puka	-	High
Middle and Lower Horokiri East	RFP Appendix 2, Part B and RFP Appendix 3, Part A	High
Upper and Middle Duck	RPS & RFP Appendix 3, Part A	High
Moderate Value Stream Habitat		
Upper Horokiri East	RFP Appendix 2, Part B	Moderate
Lower Pauatahanui	RFP Appendix 2, Part B, and RFP Appendix 3, Part A	Moderate
Lower Duck	RPS & RFP Appendix 3, Part A	Moderate
Upper Kenepuru (Cannon)	-	Moderate
Low Value Stream Habitat		
Ration Stream	RFP Appendix 2, Part B, and RFP Appendix 3, Part A	Low
Porirua (tributaries in Ranui Heights / Linden)	-	Low

HARBOUR & STREAM MOUTH HABITAT		
Estuary & Harbours (Pauatahanui)		
Tidal saltmarsh (PCC 22, PCC30, PCC65)	RSP & RCP	High
Intertidal zones including stream mouths	RPS & RCP	High

Shallow subtidal margins	RPS & RCP	Moderate
Central subtidal basin	RPS & RCP	Low
Estuary & Harbours (Onepoto)		
Intertidal zones including stream mouths	-	Moderate
Central subtidal basin	-	Low
Estuary & Harbours (Kapiti Coast)		
Wainui Stream Mouth	-	High
Whareroa Stream Mouth	-	High

SPECIES OF CONSERVATION VALUE		
Terrestrial Flora		
Leptinella tenella	(Mid Horokiri – boggy pasture)	At Risk (Declining) DP, RR, S
Terrestrial Invertebrates		
Velvet worm (*Peripatus novaezealandiae)*	Wainui Saddle and upper Horokiri Valley	Not Threatened
Lizards		
Copper skink (*Oligosoma aeneum)*	Upper Horokiri / boulderfield	Not Threatened PD
Common skink (*O. polychrome)*	Cannons Creek Bush / rank grassland	Not Threatened
Common gecko (*Hoplodactylus maculates)*	Lower Te Puka / boulderfield	Not Threatened PD
Avifauna		
Bush Falcon *(Falco novaeseelandiae* "bush")	Wainui Saddle	Nationally Vulnerable DP St
NI Kaka *(Nestor meridionalis)*	Wainui Saddle	Nationally Vulnerable
Pipit *(Anthus novaeseelandiae)*	Te Puka, Upper Horokiri	At Risk
Pied Shag *(Phalacrocorax novaehollandiae)*	Horokiri and Pauatahanui	Naturally Uncommon
Black Shag *(Phalacrocorax varius)*	Horokiri and Pauatahanui	Nationally Vulnerable
Bats		
Long-tailed bat *(Chalinolobus tuberculatus)*	Akatarawa Forest (potential)	Nationally Vulnerable
Freshwater Fauna		
Long fin eel *(Anguilla dieffenbachia)*	Throughout	At Risk (Declining) C2
Giant kokopu *(Galaxias argenteus)*	Lower reaches of Duck, Pauatahanui, Ration, Horokiri	At Risk (Declining) B1 PD)
Koaro *(Galaxias brevipinnis)*	Throughout	At Risk (Declining) C1
Inanga *(Galaxias maculates)*	Lower and mid reaches throughout	At Risk (Declining) C1 CD DP
Short jaw kokopu *(Galaxias postvectis)*	Not seen	At Risk (Declining) A1 DP
Red fin bully *(Gobiomorphus huttoni)*	Throughout	At Risk (Declining) C1
Lamprey *(Geotria australis)*	Lower reaches of Duck	At Risk (Declining) B1 DP
Marine Fauna		
Pipefish (Syngnathus norae)	Throughout the Porirua Harbour	At Risk (Sparse) SO

6.9 SUMMARY OF SITES OF VALUE

Terrestrial Vegetation

- Three sites of high value (Cannons Creek Bush - PCC12, Porirua Park Bush - PCC76, and Akatarawa Forest) lie beneath the Footprint and there will be some loss of habitat within each.
- Two sites (Rowans Bush - QEII5/07/363, and McKays Crossing Wildlife Reserve - KCDC106) are crossed by the Designation but in each case there is the potential to avoid effects through careful management.

Streams

- The Horokiri, Te Puka and Duck streams are considered to contain sections that are of high value. These sections are the least modified by rural activities and urban influences. They are:
  - Upper, Mid and Lower Te Puka Stream;
  - Middle and Lower Horokiri East Stream;
  - Upper and Middle Duck Creek.

Harbours and River Mouths

No harbours or river mouths, or their habitat will be directly affected by construction of this route. In these cases, any effects will be indirect and relate to potential contamination of streams that flow through them, either via sediment discharge during earthworks or stormwater discharge during highway operation. High value sites include:

- Pauatahanui Inlet including its stream mouths, tidal saltmarsh and intertidal zones is considered to have high ecological value. This includes four protected natural areas:
  - Duck Creek Scenic Reserve - PCC22;
  - Pauatahanui Wildlife Management Reserve - PCC65;
  - Pauatahanui Wildlife Refuge;
  - Horokiri Wildlife Management Reserve - PCC 30).
- Both the Wainui and Whareroa Stream mouths on the Kapiti Coast are considered to have high value.

Fauna

- Three species of bird; falcon, kaka, and black shag, which are classified nationally vulnerable, are present in key habitats along the alignment.
- The native bat, if present, is also classified as nationally vulnerable.

Other

Seven sites of terrestrial vegetation and habitat are considered to have moderate value. All are affected by the footprint. A further twenty six sites or areas are considered to have low ecological values but still provide some ecological benefits.

In addition to the ecologically valued sites outlined above, the substantial restoration planting undertaken by NZTA since 2000 is now developing, with a low canopy beginning to form in most of the planting areas. This restoration planting is now developing ecological value.

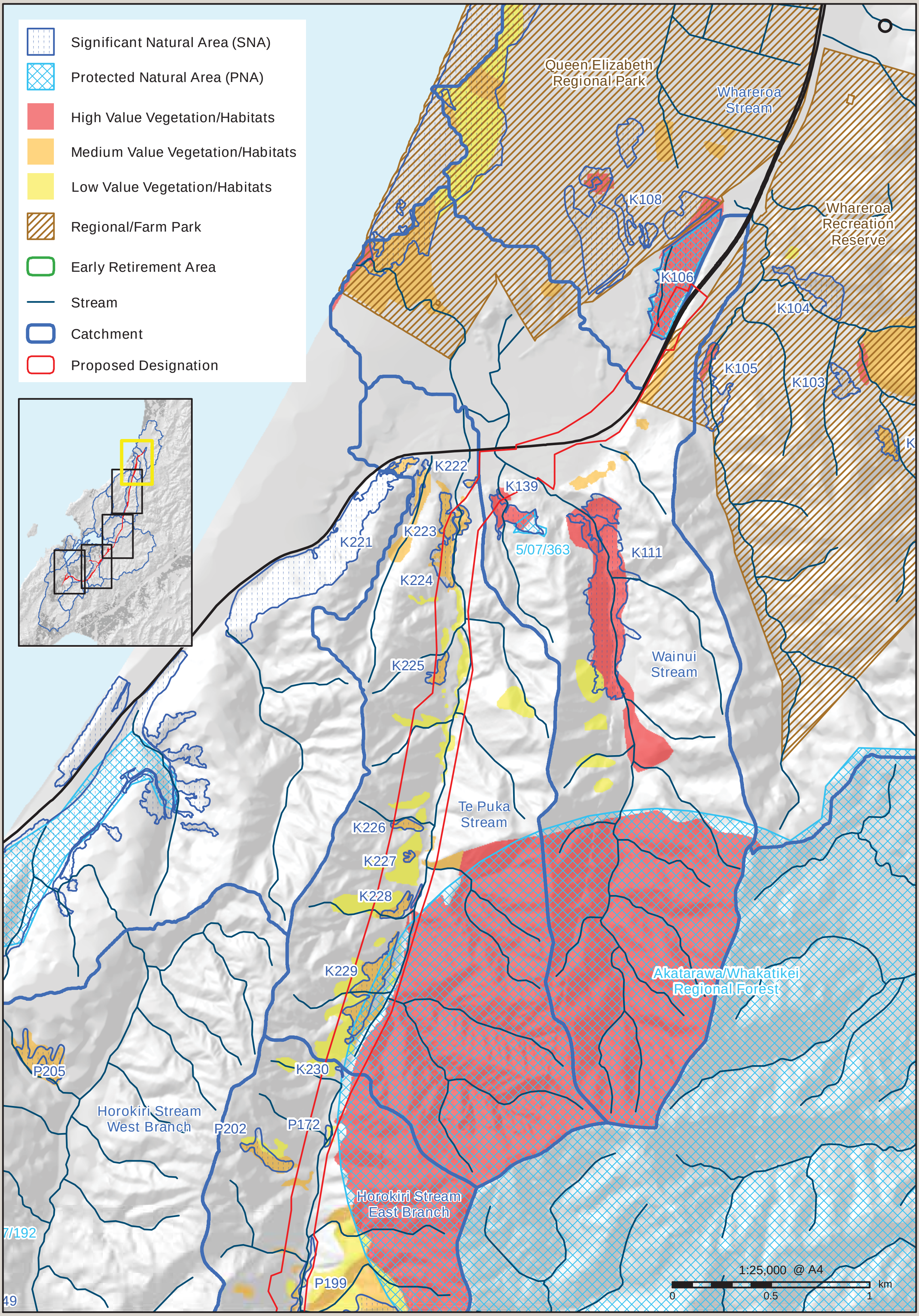
The upper reaches of Horokiri Stream, lower Pauatahanui, Lower Duck and upper Kenepuru streams are considered to have moderate value.

The more modified intertidal zone of the Onepoto Arm of Porirua Harbour and the shallow subtidal zone of Pauatahanui Inlet are considered to have moderate value.

A number of native species of fauna, while not nationally threatened, are considered to be At Risk (Declining) including

- Seven species of native freshwater fish
- Pied shag and pipit
- A wetland plant

No threatened species of lizard or macro-invertebrate were located during this study. Some may still be present but in very low numbers



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TRANSMISSION GULLY
SIGNIFICANT ECOLOGICAL AREAS OF THE PROJECT CORRIDOR
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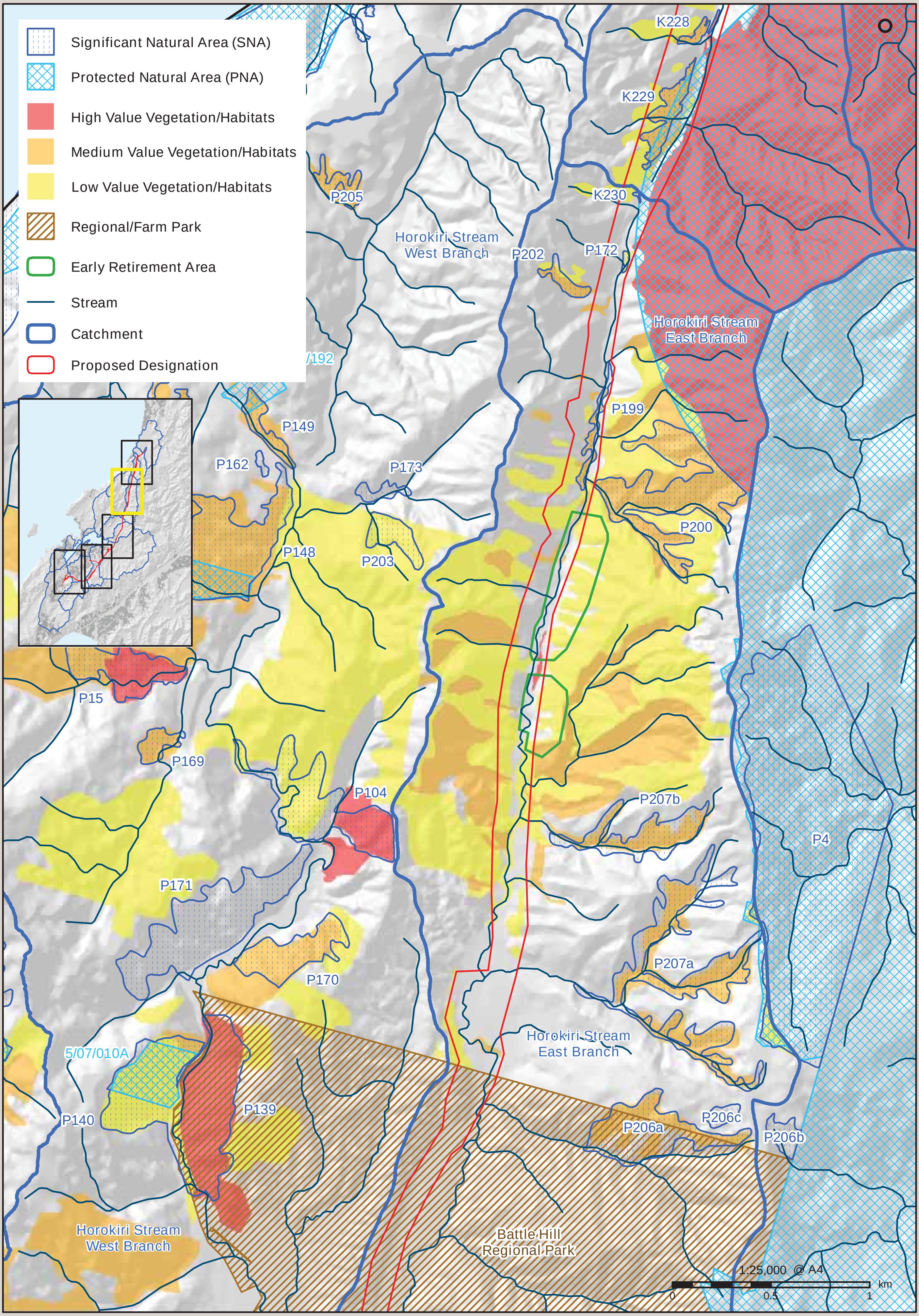

Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY
SIGNIFICANT ECOLOGICAL AREAS
OF THE PROJECT CORRIDOR

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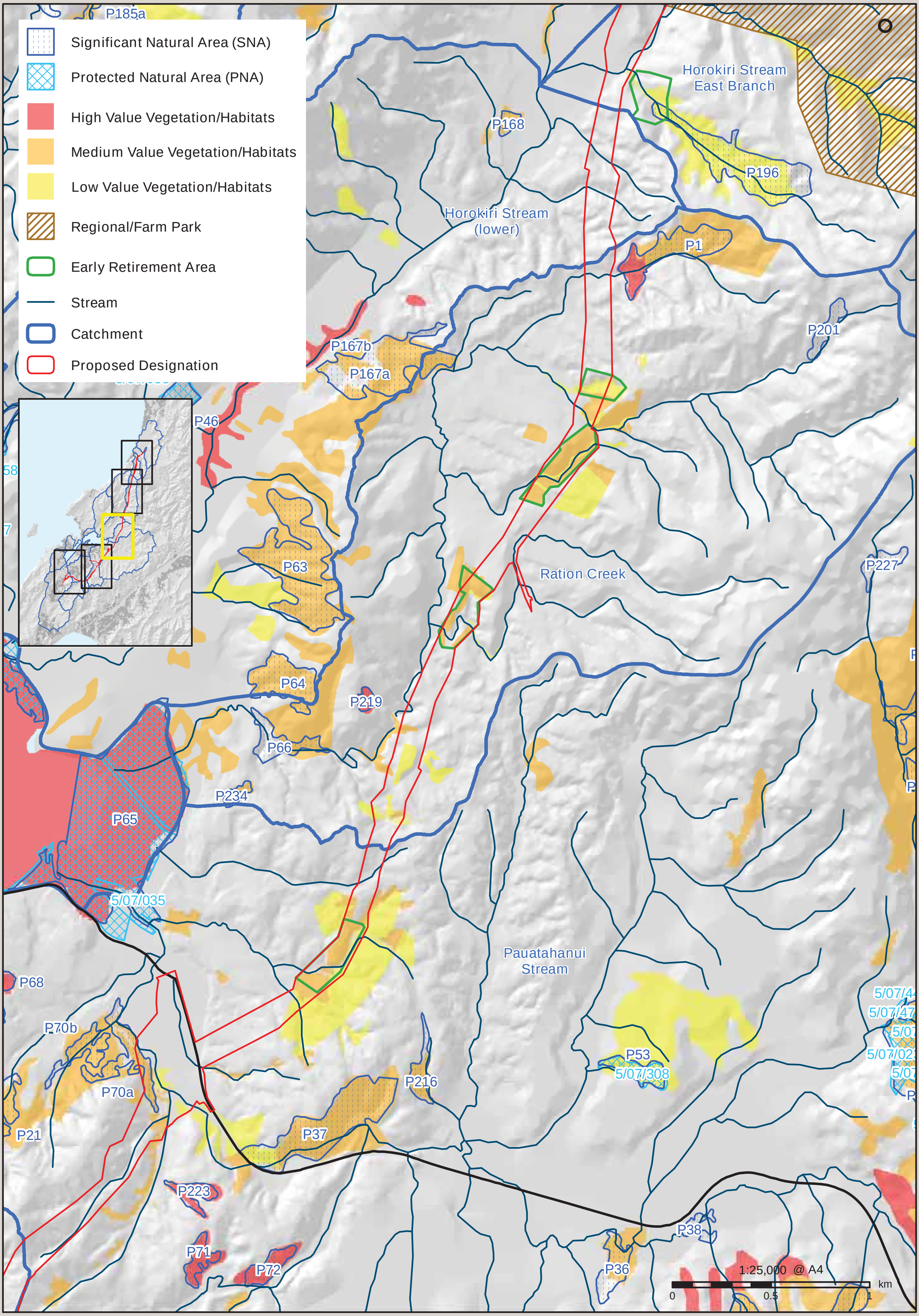

Significant Natural Area (SNA)
Protected Natural Area (PNA)
High Value Vegetation/Habitats
Medium Value Vegetation/Habitats
Low Value Vegetation/Habitats
Regional/Farm Park
Early Retirement Area
Stream
Catchment
Proposed Designation
Horokiri Stream East Branch
Horokiri Stream (lower)
Ration Creek
Pauatahanui Stream
P185a
P168
P196
P1
P201
P167b
P167a
P46
P63
P227
P64
P219
P66
P234
P65
5/07/035
P68
P70b
P70a
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P216
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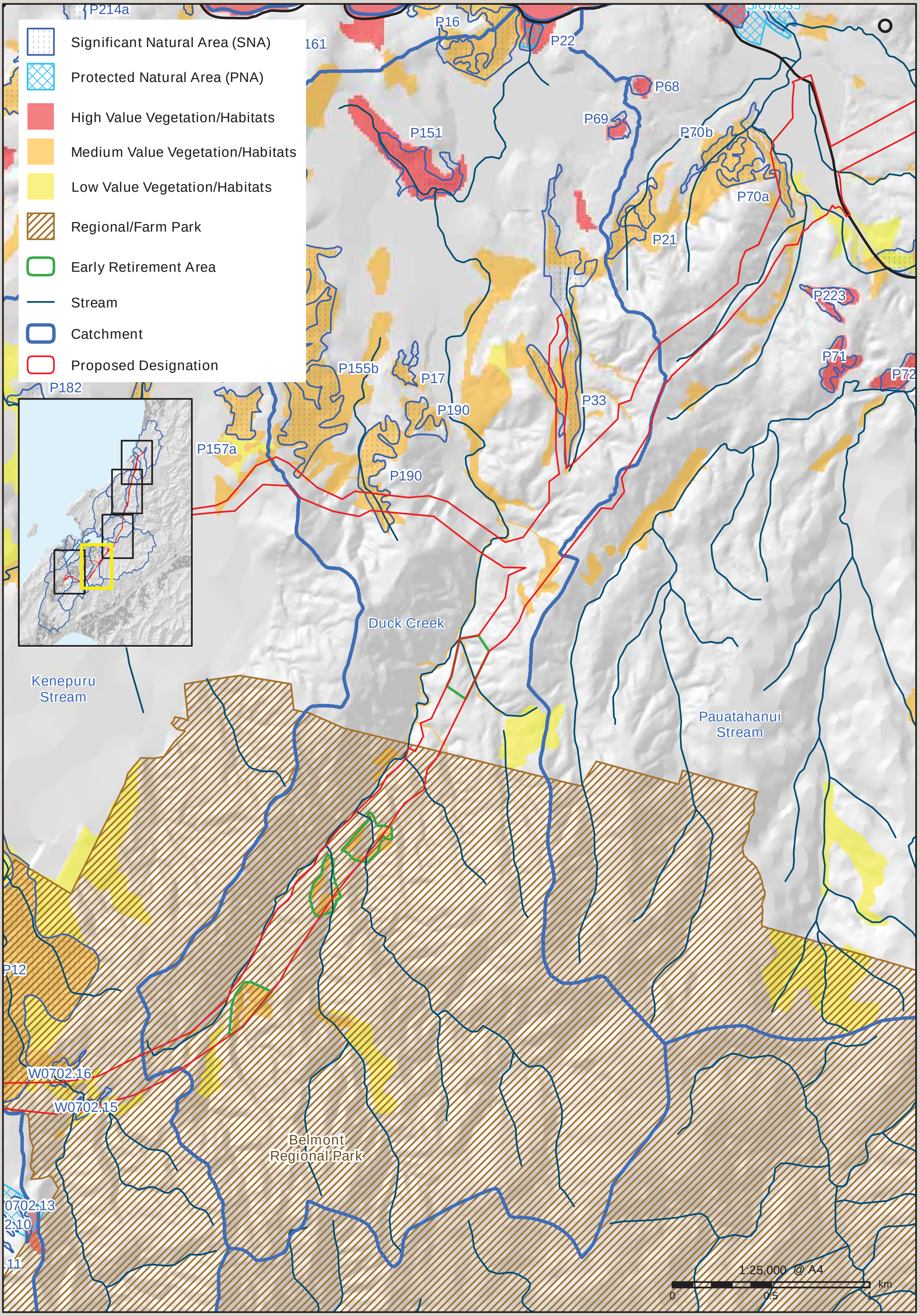

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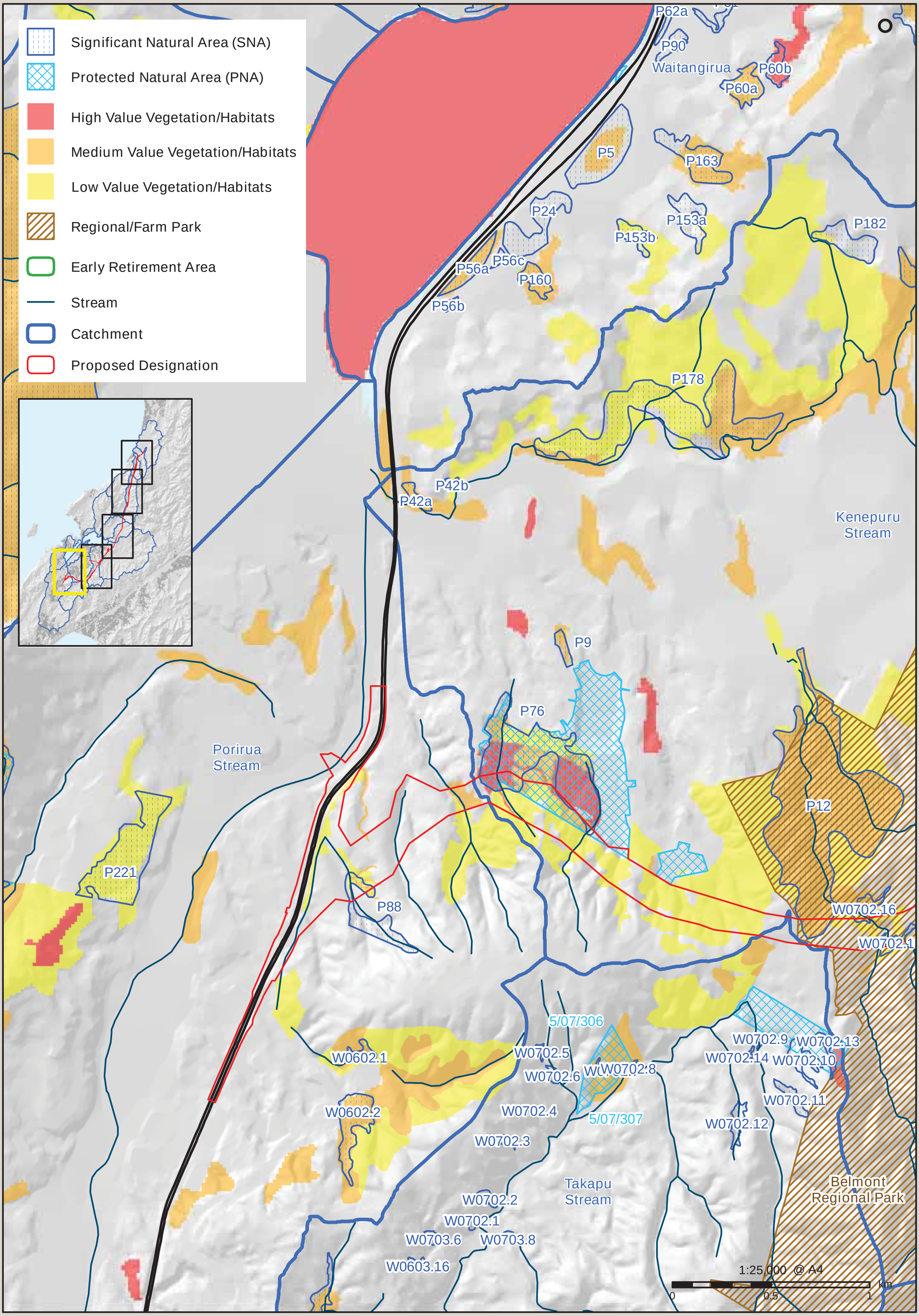

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TRANSMISSION GULLY
SIGNIFICANT ECOLOGICAL AREAS OF THE PROJECT CORRIDOR
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7. PROJECT SHAPING

This section describes the activities that have occurred through the design phases of this Project with a focus on decisions that have resulted from recognition of ecological issues and which have sought to avoid or minimise adverse effects.

