22. Freshwater ecology

Overview

The Project involves works in nine separate catchments across three watersheds. The streams in these catchments provide varying qualities of habitat for freshwater species, although all are in heavily modified catchments and the habitat values and species composition are reflective of this.

During construction, sediment runoff from the large-scale earthworks has the potential to adversely affect freshwater habitats and species. A high level of erosion and sediment control is proposed and based on sediment modelling, levels of sediment entering streams during normal conditions are predicted to be low and the ecological impact of this is considered negligible. As currently occurs, during, and immediately after high rainfall events, sediment levels in streams will rise. During the construction period the additional earthworks area for the Project will increase sediment levels in streams between 1 and 30% (in a Q2 event). Given the current experience this is not considered to be ecologically significant because:

- freshwater species in these streams are currently able to tolerate temporary increases in sediment levels higher than this; and
- by definition, these events coincide with increased stream flows and the hydraulically active nature of the streams (e.g. they are in relatively steep terrain) means that sediment is rapidly transported downstream, rather than being deposited on stream beds (were greatest effect occurs).

The long term operation of the Project will require the modification of streams in eight of the nine catchments. Primarily this modification is the construction of culverts and bridges and the re-alignment of parts of streams as part of the hydraulic design of the Project. While considerable efforts have been made to reduce the degree of modification to streams (as discussed in Chapter 9), it cannot be avoided completely. The adverse effects on freshwater ecology resulting from stream works can be offset by restoring and protecting streams to ensure an overall remediation and mitigation of the loss of freshwater habitat. In total, approximately 10.5km of stream habitat will be affected (through stream realignment and / or armouring) and this will require the restoration and protection of approximately 26.5km of streams to mitigate for this. As part of the overall mitigation package of the Project, approximately 31km of streams will actually be restored and protected, meaning the Project will result in a net gain in freshwater habitat quality and a balance in freshwater habitat quantity, across the Project area. This positive effect will be on-going and expanding as the wider catchment areas retired from pasture (predominantly in the Te Puka and Horokiri catchment) are planted in native vegetation.

Stormwater runoff from the road surfaces will be treated to a high standard (as discussed in Chapter 20) and will have negligible, if any, impacts on freshwater ecology against the anticipated background contaminant loading.

22.1 Introduction

This chapter presents the findings of investigations undertaken to determine the likely effects of the Project on freshwater ecology.

Information about existing freshwater ecology was obtained from ecological databases and previous relevant studies. Ecological field investigations were also undertaken specifically for the Project. Once a baseline of freshwater ecology had been determined, the impacts of the construction and operation of the Project were assessed. This first assessment stage was undertaken without the application of any specific ecological mitigation. The Project ecologists worked closely with the design team to seek to avoid adverse ecological effects where possible. Where avoidance was not possible and effects were more than negligible, ecological mitigation was then developed to mitigate those adverse effects.

The final assessment stage considered the likely environmental effects with the application of the proposed mitigation.

22.2 Ecological investigations

The identification of effects on freshwater ecology required the assessment of the composition and values of the existing aquatic ecosystems. This relied on two complementary methods:

- desktop studies of available relevant information such as ecological databases, publications and previous ecological investigations; and
- field surveys.

The description of existing freshwater ecology given in this section includes a brief overview of the investigations undertaken. Further details on the methods used and findings of these investigations are contained in the report on freshwater habitats and species: Description and values (**Technical Report 9**).

22.3 Existing freshwater ecosystem

22.3.1 Freshwater habitat

Freshwater habitat is considered to be streams with permanent or intermittent flows which have the capacity to provide aquatic habitat. It did not in this case include ephemeral streams, seepages or overland flow paths. This section provides a description of the physical characteristics of the seven different freshwater habitats[126].

126. An assessment of the physical habitat of the Whareroa Stream was not part of the field investigations due to fact that there are no stream works (i.e. stream crossing and/or realignments) proposed. However, the potential effects from construction (chemically treated sediment laden water) and operation (treated stormwater) have been considered and are covered later in this chapter. Collins Stream was assessed as part of the Pauatahanui Stream.

22.3.1.1 Te Puka / Wainui Stream

In its headwaters in the Wainui Saddle area, the Te Puka Stream is a poorly defined cobble and boulder base stream under a full forest canopy (the true right branch) or a narrow channelised, intermittent creek (true left branch). 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 (Figure 22.1).

