Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

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under:	the Resource Management Act 1991
in the matter of:	Notice of requirement for designation and resource consent applications by the NZ Transport Agency for the MacKays to Peka Peka Expressway Proposal
applicant:	**NZ Transport Agency** Requiring Authority

Statement of evidence of **Dr Vaughan Keesing** (freshwater ecology) for the NZ Transport Agency

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Dated: 6 September 2012

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STATEMENT OF EVIDENCE OF DR VAUGHAN KEESING FOR THE NZ TRANSPORT AGENCY

QUALIFICATIONS AND EXPERIENCE

1 My full name is Dr Vaughan Francis Keesing.

2 I am a Member of the Ecological Society of New Zealand and the New Zealand Freshwater Sciences society.

3 I am currently a Principal and Senior Ecologist of Boffa Miskell Limited (*BML*) in Wellington. I have worked for BML as a practising ecologist for the last thirteen years.

4 My expertise includes both terrestrial and aquatic ecology. I have researched and prepared ecological assessments with respect to resource consent applications, notices of requirement and for proposed plan changes/ policy statements. I have also presented ecological evidence before Councils, Boards of Inquiry and the Environment Court.

5 Recent matters on which I have provided evidence include the Transmission Gully roading project (both the Plan Change and Notice of Requirement/resource consents), the Schedule of Significant Natural Areas for Taupo District Council, the Porters Ski Field rezoning, the Water Conservation Order hearing for the Hurunui River, Meridian's Mill Creek Windfarm, Waitahora and Hauāuru mā raki Windfarm Environment Court and Board of Inquiry hearings, and the schedule of wetlands of regional significance and associated policies and rules in the West Coast Regional Plan.

6 I have been involved in the development of a number of roading projects, having produced ecological reports and evidence before Councils, the Environment Court and Boards of Inquiry. Some of the larger roading projects I have worked on include the Albany to Puhoi State Highway 1 (*SH1*) extension, the SH16-18 extension and the SH20 west extension (all in Auckland), the Transmission Gully Project for the NZ Transport Agency (*NZTA*), and the Kāpiti Western Link Road for Kāpiti Coast District Council (*KCDC)*. Each has involved field data gathering (fish, invertebrates, plants, water quality, and habitat quality), analysis of the data, a values assessment, and an effects assessment. My role has also involved making recommendations as to management of discharges (assisting stormwater management experts), mitigation options and conditions of consent relating primarily to the monitoring of aquatic ecosystems.

7 My evidence is given in regard to the Notice of Requirement (*NoR)* and applications for resource consent lodged with the Environmental Protection Authority (*EPA)* by the NZTA for the construction,

maintenance and operation of the MacKays to Peka Peka Expressway Proposal (*the Project)*.

8 I am familiar with the area that the Project covers and the State highway and local roading network in the vicinity of the Project.

9 I am a technical reviewer of the Freshwater Habitat and Species Description and Values Technical Report[1] which formed part of the Assessment of Environmental Effects (*AEE),* lodged in support of the Project. I am also a collaborator on the Ecological Impact Assessment (*EIA)*[2] and the Construction Environmental Management Plan (*CEMP)*, and am one of the developers of the baseline freshwater ecological monitoring methodologies.[3]

10 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2011), and I agree to comply with it as if this Inquiry were before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

11 My evidence will not repeat or traverse in any detail what has already been submitted in Technical Reports 26 and 30, but in stating my opinion and conclusions, it considers the following:

11.1 Executive summary;

11.2 Background and role;

11.3 Summary of methodologies used;

11.4 Additional work undertaken since lodgement;

11.5 Summary and additional explanation of existing freshwater features and their values;

11.6 Discussion of effects of the construction and operation of the Project on freshwater features;

11.7 Summary and discussion of recommended mitigation of effects;

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1 Technical Report 30.

2 Technical Report 26.

3 As set out in the Ecological Management Plan (*EMP)*, Appendix M of the CEMP and discussed in this evidence.

11.8 Discussion regarding the freshwater monitoring programme;

11.9 Response to the Section 149(G) Key Issues Reports;

11.10 Response to submissions; and

11.11 Conclusions.

EXECUTIVE SUMMARY

12 A total of 3.12 km of stream loss or modification will occur through the construction of the proposed Expressway. These effects are distributed over 15 water bodies (within 5 catchments) of generally low value and containing tolerant aquatic communities. The exception is the Waikanae River which has higher ecological values and more sensitive taxa.

13 Many of the works proposed, including rock armouring of some streams and diversions of others will, if properly undertaken, provide opportunity for aquatic habitat improvement in otherwise highly modified, urban and rural soft bottomed streams.