7.1 HISTORICAL CONTEXT

DESIGNATION (1994 – 1997)

The original ecological assessment that was carried out for the Notice of Requirement to Designate Transmission Gully identified several significant ecological effects that were likely to occur with the design at that time (Fuller, 1994). These potential effects included:

- The loss of considerable areas of freshwater habitat in Duck Creek, Ration Stream, and Horokiri Stream due to diversion, channelling, and piping.
- The loss of freshwater fishery from much of the Horokiri Stream and Duck Creek through loss of habitat, and potential fish passage issues;
- Significant adverse effects on the ecology of the Pauatahanui arm of Porirua Harbour from sediment discharge.

Because design for the designation was only done to a sufficient level of detail to support a designation these issues could not be fully addressed by this process.

Two decisions were made as part of the designation process in an attempt to mitigate for these ecological effects. These were developed in consultation with the Department of Conservation, Forest and Bird, and Guardians of the Pauatahanui Inlet. They were:

1. The designation was widened at every crossing of a watercourse with an upstream catchment area of 40 ha or more (an agreed threshold for perennial streams); to ensure that there was sufficient room for the capture, treatment and management of sediment before discharge to these watercourses.
2. Eleven sites were identified which were to be purchased and revegetated prior to construction of the route. Nine of these sites were at stream crossings, two were on steep and erosion prone slopes within the Horokiri above the alignment (these plantings have been carried out).

Notices of requirement for the route were lodged in 1996 and a hearing followed in 1997. Appeals were resolved in 2003 and the existing designation established.

COSTED VIADUCT (2004)

In 2004 a review of the TG alignment was carried out, leading to what is generally known as the Costed Viaduct Option. This project sought to reduce some of the observed construction effects through design refinements including avoidance of fish passage problems and stream loss through bridging and viaducts (Boffa Miskell Ltd, 2004). This project was however, constrained to the existing designation, which limited opportunities to consider alternatives. It was also not able to explore in more detail the issues around erosion control and sediment discharge to streams and the inlet.

SCHEME ASSESSMENT REVIEW (2006 - 2009):

In 2008 NZTA commenced a scheme assessment review (SAR) including “Phase I Investigations - Investigations and Preliminary Design”. The SAR was carried out between 2006 and 2008. The key objective was to identify the most advantageous route alignment which could then be further refined and used for assessment and consenting. The process involved multi-criteria analysis of 38 options and sub-options. Each one was assessed against the existing designation which was the baseline.

The SAR process also included extensive consultation with a wide range of statutory bodies and NGOs including their participation in workshops where the preliminary results of the multi-criteria analysis was presented, challenged and refined.

While this project still relied primarily on desktop reviews and rapid site inventories for ecological descriptions there was the opportunity for some additional studies including a survey of all affected streams (Boffa Miskell Ltd, 2008) and an assessment of McKay's crossing wetland(Boffa Miskell Ltd, 2007).

This process provided the first real opportunity to conduct on-site, in-depth investigations into the impact of the proposed alignment from an engineering and environmental perspective. Another key aspect of this process was that the project team was not constrained to the existing designation.

PREFERRED ALIGNMENT

At the conclusion of this SAR process, a preferred alignment was confirmed. This Alignment incorporated changes from the Designated Alignment that significantly reduce potential effects. These changes occur primarily in the northern section from MacKays Crossing through to the Te Puka and Horokiri catchments. Within these catchments the preferred alignment traverses the slopes above the streams on the western rather than the eastern side of these valleys. This allows greater control of effects on remnant forest and high value streams than the existing designation.

Within Te Puka Stream, the Preferred Alignment reduces impacts on the significant remnant forest on the eastern slopes below Wainui Summit. It will also avoid multiple crossings and culverting of the many high value tributaries that extend east from Te Puka and Horokiri Streams into the forested headwaters. It will instead affect a number of small kohekohe forest fragments scattered along the western slopes. It will also require the diversion of the upper 1 km of Te Puka stream.

Within Horokiri Stream the Preferred Alignment avoids multiple crossings of high value streams on the eastern slopes from Wainui Saddle to Battle Hill Regional Park. It also avoids most of the main stem of Horokiri Stream with only a small number of short diversions to protect stream values.

Both alignments have effectively identical footprints from south of Battle Hill to Cannons Creek. At Cannons Creek the Preferred Alignment is moved a significant distance east of the Designated Alignment and will have a smaller impact on the indigenous vegetation of Cannons Creek Reserve.

During the existing designation process, the decision was made that key sites along the alignment would be retired and revegetated prior to construction commencing. Eleven sites were identified with a total area of 57 ha and containing 5,100 m of stream. These sites were located at main stream crossings where revegetation of riparian margins was intended to provide refuges for freshwater fauna during construction and planting of slopes was intended to assist in capture of sediments and management of erosion. This was seen as offset mitigation for permanent loss of streams within culverts.

These sites have been progressively purchased, fenced, and planted and this process was completed for all but one site in 2009.

7.2 DEVELOPMENT OF THE PREFERRED ALIGNMENT

In 2009 NZTA commenced Transmission Gully Phase II Investigations - Engineering and Environmental Assessments. The main objectives were to:

- Carry out detailed site investigations;
- Further refine the alignment taking into account the findings of investigations;
- Project a final project design;
- Carry out an assessment of effects.

7.2.1 CONSENTING TEAM COORDINATION

At the beginning of the design and assessment process key linkages with other work streams were identified. They included:

Table 11-26: Consenting Team Coordination

WORKSTREAM	Requirement
#02 Roading Design	• Agreement on construction footprint and activities • Define road footprint, cut slopes and fill batters. • Define designation extent. • Construction access road location. • Agree location of disposal sites • Co-ordination of CEMP and SSEMP
#03 Structural Design	• Agreement on bridge and culvert locations • Bridge construction methodology • Design of retaining walls.
#04 Hydrology & Stormwater & #12 Water Quality	**Hydrology** • Hydraulic modelling for culverts to ensure the issue of fish passage is sufficiently addressed • Hydraulic modelling for diversions so that design of stream diversions has a sound ecological basis. **Erosion & Sediment** • Coordination with BML aquatic habitat sampling. • Baseline sediment loadings of all affected streams and modelling of sediment discharges under different scenarios including worst case. • Estuarine modelling and sediment deposition • The location, design, and sizing of erosion and sediment management systems to the recognised standards. **Stormwater** • Baseline contaminant loadings of all affected streams and modelling with new road based on treatment design. • Stormwater treatment locations & type
#05 Programme & Cost	• Construction duration – staging / locations - % exposed earthworks
#07 Landscape & Visual	• Coordination of mitigation planting / habitat restoration (ecology) and mitigation planting (visual & landscape) • Coordination of landform shaping / cut batters / fill batters / benching / disposal sites. • Agreement on mitigation standards and costs • BML's scope will include all revegetation and restoration of streams and riparian margins, and any stormwater ponds requiring treatment by planting. Isthmus (WS#07) will cover revegetation and restoration of earth worked areas outside of stream margins including cut and fill batters, landscaped or shaped surfaces, and revegetation of disposal sites and retired land.

In particular, the ecological assessment for freshwater and marine environments relied on baseline sampling of water quality carried out by SKM (Technical Reports 14). BML ecologists consulted with SKM to confirm the types and frequency of sampling, the sampling locations, and assisted SKM locate and install the four turbidity loggers.

BML reviewed the draft water quality, hydraulic modelling, and harbour monitoring reports to ensure that the analysis provided the information and detail required for the assessment of ecological effects.

The ecology assessment of discharges to streams and the Porirua Harbour relied on modelling of sediment and stormwater generation carried out by SKM (Technical Report 15). BML worked with SKM to confirm the modelling assumptions.

BML also worked with SKM on culvert and diversion designs to ensure ecological flows and velocities were achieved, and fish passage could be provided (SKM Technical Reports 14).

7.3 THE SHAPING PROCESS

The focus on the shaping process was to avoid effects wherever possible, or reduce effects if they could not be avoided. This was done through numerous small changes to the alignment, through a range of decisions on design components such as diversions and culverts and through bridging of ecologically significant streams.

7.3.1 DESIGN CHANGES TABLE

Throughout the shaping process a design changes table was maintained. It logged

- Item, Location, date, chainage;
- Description of the change;
- Reasons for the change;
- Effects of the change;
- Who the change was requested by and why.

Appendix 11.C provides a summary of the design changes table with those items of ecological concern.

7.3.2 EFFECTS REDUCED OR AVOIDED

Through the shaping process a large number of effects, both large and small were avoided or reduced. Much of the work focused on stream effects, with minor changes of alignment avoiding in some cases the need for diversions or reducing their length.

Design changes also led to the decision to replace very large culverts with bridges particularly where cost was not a strong driver for the decision. Five 'environmental' bridges are included in the preferred design in the Te Puka, Duck, and Kenepuru.

Other small design changes reduced earthworks, significantly reduced the number of fill sites, and avoided or reduced effects on identified vegetation, including avoidance of the Akatarawa Forest.

7.3.3 EFFECTS INCREASED

The only area that ecological effects will increase as a result of this design process is the Te Puka Valley. During the SAR, the streambed was largely avoided using vertical retainers, cantilevered sections, and short viaducts. However, further geotechnical investigation alerted the design team to the risk of complete loss of the road during slope failure in an earthquake. As a key objective of the TG alignment is route security this risk was considered unacceptable.

This risk could be largely eliminated by the use of a sloping 1:1 earth reinforced (MSE) wall. However, this meant that the batter slope would eliminate large sections of Te Puka streambed, the toe of the batter in some places extending up the opposite slope. This requires the diversion of the entire affected channel, lifting the streambed into a new channel formed along the toe of the batter slope and some height above the existing bed. The design of this diversion and calculations of necessary mitigation are discussed in subsequent sections.

A total of 1.2 km of the upper Te Puka valley is affected by this change and this is reflected in the tables that follow.

7.3.4 CEMP / SSEMP

As part of the process of design development several indicative Site Specific Environmental Management Plans (SSEMPs) were prepared. Six locations were chosen which were representative of the range of issues that will be encountered during construction of the route.

The aims of this work were to:

- Explore challenging aspects of the route and reach agreement on how they can be managed.
- Explore these issues collaboratively, drawing on the wider team for solutions.
- Consider refinements.
- Provide a suite of indicative details and staging to show how.
- Provide greater certainty over our assessments.
- Provide confidence in our mitigation packages.
- Help us structure the consent conditions.
- Provide clarity on what the plans required by consent will look like / be responsible for managing.

The process also provided a consultation tool for:

- Introducing stakeholder groups to the key issues and complexities of the site
- Helping stakeholders understand the scope of the Project.
- Encouraging stakeholder contributions, where appropriate.

7.3.5 CONSULTATION

Throughout the shaping process there was ongoing consultation with stakeholders. This consultation continued after project shaping and through the assessment of effects and development of mitigation options.

Consultation ranged from presentations to individual groups, public open days, and stakeholder workshop. The stakeholder workshops focused on the SSEMP process which was used as a tool to understand construction and environmental issues and options.

Over the development of this EcIA Boffa Miskell has consulted with:

- Department of Conservation
- Greater Wellington Regional Council
- Porirua City Council
- The Guardians of Pauatahanui Inlet
- Pauatahanui Inlet Community Trust
- The Royal Forest and Bird Protection Society
- Ngati Toa

BML also attended joint site visits with DoC, GWRC and Porirua City Council staff.

7.4 ROUTE COMPARISON

7.4.1 TERRESTRIAL VEGETATION LOSS

The following table shows the areas of vegetation found within the existing designation and the proposed designation (preferred alignment), and the difference between the two. For the purpose of assessing effects on terrestrial habitats all vegetation within the designation is considered to be at risk.

The proposed designation affects a greater area than the existing designation, at least in part due to the improved awareness of the space requirements for the management of the site during construction.

Table 11-27: Terrestrial Habitats – Effects

Description		Existing Designation Area (ha)	Proposed Designation Area (ha)	Difference ha (%)
Grassland, shrublands, rushland and wetlands				
1.01	Improved pasture	101	183	82 (81%)
1.02	Rough pasture and shrublands	17	30	13 (76%)
1.03	Cropland	0	4	4 (100%)
1.04	Stony streambed in pasture	8	10	2 (25%)
1.05	Riparian margins in rushland	3	4	1 (33%)
1.06	Indigenous wetland	3	2	-1 (-33%)
Pioneer shrublands and low scrub				
2.01	Gorse dominated scrub (closed canopy)	36	31	-5 (-14%)
2.02	Tauhinu dominated scrub (closed canopy)	4	16	12 (300%)
2.03	Riparian margins beneath scrub	2	3	1 (50%)
Seral manuka/kanuka forest				
3.01	Secondary native forest (kanuka)	4	10	6 (150%)
Seral broadleaved forest				
4.01	Transmission Gully restoration planting	15	16	1 (7%)
4.02	Secondary native forest (mahoe)	19	15	-4 (-21%)
4.03	Riparian margins with 2° native forest	6	6	(0%)
Mature or maturing indigenous forest				
5.01	Lowland tawa forest	8	4	-4 (-50%)
5.02	Coastal kohekohe forest	11	12	1 (9%)
5.03	Remnant sub-montane hardwood forest	2	1	-1 (-50%)
5.04	Riparian margins with indigenous forest	3	3	(0%)
Exotic vegetation				
6.01	Plantation pine	72	47	-25 (-35%)
6.02	Plantation pine – harvested	31	43	12 (39%)
6.03	Exotic trees (shelterbelts, gardens)	7	12	5 (71%)
6.04	Riparian margins with exotic trees	2	2	(0%)
Undefined				
7.01	Built-up area	9	29	20 (222%)
TOTALS		363	483	120 (33%)

The key differences between the two options are:

- Movement of the preferred alignment from the eastern to the western slopes of the Horokiri Stream and Te Puka Stream has the following effects:
  - An increase in the amount of rough and improved pasture affected;
  - A reduction in the amount of plantation forest affected (25 ha – 35% reduction);
  - An increase in the amount of tauhinu dominated shrublands affected (12 ha – 300% increase);

- A reduction in the amount of mahoe dominated secondary native forest affected (4 ha – 21% reduction);
- A reduction in the amount of lowland tawa forest (4 ha – 50% reduction) and sub-montane forest (1 ha – 50% reduction) affected in the Te Puka and at the Wainui Saddle;
- An increase in the amount of coastal kohekohe forest affected (1 ha - 9% increase).

- The movement of the Cannons Creek link road from Cannons Creek to Waitangirua has the following effects:
  - A reduction in improved and rough pasture affected (predominantly within Belmont Regional Park);
  - An increase in the area of kanuka forest (6 ha – 150% increase).
- There is also a small decrease in the amount of McKays crossing wetland that falls within the proposed designation.

Overall the proposed designation results in a reduction of affected mature native forest and seral broadleaved forest (not including mitigation planting) of 8 ha, and an increase of affected kanuka scrub and forest of 6 ha.

In total, the proposed designation will result in vegetation and habitat loss of approximately:

- 20 ha of mature or maturing native vegetation
- 21 ha of seral broadleaved forest (not including mitigation planting);
- 10 ha of seral kanuka forest
- Consideration of the effect of the loss of 50 ha of mixed shrubland habitat (gorse and tauhinu).

7.4.2 IN-STREAM HABITAT LOSS

The estimated loss of perennial or intermittent stream through culverting for the existing Designated Alignment was 6,630 m. For the Preferred Alignment this loss is reduced by 20% to 5,286 m due to the changed relationship between the road and the Te Puka and Horokiri Streams and their tributaries. The Preferred Alignment is therefore considered to have less effect on high value stream habitat.

Both alignment options will require significant lengths of both temporary and permanent stream diversions. For the Preferred Alignment this has increased to 5,132 m due to necessary changes to road construction in the Te Puka and upper Horokiri.

Finally, significant lengths of stream will be affected by formation of disposal areas. In these sites the original stream beds will be lost and new stream channels formed over the surface of the disposal site. Disposal sites for the existing Designated Alignment will affect considerably more stream habitat than those for the Preferred Alignment.

The following table shows the lengths of perennial or intermittent stream affected permanently or temporarily by the two alignment options.

Table 11-28: Stream Habitat – Effects

Habitat Type	Existing Designation Length (m)	Proposed Designation Length (m)	Difference m (%)
Stream bed habitat lost by culverting	6,630	5,286	-1,344 (-20%)
Stream bed habitat modified by diversion	2,965	5,132	+2,167 (+73%)
TOTAL stream habitat requiring mitigation	9,595	10,418	+ 825 (8%)

7.4.3 RIPARIAN HABITAT LOSS

Overall the areas of affected riparian habitat are similar for the two alignment options. The Preferred Alignment affects slightly more habitat through culverting and stream diversion. The Designated Alignment affects slightly more habitat through formation of disposal areas.

The following table shows the areas of riparian habitat that will be lost permanently by the two alignment options.

Table 11-29: Riparian Habitat – Effects

Habitat Type	Existing Designation Area (ha)	Proposed Designation Area (ha)	Difference m (%)
Riparian habitat modified by bridging	1.3	1.0	-0.3 (-21%)
Riparian habitat lost by culverting	13.1	8.9	-4.2 (-32%)
Riparian Habitat modified by diversion	5.9	9.1	3.2 (+54%)
TOTAL stream habitat requiring mitigation	20.3	19	-1.3 (-6%)

7.4.4 CONCLUSION

In conclusion we are confident that all opportunities for avoidance of effects through the location of the road alignment and associated works have been explored.

Significant reductions in adverse effects have been achieved through the evolution of this alignment from existing designation, through Scheme Assessment, and finally as part of these detailed investigations.

There will still be some opportunities for further avoidance or reduction of effect during the detailed design stage and these are identified in the following sections as part of the mitigation package.

7.5 CONSTRUCTION & OPERATIONAL ACTIVITIES

The Project described in this Section of the EcIA will be carried out through a set of “activities” and these are listed in Table 11-30. These activities cover both the construction and operational phases of the Project. The construction phase has been further divided into direct & indirect construction impacts. Direct impacts of construction include:

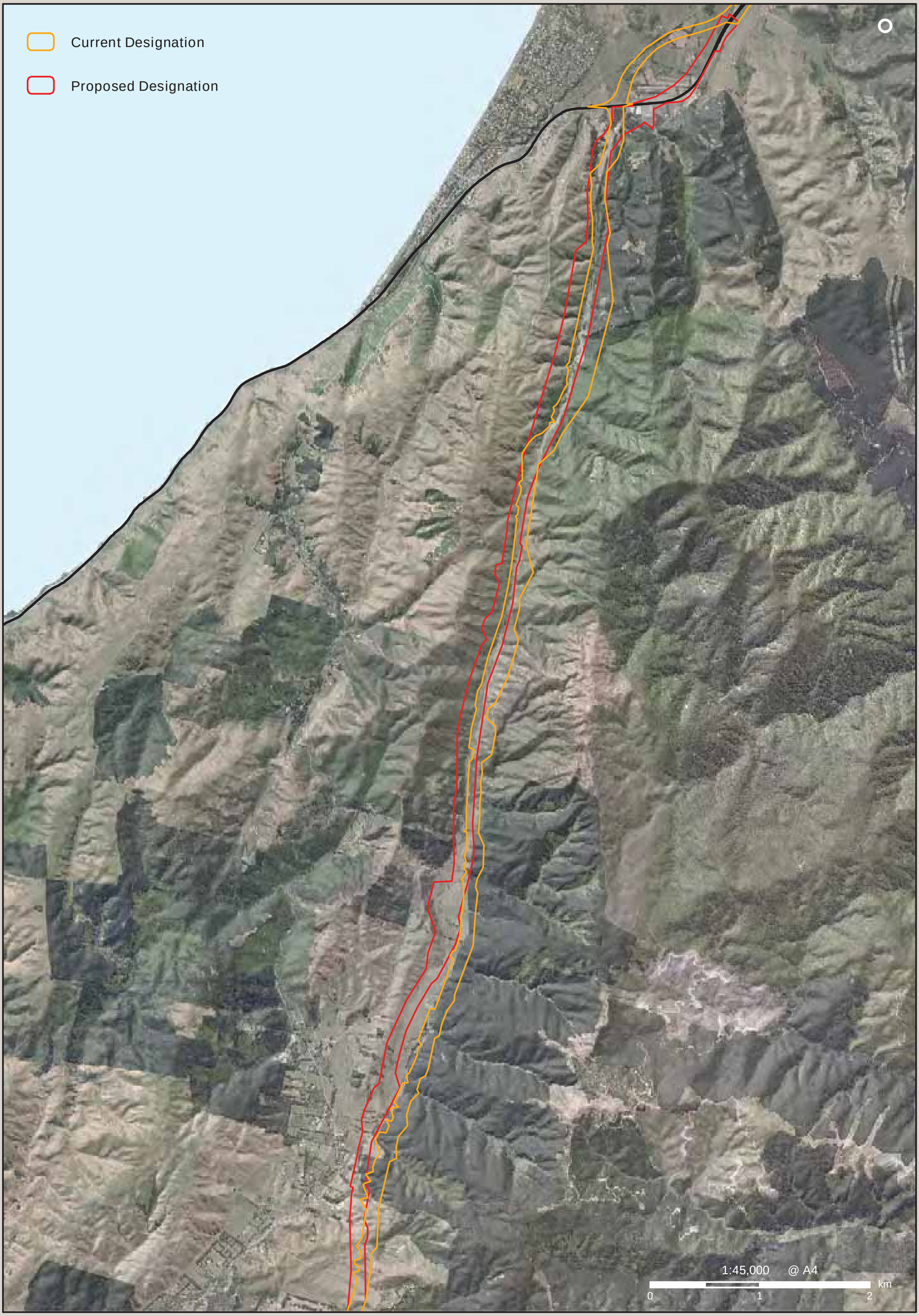
- Loss of terrestrial habitat and species through land take for infrastructure and construction activities.
- Loss & modification of aquatic habitat through culverting, diversions & stream straightening;
- Disturbance and displacement of terrestrial fauna through construction activities;

Indirect impacts of construction include:

- Impact on streams, wetlands and harbour habitats and species through increased turbidity and blanketing of stream bed, estuarine and marine habitat by sediment generated by construction activities;
- Risk of impact on streams, wetland and harbours through discharge of construction contaminants (oil, cement, lubricants) from stores or vehicles;
- Impact on freshwater ecosystem through water take from streams (no consents are currently being sought for this);
- Risk of impact on terrestrial habitat and species loss through dust, fire and weed introduction caused by construction activities;

Table 11-30: Transmission Gully: Summary of Activities Potentially Causing Adverse Effects

CONSTRUCTION STAGE:	
Activity	**Potential adverse effects**
Vegetation clearance along route	Disruption of ecological values on site and adjacent lands/waters; disruption eco processes "downstream"; habitat fragmentation; vegetation/habitat loss; stormwater management requirements for ecological values
Bulk Earthworks	Loss of land form and habitat, erosion, sediment discharge, weed sites.
Importing and depositing fill	Vegetation/habitat loss; stormwater management requirements for ecological values; importation of weeds
Temporary Access Roads and temporary culverts	Habitat loss, vegetation clearance, disruption to fish passage, discharge of sediment, remedial works.
Discharge to waterbodies of sediment generated by earthworks.	Increased TSS and sedimentation of stream mouths and harbour in general. Smothering of organisms, changes to habitat characteristics.
Construction temp sediment management structures	Vegetation /habitat loss; flocculation,
Construction permanent stormwater treatment ponds	Vegetation /habitat loss.
Waterway crossings – building bridges, culverts installation	Erosion, sedimentation, disruption in-stream animal movements, contamination (spills etc); habitat loss
Temporary diversions associated with construction of crossings	Erosion, sedimentation, disruption in-stream animal movements, contamination (spills etc); habitat loss
Permanent diversions – construction new channel, filling old, diverting water	Vegetation / habitat loss; erosion, sedimentation, disruption in-stream animal movements , contamination (spills etc)
Waste disposal / contaminants (cement, oils, lubricants, fuels)	Soil contamination; importation weeds; toxicity (soil); encouragement rats/pests
Weed importing & management	Loss of groundcover by annuals. Introduction of new species
Dust and dust watering	Contamination of waterways if run-off occurs
Fire caused by construction activities	Hot works, smoking, exhausts, explosives.
Severance of habitat	Alignment cutting through a wildlife corridor.