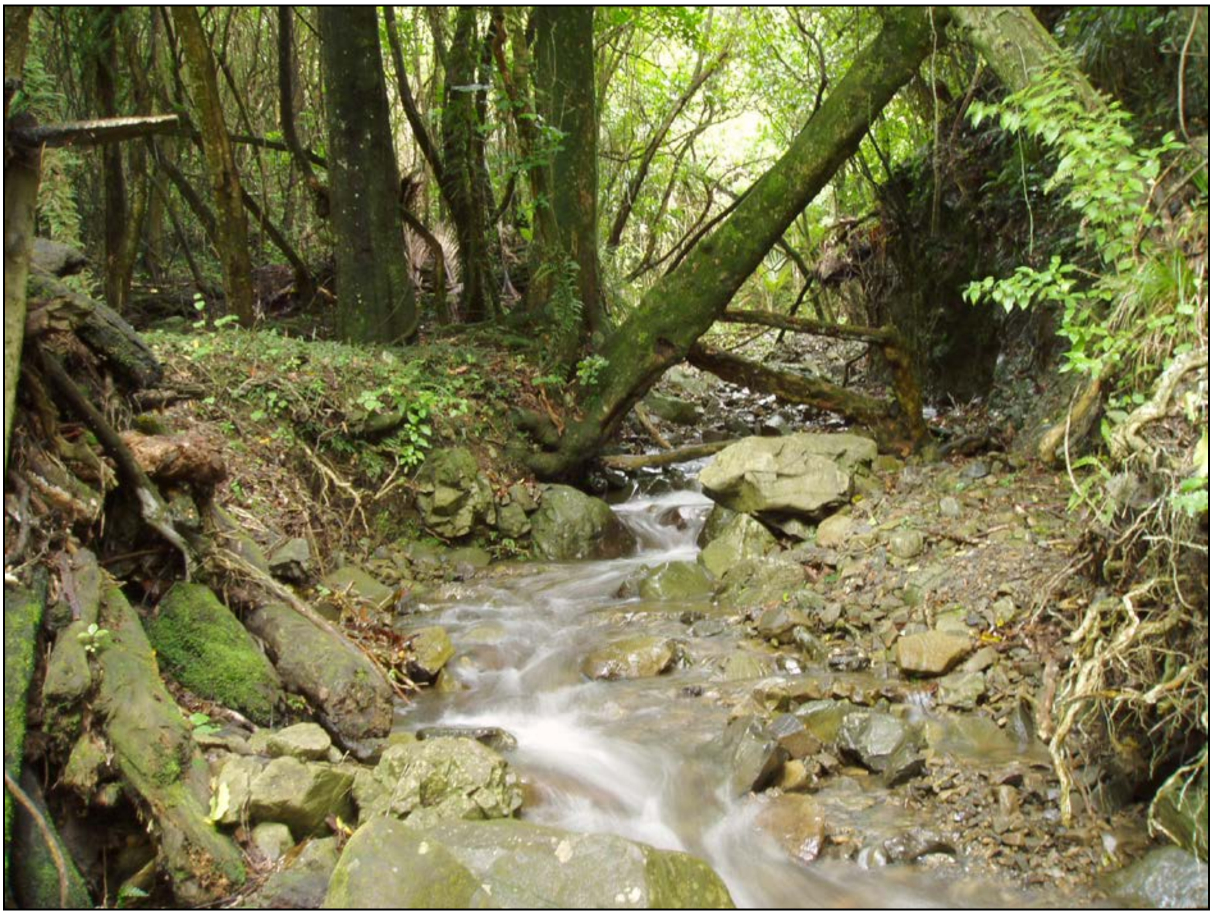

Figure 22.1: Upper Te Puka Stream

These are ideal habitat for koaro and banded kokopu but less so for shortjaw kokopu. Riffle habitat makes up around 40% of the aquatic habitat with cascades, stepped riffles, and stepped pools making up the remaining general aquatic habitat types. All represent relatively shallow “fast” water habitat.

The middle and lower reaches of the stream drop out of forest into pastoral farmland (Figure 22.2). These reaches are semi-braided with a relatively undefined channel set in wide banks.

Figure 22.2: Mid Te Puka Stream

22.3.1.2 Horokiri Stream

The upper western tributaries of the Horokiri are largely in rough pasture and many are ephemeral. The larger, eastern tributaries are perennial and lie in native regenerating shrublands and forest. While the water is clear and the substrate cobble relatively clean, the riparian areas of the main stem are largely in exotic pasture species and are unprotected from stock (Figure 22.3).

Figure 22.3: Upper Horokiri Stream

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 (Figure 22.4). The water generally runs clear in a wide deep set channel as a shallow run and riffle system.

Figure 22.4: Mid Horokiri Stream, with gorse covered riparian margins

The lowest reaches are much flatter and the stream 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.

22.3.1.3 Ration Stream

This is a generally flatter catchment than the others in the Project area. The majority of the upper reaches are in beef and sheep pasture, the middle reach in plantation forestry and the lower reaches in life style farming.

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 (Figure 22.5) under pine plantation or through the farmlands near the inlet.

Figure 22.5: Mid Ration Stream with low flows and bank modification, running though the Pauatahanui golf course

22.3.1.4 Pauatahanui Stream

The upper catchment area has pockets of bush and shrubland, the middle and lower catchment is largely in exotic shelter belts and pasture. The middle and upper reaches were not investigated by field work.

Typically the riparian areas are in 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.

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 (Figure 22.6).

Figure 22.6: Lower Pauatahanui Stream

22.3.1.5 Duck Creek

The upper catchment is generally in pasture, with the headwaters (four or five tributaries) lying in scattered riparian native shrubland and pasture. The catchment contributing to the middle-lower section is in plantation forest. Approximately half the catchment is in steep to very-steep pastoral land with the other half being in forestry.

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 three perched culverts which prevent continuous upstream fish passage (Figure 22.7).

Figure 22.7: One of the existing perched culverts (acting as barriers to fish passage) in Duck Creek

22.3.1.6 Kenepuru Stream

While the majority of the catchment is urbanised, the upper reaches contain some pastoral and scrub areas. Its headwaters (a tributary of Kenepuru Stream known as Cannons Creek) lie in Belmont Regional Park and the stream descends through farmland and regenerating bush for 3.6km until it joins Kenepuru Stream. For approximately 1.4km Cannons Creek flows in a concrete-lined channel before dropping steeply down a series of large stepped concrete structures to join Kenepuru Stream. Kenepuru Stream eventually enters Porirua Harbour approximately 3.0km from the Cannons Creek Lakes Reserve.