14 In particular, I see the proposed waterway diversions (of which there are nine involving intermittent/perennial systems) as opportunities to reset stream banks and substrate formation, and create riparian enhancement.

15 Most larger streams are crossed by bridges but smaller channels will be crossed by long culverts. I believe that properly installed culverts will have no adverse effect on fish passage. Also, given the regular works undertaken in many of the affected streams (for flood risk management), I believe culverts in these channels will provide some stable cover and habitat for those fish species currently exposed to these practices (i.e. stable refuges). As a result I believe that the overall loss of ecological value in these streams will be minimal. However, as there will be some loss of stream length and instream habitat at a number of culverts, and the installation of culverts will remove the opportunity for future restoration of these stream channels, some mitigation is required.

16 Overall, it is my opinion that adverse aquatic effects of these activities will be low to very low and can be readily mitigated. My conclusions are supported by the calculated aquatic benthic community biometrics, the Stream Ecological Valuation (*SEV)*[4] functionality scores, the apparent diminished fishery, and the low Ecological Compensation Ratio (*ECR)* that were derived from the SEV

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[4] Rowe et al 2008, ARC TP 302 2nd ed.

analysis for each construction activity within these streams and associated mitigation sites.[5]

17 Irrespective of their generally low ecological values, the functional length of each existing stream should, in my opinion, be at least maintained by the Project. Utilising the ECR ratio derived from my SEV analysis, 5.246 km of restorative and enhancement actions should be provided as mitigation for the loss or modification of 3.12km of stream habitat. In my opinion, given the modified environment and the current ecological values, such actions would result in a net aquatic ecological gain over the existing condition and current predictable future of those waterways.

18 Furthermore, through added road runoff treatment (through the use of swales and wetlands), the estimated contaminant load calculations indicate that the longer term water quality of local waterbodies, and consequently their longer term faunal condition, would appear to be better off than they are currently. This outcome would also represent a benefit of the Project.

19 To ensure the impacts on freshwater ecology are as anticipated, and to measure the success of the mitigation undertaken since lodgement, I have worked further with **Mr Stephen Fuller** to develop a Proposed Ecological Baseline Monitoring Plan (the first step in forming the construction monitoring programme which will need to be completed in the final EMP).[6] The proposed Ecological Baseline Monitoring Plan replaces part of the draft EMP lodged with the EPA.

20 Further detail and revision of the draft EMP is required by proposed consent conditions prior to submission with certification by the GWRC.[7] It will cover all aspects related to freshwater ecology including all effects monitoring, design guidance and all mitigation success monitoring components.

21 I have reviewed submissions lodged on the Project relevant to my area of expertise. Nothing raised in those submissions causes me to depart from the conclusions reached in my technical assessment of the Project.

BACKGROUND AND ROLE

22 In 2001 I undertook field work and research for KCDC to understand the ecological values within and near the then proposed Western Link Road project. Through that process I became familiar with the area between the Waikanae River and the Waimeha / Ngarara waterways.

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5 See Technical Reports 26 and 30 and discussed further in my evidence.

6 This is attached as **Annexure D** of my evidence. It is to form part of the EMP and is discussed further below.

7 Proposed conditions G.34-G.37.

My evidence on the outcomes of that investigation was heard by the Environment Court in October 2001 as part of the consents for the Western Link Road.

23 In relation to this Project, I had an advisory role in 2010 to Mr Matiu Park (BML ecologist) regarding the ecology of the area. Following the freshwater field work undertaken by BML staff,[8] I reviewed and advised on data analysis and on SEV interpretation, and assisted in undertaking the SEV calculations and formulation of the ECRs. I later reviewed the Freshwater Habitat and Species Description and Values report (Technical Report 30).

24 Throughout the ecological investigations and assessment in relation to the Project, Mr Park and Ms Risi have sought advice from me on freshwater matters. I have also been part of a group who have discussed and determined aspects of the Baseline Water and Sediment Quality Investigation Report (Technical Report 24) and aspects of hydrology, including the proposed sediment management regimes as outlined in the evidence of **Mr Levy** (hydrology) and **Mr Ridley** (sediment management) and **Ms Williams** (hydrological effects related to groundwater).

25 My evidence is part of the wider ecological evidence and overlaps with the wetland, terrestrial and riparian work discussed in the evidence of **Mr Park**, the avifauna evidence of **Dr Bull** and the marine (downstream) evidence of **Dr De Luca**.