Boffa Miskell

NZ TRANSPORT AGENCY
WAKA KOTAHI

TRANSMISSION GULLY

COMPARISON OF DESIGNATIONS

EXISTING & PROPOSED (TE PUKA / HOROKIRI)

11.10

8. ASSESSMENT OF CONSTRUCTION IMPACTS

8.1 ASSESSMENT CRITERIA

In this section, we assess the magnitude of ecological impacts using the following criteria:

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

We then assess the significance of ecological effects using ecological value (determined in Section 6) and impact magnitude (above) as shown in the following matrix:

SIGNIFICANCE		Ecological &/or Conservation Value			
		Very High	**High**	**Moderate**	**Low**
Magnitude	**Very High**	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Low	Very Low
	Low	Moderate	Moderate	Low	Very low
	Negligible	Low	Low	Very Low	Very Low

8.2 DIRECT IMPACTS OF CONSTRUCTION

8.2.1 TERRESTRIAL VEGETATION AND PLANT SPECIES LOSS

A total of 40 ha of native vegetation lies beneath the project footprint and will be permanently removed during construction. A further 80 ha of native vegetation lies within the designation and is likely to be temporarily lost or modified by earthworks associated with road formation. Table 11-31 assesses the magnitude of impact to this vegetation as a % of the total vegetation of this type found within the study area.

The highest score of Moderate is for the loss of mature native forest dominated by tawa and kohekohe (including parts of K139, PCC88, WCC0702.15, W0702.16), and for the loss of high value regenerating broadleaf forest (including parts of PCC12, PCC76). All other loss is assessed as low or very low when taken in the context of the total amount of that plant community in the study area.

Table 11-31: Magnitude of Terrestrial Vegetation Loss and Modification (without mitigation)

DESCRIPTION (listed North to South)	Maximum area of habitat loss (ha)	Study Area (ha)	Loss as % of Study Area	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
FW Wetlands						
Wetlands of low value - (Sphagnum bog)	0.8	34	2%	Low	Low	Very Low
Wetland of high value - (K106)	1.2	34	4%	High	Low	Moderate
Shrublands & Scrub						
Shrublands of low value	50.0	1,202	4%	Low	Low	Very Low
Shrubland boulderfields of moderate value (found in Te Puka, Upper Horokiri, Duck)	-	-	-	Moderate	Low	Low
Regenerating indigenous forest (kanuka dominant)						
Sites of moderate value (incl PCC33, PCC155b, Part PCC190, PCC196)	10	590	2%	Moderate	Low	Low
Regenerating broadleaf forest (mahoe dominant)						
Sites of low value (incl PCC199)	4.0	1,527	0%	Low	Negligible	Very Low
Sites of moderate value (incl PCC155b)	5.4	1,527	0%	Moderate	Negligible	Very Low
Sites of high value (incl Part PCC12, PCC76)	10.0	1,527	1%	High	Low	Moderate
Early Retirement Planting (No 1, 2, 3, 5, 6, 7)	17.7	1,527	1%	Moderate	Low	Low
Mature or maturing indigenous forest						
Sites of low value (incl K223-230, PCC88, PCC172)	16.6	225	7%	Low	Moderate	Very Low
Sites of moderate value (incl K229, PCC33, Part PCC190)	1.7	225	1%	Moderate	Low	Low
Sites of high value (incl Akatarawa Forest, K139, PCC88, WCC0702.15, W0702.16)	1.7	225	1%	High	Low	Moderate
TOTAL (ha)	**120**	-	-	-	-	

8.2.2 FRESHWATER HABITAT LOSS

Habitat loss and change can mean:

- loss of aquatic habitat (in linear metres) by stream infilling (such as to establish the toe of a road supporting batter slope) and requiring diversions; or
- major habitat change due to the installation of a culvert replacing the existing natural stream bed habitat with a concrete one; or
- loss or change of ephemeral headwater wetland habitat, potentially changing the flow regime and in particular the spread in time of rain generated flows.

The effects on aquatic and riparian habitat from the proposed highway construction may be positive or adverse. Positive effects will arise through:

- creation of diversions or alternative reaches of waterways with enhanced in-stream and riparian habitat conditions, when existing reaches lie on the alignment and cannot be avoided
- riparian restoration or revegetation associated with bridge and culvert construction
- removal of perched culverts in Duck Creek
- installation of eco-designed culverts throughout the system
- treatment of surface /stormwater run-off in areas where no treatment occurs currently
- retirement of areas from stock grazing

Adverse effects on aquatic and riparian habitats will be effects on habitat quantity and/or quality and arise through:

- removal or disturbance of riparian vegetation during construction of road, bridges and culverts
- reduction in quality of aquatic habitat resulting from change in riparian habitat (for example, loss of organic matter "rain" contribution to food chain)
- removal of reaches of streams through infilling and diversion,
- changes in substrate and bank due to culverting as well as disturbance to the bed of stream;
- reduction in quality of aquatic habitat through changes in flow regime or water quality (addressed in previous section)
- interruption of passage for aquatic species up and downstream (fish passage is addressed in the next section)
- downstream drift of species due to disturbance may result in temporal community changes.

Culverting & Associated Stream Works

The lengths and locations of all proposed culverts are listed in Technical Report 14 (SKM). For this assessment, the lengths of stream affected by culverting have been broken down into catchment and into two main hydrological stream types (i.e. ephemeral and headwater, and; intermediate and perennial) (Table 11-32).

There are 112 stream crossings of which 102 are culverted, the remaining 10 are bridged. Of the 102 culverted crossings 43 lie in perennial and intermittent stream bed affecting 5,286 m of aquatic habitat. The remaining 59 culverts lie in ephemeral channels, or in small headwater basins that do not have defined channels and are typically in pasture.

In calculating the scale of effect for each culvert, a provision of 20m per culvert was made to account for installation disturbances, concrete wing walls, debris fences, and rock armouring.

In addition the totals have taken account of the length of watercourse that is eliminated when straight culverts remove meandering stream sections. This quantity has been added to the total stream habitat affected. For example the total length of perennial and intermittent stream affected consists of 3,617 m of culvert, 860 m of associated stream works, and 809 m of lost stream length, to provide a total of stream affected of 5,286 m.

Table 11-32: Loss or modification of stream channel due to culvert installation including headwalls, armouring and stream length lost (935 m).

Catchment	Total length of affected watercourse (m)	Proportion of works in ephemeral channels or headwaters (m)	Proportion of works in perennial or intermittent streams (m)
Wainui Stream	575	0	575
Te Puka Stream	1,170	687	483
Horokiri East Stream	2,357	1,291	1,066
Ration Stream	1,960	542	1,418
Pauatahanui Stream	719	359	360
Duck Creek	1,812	1,150	662
Kenepuru Stream	613	315	298
Porirua Stream	689	265	424
Total Length affected	**9,959**	**(47%) 4,673**	**(53%) 5,286**

Around 47% of the total culverted length is of watershed/ephemeral systems (minor side tributaries) most of which are in the Horokiri and Te Puka systems. These systems have little to no aquatic habitat value and are largely rainwater conveyance systems. Those with aquatic habitat and require fish passage have all been addressed and are catered for and this process is described below under fish passage.

These culverts present an array of modified habitat. Large and well embedded culverts in streams of a gentle gradient can provide similar habitat to the habitat that was replaced, steeper culverts that do not have substrate have a much lower value. These differences have been considered in the mitigation analysis that follows.

Diversion & Reclamation

The same GIS calculation exercise was carried out for the diversion reaches. These calculations are again by catchment and are summarised in Table 11-33. Forty diversions are proposed, of which 25 lie in perennial and intermittent streams, affecting some 5,132 m of aquatic habitat. The remaining 15 diversions lie within ephemeral channels or small headwater basins.

In calculating the scale of effect for each culvert, a provision of 20m per diversion was made to account for additional disturbance associated with diversion formation.

In addition the totals have taken account of the length of watercourse that is eliminated when straight culverts remove meandering stream sections. This quantity has been added to the total stream habitat affected. For example the total length of perennial and intermittent stream affected consists of 4,039 m of diversion, 500 m of associated stream works, and 593 m of lost stream length, to provide a total of stream affected of 5,132 m.

Table 11-33: Loss or modification of stream channel due to diversion and channel reclamation including diversion armouring and stream length lost (809m).

Catchment	Total length of affected watercourse (m)	Proportion of works in ephemeral channels or headwaters (m)	Proportion of works in perennial or intermittent streams (m)
Wainui	91	0	91
Te Puka	1,867	0	1,867
Horokiri Stream	1,013	75	938
Ration Creek	896	167	729
Pauatahanui Stream	1,829	814	1,015
Duck Creek	221	0	221
Kenepuru Stream	169	169	0
Porirua Stream	474	203	271
Total	**6,596**	**(22%) 1,464**	**(78%) 5,132**

These diversions will require the formation of a new stream channel, the transfer of flows to it, and the reclamation of the original streambed. In some cases diversions can mirror to a degree the original stream bed, in others, the opportunity for restoration is limited. These differences have been considered in the mitigation analysis in the following sections.

Table 11-34 shows that the combined length of perennial or intermittent stream affected through culverting, diversion, shortening and associated stream works, is around 10,418 m. The catchments most affected are the Te Puka, Horokiri and Ration at over 2km of modification or habitat loss in each.

Table 11-34: Combined length of affected waterways (culvert and diversion) in the 8 affected catchments.

Catchment	Total length of Perennial and intermittent stream affected (m)
Wainui	666
Te Puka	2,350
Horokiri	2,004
Ration	2,147
Pauatahanui	1,375
Duck	883
Kenepuru	298
Porirua	695
Total	**10,418**

Fill Disposal Sites

There are five proposed fill sites, all located at the south end of the alignment. The first fill site lies on a rolling ridgelines above the saddle between Duck Creek and Cannons Creek. The second lies on a flat spur on the south side of Cannons Creek near the Takapu Substation. Both of these fill sites lay in improved pasture. They will take the form of blanketing fills. Neither of these sites will directly affect perennial, intermittent or ephemeral streams.

The remaining three disposal sites are located near the Kenepuru Interchange south of bridge number 22. All three lie on land that is currently in pine forest. Small ephemeral streams and seepages are present in all three sites, however, pine litter and colluviated soil from slope erosion has filled the channels. Subsurface movement of water is apparent, and occasionally it appears over brief sections as a laminar flow over silts. There is likely to be flow over some sections of these streams following heavy rain. However, no perennial or intermittent streams are present.

The small tributaries that lie near the southern two fill sites are culverted beneath SH1 and the North Island Main trunk to discharge on slopes above Porirua Stream. The northern most tributary is captured by the residential stormwater system that flows to Ribbonwood Terrace. It is unlikely that these channels provide habitat for native fish.

Stream Loss by River Environmental Classification

To assist in assessing the effects of the losses and the value and type of the mitigations required a calculation of the River Environmental Classifications (REC) changed or lost (culverted of diverted) was undertaken (Table 11-35). REC is a spatial framework that provides a context for inventories of river resources, and a spatial framework for effects assessment (Snelder et al, 2004).

REC streams are classified from 1 to 6, 1 being the smallest and 6 the largest. Note that the REC GIS layers focus on perennial stream systems that have persistent aquatic habitat. For this assessment the smaller ephemeral and intermittent systems were identified from the LINZ stream layer and categorised as REC 0 (LINZ).

Table 11-35: Quantities of River Environment classification (habitat types) affected.

Description	Total length of REC classes within affected catchments (m)	Length of REC classes affected by Stream works (m)	Proportion of affected length in each REC class (%)	Proportion of total stream length affected (%)
0 (LINZ – Ephemeral)	129,447	6,189	59%	5%
1 (REC)	85,519	2,493	24%	3%
2 (REC)	47,520	1,446	14%	3%
3 (REC)	19,518	126	1%	1%
4 (REC)	19,147	164	2%	1%
Total (LINZ)	**301,151**	**10,418**	**100%**	**3%**

The table shows that REC 0 class streams are most affected, (59%) of the total affected stream length, while one quarter of the affected stream length is REC 1 class streams. Very little of the large, main stem water bodies are affected.

Currently, in the absence of mitigation the Project stands to modify the small stream systems by around 3% across the seven catchments, the generally ephemeral and headwater water shed type systems by perhaps 5%. Those effects would be greatest in the Horokiri and Te Puka catchments. The values recognised in the results section are largely associated with the REC classes 1-3 and little habitat value for aquatic species is attributed to the REC 0 class. By and large the REC 0 class's greatest ecological value is in its functional role as the headwater in moderating rain flow discharge and as ephemeral habitat/wetland.

For this assessment of effects, we have considered only perennial and intermittent streams identified using Stream REC GIS layers (NIWA 2004). Generally, streams identified by the REC classification agree with our field assessments of streams that had permanent or intermittent flows. We have not considered impacts on ephemeral streams or overland flow paths, as these have no permanent aquatic habitat. This type of habitat is captured by the vegetation survey (TR6) which mapped riparian margins in rushland, shrubland, scrub and forest.

Summary of Potential Effects on Aquatic Habitat

Table 11-36 separates stream habitats of different ecological value for the assessment of impact magnitude. This assessment suggests that the magnitude of loss of freshwater habitat is high in Te Puka and Moderate in Ration. It is low or negligible for all other sites.

Table 11-36: Magnitude of Freshwater Habitat Loss and Modification (without mitigation)

Stream	Length of stream lost or modified (ha)	Total length of stream habitat in affected catchment (m)	Loss or modification as % of total stream length	Ecological value of aquatic habitat	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Stream Habitat						
Upper & Mid Te Puka	2,496	9,786	26%	High	Very High	Very High
Middle and Lower Horokiri East	1,109	5,083	22%	High	Very High	Very High
Upper and Middle Duck	832	14,154	6%	High	Low	Moderate
Moderate Value Stream Habitat						
Lower Te Puka / Wainui	651	3,333	20%	Moderate	Very High	Moderate
Upper Horokiri East	828	17,335	5%	Moderate	Low	Low
Lower Duck	0	5,562	0	Moderate	Nil	Nil
Lower Pauatahanui	1,374	149,029	1%	Moderate	Low	Low
Upper Kenepuru (Cannon)	274	19,944	1%	Moderate	Low	Low
Low Value Stream Habitat						
Ration Stream	2,147	19,442	11%	Low	Moderate	Very Low
Porirua (tributaries in Ranui Heights)	707	57,483	1%	Low	Low	Very Low
TOTAL	**10,418**	**301,151**	-	-	-	-

Temporary Culverts

There will be a requirement for temporary Construction Access Tracks in the Te Puka and Horokiri. These will require temporary culverts to avoid stream effects. We have not assessed these on the assumption that they are small, temporary in nature and the stream bed and margins will be remediated when they have been removed.

8.2.3 FLORA AND FAUNA

Terrestrial Flora

A locally uncommon endemic wetland plant, Leptinella tenella (At Risk – Declining), was found in a highly modified area of boggy pasture within the designation. This area is likely to be used for the formation of stormwater treatment ponds which could either eliminate this plant or create additional habitat.

Terrestrial Fauna

Indigenous insects of conservation interest (*Peripatus novaezelandiae*), and three common species of native lizard were found in low numbers in scree and boulderfield habitat in the Te Puka, Horokiri and Duck Creeks. This habitat will be reduced by earthworks and any individuals of these species that have taken refuge in this habitat will be lost.

Avifauna (Birds)

- **Bush Falcon & NI Kaka:** Bush falcon (Nationally Vulnerable) was recorded on two occasions, traversing the upper Horokiri Valley. NI kaka was seen on one occasion flying from the forest above Wainui Saddle and traversing the upper Te Puka valley. No breeding or foraging habitat for these species will be lost. It is considered unlikely that construction activity will displace these birds from their habitat;
- **Populations of Common Indigenous:** Pied Shag (Nationally Vulnerable) was observed on one occasion flying above farmland in the Ration Stream catchment. Black shag (Naturally uncommon) was seen utilising habitat in the valley floors of the Horokiri and Pauatahanui streams. These birds may be displaced from streambed habitat by construction activity;
- **NZ Pipit:** NZ Pipit (Declining) was observed within the valley floor of the Te Puka and Horokiri. It is unlikely this bird will be affected by nearby construction activity;
- **Populations of Common Indigenous Birds:** In addition the mature vegetation of Akatarawa Forest at the head of the Te Puka Valley, and Porirua Park bush above Cannons Creek, contained good numbers of native forest passerines including tui, kereru, kingfisher, fantail, tomtit and bellbird. Small areas of this vegetation will be affected by works potentially causing disturbance and reducing habitat.

Bats

An unconfirmed recording of a native bat, probably the long tailed bat (Nationally vulnerable) was recorded on the margins of Akatarawa forest at the head of Te Puka valley. No habitat of this species will be lost and it is unlikely construction will disturb and displace any bats present.

Freshwater Fish

There are eight species of native fish in study area with a threat status (At Risk; Declining). These are potentially affected by:

- The loss of habitat (culverting and stream straightening) which will potentially reduce local populations;
- Habitat changes associated with new diversion channels;
- Entrapment and mortality during reclamation of streams, and through prevention of migration (culverts).

It is our view that there is the potential for significant adverse effects on freshwater fish.

Summary of Potential Effects on Flora and Fauna

Table 11-37: Magnitude of Effects on Flora and Fauna (without mitigation)

DESCRIPTION (listed North to South)	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
FLORA & FAUNA			
FW Flora			
Leptinella tenella	Moderate	Moderate	Low
Terrestrial Fauna			
Common Lizards	Low	Low	Very Low
Peripatus novaezealandiae	Low	Low	Very Low
Avifauna			
Falcon	Very High	Negligible	Low
Kaka	Very High	Negligible	Low
Black Shag	Very High	Negligible	Low
Pied Shag	Low	Low	Very Low
Pipit	Moderate	Negligible	Very Low
Bats			
Long-tailed bat (potential)	Very High	Low	Moderate
FW Fauna			
Indigenous Fish (fish passage / construction mortality))	High	High	Very High

8.3 INDIRECT IMPACTS OF CONSTRUCTION

8.3.1 TERRESTRIAL VEGETATION

Dust

Significant amounts of airborne dust may be created during the period of construction in each catchment where large areas of earthworks are exposed. There is a small risk of adverse effects on adjacent native vegetation. This cannot be quantified but can be monitored, with appropriate management responses.

Fire

There is a risk of fire during the construction period caused by hot works, smoking, and vehicle exhausts. A fire during summer drought could potentially destroy more vegetation than construction. This risk cannot be quantified but can be mitigated through appropriate management systems.

Weeds

There is a risk during construction of the liberation of weed species not currently present on site, as a result of the importation of aggregates, topsoil, plant stock, or as seed on vehicles. This risk cannot be quantified but can be mitigated through appropriate management systems.

8.3.2 SEDIMENT DISCHARGE TO FRESHWATER

Introduction

Sediment discharge into waterways is an issue mainly during construction, when silt and soils from areas of open ground can be carried into waterways during rain events. Once the earthworks are completed and stabilised, sediment should not reach the waterways except perhaps in extreme rain events or if ground cover is again disturbed.

Sediment discharge modelling and management are addressed in Technical Reports prepared by SKM (Technical Reports 15), listed in the References section of this report.

General Adverse Effects

Poorly-controlled movement of sediment from areas of excavation or fill for road development or from areas of spoil storage, or poorly-executed culverting of streams are activities with the potential to adversely affect local stream ecology.

Some sediment discharge into all streams is both natural and necessary to supply food and to act as a medium for detritivore species and macrophytes and as food for net caddisflies. Too much sediment however, can create adverse and undesirable effects.

Too much sediment in solution (causing cloudy water) restricts periphyton growth (i.e. plant biomass, and, thereby, the food reservoirs for herbivores (including invertebrates, fish and water fowl (Briggs 1980)); it gets into, and interferes with, fish and invertebrate gills; and makes prey acquisition difficult for visual hunters. The realisation of such effects however, requires weeks of sustained heavy suspended sediment. Short-term, non-lethal effects include reach evacuation (by fish) and increased downstream drift of invertebrates, or a “close up shop” approach by Crustacea.

Prolonged periods of high suspended sediment levels can also change the physical properties of the habitat because turbid waters rise in temperature more quickly and to higher levels than clear water; also sediment increases nutrient status and smothers spawning gravels.

Too much sediment falling out of suspension and settling for too long causes coating of the substrate which, if heavy enough, kills periphyton (the grazers' food base), hides organic resource, smothers sessile or poor moving invertebrate species (killing them) and eventually fills interstitial spaces (reducing the habitat depth available). Long term it is this sedimentation of the between cobble space and surface that radically changes a hard substrate community and removes most of the EPT taxa replacing them with worms, midges and detrital species.

Guidelines and Trigger Levels

The Australia-New Zealand Environment Conservation Council (ANZECC) Guidelines (2000) have no set criteria for turbidity, because sediment itself can be both a necessity and a pollutant, and different systems require and tolerate different levels and at different frequencies. New Zealand data (ANZECC) suggests that as a first trigger (i.e. a change from unmodified to slightly modified) an NTU reading of 5.6 should be used. Above this reading, a river may be considered as modified. There is, however, no trigger point that reflects either adverse effects or sure harm. Note also that this discussion applies to base flows, not to storm flows.

In New Zealand some Regional Councils have adopted a trigger NTU of 25 based on levels needed to protect native fish. This is based on research such as Vinyard & Yaun (1996), Dorgeloh (1995), Rowe & Dean (1998) and Richardson et al (2001). These researchers showed that banded kokopu's upstream migration can be disturbed by NTU greater than 20 (22 gm-3) and in contrast that other native fish (koaro and common bully) do not avoid waters, or decrease feeding rates, with NTU as high as 300 (340 gm-3). Again this relates to base flows.

The figure of around 20-25 NTU should be considered a "warning" level (dependent on initial stream condition) rather than a "damaging" level. The data gathered by SKM through the current assessment process show (Table 11-38) that the streams studied have mean ranges of NTU between 8.9 and 24.3, already nearing the 25 NTU[5] trigger, although this mean will be elevated by higher turbidity during storm events. The median values, which limit the influence of these short term events, show a lower typical level of suspended sediment at between 2.8 and 7.3 NTU.

Table 11-38: Average Turbidity levels

Site name	Turbidity (NTU)	
	Mean	Median
Duck 2	13.8	8.1
Horokiri 3	20.5	4.9
Horokiri 4	18.4	7.6
Pauatahanui 2	21.9	2.6

Table I.1 in Appendix I. Turbidity Logger Data of Technical Report 15.

When considering the effect of much higher short term sediment pulses associated with rainfall events, Rowe et al (2002, 2004) tested suspended solid concentrations up to 10,000 NTU on a range of fish and failed to cause mortality. A range of other experiments (Rowe and Graynoth 2002, Barrett et al 1922, Vinyard & Yaun 1996, Dorgeloh 1995, James et al 2002) have explored raised sediment (NTU) effects – in all cases high sediments (>1000 NTU) in suspension are not (in the short term) significantly adverse. In summary adverse effects can occur where there is:

- a high NTU (>20-25 for migratory banded kokopu) or
- >300 NTU, or
- a 20% increase on the back ground average, or

[5] 25 NTU approximately equates to 25 mg/L (gm-3) TSS

- a level above 2 standard deviations from the norm is maintained for a long period (months) as was recorded at Meridian Energy's West Wind Windfarm project.

Each metric in this list is a proportional increase that is not scientifically proven but currently considered to be a sufficient change from a normal situation that indicates the potential for a change in state of habitat or biota.