22.3.1.7 Porirua Stream

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.

Figure 22.8: Un- named tributary of Porirua Stream

Downstream of the mahoe gorge, it is surrounded by the pine forest plantation that covers the majority of the sub-catchment of this tributary.

22.3.1.8 Water quality

As discussed in Chapter 20, the water quality data illustrates that several catchments have heavy metal issues and that most catchments currently have nutrient enrichment. The catchments with the highest levels of contamination (copper and / or zinc) are Porirua, Kenepuru, Duck, Pauatahanui, Ration and Horokiri. In terms of dissolved contaminants (which are of greater relevance to freshwater ecology), only the Kenepuru catchment has notable high dissolved copper contaminant levels. Again, it is the Kenepuru and Pauatahanui catchments that have the greatest nutrient enrichment.

The total suspended solids (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, TSS levels can be very elevated (greater than 1000 g/m³) and elevated quite frequently, whereas in other catchments levels are more typically in the range of 50-100 g/m³ during rain events.

22.3.2 Freshwater fish species

Freshwater fish species in six[127] catchments within the Project area were investigated. The Freshwater Fisheries Database (FFDB) recorded 17 species of fish. Four of these species (smelt, flounder, mullet and triple fin) are more frequently caught in tidal reaches and are typical of the lower reaches of streams.

Electric fish surveying (EFM) recorded nine of the remaining 13 species listed in the FFDB. Those not found were lamprey, torrent fish, shortjaw kokopu and giant bully. The freshwater fish species recorded in the study area catchments are shown in Table 22.1.

Table 22.1: Freshwater fish species in streams in the Project area

Fish	Recorded on FFDB						Threat status	Found in EFM sampling
	Te Puka	Horokiri	Ration	Pauatahanui	Duck	Kenepuru		
Lamprey		✓		✓			Declining	
Short fin eel	✓	✓		✓			Not threatened	✓
Long fin eel	✓	✓		✓			Declining	✓
Koaro	✓	✓		✓			Declining	✓
Inanga		✓		✓			Declining	✓
Giant kokopu		✓		✓			Declining	✓
Short jaw kokopu		✓					Declining	
Banded kokopu	✓	✓		✓			Not threatened	✓
Red-finned bully	✓	✓		✓			Declining	✓
Common bully		✓		✓			Not threatened	✓
Giant bully		✓					Not threatened	
Torrent fish		✓					Declining	
Brown trout[128]							Introduced	✓

Based on the FFDB and the EFM undertaken as part of the field investigations, the two species of eel and red fin bully are the most frequently encountered freshwater fish in streams in the Project area. Lamprey, torrent fish, shortjaw kokopu and giant bully are infrequently found (that is, in less than 1% of records) or may not now be present (only one shortjaw kokopu has been recorded, 1987).

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127. Whareroa Stream was not included as there are no physical works in this stream. Collins Stream is very small with insufficient water to sample, and access to upper Ration Stream was not attained. Porirua Stream was investigated but had insufficient water to fish.

128. Brown trout were recorded on the FFBD, and reported in historic literature but not sampled in the field work of 2009-2011 sampling.

22.3.3 Aquatic macroinvertebrates

Aquatic macroinvertebrates encompass a wide range of species, including many insects, crayfish and clams. The diversity, or species richness, of aquatic macroinvertebrates provides an indication of the overall quality of aquatic habitats.

Two indicators of quality were used:

- EPT taxa richness; and
- Macroinvertebrate community indices (MCI & QMCI).

EPT provides information about the richness of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa. This is recorded as a percentage of a community that is EPT as an indicator of overall quality of the community. A higher ratio typically indicates a higher quality of aquatic habitat.

MCI and QMCI consider the whole macroinvertebrate population structure and provide a score that indicates general water quality. Generally, an MCI score of less than 80 indicates poor water quality and a score of greater than 119 indicates excellent water quality, and an QMCI score of >6 indicates an excellent water habitat condition.

Table 22.2: MCI & QMCI score classification meanings[129]

Quality class	Stark (1998) description	MCI	QMCI
Excellent	Clean	>120	>6.0
Good	Possible mild pollution	100-120	5-6
Fair	Probable moderate pollution	80-100	4-5
Poor	Probable severe pollution	<80	<4

22.3.3.1 EPT results

In total, 81 different aquatic macroinvertebrate taxa[130] were sampled from the catchments in the Project area. All sample sites have over 10 EPT taxa and a typical range of between 15 and 20 taxa with five stream sites having over 25 EPT taxa. For most sites in the Project area, over 50% of the community's species belong to one of the three EPT groups, as shown in Figure 22.9.

129. Stark and Maxted. 2004. Macroinvertebrate Community Indices for Auckland Soft-bottomed Streams. ARC Technical publication 303

130. 'Taxa' (plural of taxon) refers to a group (i.e. one or more) of organisms.

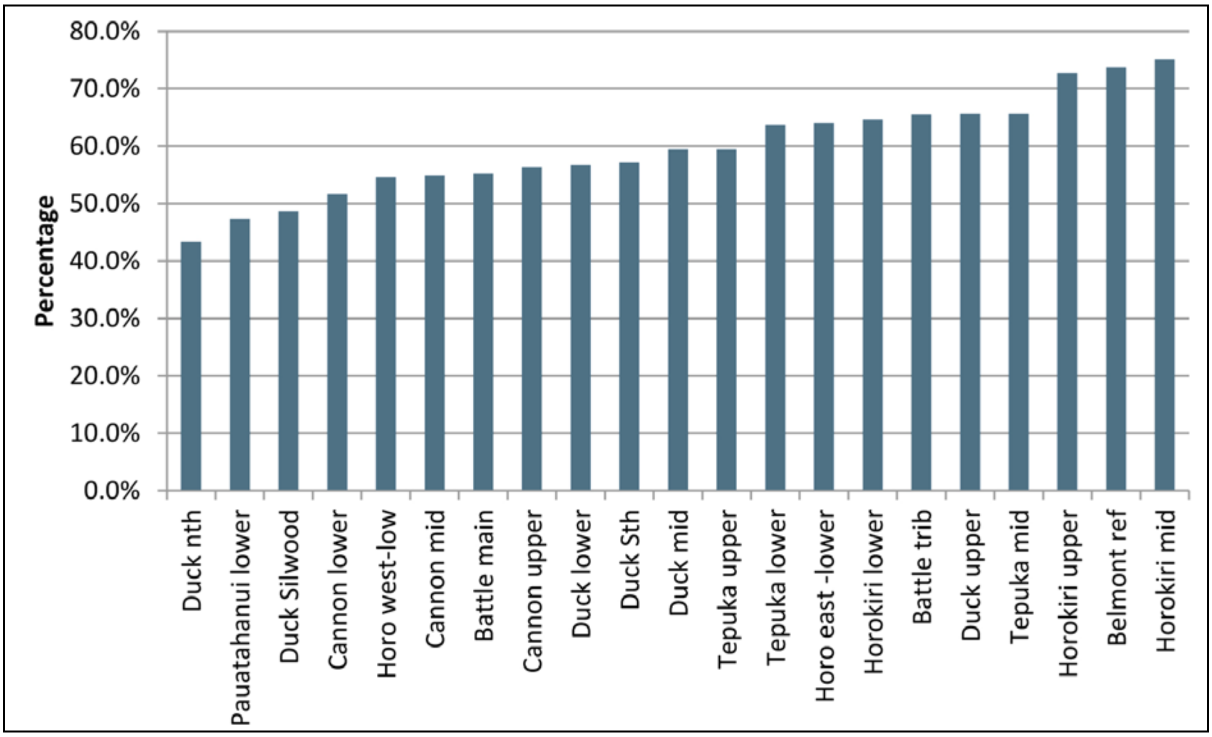

Figure 22.9: The proportion that the EPT taxa makeup of the total taxa present at each site

The lowland sites of Duck Creek and Pauatahanui were the only sampled sites that have less than 50% EPT 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 of increasing EPT representation in the fauna from lowland to upland reaches, indicating a higher species richness (and freshwater habitat) in upper reaches.

22.3.3.2 MCI and QMCI results

The MCI results are shown in Figure 22.10.