Sediment Discharge Associated with the Project

SKM have addressed sediment yield, transport and management during construction and operation of the highway, and reports by SKM (Technical Reports 15) provide the data on existing levels of sediment yield and modelling of future yields on which this assessment is based.

The following table presents an unlikely worst case 'event' with no treatment during the period of maximum length of earthworks open. The sediment yield data were produced by SKM.

These data represent an estimate of sediment yield with no or minimal sediment management and are based on the following assumptions:

- The maximum length of road undergoing construction and open as bare earth during the six-year construction period
- The maximum lengths of road undergoing construction and open as bare earth in highly erodible catchments (namely the Horokiri catchment).

Table 11-39: Estimated % increase in sediment yield (tonnes) from baseline in a Q10 event (with no or minimal treatment).

Stream Discharge	% Increase Sediment Yield	Assessment of Impact Magnitude
Wainui/Te Puka	98%	Very High
Horokiri	47%	Moderate
Ration	142%	Very High
Pauatahanui	8%	Low
Duck	89%	Very High
Kenepuru	34%	Moderate
Porirua	7%	Low

The Ration, Duck and Kenepuru streams show the greatest increase in sediment loads from the baseline scenario all showing an 80% or greater change from baseline. The other streams show a lesser increase, between 32% and 55% above baseline, however, even this predicted change to sediment loading through the period of road construction, which may be up to three years in any one of these catchments, is considered significant and large.

Such increases in sediment in the downstream portions of all of these catchments would have serious adverse effects on the habitat quality and the current biodiversity of the Ration, Duck, Kenepuru, and Wainui systems.

In contrast, the Porirua lower system is currently in such a poor condition and adversely affected by a range of activities that even a 56% increase in sediment discharge over several years probably would not result in a significant habitat or biota change.

Given regional values present in most of the waterways, sediment discharge to streams at these predicted development levels in the absence of mitigation would not meet RMA requirements in relation to sustainable use and acceptable ecological effects.

The following table assesses the significance of the effects on each catchment.

Table 11-40: Significance of effect of sediment discharge during construction (with no or minimal treatment).

Streams	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Stream Habitat			
Te Puka / Wainui	High	Very High	Very High
Middle - Lower Horokiri	High	Moderate	High
Upper and Middle Duck	High	Very High	Very High
Moderate Value Stream Habitat			
Upper Horokiri East	Moderate	Moderate	Low
Lower Pauatahanui	Moderate	Low	Low
Lower Duck	Moderate	Very High	High
Upper Kenepuru (Cannon)	Moderate	Moderate	Low
Low Value Stream Habitat			
Ration	Low	Very High	Moderate
Porirua	Low	Low	Very Low

8.3.3 DISCHARGE OF CONTAMINANTS TO FRESHWATER

Water quality (other than suspended sediments) in the various catchments may be affected during construction from spills of chemicals and fuel and oil or by disturbing contaminated soils and buried materials with insufficient care. More often, water quality issues become apparent over longer time frames related to the operation of the road.

It is unlikely that contaminates from earthworks and general construction will affect the streams given the use of what are now typical spill precautions and bunded area reserves for refuelling and storage of materials etc. Nevertheless the Environmental Management Plans must contain management conditions and address spill minimisation, protocols for managing accidental discharges, and planning of bunded storage areas, and refuelling sites etc.

There is a low probability of water quality issues arising during construction through disturbance of sites that may contain contaminants. The Aurecon report (2010) assesses the potential for such sites and suggests that there are only three sites with high potential contaminant issues: the gun range near the Porirua Stream, the Car haul-a-way yard near the Te Puka / Wainui streams (MacKays Crossing) and several buildings near the Kenepuru Stream. The Aurecon report makes detailed reference as to how these sites are to be treated and how escape of any contaminants will be avoided. The report also addresses the longer term management of contaminant removed including ecological consultation for its long term disposal.

8.3.4 SEDIMENT DISCHARGE TO HARBOURS & STREAM MOUTHS

This assessment did not model the potential effects of sediment discharge and deposition during construction without mitigation (i.e. sediment and erosion control). The assessment of impacts on the Harbour and stream mouths is contained in Section 10.1.5.

9. ASSESSMENT OF OPERATIONAL IMPACTS

9.1 STORMWATER DISCHARGE

9.1.1 INTRODUCTION

Road surfaces contribute considerably larger pollutant loads compared with other land uses. In many studies, correlations have been made between the amount of pollutants generated and the road traffic volume (Wong et al 2000).

Surface water/storm water run-off from roads may contain litter and litter breakdown chemicals (nicotine, plastics etc), heavy metals (cadmium, chromium, copper, nickel, lead and zinc), Polyaromatic hydrocarbons (PAH), oils, surfactants and cause changes to the pH.

In ecological terms, the issue is that the introduction of new contaminants or raised levels of existing contaminants may adversely affect the benthic communities, whether through toxic effects (acute or chronic) with flow-on effects to the food chain, or through reduction in habitat quality (i.e. changing oxygen availability, changing the pH), or they may result in chemical barrier to fish migration.

Currently in most of the catchments there is a nutrient issue and in many cases an issue related to low zinc, cadmium and copper (SKM Technical Reports 15). This is especially the case in the more urbanised catchments (Porirua, Kenepuru). The adverse effects on aquatic ecology of road runoff have been relatively poorly studied; however, urbanisation and impervious surfaces (of which roading is a major contributor) has been reasonably-well studied, especially in the UK and USA (e.g. Barrett et al 1995, Chadwick et al 2006, May et al 199, Maxted & Scoggins 2004, Paul & Meyer 2001, Barbec et al 2002).

Suffice to say that over the long term chronic, and eventually acute, toxicity and the reduction of the habitat quality to a poor state eventually lead to serious consequences. These include: a simplification of the fauna and flora; development of a pattern of annual or seasonal issues such as algal blooms; occurrence of mosquito population explosions etc; a general lowering of biodiversity; and simplification of food webs leading to retardation of organic matter processing and other functional issues.

9.1.2 POTENTIAL WATER QUALITY EFFECTS

The long term, operational consideration is of road run off / storm water contamination. Table 11-41 and Table 11-42 illustrate contaminant loading from literature (Wong et al 2000). While US data (Livingston, 1997) are 14 years old the values remain as indicative for the NZ condition as they were in 1997.

Table 11-41: Urban land use and typical pollutant loads (kg/ha/yr) (Livingston, 1997).

Land use	TSS	Pb	Zn	Cu	TP	TKN	NH4-N	NOx-N	BOD	COD
Freeway	986	5	2.4	0.41	1	8.8	1.7	4.7	N/A	N/A
Parking lot	448	0.9	0.9	0.04	0.8	5.7	2.24	3.24	53	302
High density residential	470	0.9	0.8	0.03	1.1	4.7	0.9	2.2	30	190
Medium density residential	213	0.2	0.2	0.15	0.5	2.8	0.5	1.6	14	80
Low density residential	11	0.01	0.04	0.01	0.04	0.03	0.02	0.11	N/A	N/A
Commercial industrial	1120	3.0	2.4	0.45	1.7	7.5	2.1	3.5	69	470
Park	3.3	0.005	N/A	N/A	0.03	1.6	N/A	0.33	N/A	2.2
Construction	67,200	N/A	N/A	N/A	90	N/A	N/A	N/A	N/A	N/A

Table 11-42: Highway runoff concentrations for various storm water pollutants (Driscoll et al., 1990)

Pollutant	EMC* for highways with <30,000 vehicles/day (mg/l)	EMC for highways with >30,000 vehicles/day (mg/l)
Total suspended solids	41	142
Copper	0.022	0.054
Zinc	0.08	0.329
Lead	0.08	0.4
Nitrite and Nitrate	0.46	0.76
TKN	0.87	1.83
Phosphate	0.16	0.4
Volatile suspended Solids	12	39
Total organic carbon	8	25
Chemical oxygen demand	49	114

*EMC: Event Mean Concentration

These examples show that motorways ("freeways") are major sources of TSS, metals volatile suspended solids and even nutrients. These tables do not include the PAH data, also reported in Wong et al (2000) from Smith et al., 1995. These too are greatly exacerbated by roading. As noted above there is a range of references that cite or show adverse effects on aquatic habitat and communities, all generally illustrating a loss in biodiversity, reduction in habitat quality and toxic effects to later food web members (typically fish).

9.1.3 STORMWATER DISCHARGE TO STREAMS

A key consideration in the assessment of the impact of stormwater discharge to Pauatahanui and to streams is the change in road use associated with the Project. The following reductions in traffic currently using Grays road and SH58 once the Project is operational have been calculated.

- SH58 between Paremata and the TG route will experience a reduction in traffic volumes of between 24% and 34%.
- Grays road between Plimmerton and the TG route will experience a reduction in traffic volumes of between 42% and 54%

Stormwater from these two roads currently discharge directly to the harbour without treatment. The movement of this traffic to Transmission Gully provides the opportunity to provide treatment prior to discharge and for there to be mixing before arrival at the harbour.

SKM has modelled the current trend in heavy metal in key streams along the alignment. Table 11-43 shows a comparison of predicted suspended contaminant levels in lower stream sections (near the mouth) of eight streams in 2031, both without Transmission Gully, and with Transmission Gully but no treatment.

Table 11-43: Comparison of contaminant discharge from Road 2031 against baseline without road (no treatment).

	2031 without road				2031 with road (No treatment)			
Catchment (taken at mouth)	Total Zinc (g/m³)	Trigger	Total Copper (g/m³)	Trigger	Total Zinc (g/m³)	Trigger	Total Copper (g/m³)	Trigger
Horokiri	0.009	Fail	0.002	Fail	0.010	Fail	0.002	Fail
Pauatahanui	0.012	Fail	0.003	Fail	0.013	Fail	0.003	Fail
Porirua	0.069	Fail	0.010	Fail	0.069	Fail	0.011	Fail
Duck	0.038	Fail	0.004	Fail	0.042	Fail	0.005	Fail
Ration	0.005	Pass	0.001	Pass	0.008	Fail	0.002	Fail
Kenepuru	0.084	Fail	0.006	Fail	0.086	Fail	0.006	Fail
Te Puka	0.004	Pass	0.001	Pass	0.005	Pass	0.001	Pass
Whareroa	0.004	Pass	0.001	Pass	0.004	Pass	0.001	Pass

From SKM Technical Report #15; App 15Z Table z.5

For this analysis we have considered whether the increases in contaminant levels will result in discharges that exceed ANZECC guidelines 95% trigger values, where they currently fall below them. The 95% trigger for zinc is 0.008 (g/m³) and for copper is 0.0014 (g/m³).

Table 11-43 shows that a number of streams are predicted to fail the ANZECC 95% test without Transmission Gully. Further, the predicted increases in total copper and zinc associated with the Project are very small or negligible. It concludes that discharges from Transmission Gully are only predicted to increase baseline levels above the ANZECC 95% trigger for Ration Stream.

Table 11-44 predicts changes to total (deposited and suspended) sediment with road construction at specific stream locations, based on the existing levels of zinc and copper in sediments at sampling sites along the alignment, compared with predicted increases of zinc and copper based on data from other SH1 roads in Wellington and Auckland.

Table 11-44: Predicted changes in total zinc (Zn) and copper (Cu) using existing sampling results and predicted levels based on motorway data from Auckland and Wellington.

	2010 without road (Median concentrations)				**Predicted sediment concentration with road**			
Deposited sediment sampling sites	Zn (g/m3)	Trigger (0.008 g/m3)	Cu (g/m3)	Trigger (0.0014 g/m3)	Zn (g/m3)	Trigger (0.008 g/m3)	Cu (g/m3)	Trigger (0.0014 g/m3)
Whareroa 1	0.003	Pass	0.0011	Pass	0.0030	Pass	0.001	Pass
Te Puka 1	0.001	Pass	0.0003	Pass	0.0038	Pass	0.001	Pass
Te Puka 2	0.002	Pass	0.0008	Pass	0.0032	Pass	0.001	Pass
Upper Horokiri 1	0.001	Pass	0.0006	Pass	0.0029	Pass	0.001	Pass
Horokiri 2	0.001	Pass	0.0005	Pass	0.0018	Pass	0.001	Pass
Upper Ration 1	0.003	Pass	0.0007	Pass	0.0064	Pass	0.002	**Fail**
Ration 1	0.003	Pass	0.0007	Pass	0.0049	Pass	0.001	Pass
Pauatahanui 2	0.003	Pass	0.0020	**Fail**	0.0035	Pass	0.002	**Fail**
Duck 1	0.001	Pass	0.0004	Pass	0.0019	Pass	0.001	Pass
Duck 2	0.002	Pass	0.0009	Pass	0.0029	Pass	0.001	Pass
Kenepuru 1	0.001	Pass	0.0005	Pass	0.0020	Pass	0.001	Pass
Kenepuru 2	0.002	Pass	0.0008	Pass	0.0024	Pass	0.001	Pass
Porirua 2	0.045	**Fail**	0.0040	**Fail**	0.0445	**Fail**	0.004	**Fail**

Data provided by SKM. Shown as graphs in Technical Report #15; Figures 15.58 to 15.65

Sampling shows that two streams currently have total levels of zinc and or copper that exceed the ANZEEC 95% Ecological Trigger levels (Sample sites Pauatahanui 2 and Porirua 2).

This table predicts that in all cases construction of a motorway will lead to increases in total contaminants at all sites. However, it predicts that only one stream (Upper Ration) that does not currently exceed trigger level, will have increases that cause it to exceed the ANZEEC 95% Ecological Trigger with the road.

Additionally, Figure 15.64, 15.65 (SKM TR15) present loadings of zinc and copper at a stream catchment level. These results show that in addition to Ration, Pauatahanui and Porirua, two other streams, Duck and Kenepuru, may currently fail to meet the ANZEEC 95% Ecological Trigger levels and will continue to do so with the road. However, no other catchment is pushed over the ANZECC trigger level by motorway operation.

Table 11-45 assesses the ecological impact of stormwater discharge given the results of the above modelling. Overall we consider that even without treatment the ecological effects will be very low.

Table 11-45: Significance of effect of stormwater contamination on streams during operation (with no or minimal treatment).

Catchment (taken at mouth)	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Stream Habitat			
Te Puka Stream	High	Negligible	Low
Mid and Lower Horokiri Stream	High	Negligible	Low
Upper and Mid Duck Creek	High	Negligible	Low
Moderate Value Stream Habitat			
Upper Horokiri Stream	Moderate	Negligible	Very Low
Lower Duck Creek	Moderate	Negligible	Very Low
Pauatahanui Stream	Moderate	Negligible	Very Low
Kenepuru Stream (Cannons)	Moderate	Negligible	Very Low
Whareroa / Wainui Stream	Moderate	Negligible	Very Low
Moderate Value Stream Habitat			
Ration Stream	Low	Moderate	Very Low
Porirua Stream	Low	Negligible	Very Low

It should be noted that these minor increases are averaged across the catchment and there will be elevated levels in short sections of stream immediately downstream of discharge. These cannot be modelled accurately.

9.1.4 STORMWATER DISCHARGE TO HARBOUR AND ESTUARIES

Currently, stormwater contaminants are below biological effects thresholds in surface sediment from the Pauatahanui Inlet arm of Porirua Harbour, whereas the Onepoto Arm surface sediment is commonly above biological effects thresholds. Higher concentrations of contaminants are present in the central subtidal basins within the Pauatahanui Inlet. It is in this part of the inlet, where ecological values are lower, that we expect contaminant concentrations to further increase in the long term, potentially to above biological effects thresholds.

During the operational phase of the Project, treated runoff from the road will discharge to the Porirua Harbour and to the open coast via Wainui Stream. For this analysis of changing contaminant levels over time to these waterbodies we have used the same catchment projections from SKM, but have applied the ANZECC marine 99% Trigger Guideline which is Zinc 0.007 (g/m^3), and Copper 0.0003 (g/m^3).

Table 11-46: Comparison of Contaminant Discharge from Road 2031 against baseline without road (no treatment).

	2031 without road				2031 with road (No treatment)			
Catchment (taken at mouth)	Total Zinc (g/m^3)	Trigger	Total Copper (g/m^3)	Trigger	Total Zinc (g/m^3)	Trigger	Total Copper (g/m^3)	Trigger
Horokiri	0.009	F	0.002	F	0.010	F	0.002	F
Pauatahanui	0.012	F	0.003	F	0.013	F	0.003	F
Porirua	0.069	F	0.010	F	0.069	F	0.011	F
Duck	0.038	F	0.004	F	0.042	F	0.005	F
Ration	0.005	Pass	0.001	F	0.008	F	0.002	F
Kenepuru	0.084	F	0.006	F	0.086	F	0.006	F
Te Puka	0.004	Pass	0.001	F	0.005	Pass	0.001	F
Whareroa	0.004	Pass	0.001	F	0.004	Pass	0.001	F

From SKM Water Quality Assessment of Effects (Table 79, pg 236)

This projection (to 2031) without the road already exceeds ANZECC Trigger levels of biological effects for Copper at all stream mouths and for Zinc at all but three. With the road, the only change is that Ration moves from a pass to a fail trigger.

Table 11-47 shows the assessment of ecological impact given the results of the above modelling. Overall we consider that even without treatment the ecological effects will be very low.

Table 11-47: Significance of effect of stormwater contamination on stream mouths during operation (with no or minimal treatment).

Catchment (taken at mouth)	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Horokiri	High	Negligible	Low
Pauatahanui	High	Negligible	Low
Duck	High	Negligible	Low
Ration	Moderate	Moderate	Low
Porirua	Moderate	Negligible	Very Low
Kenepuru	Moderate	Negligible	Very Low
Whareroa / Wainui	Moderate	Negligible	Very Low

The discharge of treated stormwater will contribute in the long term to the accumulation of contaminants in marine sediments. As with any stormwater discharge, there will be cumulative effects in the long term arising from the contaminants contained in the discharge accumulating in the environment.

9.2 FAUNA

Falcon & Kaka

Both of these species are present in low numbers. No habitat required by these forest species for roosting, nesting, or feeding will be lost. There is no evidence that either species is at risk of collision with traffic. In the long term retirement of pasture and revegetation of the Te Puka and Horokiri will expand forest habitat.

Overall we consider the risk of adverse effects on these species from operation of this road to be negligible.

Black and Pied Shag

These birds make use of the habitat provided by the main stem of the Horokiri Stream. No habitat required by bats for roosting and nesting, and feeding will be lost and in the long term the revegetation of the stream margins will provide additional roosting habitat.

Overall we consider the risk of adverse effects on these species from road operation of this road to be negligible.

Bats

There is no research in New Zealand on the effect of roading on bats, either in terms of disturbance or mortality. Internationally research suggests that bats display clear avoidance behaviour of traffic (Zurcher, 2010), however, bat mortalities have been recorded at a number of sites (Gaisler, 2007 and Lesiński, 2007). There appears to be a range of factors influencing mortality, for instance in some studies the species most affected are those that "commute" daily to feeding areas. Other factors are the density of the resident bat populations, and the types of roadside vegetation (Russell, 2009).

We have not yet confirmed the presence of bats at this site and this should be done. An accurate assessment of risk requires a better idea of distribution and abundance. However, assuming they are present in the forest above Wainui Saddle and actively forage along the bush margins of the Te Puka and upper Horokiri there is a risk of mortality. This effect may, at least in part be mitigated by the retirement of pasture, and expansion of shrublands and scrub across this site.

Overall, and assuming bats are present, we consider the risk of adverse effects from operation of this road to be low to moderate.

Pipit

In the long term, the retirement and revegetation of pasture will reduce habitat for Pipit in the Te Puka and upper Horokiri, therefore it will impact on the local population. However, this revegetation is returning the landscape to its original forested habitat. Pipit are present today only as opportunistic species making use of a landscape that has been modified in such a way that it provides habitat.

Overall, we consider the effect on pipit from operation of this road to be low.

Fish Passage

We are confident that fish passage can be provided to all streams affected by this Project where native fish are known to be present. One issue during operation is the continued maintenance of culverts, their intakes and outlets to ensure that bank erosion, debris deposition, and structural wear and tear, are managed to maintain the conditions necessary for passage past these structures.

With ongoing programmed monitoring and maintenance of culverts, we consider the risk of adverse effects on fish passage from operation is moderate. Table 11-48 summarises our assessment of effects for flora and fauna.

Table 11-48: Significance assessment of operation on Flora and Fauna of Conservation Value (without mitigation).

	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Terrestrial Flora			
Leptinella tenella	Moderate	Negligible	Very Low
Terrestrial Fauna			
Lizards and Invertebrates	Low	Negligible	Very Low
Avifauna & Bats			
Falcon	Very High	Negligible	Low
Kaka	Very High	Negligible	Low
Pied Shag	Moderate	Negligible	Very Low
Black Shag	Very High	Negligible	Low
Pipit	Moderate	Low	Low
Long-tailed bat	Very High	Low	Moderate
FW Fauna			
Indigenous Fish (fish passage)	High	Low	Moderate

9.3 SUMMARY OF CONSTRUCTION AND OPERATION EFFECTS

In summary construction and operation of the road is likely to have moderate to very high impacts on several ecological components without mitigation as follows:

Very High

- Habitat loss and modification in Te Puka stream as a result of diversion and culverting;
- Habitat loss and modification in Horokiri stream as a result of diversion and culverting;
- Potential Impacts on Te Puka Stream from sediment discharge during construction;
- Potential Impacts on Duck Creek as a result of sediment discharge during construction.

High

- Potential Impacts on Horokiri Stream as a result of sediment discharge during construction;
- Potential Impacts on Pauatahanui Inlet as a result of sediment discharge during construction;
- Potential Impacts on Kenepuru Stream as a result of sediment discharge during construction.

Moderate

- Potential loss of small areas of high value regenerating broadleaf forest (Cannons Creek Bush and Porirua Park Reserve);
- Potential loss of small areas of high value mature native forest (Rowans Bush, Roberts Bush, Tawa forest in Cannons Creek Bush);
- Habitat loss and modification in Lower Te Puka stream as a result of diversion and culverting;
- Habitat loss and modification in Duck Creek as a result of diversion and culverting;
- Potential Impacts on Ration Stream as a result of sediment discharge during construction;
- Potential Impacts on fish populations through habitat loss and construction mortality;
- Potential Impact during operation on long-tailed bat populations.

In addition we conclude that without comprehensive management of erosion and sediment discharges there will be high to very high adverse effects on Pauatahanui Inlet intertidal and shallow subtidal habitat, and moderate to high adverse effects on the Onepoto Arm. This is assessed in the following section.

All other ecological components are assessed to have low to very low impacts due to either their low value, or the low magnitude of anticipated effects.

10. PROPOSED MITIGATION

10.1 PROPOSED CONSTRUCTION MITIGATION

10.1.1 TERRESTRIAL VEGETATION & HABITATS

Conservative Approach

For this assessment of effects and the calculation of mitigation we have considered that all vegetation within the designation is at risk, even though some of this land will not be cleared. This conservative approach has the following benefits:

1. We believe that the magnitude and duration of potential effects to streams and the estuary are greater than the effects from vegetation clearance, and the mitigation of impacts of freshwater and estuarine systems is much harder to achieve than for terrestrial vegetation loss. For this reason we believe that all land within the designation should be available, without constraint, during construction to achieve the levels of erosion control and sediment management required and respond to issues that arise.
2. Providing this flexibility during construction is also anticipated to reduce construction time which reduces risk.
3. This approach also recognises that, for some vegetation types, die back will extend many metres beyond the cut edge as a result of desiccation, windthrow, and weed invasion.

Avoidance through Detailed Design

There will be some opportunities during detailed design to minimise effects on a number of high value areas of mature forest (coastal kohekohe, lowland podocarp/tawa, or montane podocarp hardwood forest that falls within the designation but not the Project Footprint.

Table 11-49 shows for instance that careful design and site management could potentially reduce the effects on mature indigenous forest from 21 ha to 6 ha.

Table 11-49: Magnitude of Terrestrial Vegetation Loss and Modification (by feature)

DESCRIPTION (listed North to South)	Ecological Value	Area within study area (ha)	Area in Designation (ha)	Area in footprint (ha)
Wetlands	H	34	2	2
Shrublands & Scrub	L	1,202	50	16
Manuka or Kanuka	M	590	10	4
Regenerating broadleaf forest	H	1,527	37	12
Mature or maturing indigenous forest	H	225	21	6
Total		**3,578**	**120**	**40**

The sites where opportunities exist for further avoidance may be achievable are:

- Rowans Bush (139) in the Wainui Catchment.
- The various coastal kohekohe remnants in the Te Puka Catchment (KCDC Ecosites K223-229)
- The Akatarawa - Whakatikei Regional Forest Park
- TG Riparian Area (PCC Ecosite 199).
- Tawa remnants within Cannons Creek Bush (PP12) in the vicinity of the Cannons Creek Bridge
- Porirua Park Bush (PCC76)

In addition, where possible attempts should be made to avoid seral scrub and forest (kanuka scrub and forest, mahoe dominated scrub and low forest) particularly where it is found as riparian cover. This includes:

- Gullies crossed by the TG alignment on the western slopes of Te Puka and Horokiri catchments.
- Scoresby Grove Kanuka (PCC Ecosite 196).
- James Cook Drive Bush (PCC Ecosite 33).
- Whitby Bush (PCC Ecosite 155b).
- Exploration Drive Kanuka (PCC 190).
- Cannons Creek Bush (PCC 12).
- Roberts Bush (PCC88).