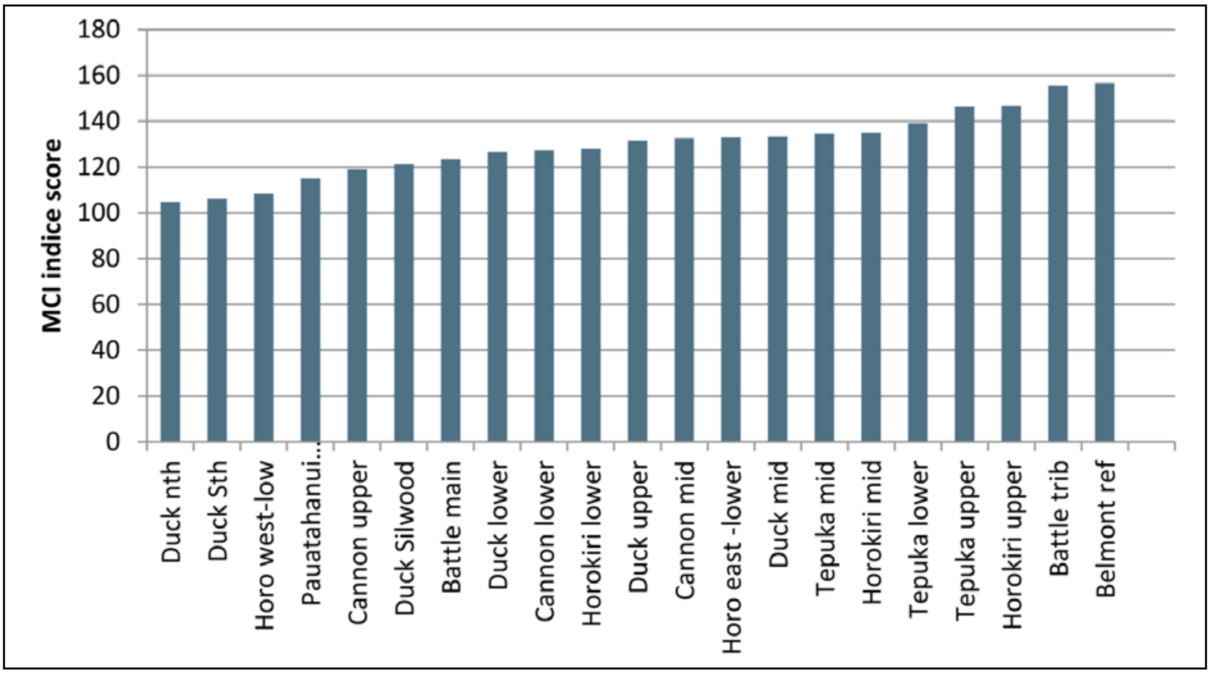

Figure 22.10: MCI results for streams in the Project area

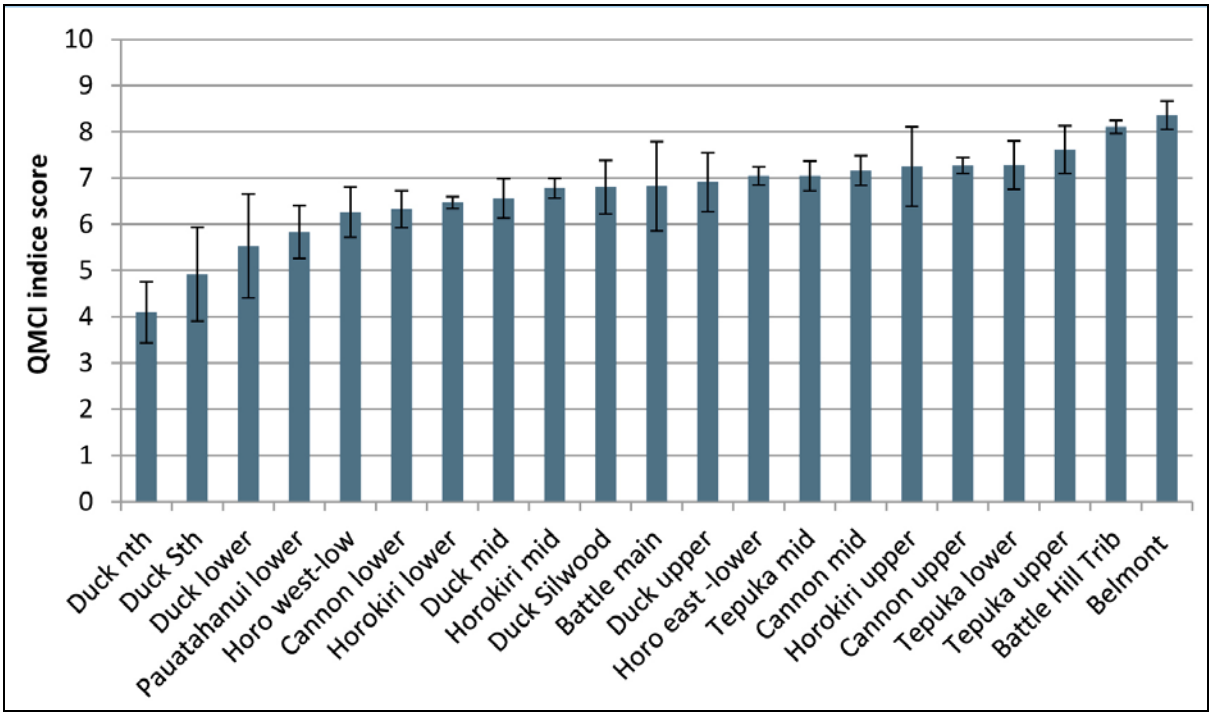

Figure 22.11: QMCI results for streams in the Project area

The results indicate that all the streams are 'good' or 'excellent' in terms of their MCI & QMCI scores. Other general conclusions are that Te Puka and the mid and upper Horokiri stand out as having some of the highest scores (discounting a tributary in Battle Hill Farm Forest Park).

The other main conclusion is that MCI and SQMCI scores for all streams tend to decrease in the lower reaches of the stream. This is consistent with the general trend of increased levels of contamination and softer substrate prominence in lower reaches.

22.3.4 Summary of freshwater habitat value

Based on the ecological investigations considering both freshwater habitat and species, the following overall conclusions can be made:

- The streams sampled generally 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 values. The western tributaries lie predominantly in pasture and have lower habitat values.

Table 22.3 provides an overall summary of the ecological value of the relevant streams.

Table 22.3: Ecological value of streams in the Project area

Stream reach	Physical habitat (SEV)	Fish	Aquatic invertebrates	Compilation and result
High value stream habitat				
Upper Te Puka	High	Moderate	High	High
Lower-middle Te Puka	High	Low	High	High
Middle Horokiri (East)	Moderate	High	High	High
Lower Horokiri (East)	Moderate	High	High	High
Upper-middle Duck	High	Low	High	High
Middle Duck	Moderate	High	High	High
Moderate value stream habitat				
Upper Horokiri (East)	Moderate	Moderate	High	Moderate
Lower Pauatahanui	Low	High	Moderate	Moderate
Lower Duck	Moderate	High	Moderate	Moderate
Upper Kenepuru (Cannons)	Moderate	Moderate	High	Moderate
Low value stream habitat				
Middle Ration	Low	Low	Low	Low
Lower Ration	Low	Moderate	Low	Low
Porirua tributary (Linden)	Low	Low	Low	Low

22.4 Assessment of construction effects on freshwater ecology

22.4.1 Freshwater habitat degradation and loss

The main construction activities that have the potential to effect freshwater habitat and species are construction works in stream beds which could degrade habitat through physical disturbance and / or the increase of contaminants (mainly sediment) into the water column and eventually the stream bed. In addition permanent diversions cause the infilling and loss of habitat reaches (albeit with recreation of new habitat).

22.4.1.1 Physical habitat disturbance

Works in streams (such as the construction of bridges and culverts) have the potential to disturb freshwater species, both through direct physical disturbance and the disturbance of sediment on stream beds. This effect can be adequately managed to minimise habitat disturbance so that species are not significantly affected.