Where any of these forests cannot be avoided, mitigation needs to be provided that takes into account their value and maturity.

Mitigation for Permanent Vegetation Loss

We have calculated conservatively that up to 120 ha of vegetation could be affected by construction activities, which could include permanent loss beneath the project footprint, or damage or removal in other areas within the designation.

There is no national standard or accepted guidance for the calculation of mitigation for vegetation loss. We have calculated that 250 ha of revegetation is required based upon the following Compensation Ratios.

Table 11-50: Mitigation Calculation for Vegetation Loss

Habitat Type	Loss (ha)	ECR Ratio	Mitigation Area (ha)
Wetlands	2	x 3	6
Shrublands in pasture dominated by tauhinu	50	x 1	50
Kanuka scrub and low forest	10	x 2	20
Regenerating native forest (Mahoe)	37	x 3	111
Mature native forest (tawa, kohekohe)	21	x 3	63
TOTALS	**120**	-	**250**

Four broad restoration treatments are proposed for the site. They will be like for like and generally in the catchments where the most vegetation clearance will occur. They are:

- **Terrestrial Revegetation**: standard mass planting, typically in pasture, and using native pioneer species (e.g. tauhinu, cottonwood, *Coprosma*, *Hebe*, kanuka, *tarata*, ngaio), with some future canopy species interspersed.
- **Riparian Revegetation**: as above but using rapid growing and strongly rooted species suited to riparian environments (e.g. toetoe, flax, kowhai, cabbage tree, tutu, kohuhu, wineberry), with some future canopy species interspersed (e.g. kahikatea, pukatea, swamp maire). The objective is to restore a forest canopy to streams that are revegetated.
- **Enrichment planting**: typically where there is already regeneration of open shrublands that can provide a nursery. Planting will be of future canopy species (e.g. rewarewa, titoki, kohekohe, pigeonwood, tawa, and podocarps).
- **Retirement**: typically where natural regeneration has progressed to the point that additional planting is not required. The activities associated with this are fencing and pest control.

Early Retirement Planting

Approximately 31 ha of early retirement plantings, including both riparian and terrestrial revegetation, have been undertaken by NZTA over the last eight years as part of conditions for the existing designation. These are now the best areas of indigenous forest within the proposed designation in Ration Stream and within the main branch of Duck Creek.

The original purpose of these was to provide advance mitigation for stream loss and provide some buffer between construction effects and these streams. The base estimate considers these areas to provide existing environmental benefits.

Proposed mitigation planting for this Project includes continued maintenance of these sites and identifies opportunities to expand several of them.

A detailed discussion of the retirement and revegetation of these sites is provided in Appendix 11.L.

Proposed Mitigation Areas

In determining the ideal mitigation areas a number of potential sites were considered and the range of benefits that could be achieved by their retirement and revegetation were assessed (See Appendix 11.G). In addition the current vegetation within each potential mitigation site was mapped so that the existing values could be considered (see Appendix 11.H).

From this work, in addition to the existing retirement areas, a further four mitigation sites were chosen:

- Te Puka Valley: western slopes to ridgeline and valley floor;
- Horokiri Valley: eastern slopes to ridgeline and valley floor;
- Lanes Flats: swampy terraces adjacent to Pauatahanui Stream;
- Ranui Heights: a strip of planting from Cannons Creek Bridge to Kenepuru off-ramp.

The total area of selected mitigation sites, including early retirement sites, is 426 ha which exceeds the 250ha required. However, only 270 ha of this land is proposed to receive some form of planting treatment. The retirement of the remaining 155 ha is required for mitigation of effects on freshwater habitat which is described below.

The following table lists the areas of retirement and treatment that are proposed. More detail can be found in Appendix 11.I and Figure 11.11.

Table 11-51: Mitigation Treatments proposed for Vegetation Loss

Type of Mitigation	Retirement Area (ha)
Existing Benefit (early retirement planting)	31
Revegetation Area (proposed)	53
Enrichment Area (proposed)	187
Retirement and Protection (proposed)	155
TOTAL	**426**

Summary

Assuming that the compensation ratio is accepted and there is agreement that the early retirement planting can be included as existing benefit, we conclude that all vegetation effects with mitigation are neutral or positive depending on the catchment, and given a greater area of land will be retired than is required.

10.1.2 TERRESTRIAL FAUNA

Terrestrial invertebrates

Effects on *Peripatus novaezealandiae* can be minimised by translocation of logs and debris containing these insects to safe habitats adjacent to the project footprint, immediately prior to vegetation clearance/construction. These habitats are easily identified and can be moved by hand or small vehicle to the edge of suitable vegetation. No further mitigation is required.

Lizards:

Effects on common lizards, found in some habitats along the route, can be minimised by capture and translocation of animals immediately prior to vegetation clearance/construction. No further mitigation is required.

10.1.3 FRESHWATER FAUNA

Through the process of route refinement, all streams that will be affected by the project have been visited and those that require fish passage have been identified.

Of the 102 culverts that will be installed, we have determined that 27 will be placed in streams that contain resident fish and must be designed for fish passage. In addition we have considered culvert size, length and gradient and identified those that require standard treatments such as embedding (17 culverts) and those that will require innovative solutions due to their length or extreme gradient (10 culverts).

We have also developed guidelines for the formation of diversions intended to mirror the gradients, flow velocities, bed roughness, and habitat richness of the reclaimed stream.

Overall we believe fish passage can be maintained within all streams where fish are currently resident.

10.1.4 FRESHWATER HABITATS

Mitigation of adverse effects on aquatic and riparian habitat loss/change is proposed to be achieved through:

- Maintenance of water quality – via treatment of sediment run-off and stormwater water quality;
- Revegetation of riparian edges in strategic locations (locations selected to maximise biodiversity gain);
- Creation of new reaches of waterways for reaches diverted from road footprint;
- Creation or enhancement of wetlands (including those for water quality management);
- Limited retirement from grazing/stock access to waterways in Horokiri and Te Puka catchments;
- Weed and pest control.

The Stream Ecological Valuation system (SEV) was used for assessing mitigation requirements. SEV was developed by NIWA for the Auckland Regional Council as a tool to provide standardised stream assessments, create a functional measure and provide a method for the calculation of off-setting mitigation based on stream quality. It is described in more detail in Technical Report 9.

SEV was used to run several scenarios looking at the values remaining to a culvert channel, of a healed diversion channel, of opening up a non-fish passage upper catchment section to fish and of a general side tributary enhanced by the mitigation land management change proposed. These were run to allow estimates of value gained and lost by changes to the physical structure of a stream or management /restorations/ proposed.

The SEV off-set values were attained using representative Duck, Te Puka and Horokiri sections. Duck Creek was used in the fish passage modelling as this is where the upper catchment will gain from the mitigation actions proposed to retrofit existing passage blocking main stem culverts. Horokiri and Te Puka were used for the diversion modelling as these systems are areas where much of the main stem diversions will be installed, and Horokiri was also used in the stream loss modelling.

The resultant ECRs are the compensation ratios produced by these modelled scenarios. The following table (Table 11-52) presents the ECRs for each modelled scenario. The data used to derive these ECRs is presented in Appendix 5 of Technical Report 9.

Table 11-52: Ecological Compensation Ratios for differing effect scenarios.

Scenario	ECR
Correcting fish barrier culverts in Duck	-1.5
Horokiri-Te Puka diversions	1.7
Culverting flat sections	2.2
Culverting steep sections	4.1
Complete loss of stream sections	6

Using the ECRs in conjunction with linear measures of different stream effect provides the following linear measures of stream mitigation (Table 11-53). Note armouring is considered as a diversion in that it is not new but modified habitat.

Table 11-53: Calculation of ecological aquatic compensation requirements for the Transmission Gully roading Project.

Scenario effect	Affected length (linear m)	ECR Ratio	Calculated Compensation Required (linear m)
Culvert steep	409	4.1	1,677
Culvert flat	3,208	2.2	7,058
Culvert armouring	860	1.7	1,462
Culvert stream loss	809	6.0	4,854
Diversion length	4,039	1.7	7,029
Diversion armouring	500	1.7	870
Diversion stream loss	593	6.0	3,555
TOTAL	**10,418**	**TOTAL**	**26,504**

In this table we have divided culverts to be installed into steep ones (over 20% gradient) or flat ones (<20% gradient). Because they offer very different habitat opportunities after installation, we have decided that they have different ECR ratios. We have treated bank armouring as habitat recreation under the diversion scenario for the ECR. The habitat totally lost from the process (i.e. in-filled, and later to be diverted around) has the highest ECR ratio based on the enhancement of the remaining main stem and side tributaries in the Horokiri.

Habitat Loss And Modification

Around 10,400 m of perennial or intermittent stream are adversely affected in the Project. The SEV calculation (with the array of assumptions required) suggests 26,000 m of stream will be required within the mitigation package based on the benefits and actions we have proposed.

As discussed in section 10.1.1 above, the proposed mitigation actions are largely centred on the upper Horokiri and Te Puka, although there are a number of pre-planted riparian areas associated with the Duck and Ration systems and the culvert correction actions in the main stem of the Duck.

We have chosen to focus mitigation for stream effects on these two catchments, where substantial land retirement and stream enhancement is possible, rather than creating small isolated sites along the route and within each affected catchment.

The goal of the mitigation is to achieve at least no net loss, and if possible some long term ecological benefit, which we feel is appropriate given the scale of stream effects that will occur.

Four mitigation treatments are proposed for the loss or modification of aquatic habitat:

1. **Diversion Construction**: During the field investigations detailed information was gathered on the morphology of the streams that will be diverted. This information can be used in the design and construction of the diversion.
2. **Culvert Design**: In all culverts in perennial or intermittent streams, with a grade <20%°, will be embedded to allow streambed habitat to pass through them. There are a number of accepted methods for the design of these culverts that will also ensure fish passage.
3. **Land retirement & Revegetation**: as described in 10.1.1.
4. **Offset Mitigation**: This assessment process has identified opportunities for additional offset mitigation through the repair of perched culverts in Duck Creek and SH58, which are limiting fish movement within these catchments. The replacement of these culverts would provide significant ecological benefits within these catchments. The cost of replacing these culverts is included in the ecological mitigation costs.

Table 11-54: Mitigation Treatments proposed for Stream Bed and Riparian Habitat Loss

Type of Mitigation (Required EC of 26,000 m)	Length
Diversion length restored and new culvert habitat	8,607
Land use change and Riparian Planting (existing 10.5 ha; plus new 7.5 ha)	13,762
Offset (Duck Creek Culvert fish passage)	8,541
TOTAL	**30,910**

This mitigation will also deal with the fundamental characteristics of all stream diversions (i.e. alignment, sinuosity, width, profile, bank and bed treatment, etc).

Assuming that the compensation ratios (SEV) for different stream activities are accepted and there is agreement that the early retirement planting can be included as existing benefit (for both loss of terrestrial vegetation and riparian vegetation), we conclude that on average effects on freshwater habitat will be neutral. There will be specific locations where significant adverse effects will occur (e.g. Te Puka) that cannot be mitigated within that site, and other areas where the effects of mitigation will be significantly positive (e.g. Horokiri) and offset effects on areas elsewhere.

10.1.5 TEMPORARY CULVERTS

Subject to the following suggested conditions, we do not believe the installation of temporary access culverts will lead to sufficient adverse effects to warrant mitigation. Our conditions are:

- No culvert will be in place longer than two years;
- Where reasonably practical all temporary culverts will be installed at existing crossings to minimize riparian effects and earthworks;
- Culvert design will follow ARC31 protocols to ensure fish passage is maintained;
- Following removal, remedial action will include substrate cleaning, bank reformation and stabilization (gabions or riprap to prevent erosion and undercutting); and
- Riparian revegetation will be carried out over the section affected.

10.1.6 CONSTRUCTION DISCHARGES

Mitigation Of Sediment Discharge Effects

Mitigation of effects on ecological values is based on proposals for sediment discharge put forward as part of design and mitigation by SKM (Technical Reports 14). Treatment at source underpins the approach to management of construction run-off. A realistic understanding of the efficiency of treatment systems and the nature, levels and timing of discharge of sediment actually likely to reach waterways is essential and provided by SKM (Technical Reports 15).

The Erosion & Sediment Control (E&SC) Philosophy produced by SKM was based around the Greater Wellington Regional Council (GWRC) Sediment and Erosion Control Guidelines (2006). The guidelines draw on material from the Auckland Regional Council (ARC) Technical Publication 90 (TP90), Erosion and Sediment Control Guidelines for Land Disturbing Activities.

SKM and BML have worked together to formulate the sediment management principles and goals, and to develop the Supplementary Environmental Management Plan (SEMP) details in respect of "hot spots" (Horokiri, Pauatahanui and Duck), as well as management and minimisation of sediment generation and discharge.

The principles are now relatively standard across New Zealand[6,] and include:

- minimise earth disturbance;
- stage works,
- protect steep slopes;
- protect the site from external water;
- protect water bodies;
- stabilise exposed areas as fast as possible;
- have perimeter controls;
- employ sediment retention devices;
- have a plan with provisions for thorough inspection and revision to ensure that plan is effective and evolves.

In essence the majority of sediment management involves cut off drains around the works; early (first) installation of tributary culverts; use of various surface stabilisation methods (geotextiles, grassing mulching etc); sediment retention devices (often tanks due to the terrain's steepness); velocity control devices; and establishment of a suitable vegetated waterway buffer. Table 11-55 below (taken from SKM E&S report, table 12) shows the predicted sediment yields with mitigation management.

Table 11-55: Sediment yield estimates for construction with mitigation

	Increase in sediment (%) from base line		
Catchment	**Q2 event**	**Q 10 event**	**Q50 event**
Whareroa	5	5	9
Wainui / Te Puka	29	29	59
Horokiri	14	14	28
Ration	43	43	85
Pauatahanui	2	2	5
Duck	27	27	53
Kenepuru	10	10	20
Porirua	2	2	4

From SKM Technical Report #15; App 15.S, Table S.2.

[6] Refer SKM reports

Table 11-55 shows the levels of increased sediment entering streams with comprehensive erosion control and stormwater treatment Table 11-56 compares this result for a Q10 rainfall event, with the level of sediment generation without treatment. These tables show a significant reduction in sediment loads due to mitigation.

Overall, in a Q10 event the predicted sediment discharges to the various waterways of the catchments affected by the road development, with the array of treatment envisaged, and with the effectiveness of that treatment as predicted, results in sediment changes within 20% of the background levels.

This then means that the expected sediment increase with a successful sediment management programme is can be expected to raise the typical rain event suspended sediment levels in the rivers as follows (Table 11-56). This calculation also assumes: the Q50 large storm effect is ignored; the retirement is immediate; and the effects on vegetation and relief from current sediment discharge are also immediate.

Table 11-56: Comparison of estimated % increase in sediment yield (tonnes) from baseline in a Q10 event (with and without treatment).

Catchment	Q10 (without treatment) see Table 11-39	Q10 with full treatment (as above)	Assessment of Impact Magnitude with treatment
Whareroa	16%	5%	Negligible
Te Puka/Wainui	98%	29%	Moderate
Horokiri	47%	14%	Low
Ration	142%	43%	Moderate
Pauatahanui	8%	2%	Negligible
Duck	89%	27%	Moderate
Kenepuru	34%	10%	Low
Porirua	7%	2%	Negligible

The reductions in sediment yield between the two scenarios ranges from 75% to 80% and results in the following assessment of significance.

Table 11-57: Significance of effect of sediment discharge during construction (with mitigation).

Streams	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Stream Habitat			
Te Puka / Wainui	High	Moderate	High
Middle - Lower Horokiri	High	Low	Moderate
Upper and Middle Duck	High	Moderate	High
Moderate Value Stream Habitat			
Upper Horokiri East	Moderate	Low	Low
Lower Pauatahanui	Moderate	Negligible	Very Low
Lower Duck	Moderate	Moderate	Low
Upper Kenepuru (Cannon)	Moderate	Low	Low
Low Value Stream Habitat			
Ration	Low	Moderate	Very Low
Porirua	Low	Negligible	Very Low

Land Retirement

A number of areas are proposed for retirement for a range of reasons including ecological, aesthetic and habitat and involve largely areas in the headwaters of Te Puka, Horokiri and Duck. This retirement will lead to removal of stock, cessation of some other land uses, and reversion to shrubland vegetation. This land retirement will reduce the future background discharge. SKM have attempted to calculate the outcome of that effect.

SKM state that:

> *"It is difficult to quantify the effect that these areas will have on reducing sediment in the streams and Harbour as not a lot of research exists that quantifies this in measurable terms. A rough estimation can be approximated using the USLE as one of the factors used in this equation accounts for land cover type. However unfortunately the USLE doesn't differentiate significantly between 'plantation forest' and 'pasture' but it does account for 'native bush/forest' where the structure and complexity of this type of land cover would have an effect on sediment runoff." (TR15).*

SKM calculate that the background levels in the Duck catchment will fall 9.7%, 3.6% in Horokiri, 9.0% in Te Puka/Wainui, 0.5% in Kenepuru and 0.1% in Pauatahanui, once those catchment areas are retired (TR15, Table 15.26). This will provide small ecological benefits to both these streams and to the Porirua Harbour.

<u>Conclusion</u>

It appears that provided:

- construction is managed to minimise sediment generation (using the best practice methods and the mechanisms and philosophies as outlined in the SKM report and the Greater Wellington Regional Council practice guideline) and
- all of the devices are installed (as in the SEMP "Hot spots" example), appropriately sized, and managed and maintained correctly;

then the freshwater systems downstream of the construction zone should experience less than a 30% increase in sediment discharged over a year, with the exception of Ration Stream (43%). The discharges, where they occur should only be in larger rainfalls, and the pattern of raised turbidity should mimic the current "natural" pattern. That is, a pattern of frequent rises to 300 NTU in the Horokiri and frequent rises to 100 NTU in the other waterways, on top of relatively high background turbidity.

Most of the suspended material is rapidly flushed from the stream into the Pauatahanui Harbour, with little deposition (in rain events) on to the benthos (SKM TR15, Tables 15.33 and 15.34). If the discharge pattern continues to follow more or less the current pattern, and the predicted quantities are managed to the predicted levels, the fauna and habitat present in the downstream areas should not be adversely affected since they currently experience and cope with these levels

While the benthic macroinvertebrate faunal communities have an array of "sensitive" fauna it appears that the habitat is diverse and robust enough, and the gradient and velocities "steep" enough that the magnitude of suspended sediment deposited will not be such that it will change those communities.

10.1.7 SEDIMENT TO PORIRUA HARBOUR

<u>BACKGROUND</u>

During construction and operation of the Project treated stormwater will be discharged to streams which ultimately discharge to the Porirua Harbour and beaches of the Kapiti Coast. Sediment associated with the stormwater discharges has the potential to smother intertidal and subtidal marine flora and fauna.

The effect of the discharge of sediment on marine organisms and habitats relates to both suspended sediment and deposited sediment. Effects are a factor of volume of sediment (concentration of suspended sediment and depth of deposited sediment) and duration of exposure and further depend on the nature and values of the existing receiving environment.

The current published scientific research indicates that the deposition of fine terrigenous sediment at a depth of 5 mm on top of muddy benthic sediment has adverse effects on small, less mobile marine invertebrates (Nicholls et al., 2009). Thicker deposits of clay affect an increasing number of species, with most bivalves and gastropods affected at 5-10mm deposition. Layers greater than 30 mm significantly affecting most organisms that inhabit muddy sediment and thereby affecting food supply for fish and birds that use the marine habitat. Adverse effects are experienced at shallower depths of fine sediment deposition when the receiving environment sediment is coarse grained i.e. mud deposited on sand has effects at shallower depths of deposition compared to mud deposited on mud (Lohrer et al., 2006).

With respect to the duration of sediment deposition remaining in place, the literature suggests that most marine invertebrates can tolerate a deposition of sediment for up to three days by isolating themselves from environmental stressors (e.g. bivalves close their valves, other invertebrate cease feeding) (Nicholls et al., 2009). Many organisms change their metabolic pathway from aerobic to anaerobic during this time. If the sediment deposition persists for longer than three days, sublethal and lethal effects begin to occur in the most sensitive taxa. Less sensitive organisms may tolerate sediment deposition for a longer period before adverse effects begin to occur (Lohrer et al., 2006). Our assessment has looked at the depth of sediment deposition at three days following the peak of the rainfall events modelled, in order to capture effects on the most sensitive species from a sedimentation event.

Marine invertebrates are considered to be more susceptible to the discharge of sediment, as most taxa have limited mobility or are sessile, whereas fish can move to areas that are less affected. The marine invertebrates present in the Porirua Harbour include both sensitive and tolerant taxa. The intertidal and near shore shallow subtidal invertebrate community composition includes species that are sensitive to mud e.g. gastropods (such as *Cominella glandiformis*, *Diloma subrostrata*), bivalves (such as *Austrovenus stutchburyi*, *Macomona lilliana*, *Paphies australis*), polychaetes (e.g. *Orbinia papillosa*) and seagrass. Species that are tolerant of mud e.g. the polychaete *Scolecolepides benhami* and the amphipod *Paracorphium* sp. are also present. Central subtidal sites have an invertebrate community composition that is dominated by tolerant polychaete worms such as *Nicon aestuariensis* and bamboo worms (Maldanidae).

There is little information on the tolerance of seagrass to increased sedimentation and suspended sediment, but it is known that reduced light and smothering result in degradation to seagrass beds. Saltmarsh, conversely, naturally traps sediment and is unlikely to be affected by the depths of sediments likely to be deposited by this project.

In the Porirua Harbour, sediments tend to be coarser within the intertidal areas, whereas fine sediment accumulates subtidally. Therefore, we anticipate that adverse effects may be experienced by marine organisms inhabiting intertidal areas at shallow depths of sediment deposition compared to organisms inhabiting the subtidal fine sediment habitats. In our assessment, however, we have considered those areas of harbour that receive sediment during various rainfall events that pushes the total deposition in an event to 5-10mm and to >10mm. We consider that individual sensitive species may be adversely affected at 5-10mm deposition (both intertidally and subtidally), and a large number of species (potentially communities) may be adversely affected at >10mm deposition. It may be that the organisms inhabiting the subtidal basins are able to tolerate greater depths of deposition. However, in order to be conservative, we have used the same effects thresholds across the entire Porirua Harbour.

HYDRODYNAMIC MODELLING

SKM has modelled baseline sediment movement into Porirua Harbour and the potential increase in sediment discharged to the harbour as a result of open earthworks during construction, in a Q2 and Q10 rainfall event under various wind conditions (Technical Report 15). The patterns of sediment deposition and total suspended sediment (TSS) varies from catchment to catchment depending on many factors, including the underlying geology, soil, slope, land use, and the proximity of the discharge point to the harbour taking into account mixing.

The harbour is estimated to cover approximately 800 ha including both intertidal and subtidal habitat in both the Pauatahanui Inlet and Onepoto Arm. Of the rainfall events modelled, between 615 ha and 718 ha receives less than 3 mm of sediment (i.e. 76-90%). Under baseline conditions (i.e. without the road), the Porirua Harbour receives a large volume of sediment during rainfall events. The hydrodynamic modelling of various storm events carried out by SKM indicates that there is approximately a 5-6% increase in areas affected by sediment deposition one day after the peak of the rainfall event. For example, in a two year rainfall event under calm wind conditions in the Pauatahanui Inlet, under baseline conditions, the area of harbour that receives >3mm of sediment from the catchments modelled is approximately 108 ha. Under the same rainfall and wind conditions, during peak construction of the road, this area increases by 5.5% (6 ha) to 114 ha.

Bioturbating organisms play a role in breaking up the clay layer and reducing the impacts on marine organisms. The movement of large bivalves (wedge shell and cockles), crabs and burrowing shrimp helps to break up the deposited sediment and assist with sediment removal (Nicholls et al., 2009).