Streamworks will not be undertaken in wetted channels and temporary upstream diversions will be put in place prior to works starting in the natural channel. Where necessary, fish will be captured and transferred to alternative sites prior to the commencement of streamworks.

22.4.1.2 Temporary culverts for construction access

The construction of the access track will require the installation of approximately 61 temporary culverts which will be in place for up to two years. Many of these will only be in ephemeral water bodies. Due to the temporary nature and small scale of these culverts, any potential adverse effects on freshwater ecology are considered to be minor.

Any damage to streams bank or riparian vegetation will be remediated after the culverts have been removed.

22.4.1.3 Sediment from earthworks

The main potential effect during construction that could have significant adverse effects on freshwater ecosystems is increased levels of sediment entering waterways from the large scale earthworks required for the Project. While a level of sediment is required for the healthy function of freshwater ecosystems, too much sediment can adversely affect ecosystems.

The possible adverse effects of too much sediment on species could include:

- smothering of species living of the streambed;
- interference with the gills of fish and invertebrates;
- increased sediment in the water column can reduce periphyton growth levels which provide food for many freshwater species; and

- changes in the visual clarity of water can affect the ability of fish to see their prey.

The level of sediment in the water column is indicated by the turbidity of the water which is measured in units known as NTU[131]. There is no standard for trigger levels of NTU in relation to freshwater habitats as it can be very ecosystems and species specific. However, the Project ecologists have identified that figures of around 20 – 25 NTU can be considered as ‘warning’ (but not damaging) levels. Table 22.4 shows the recorded turbidity levels for some of the affected streams, with all of these streams having median turbidity levels well below the 20 – 25 NTU ‘warning’ level.

Table 22.4: Average turbidity levels of selected streams

Stream	Turbidity (NTU)	
	Mean	Median
Duck	8.9	7.3
Horokiri (Upper)	12.2	4.2
Horokiri (Lower)	13.6	5.7
Pauatahanui	24.3	2.8

The erosion and sediment control philosophy to reduce and manage sediment from the earthworks was discussed in Chapter 20. Based on the assumed performance of the proposed erosion and sediment and sediment control (*ESC*) measures, sediment yield increases for streams has been estimated and used as a basis for considering the potential effects on freshwater ecosystems.

Under regular conditions (i.e. not at Q2 or above rainfall event) erosions and sediment control measures are expected to control and minimise the volume of sediment entering streams to such an extent that negligible (if any) adverse effects on freshwater ecology are predicted.

Storm events have the potential to result in more significant increases of sediment to waterways and ESC measures have an upper limit of effectiveness in these events. In general terms, a high rainfall event is likely to generate more sediment that could enter streams and hence adversely affect freshwater species through streambed deposition. Table 22.5 shows predicted sediment increases in the various catchments for Q2 and Q10 events.

Table 22.5: Sediment yield estimates during construction for storm events (with mitigation)

Catchment	Increase in sediment (%) from base line	
	Q2 event	Q10 event
Kenepuru	10	10
Duck	27	27
Porirua	2	2
Ration	43	43
Horokiri	14	14
Pauatahanui	2	2
Whareroa	5	5
Wainui / Te Puka	29	29

131. Nephelometric turbidity units

Modelling of the potential increase as a result of construction (with mitigation) is between 2% and 43% in a Q10 event. This varies from catchment to catchment depending on the underlying geology, soil, slope, land use and vegetation cover and proximity to the waterway.

Baseline sediment deposition in stream has also been modelled and (due to gradient) virtually no deposition changes result. The exceptions to this are in the Ration and Whareroa, two low gradient streams.

For the following assessment it is considered that a Q50 event is beyond the scope of any sediment management tools, and will result in such severe erosion within the affected catchments that the contribution from the construction site will be only a small proportion of the overall adverse catchment effect.

For a Q2 or Q10 event it can be expected that up to a 29% increase in sediment in most of the streams would occur. In Ration Stream the predicted increase is higher than other streams because of its low gradient.

Around 29% increase is the highest expected increase other than in the Ration Stream and in many streams this will be less (<20%). In these catchments rain events of these sizes currently cause an increase in sediment into the streams due to much of the catchments being in farmland. Those increases currently can be considerably more than 20% on top of the background (i.e. hundreds to thousands of NTU[132]).

Currently, temporary increases in turbidity following these events appear to cause few negative effects on freshwater ecosystems. The likely reasons for this is that the species present have a relatively good tolerance of these types of events and are able to withstand short (less than three days) exposure to elevated sediment levels. Furthermore, by definition such events coincide with increases in stream flows and most of the affected streams are hydraulically active meaning sediment is kept in suspension and transported downstream relatively quickly rather than staying in the water column or being deposited in the stream bed.

As such, while the earthworks required for the Project will result in additional sediment entering streams and being deposited on streambeds, the ecological effects of this, both in regular conditions and immediately following high rainfall events, is considered to be limited and within acceptable levels.

22.4.2 Discharge of other contaminants to streams

Other than the sediment entering streams, other general construction activities could potentially result in other contaminants entering streams such as fuel and oil from machinery. The likelihood of these substances entering streams is very low as the CEMP has procedures to avoid this, such as requiring all refuelling to be done well away from streams. It also contains procedures for accidental spills.

132. There is roughly a linear relationship between NTU and TSS up to 500.

A limited number of contaminated land sites have been identified but the CLMP contains procedures for how potential adverse effects of contaminated material can be managed and these sites do not pose a threat to streams.