The rainfall events modelled by SKM that we have used in our assessment of effects on the estuarine ecological values included a 2 year event (Q2) in all catchments at the same time, a 10 year (Q10) event in Kenepuru catchment with a 2 year elsewhere, a 10 year event in Duck Creek catchment with a 2 year elsewhere, and a 10 year event in Horokiri catchment with a 2 year event elsewhere. Each rainfall event was modelled under calm wind conditions, a south-southeast wind and a north-northwest wind, as wind has a strong influence on where in the harbour sediment is ultimately deposited.

SKM have also modelled 50 year (Q50) rainfall events. For the following assessment we have considered a Q50 event to be beyond the scope of any sediment management tools, and will results in such significant adverse effects on the harbour that the contribution from the construction site will be only a proportion that is unlikely to add to the adverse effect.

TOTAL SUSPENDED SEDIMENT (TSS)

Our approach to the assessment of effects of suspended sediment has been to gain an understanding from the modelling outputs of the area affected by suspended sediment at biological effects threshold concentrations and duration and then determine from the maps provided by SKM whether the areas receiving sediment were sensitive to suspended sediment (i.e. central subtidal basins are considered not to be as sensitive as intertidal areas).

In order to assess the effects of suspended sediment on marine organisms it is necessary to have an understanding of both concentration and duration of exposure. Marine taxa have differing sensitivities to suspended sediment concentration and duration. Organisms can be affected by suspended sediment through clogging of gills and other filter structures, inability to visually detect prey, and reduced light.

Research on the tolerance of marine invertebrates to TSS has primarily been laboratory-based, as it is difficult to manipulate the concentration of TSS in the field. Laboratory trials have shown measureable adverse effects on marine organisms at a range of TSS concentrations and a range of extended periods. Of the organisms that research has been carried out on, those that are known to be present within the Porirua Harbour are listed below, along with the relevant research findings.

Table 11-58: Laboratory trial results of the effect of TSS on marine invertebrates

Species	Effect detected	TSS concentration and duration of exposure at which effects were measured	Reference
Pipi - (*Paphies australis*)	Reduced condition	75 g/m³ (exposure >13 days)	Hewitt et al., 2001
Horse mussel - (*Atrina zealandica*)	Reduced condition	80 g/m³ (exposure >3 days)	Ellis et al., 2002
Tubeworm - (*Boccardia sp.*)	Reduced feeding rate	80 g/m³ (exposure >9 days)	Nicholls et al., 2003
Wedge shell - (*Macomona liliana*)	Reduced survival	300 g/m³ (exposure >9 days)	Nicholls et al., 2003
Cockle - (*Austrovenus stutchburyi*)	Reduced condition	400 g/m³ (exposure >7 days)	Hewitt et al., 2001

Table 11-61 indicates that the most sensitive species (pipi) researched shows sublethal adverse effects at 75 gm³ when continuously exposed for periods longer than 13 days, whereas mortality occurred in wedge shell at 300 g/m³ after 9 days exposure. Of these species, pipi and horse mussel were very uncommon in the Porirua Harbour.

SKM have modelled the distribution of TSS throughout the Porirua Harbour under a variety of rainfall events and wind conditions. The results indicate that in the combined 10 year rainfall event situation, suspended sediment, at one day post the peak of the rainfall event, reaches concentrations that may cause adverse effects on marine organisms if exposure was sustained. However, by three days post the peak of the rainfall event, the concentration of suspended sediment derived from runoff throughout Porirua Harbour is, in all scenarios, below effects threshold concentrations. These results are presented in Appendix 11.E & Appendix 11.F.

We conclude that in all scenarios modelled within both Inlets of the Porirua Harbour the effect of suspended sediments on benthic invertebrates, saltmarsh, seagrass and marine/estuarine habitat values is always negligible.

DEPOSITED SEDIMENT

Our approach to the assessment of effects of sedimentation has been to gain an understanding from the modelling outputs of the area affected by sediment deposition at biological effects threshold depths and duration and then determine from the maps provided by SKM whether the areas receiving sediment were sensitive to deposition (i.e. central subtidal basins are considered not to be sensitive to deposition, whereas intertidal and shallow near shore subtidal areas are).

Table 11-59, indicates that for most of the 10 year rainfall events under the various wind conditions, the resultant increased area of harbour that is predicted to receive sediment (three days following the rainfall event) at the thresholds considered (i.e. 5-10 mm and >10 mm) is considered to have minor and acceptable effects. Where the effect is considered to be minor, this is due to the deposition occurring primarily within the subtidal basin areas that currently accumulate fine sediment during rainfall events and are characterised by a depauperate invertebrate community with lower ecological values.

However, there are two rainfall and wind scenarios that have been assessed as potentially resulting in moderate significant adverse effects on marine ecological values. These events are

- Onepoto Arm in a 10 year event with maximum earthworks open, and a wind blowing from the S-SE (10Yr-3D-TA18); moderate effect.
- Pauatahanui Inlet in a 10 year event with maximum earthworks open, and a strong wind blowing from the N-NW (10Yr-3D-TA22); high effect.

Table 11-59 summarises a range of modelled scenarios of sediment deposition during 2 and 10 year rainfall events and at the time of peak earthworks. The simulations are three days after the event. Relevant graphical simulations of the following scenarios are provided in Appendix 11.F.

Table 11-59: Total areas (TA) subject to exceedences of the 5mm and 10mm Thresholds under the three critical scenarios 3 days following the rainfall/sediment event

Rainfall Event /Wind Environment	Net Area Sediment Deposition (ha)	SKM Map Reference	Description of Sediment Deposition	Significance of Effect of Potential Rainfall Event
10 Yr Kenepuru, 2 yr in other catchments modelled				
	5-10 mm			
Calm	6.4	10Yr-3D-TA08	Negligible deposition. Predominantly subtidal.	Negligible
N-NW	3.0	10Yr-3D-TA26	Small areas of deposition intertidally at Porirua Stream mouth and to the east. Subtidal deposition in the central area of Onepoto Inlet.	Low
S-SE	-7.9	10Yr-3D-TA17	Deposition intertidally (south of O2 and O3) to the west of Porirua Stream mouth, and subtidally around sample point O1. Significant areas showing a reduction in area of deposition in Onepoto Inlet, predominantly subtidally. Net reduction in 5-10mm deposition in the Onepoto Inlet of 3.6ha.	Low
	>10 mm			
Calm	1.5	10Yr-3D-TA09	Negligible deposition. Predominantly subtidal, with a small area deposition around sampling site O1.	Negligible
N-NW	2.6	10Yr-3D-TA27	Small areas of deposition, primarily subtidally in central areas of Onepoto Arm.	Low
S-SE	1.6	10Yr-3D-TA18	Deposition intertidally (south of O2 and O3) to the west of Porirua Stream mouth and subtidally.	Moderate
10 Yr Duck/Pauatahanui, 2 yr in other catchments modelled				
	5-10 mm			
Calm	3.8	10Yr-3D-TA04	Predominantly subtidal. Sediment deposited in the northern parts of central subtidal basins.	Low
N-NW	3.0	10Yr-3D-TA22	Patchy deposition both intertidally and subtidally throughout the Pauatahanui Inlet. Sediment deposited in intertidal area adjacent to Duck Creek and to the west of Duck Creek, adjacent to Pauatahanui and Kakaho Stream mouths, and to the east of Kakaho Stream mouth.	High
S-SE	3.9	10Yr-3D-TA13	Very small areas of deposition adjacent to Duck Creek, Pauatahanui Stream and Kakaho Stream mouths. Subtidal deposition in the central basins.	Low
	>10 mm			
Calm	2.6	10Yr-3D-TA05	Sediment deposited predominantly in the central subtidal basins, with a thin band of sediment between Pauatahanui Stream and Duck Creek.	Low
N-NW	3.2	10Yr-3D-TA23	Patchy deposition throughout the Pauatahanui Inlet. Sediment deposited in shallow subtidal area adjacent to Duck Creek and to the west. Small area of deposition intertidally at Pauatahanui Stream mouth. N	High
S-SE	6.7	10Yr-3D-TA14	Very small area of deposition adjacent to Duck Creek, predominantly deposited subtidally at the eastern end of the estuary.	Low

Rainfall Event /Wind Environment	Net Area Sediment Deposition (ha)	SKM Map Reference	Description of Sediment Deposition	Significance of Effect of Potential Rainfall Event
10 Yr Horokiri, 2 Yr all other catchment modelled				
	5-10mm			
Calm	8.3	10Yr-3D-TA06	Sediment predominantly deposited around edges of the central subtidal basins, with a thin band on southern edge adjacent to Duck Creek and extending to the west.	Low
N-NW	12.6	10Yr-3D-TA24	Sediment depositing around the outer edges of the central subtidal areas, with negligible areas of deposition around the stream mouths.	Low
S-SE	1.5	10Yr-3D-TA15	Patchy deposition both intertidally and subtidally throughout the Pauatahanui Inlet. Sediment deposited in intertidal area adjacent to Duck Creek and to the west of Duck Creek. Area of deposition adjacent to Kakaho Stream mouth, and smaller intertidal areas to the east of Kakaho Stream mouth, south of Penryn Road at Camborne and adjacent to Grays Road at the eastern boundary of Camborne. Reduction in deposition of sediment around the Pauatahanui Stream mouth.	Low
	>10 mm			
Calm	8.2	10Yr-3D-TA07	Sediment deposited predominantly around edges of the central subtidal basins, with thin band on southern edge adjacent to Duck Creek.	Low
N-NW	5.2	10Yr-3D-TA25	Sediment depositing subtidally to the south around the outer edges of subtidal basins, with negligible areas of deposition around the stream mouths. A reduction in sediment >10mm depositing around Pauatahanui Stream.	Low
S-SE	0.8	10Yr-3D-TA16	Deposition primarily subtidally in the Pauatahanui Inlet. Sediment deposited in shallow subtidal area adjacent to Duck Creek and to the west of Duck Creek. Area of deposition subtidally adjacent to Kakaho Stream mouth, and smaller intertidal area to the south of Penryn Drive at Camborne. Reduction in deposition of sediment around the Pauatahanui Stream mouth. Net reduction in the area of deposition >10mm in the Pauatahanui Inlet of 0.58ha.	Low
2 Yr in all catchments modelled				
	5-10mm			
Calm	6.1	2Yr 3D-TA02	Subtidal deposition in the central subtidal basins.	Low
N-NW	3.5	2Yr 3D-TA08	Patchy deposition throughout Papakanui Inlet subtidally, with small areas to the north of Pauatahanui Stream and adjacent to Duck Creek mouths.	Low
S-SE	5.5	2Yr 3D-TA05	Deposition is primarily in the central subtidal basins, with a thin band of sediment in the shallow subtidal area adjacent to Duck Creek.	Low
	>10 mm			
Calm	1.3	2Yr 3D-TA03	Small area of deposition subtidally adjacent to the mouth of Duck Creek.	Low
N-NW	0.8	2Yr 3D-TA09	Small areas of deposition intertidally to the north of Pauatahanui Stream mouth and in the shallow subtidal area adjacent to the mouth of Duck Creek.	Low
S-SE	2.0	2Yr 3D-TA06	Deposition is primarily in the central subtidal basins, with a thin band of sediment in the shallow subtidal area adjacent to Duck Creek.	Low

The effects on Pauatahanui Inlet were explored further in a range of simulations using an intensive construction scenario in the Pauatahanui Catchment. The results are summarised in Table 11-60.

Table 11-60: Total Areas Subject to Exceedences of the 5mm and 10mm Thresholds in the Pauatahanui Intensive Construction Scenarios 3 days Following the Rainfall/Sediment Event

Rainfall Event/Wind Environment	Net Area Sediment Deposition (ha)	SKM Map Reference	Description of Sediment Deposition	Assessment of Effect of Potential Rainfall Event
10 Yr Pauatahanui/Duck, 2 yr in other catchments modelled				
	5-10 mm			
Calm	3.3	10Yr-3D-SC02	Small areas of deposition in central subtidal basins.	Low
N-NW	2.9	10Yr-3D-SC05	Small areas of deposition intertidally adjacent to Pauatahanui Stream and Duck Creek, to the west of Kakaho Stream mouth, and south of Penryn Drive (Camborne). Patchy deposition subtidally throughout the Pauatahanui Inlet. Sediment is deposited in areas that receive deposition during the peak construction.	High (considered in the 10 yr Duck modelling during peak constructio n)
S-SE	1.6	10Yr-3D-SC08	Negligible areas of deposition on the outer edges of the subtidal basins.	Negligible
	>10 mm			
Calm	1.9	10Yr-3D-SC03	Small areas of deposition in central subtidal basins.	Negligible
N-NW	2.9	10Yr-3D-SC06	Small areas of deposition intertidally adjacent to Pauatahanui Stream mouth and south of Penryn Drive at Camborne. Small patchy areas of subtidal deposition in the subtidal habitat. Sediment is deposited in areas that receive deposition during the peak construction.	High (considered in the 10 yr Duck modelling during peak constructio n)
S-SE	2.6	10Yr-3D-SC09	Negligible areas of deposition on the outer edges of the subtidal basins.	Negligible

In summary our findings are:

10 Year Kenepuru, with SSE wind – resulting in 2.7ha receiving >10mm.

The deposition predominantly occurs in the intertidal and shallow subtidal area to the west of the Porirua Stream mouth. Ecological values in this general area are considered to be lower than in the Pauatahanui due to higher contaminant concentrations in sediment and lower invertebrate diversity and abundance. However, the deposition of >10 mm of sediment over 2.7 ha of marine habitat is sufficient to significantly affect the invertebrate community composition through a loss of sensitive species. Both intertidal and subtidal monitoring is proposed in this area as part of the Adaptive Estuarine Monitoring Plan.

10 Year Duck, with NNW wind – resulting in 3.0 ha receiving 5-10 mm deposition, and 3.2 ha receiving >10 mm deposition

Sediment deposition at a depth of 5-10 mm occurs in patches both intertidally and subtidally throughout the Pauatahanui Inlet over a total area of 2.9 ha. Intertidally, this deposition includes areas adjacent to Duck Creek, Pauatahanui Stream, Kakaho Stream and to the east of Kakaho Stream, where ecological values are high. If this rainfall and wind scenario occurs during peak construction, and deposition of sediment 5-10mm occurs in the areas predicted, there may be some mortality of sensitive species, including cockles. Deposition in the >10mm threshold occurs primarily in the near shore shallow subtidal habitat adjacent to, and to the west of Duck Creek, over an area of 3.2ha. Invertebrate community composition is likely to be adversely affected in these areas, including cockle beds. Saltmarsh and seagrass are not considered likely to be adversely affected from an event of this nature due to being outside the main deposition areas and TSS dissipating rapidly. Both intertidal and subtidal monitoring is proposed in these areas as part of the Adaptive Estuarine Monitoring Plan.

Deposited fine sediment, both in the intertidal and shallow subtidal habitats, is likely to persist in the short-term, but will be eroded over time and broken up by the movement of water and wind, and bioturbation activities of benthic organisms. The fine sediment (from the Project and other more significant sources) will, in the moderate and long term, be redistributed within the harbour and ultimately accumulate in the subtidal basins. This is evidenced in the subtidal basins comprising deep fine-grained sediment and a depauperate invertebrate community composition.

A statistical analysis was commissioned to determine the probability of the event scenarios identified as having potentially moderate adverse effects on marine ecological values is as follows (See Appendix 11.M.). For the two events of concern, the probability is as follows:

A 10 year rainfall event (Kenepuru catchment)

- The probability of occurring with a southerly wind during the peak 2 year construction period is approximately 7% (with 95% confidence intervals of 3% to 14%). (based on Wellington Aero wind data only)
    - Moderate significance of adverse effects.
    - Short-term (i.e. less than 5 years) duration.

A 10 year rainfall event (Duck Creek catchment)

- The probability of occurring with a northerly wind during the peak 2 year construction is 12% (with 95% confidence intervals of 4% to 13%).
    - High significance of adverse effects.
    - Short-term (i.e. less than 5 years) duration.

Whilst the likelihood of these events occurring is considered to be unlikely (Table 15.4, SKM Technical Report #15), the consequences of the events on small areas of the Porirua Harbour are considered ecologically significant, particularly in the near shore habitats.

It is important to remember the context that these potential significant adverse effects occur in i.e. comprising only 5-6% of the sediment that is deposited in the harbour currently without the Project being constructed. Under the existing situation, without construction of the Project, the modelling shows that deposition of sediment in Porirua Harbour is above effects thresholds over large areas. However, in our opinion the additional effects of the Project on sediment deposition in the harbour, whilst comprising a small proportion of the total sediment deposition occurring, remain of moderate-high significance.

In summary, the following two tables present our assessment of the significance of these deposition effects for 2yr and 10 yr events, assuming benign wind conditions.

Table 11-61: Significance of Short Term Sediment Deposition during construction to the Porirua Harbour Estuarine Environment in a 2yr or less event (all wind conditions).

Tidal and Shallow Subtidal	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Estuary & Harbour Pauatahanui Inlet			
Horokiri Stream Mouth	High	Negligible	Low
Pauatahanui Stream Mouth	High	Negligible	Low
Duck Stream Mouth	High	Negligible	Low
Estuary & Harbour Onepoto Inlet			
Porirua Stream Mouth	Moderate	Negligible	Very Low

Table 11-62: Significance of Short Term Sediment Deposition during construction to the Porirua Harbour Estuarine Environment in a 10yr event (Worst Case Wind Conditions).

Tidal and Shallow Subtidal	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Estuary & Harbour Pauatahanui Inlet			
Horokiri Stream Mouth	High	Low	Moderate
Pauatahanui Stream Mouth	High	Moderate	High
Duck Stream Mouth	High	Moderate	High
Estuary & Harbour Onepoto Inlet			
Porirua Stream Mouth	Moderate	Moderate	Low

LONG TERM SIMULATION

Construction-related sediment that is deposited in the near shore (intertidal and shallow subtidal) areas of the harbour will, over time, move to and accumulate in the subtidal basins. In the long term, the additional sediment discharged to the harbour as a result of construction of the Project, adds to the cumulative effects of sedimentation of the central subtidal marine environment in both the Pauatahanui Inlet and the Onepoto Arm.

The 20-year simulation of sediment deposition patterns in the harbour undertaken by SKM, using actual weather data from the past twenty years, indicates a difference in bed deposition depth in the subtidal basin areas of up to 5 cm that is attributable to the Project (see SKM Figure LTS-4). In the Pauatahanui Inlet sediment is accumulated in the central subtidal basins, whereas in the Onepoto Arm accumulation is in the southern subtidal area. Averaged over 20 years, the maximum depth of deposition of sediment of 5 cm amounts to a maximum deposition of 2.5mm per year.

The long term simulation without the Project constructed indicates that approximately 61 ha of the marine habitat in the Onepoto Arm and 204 ha in the Pauatahanui Inlet will accumulate >100mm of sediment in 20 years time. With the Project, this increases to 62 mm in the Onepoto Arm and 207 ha in the Pauatahanui Inlet. These results clearly show that the majority of the sediment that is predicted to accumulate in the Porirua Harbour in the next 20 years is not from the construction or operation of the Project. The increase in total harbour area that accumulates >100mm of sediment in 20 years time is 0.79% in the Onepoto Arm and 1.6% in the Pauatahanui Inlet.

The long term simulation results without the road are likely to be an underestimate of sediment runoff and accumulation, as further urban development and felling of forestry blocks, which are associated with high sediment runoff, have not been included in the model assumptions, but are highly likely to be undertaken in the next twenty years.

Table 11-63: Harbour area affected by long term sediment accumulation.

	Area Affected Under Existing Baseline		Additional Area Affected with TG Project	
Depth of Sediment	**Onepoto Arm (ha)**	**Pauatahanui Inlet (ha)**	**Onepoto Arm (ha)**	**Pauatahanui Inlet (ha)**
>100mm	57.68	114.18	0.09	1.09
>200mm	3.76	57.80	0.39	1.11
>300mm	0	32.12	0	1.09

Whilst the additional sediment from the Project predicted to accumulate in the subtidal basin areas is a small proportion of the total sediment predicted to accumulate in these areas, it has some minor additive adverse effects on the ecological values and functioning of the estuary in the long term through habitat modification.

In summary our assessment of the long term ecological effect of sediment re-sorting in the Porirua Harbour is as follows:

Table 11-64: Significance of Long Term Sediment Re-Deposition within the Estuarine/Coastal Environment (2031).

DESCRIPTION (listed North to South)	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Estuary & Harbour Pauatahanui Inlet			
Intertidal and Shallow Subtidal	High	Negligible	Low
Shallow subtidal margins	Moderate	Negligible	Very Low
Central Subtidal Basins	Low	Moderate	Very Low
Estuary & Harbour Onepoto Arm of Porirua Harbour			
Intertidal Zone	Moderate	Negligible	Very Low
Central Subtidal basin	Low	Moderate	Very low

Contaminants

There is a risk of discharge of a range of toxicants from the construction site to streams and ultimately Porirua Harbour. They include fuel, lubricants, cement, oil etc. This risk cannot be quantified but can be avoided through implementation of appropriate management systems.

Monitoring

Monitoring of sediment deposition and marine ecological values spatially and temporally, through routine and event based data collection will be required in order to confirm the conclusions drawn in the assessment of effects. Monitoring will focus on the areas that may receive sediment deposition in the various rainfall events identified, but also will include reference sites (See Ecological Management and Monitoring Plan).

Conclusions

Hydrodynamic modelling provides predictions of concentration of total suspended sediment and depth of sediment deposition likely to occur throughout the harbour under a range of rainfall events and wind environments, with robust erosion and sediment control measures operating.

In general, erosion and sediment control measures are designed to treat the smaller and more frequent rain events (i.e. 2 year ARI). These events are unlikely to result in significant Project related exacerbation of the current patterns of suspended sediment and sediment deposition (i.e. without the road construction). However, 10 year rainfall events in some catchments under certain wind conditions will result in additional sediment discharged to the harbour that will lead to adverse effects on marine ecological values.

In other words, high value or sensitive parts of the harbour are predicted to receive >5mm sediment deposition which may affect the most sensitive invertebrate taxa, and/or >10mm sediment which may affect invertebrate community composition in the short term. Sediment deposited in the near shore (intertidal and shallow subtidal) areas of the harbour will, over time, move into and accumulate in the central subtidal basins.

In the long term, the additional sediment discharged to the harbour as a result of the Project, adds to the cumulative effects of sedimentation of the central subtidal marine environment in both the Pauatahanui Inlet and the Onepoto Arm.

It is very difficult to mitigate the deposition of sediment in marine environments. Thus, the focus throughout this Project has been on avoidance of the discharge of sediment to the harbour. However, if as a result of a large rainfall event (e.g. 10 year ARI), sediment deposition within the Porirua Harbour occurs in a sensitive area and at a depth and duration that is likely to cause adverse effects, the options for remedial measures or mitigation are limited. Removal of the deposited sediment is difficult without causing additional and potentially greater adverse effects.

10.2 PROPOSED OPERATIONAL PHASE MITIGATION

10.2.1 TERRESTRIAL VEGETATION & HABITATS

No mitigation is proposed.

10.2.2 FAUNA

No mitigation is proposed.

10.2.3 BATS

Confirmation of the presence, distribution and abundance of bats is required before decisions on mitigation can be made.

10.2.4 FISH PASSAGE

A scheduled and ongoing programme of maintenance and monitoring is required for all culverts that take into account continued fish passage requirements.

10.2.5 STORMWATER DISCHARGES TO STREAMS AND THE HARBOUR

Mitigation of the potential adverse effects on water quality in the streams is based on the water quality monitoring and proposed storm water management systems put forward as part of design and mitigation by SKM. NZTA also have a standard and guidelines for NZTA projects that addresses methods and outcomes to be achieved by NZTA roads in regard to storm water (Shaver et al 2007).

SKM reviewed and analysed their proposed mitigation against the design standards of both NZTA and GWRC requirements to “avoid adverse effects on wetlands, and lakes and rivers and their margins when considering the protection of their natural character” (GWRC, 1999). The SKM review of device effectiveness identified that an appropriate design standard could be achieved for the Transmission Gully Project utilising a combination of proprietary devices and wetlands and that they could be located along the alignment based on the identified road designation. The results of the contaminant load modelling undertaken by SKM suggest that the treatment devices proposed effectively reduce contaminant loads for TSS, zinc, copper and TPH.

The proposed treatment concept includes the first flush of rainfall runoff from the road pavement being treated by a Storm Filters (a Stormwater360 Storm Filter with ZPG media) under normal operating conditions, with any excess flow being diverted directly into streams. The storm water filter has proven to be effective against TSS, heavy metals and nutrients, but not hydro-carbons. However, the fore-bay and media will remove some hydrocarbons. In three or four cases on the Horokiri, on the Pauatahanui and possibly on the Duck and Te Puka systems, treated waters will then be passed through a native constructed or restored wetland complex for polishing. Wetlands are becoming a common tool for managing road runoff. NIWA (2010) suggest that in a well vegetated wetland, 70% removal of TSS can be expected. Farrell and Scheckenberger (2003) suggest a wetland can remove 73% of TSS, reinforcing NIWA data.

Conclusion

Based on SKM's extensive stormwater management report (SKM Technical Report 15) and the development of an array of "polishing" wetlands along with some innovative methods to convey treated road runoff across the Horokiri to the wetlands, it is almost certain that operational contaminant discharge can be managed to produce as clean as possible water to discharge. This coupled with the wider land retirement, especially in the Horokiri and Te Puka, will allow in the long term the maintenance of existing ecological values in regionally important aquatic systems. This is especially important in, at least, the middle and headwater reaches of the Duck, Horokiri and Te Puka systems.

Discharge to Streams

SKM has modelled the current trend in heavy metal and TPH in key streams along the alignment, both without the TG Project, and with the TG Project, including full suite of treatment (proprietary stormwater filters, and treatment wetlands) and mitigation (land retirement from rural use and revegetation).

The model has assumed a realistic contaminant removal performance of wetlands and proprietary filter devices of between 55% and 75%, varying depending on the contaminant being assessed and their known capture rates as follows:

Table 11-65: Estimated Treatment performance for removal of contaminants

Harbour Discharge	TSS	Zinc	CU	TPH
Wetlands	77%	54%	69%	10%
Proprietary filter device	75%	55%	65%	75%

From SKM Technical Report #15, App 15 DD, Table DD2.

In their analysis with mitigation there is no significant increase in discharge of measured contaminants to streams along the alignment. Therefore it is concluded that the construction of the TG Project will not increase contaminant loadings and effects can be neutral assuming mitigation is designed as proposed.

Based on the estimated treatment levels that can be achieved, the following reductions in levels of suspended copper and zinc have been identified by SKM. Overall, this table shows that with treatment any changes in contaminants in the short to medium term into streams are negligible.

Table 11-66: Changes in suspended zinc (Zn) and copper (Cu) between 2010 without road and 2031 with road and treatment.

	2031 without road				2031 with road (With treatment)			
Catchment (taken at mouth)	Total Zinc (g/m³)	ANZECC Trigger	Total Copper (g/m³)	ANZECC Trigger	Total Zinc (g/m³)	ANZECC Trigger	Total Copper (g/m³)	ANZECC Trigger
Horokiri	0.009	Fail	0.002	Fail	0.009	Fail	0.002	Fail
Pauatahanui	0.012	Fail	0.003	Fail	0.013	Fail	0.003	Fail
Porirua	0.069	Fail	0.010	Fail	0.069	Fail	0.010	Fail
Duck	0.038	Fail	0.004	Fail	0.040	Fail	0.004	Fail
Ration	0.005	Pass	0.001	Pass	0.006	Pass	0.001	Pass
Kenepuru	0.084	Fail	0.006	Fail	0.085	Fail	0.006	Fail
Te Puka	0.004	Pass	0.001	Pass	0.005	Pass	0.001	Pass
Whareroa	0.004	Pass	0.001	Pass	0.003	Pass	0.001	Pass

From SKM Technical Report #15 Tables 15.58 to 15.65.

This analysis shows that with treatment to further contaminant loading of significance will occur and streams currently pass will now fail the ANZECC trigger.

Table 11-67 predicts the effects of treatment to the levels of total zinc and copper (deposited and suspended) with road construction. It compares predicted copper and zinc contaminant loading based on data from roads with untreated runoff, with predicted copper and zinc assuming treatment to the levels shown in Table 11-65.

Table 11-67: Predicted changes in total zinc (Zn) and copper (Cu) using existing sampling results and predicted levels based on motorway data from Auckland and Wellington.

	Predicted sediment concentration with road				**Predicted sediment concentration with road and after treatment**			
Deposited sediment sampling sites	Zn (g/m3)	Trigger (0.008 g/m3)	Cu (g/m3)	Trigger (0.0014 g/m3)	Zn (g/m3)	Trigger (0.008 g/m3)	Cu (g/m3)	Trigger (0.0014 g/m3)
Whareroa 1	0.0030	Pass	0.001	Pass	0.003	Pass	0.001	Pass
Te Puka 1	0.0038	Pass	0.001	Pass	0.002	Pass	0.001	Pass
Te Puka 2	0.0032	Pass	0.001	Pass	0.003	Pass	0.001	Pass
Upper Horokiri 1	0.0029	Pass	0.001	Pass	0.002	Pass	0.001	Pass
Horokiri 2	0.0018	Pass	0.001	Pass	0.002	Pass	0.001	Pass
Upper Ration 1	0.0064	Pass	0.002	**Fail**	0.004	Pass	0.001	Pass
Ration 1	0.0049	Pass	0.001	Pass	0.004	Pass	0.001	Pass
Pauatahanui 2	0.0035	Pass	0.002	**Fail**	0.003	Pass	0.002	**Fail**
Duck 1	0.0019	Pass	0.001	Pass	0.001	Pass	0.001	Pass
Duck 2	0.0029	Pass	0.001	Pass	0.002	Pass	0.001	Pass
Kenepuru 1	0.0020	Pass	0.001	Pass	0.001	Pass	0.001	Pass
Kenepuru 2	0.0024	Pass	0.001	Pass	0.002	Pass	0.001	Pass
Porirua 2	0.0445	**Fail**	0.004	**Fail**	0.044	**Fail**	0.004	**Fail**

Data provided by SKM. Shown as graphs in Technical Report #15; Figures 15.59 to 15.60

This shows that treatment in nearly all cases reduces loading without treatment. In one case, upper Ration) which would fail without treatment, the prediction is that contaminants are managed to below ANZECC guidelines. Those that currently fail will continue to fail. The results from the above analysis are presented in Table 11-68. In all cases we conclude that effects of increased contaminants to streams due to stormwater discharge from the new road will have very low adverse effects.

Table 11-68: Assessment of effects of stormwater discharge on streams.

Streams	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
High Value Stream Habitat			
Te Puka / Wainui	High	Negligible	Very Low
Middle - Lower Horokiri	High	Negligible	Very Low
Upper and Middle Duck	High	Negligible	Very Low
Moderate Value Stream Habitat			
Upper Horokiri East	Moderate	Negligible	Very Low
Lower Pauatahanui	Moderate	Negligible	Very Low
Lower Duck	Moderate	Negligible	Very Low
Upper Kenepuru (Cannon)	Moderate	Negligible	Very Low
Low Value Stream Habitat			
Ration	Low	Negligible	Very Low
Porirua	Low	Negligible	Very Low

Discharge to Stream Mouths and Harbours

Table 11-69 presents data on the modelled long term changes to copper and zinc in the three marine areas assessed. The modelling predicts that without treatment the concentrations of these two contaminants will increase slightly except in the Onepoto Arm of the Porirua Harbour, due to significant reductions in traffic on the existing road.

With treatment they show reductions of these contaminants on the Kapiti Coast form baseline, and further reductions to these contaminants in the Onepoto Arm of Porirua Harbour below predicted baseline. For the Pauatahanui inlet treatment essentially maintains predicted levels of contaminants as they would be without a road. This is also the result of reduction in traffic on Greys Road and SH58, this traffic moving to Transmission Gully where runoff is treated.

Table 11-69: Changes to contaminant loadings of coastal marine areas without road, with road (no treatment) and with road and treatment.

	2031 without road		2031 with road (no treatment)		2031 with road and treatment devices		% Change	
Deposited sediment sampling sites	Zn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Zn	Cu
Kapiti (Te Puka - Whareroa)	80	19	83	19	77	17	-3.8%	-10.5
Pauatahanui (NE catchments)	71	12	77	14	73	12	2.8%	0.0
Onepoto (SW catchments)	620	81	591	70	589	70	-5.0%	-13.6

SKM TP15, Appendix 15BB Contaminant Load Model Results – Coastal Areas

Table 11-70: Assessment of effects on the Coastal Marine areas with mitigation

Catchment (taken at mouth)	Ecological Value	Assessment of Impact Magnitude	Assessment of Impact Significance
Kapiti (Te Puka - Whareroa)	H	Low positive	Positive
Pauatahanui (NE catchments)	H	Negligible	Low
Onepoto (SW catchments)	M	Low Positive	Positive

10.3 SUMMARY OF RECOMMENDED MITIGATION MEASURES TO MITIGATE AND MONITOR ECOLOGICAL EFFECTS

10.3.1 TERRESTRIAL HABITAT LOSS OR MODIFICATION

Conservative Approach

A conservative quantity of mitigation for vegetation loss has been used to provide flexibility within the designation to manage construction effects, in particular on streams, without constraint.

Additional Opportunities To Avoid

There will be some opportunities during detailed design to minimise effects on a number of high value areas of mature forest (coastal kohekohe, lowland podocarp/tawa, or montane podocarp hardwood forest) that fall within the designation but not the project Footprint. These sites are:

- Rowans Bush (139) / KCDC Ecosites K223-229) / Forests contiguous Akatarawa Regional Forest Park / TG Riparian Area (PCC Ecosite 199) / Cannons Creek Bush (PP12) / Porirua Park Bush (PCC76) / Scoresby Grove Kanuka (PCC Ecosite 196) / James Cook Drive Bush (PCC Ecosite 33) / Whitby Bush (PCC Ecosite 155b) / Exploration Drive Kanuka (PCC 190) / Roberts Bush (PCC88).
- In addition there are eleven early retirement sites located along the alignment where pre-construction planting has occurred. Best endeavours are needed to protect this planting.

Mitigation

Mitigation for vegetation loss will require the retirement and revegetation of 250 ha to mitigate for the potential loss of 120 ha of indigenous vegetation of varying values. Various treatments are identified for this land ranging from full revegetation, through enrichment planting, to retirement and protection.

Other

We have identified a number of other risks to terrestrial habitat during construction that will require management. These are fire and weeds.

In the long term retirement and revegetation of land in the Te Puka, Horokiri, Ration, Pauatahanui, Duck and Kenepuru catchments will expand a range of plant communities along the road corridor, providing both more habitat and green corridor along the route. This goal should form part of the mitigation vision.

Planning & Consent Conditions

The following are recommended:

- Best endeavours to avoid high value vegetation (sites specified above). This will require an ecologist involved at an early stage to identify the extent of these sites and contribute to decisions about vegetation clearance during detailed design.
- Identified mitigation areas to be legally protected to provide certainty of mitigation and stock removed prior to commencement of works.
- A Landscape and Restoration Plan for all retirement areas including fencing and weed and pest management and plant replacement for standard periods (3 yrs).
- Monitoring of restoration for standard periods (with 10yr review), and agreed measures of achievement of mitigation.
- A Fire Management Plan including; liaison with rural fire service, Restrictions on hot works during drought, etc.
- A requirement for weed management which will include but not be limited to:
    - Vehicle washing,

- Sourcing of aggregate and topsoil
- Weed monitoring and control (as required) during and following earthworks.

10.3.2 MITIGATION FOR EFFECTS ON TERRESTRIAL FLORA & FAUNA

Avoid

Re design of the route through the SAR process and consenting process has allowed us to avoid the highest quality fauna habitat above Wainui Saddle and on the eastern slopes of the upper Te Puka and Horokiri Streams.

Planning & Consent Conditions

Terrestrial Flora

- Design of stormwater treatment wetland to allow for the presence of rare plants (*Leptinella* sp) including location of plants by ecologist prior to earthworks commencing.

Terrestrial Fauna

- Prior to commencement of earthworks ecologist to locate all boulderfield habitat of lizards and Peripatus spp. Map to be produced and quantity of equivalent mitigation to be determined.
- Capture and transfer of identified lizards and Peripatus prior to works and transfer to nearest safe equivalent habitat.
- Following formation of road alignment, formation of scree and boulderfields type habitat at the toe of fill batters in Te Puka and Horokiri catchments for natural recolonisation.

Avifauna & Bats

- Verify the presence, species, and distribution of bats at Wainui Saddle.
- No transparent sound barriers in or around Wainui Saddle and Pauatahanui Stream crossing.

10.3.3 STREAM HABITAT LOSS OR MODIFICATION

Conservative Approach

The assessment of Mitigation for streams has applied SEV analysis to the calculation of stream length required for mitigation. This applies a 1.5x scale up to account for the time it takes for riparian vegetation to establish before environmental benefits occur.

Avoid

During construction efforts should be made to limit impacts to streams outside the construction footprint. This includes culverting temporary construction access tracks and reinstating the stream bed once works are complete. It also includes retention of as much riparian vegetation as possible which, is an important component of the stream habitat, reduces stream bank erosion, and assists with entrapment of overland sediment.

Mitigation

- SEV analysis requires 26,500 m of stream to be protected and enhanced as mitigation of loss of 10,000 m (Note: identified mitigation areas provide 30,000 m).
- Existing early retirement areas provide 1.6 ha of riparian planting in this catchment (1,961 m of stream) provide existing benefit.
- Agreed focus on Te Puka and Horokiri for mitigation of habitat as they have the highest value and highest potential for rapid recovery and long term benefit.
- Diversions - design principles to require matching in-stream habitat types, substrates, velocities.

Other

- In the long term retirement and revegetation of land in the Te Puka, Horokiri, Duck and Kenepuru catchments will create corridors of riparian communities and stream habitat of increased value, providing both more habitat and blue corridor along parts of the route. This goal should form part of the mitigation vision.

Planning & Consent Conditions

The following are recommended:

- Best endeavours to avoid riparian vegetation outside footprint. This will require an ecologist involved at an early stage to identify the extent of these sites and contribute to decisions about vegetation clearance, both extent and method, during detailed design.
- Identified mitigation areas to be legally protected to provide certainty of mitigation and stock removed prior to commencement of works.
- A Riparian Restoration Plan for all retirement areas including fencing and weed and pest management and plant replacement for standard periods (3 yrs).
- Monitoring of restoration for standard periods (with 10yr review), and agreed measures of achievement of mitigation.
- A requirement for weed management during construction which will include but not be limited to:
    - Vehicle washing,
    - Sourcing of aggregate and topsoil
    - Weed monitoring and control (as required) during and following earthworks.
- Diversion Design Guide requiring restoration as close as possible to the condition of the original stream bed with supervision by a suitably qualified ecologist.
- Culvert Design Guide with principles for habitat maintenance, and fish passage.
- Monitoring plan for in-stream works including successful freshwater habitat establishment in diversion.
- For temporary culverts limit the in stream period to two years from installation
    - Involve a suitably qualified ecologist to assist in the appropriate installation, following fish passage guidelines.
    - Prepare and carry out a remedial programme on decommissioning of the culvert which will include riparian revegetation and substrate rejuvenation.

10.3.4 MITIGATION FOR EFFECTS ON FRESH WATER FAUNA

Construction

- Ecological involvement in detailed design and installation of culverts and associated infrastructure (rip rap).
- Capture and translocation of fish during culvert installation and diversion.
- Timing of works in stream beds to minimise adverse effects on peak movements (Spring Migration 1 Oct -30 Dec; Autumn Migration 1 April – 30 May) but with flexibility to carry out works for short prescribed periods within these periods.
- Retrofit six existing perched culverts in Duck Creek (as specified above??) which are currently barriers to fish passage.

Operation

- Post construction monitoring of fish passage is required to ensure the designs used are effective and that the, diversion, culverts and constructed fish ladders continue to operate to their design standards.

10.3.5 MITIGATION FOR SEDIMENT DISCHARGE

Freshwater Estuary & Harbour

- Staging of works and establishment of maximum open earth worked area to reduce risk.
- Erosion management and sediment control to exceed regional guidance.
- Risk management plan, including earthworks stabilisation procedures, for significant storm event monitoring and response.

Planning & Consent Conditions

- Preparation by a suitably qualified ecologist of a Stream and Estuarine water quality and aquatic habitat monitoring plans for pre, during and post construction monitoring. This includes the gathering of sufficient baseline (minimum 2 years) on rainfall event size, stream water quality, and aquatic community composition.
- Establishment of appropriate hierarchy of ecological indicators and water quality triggers and design of storm event disaster plan.
- Qualified ecologist to be involved in monitoring of erosion and sediment management programme, and water quality monitoring with a focus on contribution to adaptive management.
- Preconstruction establish site specific “reasonable” mixing zones in each receiving water body, acknowledging difficulties of access and receiving habitat homogeneity.

10.3.6 MITIGATION FOR STORMWATER DISCHARGE

Operation

Note that the assessment of impact significance has factored in the calculated transfer of traffic from Pauatahanui Inlet to TG, SH58 (25-35%) and Grays Road (40-60%). This means that road runoff which currently discharges directly to the inlet without treatment will be significantly reduced, and the runoff from the traffic which transfers to TG will receive a filtering and in some areas polishing, to remove contaminants.

Freshwater Habitat

- Target treatment levels achieved through proprietary devices and wetland treatment prior to discharge.
- Use of stormwater treatment wetlands (with habitat benefits), and proprietary filter devices to meet target removal rates.

Planning & Consent Conditions

- Water quality monitoring plan, including treatment pond and proprietary device during initial years of operation.

10.3.7 OTHER

Landscape Mitigation

In this analysis we have only assessed the positive effect of mitigation required by ECR calculation. It should be noted that, for purposes of visual and landscape mitigation, additional large sections of the route will be planted in native vegetation. We have provided advice on appropriate species and their provenance. These will provide additional ecological benefit which we have not included in our mitigation assessment.

However, if the concept of a green corridor is accepted this will be an important part of achieving it, and there will need to be integration of the planting plans.

11. ASSESSMENT OF RESIDUAL IMPACTS FOLLOWING MITIGATION

The following table summarises the results of this assessment for terrestrial habitats, freshwater habitats, harbours, and fauna for both construction and operation of the TG Alignment. It provides both the assessed significance of effects without mitigation and an assessment of the residual impact with mitigation.

Table 11-71: Summary of Impacts and Residual Impacts after mitigation.

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
DIRECT EFFECTS ON TERRESTRIAL HABITAT - LOSS OR MODIFICATION				
FW Wetlands				
Wetlands of low value	• Potential loss of habitat through stormwater pond design	Very Low	• Careful design of stormwater treatment wetland to minimize impact on natural wetland.	Long term Low positive
Wetland of high value	• Loss of up to 1.2 ha of 8 ha beneath footprint.	Moderate	• Minimize effect through careful design. • Offset effects through formation of stormwater treatment wetlands. • Aim for 3:1 mitigation.	Long term Low positive
Shrublands & Scrub				
Shrublands of low value	• Minor loss of a locally abundant plant community (tauhinu / gorse) of low value	Very Low	• Retirement of upper Horokiri will protect equivalent areas of regenerating shrubland from potential future changes to land use. • Aim for 1:1 mitigation.	Mid-term Low positive
Shrubland boulderfields of moderate value	• Moderate loss of locally abundant shrubland habitat of low value	Low	• Retirement from farming of Te Puka and Horokiri. • New lizard habitat on road cut and fill	Neutral
Regenerating indigenous forest (kanuka dominant)				
Sites of moderate value	• Minor loss of habitat	Low	• Equivalent areas of kanuka have already been planted as part of early retirement.	Neutral
Regenerating broadleaf forest (mahoe dominant)				
Sites of low value	• Minor loss of a locally common plant community (mahoe-gorse monoculture).	Very Low	• Retirement and enrichment planting of large areas of regenerating native forest in Horokiri.	Long term Neutral
Sites of moderate value	• As above but with increased canopy height and diversity.	Very Low	• As above.	Long term neutral
Sites of high value	• Minor loss of a locally common plant community (mahoe dominant but high canopy diversity).	Moderate	• As above. • Opportunities for reduction of impact through detailed design. • Extensive retirement of diverse broadleaf low forest in Horokiri in excess of mitigation requirements for vegetation loss.	Long term high positive
Moderate value early Retirement Planting	• Minor loss of early retirement planting and associated benefit.	Low	• Retain as much as possible through detailed design phase. • Additional planting at each site proposed following works to repair	Neutral

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
			and infill.	
Mature or maturing indigenous forest				
Sites of low value	• Some minor loss of mature or maturing native forest of low value (e.g. Kohekohe monoculture)	Very Low	• Continued reduction of impact through detailed design. • Retirement and enrichment planting of large areas of regenerating native forest in Horokiri. • Aim for 3:1 mitigation.	Long term neutral
Sites of moderate value	• Some minor loss of mature or maturing forest of moderate value (e.g. tawa kohekohe fragments)	Low	• Continued reduction of impact through detailed design. • Retirement and enrichment planting of large areas of regenerating native forest in Horokiri. • Aim for 3:1 mitigation.	Long term neutral
Sites of high value	• Some loss of mature or maturing forest of high value (e.g. large contiguous forest with high diversity and habitat values)	Moderate	• Continued reduction of impact through detailed design. • Revegetation of mitigation area above Porirua Park Bush • Retirement of land and enrichment planting upper Horokiri. Aim for 3:1 mitigation.	Long term neutral

DIRECT EFFECTS ON FRESHWATER HABITAT - LOSS OR MODIFICATION

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
High Value Stream Habitat				
Upper & Mid Te Puka	• Major loss and modification of stream bed & riparian habitat of high value through extensive diversion.	Very High	• Extensive stream restoration and riparian planting / design principles to require matching in-stream habitat types, substrates, velocities. • Proposed mitigation in Horokiri as compensation for this loss.	Midterm neutral
Middle Horokiri East	• Major loss of stream bed & riparian habitat of high value	Very High	• Areas of stream restoration and riparian planting / design principles to require matching in-stream habitat types, substrates, velocities. • Extensive protection, retirement and revegetation of high value streams with riparian cover and advance regeneration.	Long term moderate positive
Upper and Middle Duck	• Major loss of stream bed & riparian habitat of high value	Moderate	• Existing early retirement areas provide 1.6 ha of riparian planting in this catchment (1,100 m of stream) • Retrofit fish barrier culverts to provide fish access to 3,000m of unused habitat	Long term moderate positive
Moderate Value Stream Habitat				
Lower Te Puka / Wainui	• Minor loss of stream bed through diversion and culverting	Moderate	• Mitigation achieved through land retirement and revegetation of riparian margins.	Mid term neutral

Upper Horokiri East	• Major loss of stream bed & riparian habitat of moderate value.	Low	• Mitigation achieved through land retirement and revegetation of riparian margins.	Midterm neutral
Lower Pauatahanui	• Minor loss of stream bed & riparian habitat of moderate value through diversion & bridging.	Low	• Existing early retirement areas provide 1.3 ha of riparian planting in this catchment (360 m of stream). Retirement and revegetation of Lanes Flats including kahikatea river corridor and stormwater treatment wetlands. • Revegetation Lanes Flats	Midterm Low positive
Lower Duck	• No loss	Low	• NA	NA
Upper Cannon	• Minor modification of stream bed & riparian habitat of moderate value through bridging.	Low	• Riparian revegetation following bridge construction	Neutral
Low Value Stream Habitat				
Ration Stream	• Major loss of stream bed & riparian habitat of low value.	Moderate	• Existing early retirement areas provide 2.4 ha of riparian planting in this catchment (499 m of stream) / Areas of diversion to be restored.	Midterm neutral
Porirua Stream (tributaries)	• Minor loss of stream bed & riparian habitat of low value	Low	• Proposed mitigation in Horokiri as compensation for this loss.	Midterm neutral

DIRECT IMPACTS ON FAUNA (HABITAT LOSS)

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
Terrestrial Flora				
Leptinella tenella	• Loss of habitat	Low	• Design of stormwater treatment wetland to allow for the presence of rare plants.	Neutral
Terrestrial Fauna				
Peripatus novaezelandiae	• Loss of habitat, and loss of animals within habitat.	Very Low	• Creation of new boulderfield habitat in Te Puka and Horokiri. • Retirement from grazing • Capture and transfer prior to works	Midterm neutral
Common Lizards	• As above	Very Low	• As above	Midterm neutral
Avifauna & Bats (habitat loss)				
Falcon	• Nationally vulnerable species present in low numbers. • No habitat will be lost. • Unlikely this species will be displaced by construction activity.	Low	• Retirement and revegetation of Te Puka and Horokiri will extend habitat	Neutral or Long term minor positive
Kaka	• As above	Low	• As above	As above
Black Shag	• As above	Low	• As above	Neutral
Pied Shag	• Nationally Vulnerable species present in the designation in low numbers. • May be displaced from streambed habitat by construction activity.	Very Low	• Retirement and revegetation of Te Puka and Horokiri will improve stream habitat.	Neutral
Pipit	• May be displaced from valley floor habitat	Very Low	• No mitigation feasible.	Low negative

Long-tailed bat	• A nationally vulnerable species may utilize habitat within the designation. • No habitat will be lost. • Unlikely this species will be displaced by construction activity	To be determined (potentially moderate)	• Retirement and revegetation of Te Puka and Horokiri will extend habitat.	To be determined
FW Fauna				
Indigenous Fish	• Eight species that occur in study area with threat status (Declining). • Possible effect on passage of migratory species. • Will be habitat reduction through extensive culverting thus reduced local populations. • Potentially detrimental habitat changes with diversion. • Potential for fish mortality during reclamation of stream channels.	Very High	• Design of fish passage, diversions, culvert installation according to ecological principles. • Retirement and Revegetation of stream and riparian habitat. • Removal of stock. • Timing of works to avoid peak movements. • Post construction monitoring of fish passage. • Innovative culvert design. • Replacement of perched culverts in Duck Creek to reinstate fish passage to upper catchment. • Capture and translocation of fish during culvert installation and diversions.	Long term positive in Horokiri, upper Duck and Pauatahanui.