22.5 Assessment of operational effects on freshwater ecology

There are two main potential long-term effects from the on-going operation of the Project:

- freshwater habitat modification resulting from the required realignment of sections of some streams; and
- stormwater runoff from road surfaces entering streams,

22.5.1 Freshwater habitat modification

The Project will result in the permanent modification (to varying degrees) of streams (and their tributaries) in all catchments except the Whareroa.

The modification of streams will result from the following aspects Project:

- permanent culverts and bridges; and
- permanent channel realignment (as part of the hydraulic design).

As discussed previously (particularly in relation to the road alignment through the upper Horokiri Stream valley), a consideration in the design of the Project has been the minimisation of stream modification (and hence potential effects on freshwater habitats). However, while considerable efforts have been made to minimise the level of modifications required, the location and scale of the Project means that some stream modification is unavoidable.

From a hydraulic and ecological perspective, the function of modified streams must be undertaken on a catchment-wide basis. That is, individual culverts and diversions cannot be considered in isolation but as part of the wide package of streamworks within the catchment.

In general terms the types of effects that can result from the streamworks proposed could include:

- loss of stream length (i.e. physical habitat);
- changes to flow regimes (water volumes and velocities);
- loss of riparian vegetation which can influence habitat characteristics such as water temperature and the quality of spawning habitat;
- impediments to fish passage (e.g. by culverts);

Table 22.6 gives an indication of the total stream modification for the Project as a result of culverting and channel realignment.

Table 22.6: Magnitude of freshwater habitat loss and modification (without any mitigation)

Stream	Ecological value[133]	Total length of stream habitat in catchment (m)	Length of stream lost or modified (m)	Loss or modification as % of total	Impact magnitude
High value stream habitat					
Upper and mid Te Puka	High	9,786	2,496	26	Very high
Middle and Lower Horokiri East	High	5,083	1,109	22	Very high
Upper and middle Duck	High	14,154	832	6	Moderate
Moderate value stream habitat					
Lower Te Puka / Wainui	Moderate	3,333	651	20	Moderate
Upper Horokiri East	Moderate	17,335	828	5	Low
Lower Duck	Moderate	5,562	0	0	None
Lower Pauatahanui	Moderate	149,029	1,374	1	Low
Upper Kenepuru (Cannons)	Moderate	19,944	274	1	Low
Lower value stream habitat					
Ration Stream	Low	19,442	2,147	11	Very low
Porirua (tributaries in Ranui Heights)	Low	57,483	707	1	Very low
TOTAL	**10,418**	**301,151**	-	-	-

The magnitude of habitat loss and modification is greatest in the Te Puka and Horokiri Streams. Based on the ecological values of the stream and the degree of modification, the impact magnitude (without mitigation) is considered to be very high for upper and mid Te Puka and mid and lower Horokiri east Streams. It is considered to be moderate for the Upper and Middle Duck and the Lower Te Puka / Wainui. It is considered to be low, very low or negligible for all other streams.

22.5.1.1 Approach to freshwater habitat mitigation

When considering how effects on freshwater habitats will be managed it is useful to first acknowledge that the effects of permanent stream realignment cannot be avoided completely (although every effort has been undertaken to reduce the scale of modification) or remedied (as the re-alignment will be permanent). As such, management options have necessarily focused on how potential effects can best be mitigated.

133. The ecological values assigned to streams within the Project area have been derived from field observations and analysis by the Project ecologist specifically for the Project. These values do not entirely align with those values assigned to them in the Regional Freshwater Plan for the Wellington Region 2000. The key differences are that the Project ecologists consider that Te Puka Stream and Duck Creek have higher ecological values than they have been assigned in the RFWP, while Ration Stream has lower values than it has been assigned. This is discussed further in relation to the approach to freshwater habitat mitigation.

The philosophy for the mitigation of adverse effects on freshwater habitat is that across the entire Project area there will be no net loss of the quality (i.e. the life-supporting capacity) of freshwater habitat as a result of the Project. In some catchments there will be a small net loss in terms of quantity (i.e. stream length), but in other catchment these will be a substantial gain in quality. Overall, there will be a net gain in the quality freshwater habitat as a result of the Project.

The stream ecological valuation (SEV) method has been used in order to quantify and then to assist in balancing the effects of the project on the values of watercourses (in quality and quantity terms). One of the advantages of using the SEV method is that it takes into account the different ecological functional values of streams. For the Project, these values have been derived from ecological investigations, rather than just their significance in planning documents. This has meant that all the streams affected by the Project have been treated consistently. In order to mitigate for effects on watercourses only ecological mitigation has been offered (i.e. there is no consideration of amenity benefits etc.).

22.5.1.2 Development of mitigation using the stream ecological valuation method

The SEV method is a tool used to quantify the ecological value and performance of streams. It can also specifically be used to determine the mitigation required to compensate (or mitigate) adverse effects on streams. It is increasingly being used in New Zealand, including being adopted by the Auckland Regional Council in 2007 as a best practice method for providing environmental compensation for adverse effects on streams[134].

The methodology for using SEV is outlined in **Technical Report 11**, but broadly it involves:

- assessing the ecological value of the affected streams;
- determining the extent of effect (e.g. stream loss etc.) for each type of habitat (e.g. perennial, ephemeral etc.);
- determining the environmental compensation ratio (ECR) for each type of habitat;
- calculating the quantity of each habitat needed to compensate for the loss by multiplying the habitat loss by the ECR; and
- it does have a weakness in not weighting threatened species and in only using faunal presence / absence.