INDIRECT EFFECTS ON FRESHWATER HABITAT – CONSTRUCTION SEDIMENTATION

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
High Value Stream Habitat				
Te Puka Wainui	• Habitats dominated by sensitive taxa, likely to be very high short term effects without treatment. • Effect diminishes from point of source.	Very High	• Erosion management and sediment control to exceed regional guidance. • Intensive monitoring of water quality and aquatic habitat, and adaptive management of erosion and sediment devices.	High
Middle Horokiri East	• As above	Moderate	• As above	Moderate
Upper and Middle Duck	• As above	Very High	• As above	High
Moderate Value Stream Habitat				
Upper Horokiri East	• Habitats affected by existing land uses with a mix of sensitive and resilient species more able to cope with moderate changes to environment.	Moderate	• As above	Low
Lower Duck	• As above	Very High	• As above	Very Low
Lower Pauatahanui	• As above	Low	• As above	Low
Upper Cannon	• As above	Moderate	• As above	Low

Low Value Stream Habitat				
Ration Stream	• Lower value habitats with existing sediment issues, dominated by resilient species.	Moderate	• As above	Very Low
Porirua Stream (tributaries)	• As above	Low	• As above	Very Low

INDIRECT EFFECTS ON ESTUARIES & HARBOURS – CONSTRUCTION SEDIMENTATION

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
2 Year Rainfall Event during construction				
Horokiri Stm Mouth	• Sediment deposition on high value intertidal & shallow subtidal zone	-	• Erosion Control and sediment management as designed to exceed regional guidance. • Staging of works and establishment of maximum open earth worked area to reduce risk. • Risk management plan for storm event monitoring and response • Retirement of erosion prone land in Horokiri / Te Puka and Duck.	Low
Pauatahanui Stm Mouth	• As above	-		Low
Duck Strm Mouth	• As above	-		Low
Porirua Stm Mouth	• Sediment deposition on moderate value intertidal & shallow subtidal zone	-		Very Low
10 Year Rainfall Event during construction within benign winds				
Horokiri Stm Mouth	• As above	-	• As above	Low
Pauatahanui Stm Mouth	• As above	-		Low
Duck Strm Mouth	• As above	-		Low
Porirua Stm Mouth	• As above	-		Very Low
10 Year Rainfall Event during construction within extreme wind				
Horokiri Stm Mouth	• As above	-	• As above	Low
Pauatahanui Stm Mouth	• As above	-		High
Duck Stm Mouth	• As above	-		High
Porirua Stm Mouth	• As above	-		Moderate
Long term re-sorting and deposition (2031)				
Pauatahanui Inlet	• Sediment deposition on high value intertidal & shallow subtidal zone	-	• Re - sorting of sediments over 20yrs from tidal to subtidal basins.	Low
	• Sediment deposition on low value subtidal basin.	-		Low
Onepoto Arm	• Sediment deposition on moderate value intertidal zone	-		Very Low
	• Sediment deposition on low value subtidal basin.	-		Low
Wainui &	• Impact to river mouth and	-		Low

Whareroa Stream mouths	coastline from sediment discharge from streams.			

POTENTIAL OPERATIONAL IMPACT

Description	Predicted Impact	Significance of Impacts without mitigation	Proposed Mitigation	Significance of Residual Impact after mitigation
Freshwater Habitat (Stormwater)				
Low Value Habitat	• Contamination from road runoff into stormwater into streams already highly modified by land use.	Low	• Target treatment levels achieved through proprietary devices and wetland treatment prior to discharge.	Very Low
Moderate Value Habitat	• As above	Very Low	• As above	Very Low
High Value Habitat	• As above	Very Low	• As above	Very Low
Estuary & Harbours (Stormwater)				
Pauatahanui Inlet	• Contamination from road runoff into stormwater into inlet with only localized contamination issues and sensitive fauna.	Moderate	• Stormwater treatment wetlands and proprietary devices to meet targeted removal rates. • Transfer of traffic from SH58 (25-35%) and Grays Road (40-60%) to TG route.	Low
Onepoto Inlet	• Contamination from road runoff into stormwater, discharging to inlet with existing contamination issues and robust fauna.	Neutral	• Stormwater treatment wetlands and proprietary devices to meet targeted removal rates.	Low positive
Wainui & Whareroa Stream Mouths	• Contamination from road runoff into stormwater to stream mouth with no contamination issues.	Low	• As above	Low positive
Avifauna & Bats				
Bush Falcon	• Unlikely to be affected by traffic	Low	• Retirement and revegetation of Te Puka and Horokiri will extend habitat	Neutral
NI Kaka	• Unlikely to be affected by traffic	Low	• As above	Neutral
Black Shag	• As above	Low	• As above	Neutral
Pied Shag	• May be displaced from stream bed habitat by construction activity	Very Low	• Retirement and revegetation of Te Puka and Horokiri will improve stream habitat • Removal of stock.	Neutral
Pipit	• Will be displaced from grassland in valley floors by revegetation	Very Low	• No mitigation possible.	Low
Long-tailed bat	• Potential risk of traffic collision	Indetermina te	• Verify presence and distribution.	Indeterminate
FW Fauna				
Indigenous Fish (fish passage)	• Reductions in fish passage and habitat availability for species of conservation concern through extensive culverting and detrimental habitat and flow changes with diversions.	Moderate	• Monitoring and maintenance of fish passage structures, flows, diversions, culvert installation according to ecological principles.	Neutral

11.1 SUMMARY OF RESIDUAL IMPACTS FOLLOWING MITIGATION

11.1.1 POTENTIAL ADVERSE EFFECTS

It is acknowledged that during construction most ecological components will suffer short term adverse effects. This table considers the effects of mitigation in the short, medium, and long term. In summary key ecological components that are likely to have moderate to high impacts with mitigation are:

High

- High adverse effects on Duck Creek and Te Puka Stream due to sedimentation during construction. Note: these effects will be lower in the middle and upper catchment where slope and velocities will flush sediment through the system. The high adverse effect is likely to occur in the gentler reaches of lower Duck within the urbanised sections. In these sections the effects will be cumulative.
- Adverse effects on intertidal and shallow subtidal near shore estuarine habitat within the Pauatahanui Inlet in the event of a 10 year storm in the Duck Creek and Pauatahanui catchments during peak earthworks with northerly wind conditions.

Moderate Negative

- Moderate adverse effects on mid Horokiri due to sedimentation during construction.
- Adverse effect on intertidal and subtidal habitat within the Onepoto Arm from sedimentation arising from a 10 year rainfall event in Kenepuru Stream catchment associated with a southerly wind.

All other ecological components are assessed to have low to very low adverse effects or potential positive effects following mitigation.

11.1.2 POTENTIAL POSITIVE EFFECTS

High

- Blue and Green corridor through additional retirement and land surface protection from the Kapiti Coast (TE Puka) to Battle Hill (Horokiri).

Moderate Positive

- Expansion of wetland habitat along the route through the creation of stormwater treatment ponds and wetlands.
- Through retrofitting of culverts and existing mitigation planting improved fish passage and habitat values in Duck Creek.

Low Positive

- Potential for reductions in erosion and discharge to Pauatahanui Inlet and Wainui Stream form land retirement and revegetation in the Te Puka, Horokiri and Duck streams.
- Reduction of traffic on SH58 reducing the contaminant load that enters the Pauatahanui Inlet untreated from this road as runoff.

12. SUMMARY & CONCLUSIONS

12.1 POTENTIAL ADVERSE ECOLOGICAL EFFECTS

12.1.1 VEGETATION AND TERRESTRIAL HABITATS

The Transmission Gully Project is a major infrastructure project running for 27 km through steep and dissected hill country north of Wellington. It has a designation of 485 ha and a road footprint of 172 ha. The great majority of the route lies in modified farmland with scattered fragments of old growth forest, secondary forest of varying size and quality, and large areas of regenerating farmland. Some sections traverse sensitive and ecologically significant environments and there will be unavoidable effects.

A total of 40 ha of native vegetation will be permanently lost beneath the road footprint and a further 80 ha lies within the road designation and will be affected, in part or whole, during construction. We have calculated that the protection and restoration of 250 ha of land will mitigate for this loss.

Our assessment of habitat loss has been conservative, with the assumption made that all indigenous habitats within the designation are at risk and calculations of necessary mitigation have been based on this total area. However, there is still the opportunity during detailed design and construction to further avoid effects on habitats that lie within the designation. These opportunities have been identified.

Our conclusion is that there will be a moderate short term effect on native vegetation but this will not be ecologically significant and in the long term with the recommended mitigation there will be an increase in total indigenous vegetation along the route.

12.1.2 STREAMS AND FRESHWATER HABITAT

A total of 5,286 m of stream will be permanently lost or significantly modified through culverting or through the shortening of stream length associated with diversion. A further 5,132 m of stream will be diverted into new channels and the existing channel reclaimed.

These adverse effects are on regionally significant aquatic systems as well as systems that are of much lower current value. All of the systems affected are somewhat modified and somewhat tolerant to perturbations and are not particularly sensitive. The changes of habitat type due to culverts and diversions will result in moderate to high adverse effects depending on stream value,

We have calculated that the protection and restoration of 26,500 m of stream is needed to compensate for the loss described above. The land available for mitigation provides 30,000 m of stream.

With care the proposed diversions have a strong probability of creating as good, if not better, aquatic habitat than as exists today. The extensive areas of stream to be placed into protection and riparian planting and changes in land management more than "compensates" for the concrete substrate changes caused by the culverts required.

We believe that construction effects can be managed to an extent that adverse effects will be sufficiently small and not long term. Aspects of the mitigation proposed also assist with the reduction in levels of effect.

Our conclusion is that adverse effects on streams will be ecologically significant; however, we believe the calculated mitigation is sufficient to ensure that the functional integrity of the stream is maintained, and that no fish species are lost. We believe that the ecological enhancement recommended will compensate in the medium to long term for the loss of habitat by raising the ecological health of historically modified streams through retirement, the removal of stock and revegetation.

It is also possible that in the long term the levels of mitigation proposed will cause a net gain in those values post construction.

12.1.3 FAUNA

We have identified a number of fauna that require consideration during construction. Generally the species identified are unlikely to be significantly affected by construction or operation of the road. Where there will be an effect such as habitat loss, mitigation is readily achievable.

12.1.4 PORIRUA HARBOUR

The adverse effects of the Transmission Gully Project on the Porirua Harbour are restricted to 10yr rainfall events or greater which coincide with the maximum period of earthworks, and winds blowing continuously for a period of up to three days. If these events occur they can lead to high adverse effects in parts of Pauatahanui Inlet in and around the mouths of Duck Creek and Pauatahanui inlet or moderate effects in and around the mouth of Horokiri Stream, or Porirua Stream in the Onepoto Inlet.

In any storm event smaller than a 10 yr event, or where the contributing factors described above do not coincide, modelling results suggest that the levels of performance achievable from erosion and sediment treatment devices can minimise sediment discharge to the harbour to the point that any effects are low to very low effects.

12.2 SUMMARY OF MITIGATION PROPOSED

12.2.1 HABITAT LOSS

In total it has been calculated that 250 ha of land needs to be retired and revegetated to mitigate for the permanent loss or modification of 120 ha of terrestrial habitat.

In addition, to mitigate for the permanent loss or modification of 10,400 m of stream habitat a total of 26,500 m of stream needs to be restored. This relies on:

- Careful design of diversions so that they match as closely as possible the original morphology and hydrology and habitat values.
- Careful design of culverts to ensure continued fish passage in all streams currently containing native fish.
- Careful design of low grade culverts to provide continuous stream bed habitat along their length.

Mitigation sites have been located along the alignment with a total area of 425 ha. Within these sites 270 ha of revegetation or enrichment planting is proposed. This meets the requirements for vegetation mitigation.

Within these sites are is a quantity of land and waterway in which mitigation of stream effects where mitigation can be readily achieved. These blocks combined with the other 9 early retirement sites (already protected), and the retrofitting of culverts in Duck Creek, provide a quantity of stream types (30.9km) that exceeds our calculated mitigation requirements by some 12-13% or 4.4 km. This land will be treated in a variety of ways to achieve the riparian enhancements required by the SEV analysis.

We would note that retirement and revegetation of this land will have benefits that extend beyond vegetation loss and stream mitigation, including reduced catchment erosion and reduced impacts on estuaries.

- In the Horokiri this benefit will admittedly be small, but it adds to the argument of NZTA doing all they can do to protect Pauatahanui inlet.
- In the Te Puka the short to medium increase in slope stability and associated reduction in surface erosion will be experienced on steep slopes immediately above the road! So we suggest this will have direct, major benefit for route security and public safety that are at least as important to the project as mitigation for stream loss. It will also aid in keeping the culverts clear of debris.

12.2.2 SEDIMENT

It is proposed to significantly exceed regional guidelines for erosion management and sediment control. Targets of 70% for on-site capture of sediment from erosion on site, and 75% efficiency for stormwater pond treatment have been adopted by NZTA. In addition, decisions have been made regarding the maximum area of earthworks that can be open in a watershed at any one time to reduce the risk of large scale failure during a storm event.

It has been calculated that these measures will manage sediment release from the construction site to streams to acceptable levels, but with minor deposition in the lower reaches of Horokiri Stream and Duck Creek, the quantity depending on seasonal rainfall events.

It has been calculated that in rainfall events smaller than a 2 year flood there will be negligible sediment deposition to Porirua Harbour which is unlikely to cause community scale effects. In ten year events, the scale of effect is linked to the area of open earthworks in specific catchments and the prevailing wind conditions. For Duck Creek strong northerlies leading to wave action results in deposition in the Pauatahanui Arm which exceeds ecological triggers over an area of approximately 2.9 ha. This will have a major affect on some benthic communities of high ecological value.

Similarly, for Porirua Stream (Kenepuru Tributary) strong southerlies leading to wave action result in deposition to the Onepoto arm which exceeds ecological triggers over an area of 2.7 ha. This will have a moderate affect on some benthic communities of low to moderate ecological value.

12.2.3 STORMWATER

Modelling suggests that the new alignment will have a neutral or negligible effect on stormwater discharge of contaminants. However, NZTA has committed to treatment of stormwater runoff from the new alignment to meet their internal guidelines. This will be achieved through the use of stormwater treatment wetlands, and proprietary stormwater filter devices, and will ensure that any effects will be very low or low.

12.2.4 FAUNA

All mitigation is proposed to occur during construction and will focus on terrestrial and freshwater fauna that reside in habitats which will be lost beneath the Project footprint.

Capture and translocation of Peripatus and native lizards prior to earthworks is recommended.

Capture and transfer of freshwater fish from streams prior to reclamation for culverts and diversions is also recommended.

A range of other mitigation measures are detailed in the preceding sections.

12.3 POTENTIAL POSITIVE EFFECTS

The retirement and revegetation required in mitigation for the loss of terrestrial and freshwater habitat, and the methods of stormwater management, will have a number additional positive environmental outcomes. They are:

- **A green corridor**: There is an opportunity through retirement and revegetation along sections of the route (as part of both ecological and landscape mitigation), to provide a series of habitat "stepping stones" along the alignment, and connect existing bush areas. This will have ecological benefits for both terrestrial fauna and native birdlife as well as providing landscape and amenity benefits.
- **A blue corridor**: There is an opportunity through retirement and revegetation of sections of stream within the Te Puka Stream, Horokiri Stream, and Duck Creek (as part of both ecological and landscape mitigation), to create sections of aquatic habitat with greater habitat values than are currently present in these largely rural landscapes. This will have long term ecological benefits.
- **Reductions in long term erosion**: The land retirement proposed in the Te Puka and upper Horokiri will lead to long term reductions in erosion within these sections of catchment with the benefit of reduced sediment transport to the lower reaches of these streams and to the coast (Wainui stream mouth) and harbours (Pauatahanui Inlet).
- **Distribution & abundance of native fish:** Existing stream crossings and culverts along the route have been confirmed as native fish barriers. The recommended replacement of these barriers as offset mitigation for habitat loss will open up large areas of these catchments to native fish species that have declined or disappeared due to these barriers.
- **New wetlands:** The current Project design uses 5 treatment wetlands for the capture and removal of contaminants from stormwater. These wetlands, if designed and managed properly, will also provide additional benefit for native flora and fauna.
- **Research:** this Project will result in a range of ecological investigations that will provide public good in terms of increasing local conservation knowledge, and will potentially involve new science around stream diversions and rehabilitation, and modelling of effects on the estuary. This knowledge and science can be fed directly into management of adjoining areas under control of other agencies.

12.4 SUMMARY OF MONITORING PROPOSED

Baseline, construction and post construction monitoring of sensitive environments, water quality, culvert installation, earthworks, discharges to the harbour, and mitigation will be critical to achieving the outcome discussed above.

We strongly recommend a process of adaptive management for dealing with erosion and sediment control, and for the design and installation of culverts and diversions. Adaptive management would require detailed monitoring, the results of which feedback into the design and ongoing management.

12.5 CONCLUSIONS

Through this process continual refinement of the road alignment has been carried out in an attempt to avoid the most ecologically sensitive areas, or where that was not possible to minimise effects as much as possible. The most significant change made has been to move the alignment outside the existing designation to avoid forests and stream habitat of high value on the eastern slopes of Te Puka and Horokiri Streams. There have been a large number of other smaller changes of alignment or design that have all contributed to an improved environmental result. Overall, we are satisfied that every opportunity to avoid effects through refinement of the road alignment has now been explored.

Despite these efforts, areas of indigenous vegetation and some significant lengths of stream will be lost beneath the road and will be affected by other construction activities. This will lead, at least in the short term, to significant and unavoidable impacts on terrestrial and freshwater habitats and their associated fauna. There will also be an unavoidable increase in sediment transported from the site to Porirua Harbour.

The later part of this assessment assessed the magnitude and significance of these impacts and determined the measures required to mitigate for these effects to the point that there is at least no net loss and if possible some benefit.

In considering effects on terrestrial and freshwater habitat, and assuming the proposed mitigation is put in place, there will be a reduction in these effects over time, to the point where most effects are considered to be neutral. In some instances, the land retirement and revegetation proposed will lead to minor positive effects for some aspects of the local ecology.

However, this Project will generate large quantities of sediment during construction which can be reduced but not eliminated and there will be adverse effects of this on estuaries during large rainfall events. The sediment predicted to be generated by peak construction earthworks of Transmission Gully Project during rainfall events forms a small proportion of the sediment discharged to the streams and estuaries from other sources. Overall we consider that the combination of wind and rainfall conditions modelled by SKM that are predicted to generate adverse effects on highly valued estuarine habitat have a low probability of occurring. However, the resultant effects of the event(s) are unavoidable and difficult to mitigate.

In addition, the operation of this road will generate and discharge contaminated runoff to rural streams currently free of these chemicals, but which have nutrient issues relating to rural land uses. Retirement of land will reduce nutrient loading, but introducing the road will increase chemical contaminants. Overall we consider these effects to be unavoidable and have negligible adverse effects.

With regard to Pauatahanui Inlet, we consider that the movement of traffic from Grays Road and SH58, from which untreated stormwater discharges directly to the harbour, to the Transmission Gully route, where stormwater treatment will be provided, should lead to reduced levels of contaminant loading to the harbour in the medium term.

In the long term, sediment and associated stormwater contaminants derived from the Transmission Gully road, will accumulate in the central sub-tidal basins and low energy sheltered parts of Porirua Harbour. However, the contribution from the Transmission Gully road, given the treatment proposed, is considered to only form a small fraction of total contaminants arriving in the harbour and derived from the surrounding rural and urban land.

In conclusion:

- *Outstanding or rare indigenous plant communities;* There are no outstanding plant communities that will be directly affected by this Project. One rare plant has been identified within the designation. Effects can be avoided through careful design.
- *Areas containing nationally vulnerable species*; There are a number of habitats with vulnerable species present. With the exception of fish there will not be any significant effect on these. There is a risk of significant effects on native fish but this can be avoided with good design and installation.
- *Areas and habitats important to the continued survival of indigenous species*; There are no areas or habitats within the designation or the wider watersheds that are important for the continued survival of an indigenous species.

- *Areas important for migratory species*; The only migratory species that were recorded within the designation were native diadromous fish. The issues of continued fish passage have been explored and are addressed in this assessment. We are confident that the Project can proceed without adversely affecting fish migration. It is possible that cuckoo utilise some of the larger areas of bush within the designation but they are unlikely to be adversely affected by this Project. A number of migratory species utilise the saltmarsh and mudflats of Pauatahanui Inlet but these are unlikely to be adversely affected by this Project.
- *Areas important to vulnerable life stages of common indigenous species*; Porirua Harbour and the streams that form part of the Harbour watershed are important for spawning of a number of fish species. Proposed mitigation may improve the quality and quantity of habitat for these fish in several of the catchments.
- *Ecological corridors;* This Project has the potential to impact on movement of fish within the Pauatahanui catchment. However, with good design and monitoring we believe that in the long term the mitigation proposed will improve ecological corridors for avifauna, terrestrial fauna, and fish.
- *Protection of ecosystems vulnerable to modification, including estuaries and wetlands;* There are no wetlands within the designation that will be significantly affected by this Project. Porirua Harbour, and in particular the Pauatahanui Inlet arm, is vulnerable to modification and this issue has been explored in detail. Our conclusion is that under most conditions the harbour can be protected from sediment discharge. However a risk remains of a number of events coinciding that result in a large discharge of sediment to the harbour with effects on benthic communities. A number of activities are possible that can reduce this risk. These are discussed in our mitigation and monitoring plan (Attached).
- *Areas of scientific value;* A number of the measures recommended here for the protection and enhancement of the local ecology and for monitoring involves some areas of innovation and research. Already the harbour modelling and stream studies have contributed greatly to our knowledge of these significant ecosystems.
- *The quality of freshwater entering the coastal marine area;* This assessment, together with the work carried out by SKM indicates that there will not be a significant increase in contaminants reaching the harbour from road runoff. Treatment of stormwater is proposed to a high standard to ensure that this is the case.
- *The potential for restoration and rehabilitation of natural character;* This assessment provides for extensive restoration and rehabilitation of terrestrial plant communities, habitats for significant species and freshwater and riparian habitats. The mitigation recommended exceeds the value calculated.
- *Cumulative effects:* The issue of cumulative effects is most relevant when considering the long term health of Porirua Harbour. Whilst sediment and associated contaminants predicted to be discharged to Porirua Harbour in the form of treated stormwater from the operational phase of the Transmission Gully Project comprises a small proportion of the total sediment and contaminants discharged, we consider that the Project's contribution to the accumulation can be considered to contribute to an adverse cumulative effect on marine ecological values in the long term.
- *Natural Character:* We consider that the works proposed, combined with the mitigation described, will not lead to a negative change in the natural character values for which streams were scheduled in the Regional Freshwater Plan. In addition we note that the alignment lies some distance upstream of Pauatahanui Inlet and will not affect the natural character of this coastal harbour.
- *Indigenous biodiversity:* We consider that while some populations of indigenous flora and fauna will be affected, with the modified alignment and the mitigation proposed, no species or communities will be lost from the catchments, Ecological Districts, or Ecological Region.
- No net loss: There will be a net loss of stream length and habitat, however, we believe that with the mitigation proposed the quality of remaining stream habitat in several catchments can be enhanced to a point that this loss is mitigated.

- Additional conservation outcomes: The areas of land that are proposed for mitigation are larger and contain greater lengths of stream than are strictly required by the analysis we have conducted. This will lead to additional conservation benefit in the long term.
- Adherence to the mitigation hierarchy: The process carried out, commencing with the Scheme Assessment, have looked to first avoid effects wherever possible, reduce them where practical and mitigate those effects that remain.

From an ecological perspective, while there will be a variety of adverse effects, with the remedial mitigation proposed and understanding the avoidance that has taken place we consider that the proposed alignment can be undertaken while maintaining indigenous biodiversity and ecological values.

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