Seven types of habitat modification (with the following ECR in brackets) were identified:

- culvert steep (4.1);
- culvert flat (2.2);
- culvert armouring (1.7);
- culvert stream loss (6.0);

134. ARC, 2008: Stormwater and Sediment Field Day, Auckland Botanic Gardens 2008, Stream Ecological Valuation (SEV).

- diversion length (1.7);
- diversion armouring (1.7); and
- diversion stream loss (6.0).

The highest ECRs (i.e. 6.0) are for stream loss, whereas modification (e.g. armouring) has a lower ERC.

The ECR were derived by using Te Puka and Horokiri Streams and Duck Creek as templates as there will be a high degree of modification in those catchments. As such, the ECR derived (and applied across the entire Project area) are conservative (in that they will tend to require that the Project provides more habitat mitigation than may be strictly necessary under the SEV approach).

An ECR was also derived for the removal of existing barriers to fish passage (three perched culverts) on Duck Creek, which is work that the NZTA also proposes to undertake, not directly required by the Project. Removal of these barriers as part of the Project will improve the freshwater habitat in Duck Creek (by providing fish with access to additional habitat) and has therefore been assigned an ECR of -1.5 (the negative value indicating the improved habitat as a benefit which can be subtracted from the overall length required for compensation).

Based on the different types of freshwater habitat affected and the ECRs, the total compensation required is set out in Table 22.7.

Table 22.7: Calculation of freshwater habitat compensation required

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**		**26,504**

In essence, using the SEV method with the calculated ECRs, the loss and / or modification of approximately 10.5km of existing stream requires the restoration and protection of approximately 26.5km of stream to compensate for the loss of habitat value.

In this context, restoration and protection refers to:

- the retirement from pasture and planting of native vegetation on land in stream catchments;
- the exclusion of stock from streams and tributaries which currently have unrestricted stock access; and
- the removal of existing barriers to fish passage (i.e. the perched culverts in Duck Creek).

The majority of the offset mitigation for freshwater habitat involves pasture retirement and the planting of native vegetation. While some of this has already be done (as advanced mitigation planting as a condition of the existing designations for the Project), most of this planting will be new. This planting is similar to that required for the mitigation of terrestrial vegetation loss (described in Chapter 21) but focused in the riparian zone of the streams. The area associated with the riparian zone has not also been counted in terms of the terrestrial vegetation offsetting mitigation.

The total planting required to compensate for both the terrestrial and freshwater habitat loss will restore and protect approximately 30km of streams, 3.5km more than the 26.5km that is necessary to offset the adverse effects of freshwater habitat loss. As such, in the long term there will be a net gain in the quality of healthy freshwater habitat within the Project area. This additional 3.5km of restored and protected stream is also useful in that it provides a comfortable margin of flexibility (i.e. small changes in exact diversion and culvert lengths will not require additional stream length to be provided for offset mitigation).

Overall, in the long term the Project will result in the improvement of freshwater habitat within the Project area.

22.5.1.3 Fish movement

Fish passage can be provided to all streams affected by the Project where native fish are known to be present. This will typically be provided using modified (e.g. wooden block added as in Figure 22.12) buried culverts.

Figure 22.12: Wooden blocks bolted to culvert to improve fish passage

In steeper culverts, fish ladders are likely to be required. An example of a fish ladder is shown in Figure 22.13.

Figure 22.13: Example of a fish ladder

One issue during operation is the continued maintenance of culverts and, their intakes and outlets, to ensure that bank erosion, debris deposition, and structural deterioration, are managed to maintain the conditions necessary for passage past these structures.

With on-going programmed monitoring and maintenance of culverts, the risk of adverse effects on fish passage from operation is negligible. Further details around monitoring and the on-going maintenance of fish passage are contained in the draft EMMP.

22.5.2 Stormwater runoff

The discharge to streams of treated stormwater from road surfaces has the potential to adversely affect freshwater habitat and species.

As discussed in Chapter 20, changes to contaminants entering streams from the operation of the Project are predicted to be relatively minimal. There will be no change in TSS, while there will be reasonably small changes (some catchment experiencing increases and some experiencing decreases) in zinc, copper and TPH.

Changes to zinc and copper (relative to ANZECC 95% ecological triggers) are shown in Table 22.8.

Table 22.8: Comparison of zinc and copper discharge in 2031, without Project and with Project (no stormwater treatment) relative to ANZECC 95% ecological triggers

Catchment (taken at mouth)	2031 without Project				2031 with Project (No treatment)			
	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	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	Fail	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	Fail	0.005	Pass	0.001	Fail
Whareroa	0.004	Pass	0.001	Fail	0.004	Pass	0.001	Fail

The values show that even without any stormwater treatment, there is only one catchment (Ration) where zinc and copper levels will move from a pass to a fail in terms of the 95% ANZECC ecological triggers. When stormwater treatment is applied to the model the predicted zinc concentration is within the guidelines, meaning the only change with respect to the guideline triggers values is copper in the Ration Stream (the predicted value of 0.0015 g/m^3 only just exceeds to ecological trigger value of 0.0014 g/m^3). While this minor exceedance is acknowledged, the ecological effect of this is considered to be negligible and no further mitigation (i.e. in addition to the proposed Project-wide stormwater treatment) is required specifically to mitigate this minor exceedance.

The other contaminant modelled was TPH. The proposed proprietary treatment devices will remove 75% of TPH and it is considered that this will have negligible impacts on freshwater ecology.