ASSESSMENT METHODOLOGY

26 The methodologies for undertaking the freshwater ecological values assessment and the effects assessment are detailed in Technical Reports 26[9] and 30.[10] The methodology utilised existing published data and field collected data to characterise the habitat conditions, water quality,[11] and fauna and flora present.

27 Biometrics were then used to scale the values and allow comparisons with regional stream values.[12] Table 2 in Technical Report 30[13] summarises the data collected over an eight month period of investigations. The methods used allowed the identification of rare and threatened taxa and unique systems, measured the functional values of those systems and their comparative condition. This data

8 Ms Risi and Mr Park.

9 Effects methods are described in section 3.7 (page 31) of Technical Report 26.

10 Sampling methods, section 3 (page 8) Technical Report 30, values, section 5 (page 64) Technical Report 30; and section 3.6.4 (page 28) Technical Report 26.

11 From data collected by BML ecologists for the Project and the data set out in Technical Report 24 Baseline Water and Sediment Quality Investigation Report.

12 GWRC State of Environment Report (GWRC 2009-2012).

13 See page 11.

also allowed a measure of sensitivity and tolerance to various effects.[14]

28 While the methodologies generally follow national protocols and standard practices, there are some deviations from these guidelines to ensure the data collected enabled the questions relevant to Project to be answered. Where deviations from standard practice have been made, they were, in my opinion, appropriate and the conclusions suitably precautionary. For example, where surveys did not find all of the species recorded in the NIWA fish database a judgement call was made as to the likelihood of those fish still being present, taking into account the present habitat. All fish records upstream of our sample sites were used to make judgements of passage requirements. This is standard practise in the absence of complete upper catchment surveys.

29 I note that the fish sampling methodology in Technical Report 30 stated that each site would be sampled by ten 4m reaches with a 4 pass system (40 m^2).[15] In fact, as a result of a decision made in the field, greater effort was eventually applied at all sampled sites - although this was not then recorded in the report methodology (but should have been). For clarification, I have set out the extent of Electric Fishing Machine (EFM) surveys actually undertaken in each sampled waterway in Table 1.

Table 1 Extent of EFM fish sampling

Stream Name	Metres fished (+/- 10m)
Upper Drain 7	165m
Lower Drain 7	170m
Wharemauku Stream	260m
Mazengarb Stream	130m
Mazengarb at WWTP	85m
Muaupokau	160m
Waikanae	200m
Waimeha	260m
Ngarara Drain	170m
Kakariki	195m
Smithfield Drain	185m
Paetawa Stream	180m
Hadfield Kowhai	105m

[14] Section 5.3 (page 66), Technical Report 30.

[15] Page 16, Technical Report 30.

ADDITIONAL WORK SINCE LODGEMENT

30 This evidence is given based on the work presented in Technical Reports 26 and 30 and the draft EMP (Appendix M of the CEMP) which were lodged with the EPA as part of the AEE for the Project. Following lodgement, I note that there has been ongoing work in three areas relevant to my area of expertise.

31 Firstly, the ecology team has been working with the Project engineers to better define the ecological mitigation requirements and the locations for this mitigation, and to detail what ecological monitoring (baseline, during construction and post construction) will be required. These matters have progressed since lodgement as a result of ongoing consultation with KCDC and Greater Wellington Regional Council (*GWRC)*. Maps showing the updated freshwater mitigation areas and treatments are attached to my evidence as **Annexure C**[16] (this is discussed later in my evidence.)

32 Secondly, additional work has been carried out in response to matters raised in GWRC's Section 149G Key Issues Report, specifically to provide clarification of various sections of Technical Reports 26 and 30 and to correct some errors identified in the Report tables. These changes are discussed later in my evidence. As a result of this work, I provide in **Annexure B** corrections to Tables 10, 11 and 21 of Technical Report 30.

33 Finally, I have jointly developed an Ecological Baseline Monitoring Plan with **Mr Fuller**, in accordance with section 4.4.1 of the current draft EMP which states that a Before-After Control-Impact (*BACI)* methodology will be used to monitor freshwater habitats.[17] The proposed Ecological Baseline Monitoring Plan updates those sections of 4.4.1 and 4.4.2 which discuss what, when and how monitoring shall be carried out (i.e. for the baseline part of the BACI programme). The Ecological Baseline Monitoring Plan is the precursor to the construction monitoring programme and it provides guidance for the construction monitoring plan. The baseline Plan has been developed in consultation with GWRC. I discuss its substance later in my evidence and I have attached a copy as **Annexure D**.

DESCRIPTION OF FRESHWATER SYSTEMS, PATTERNS AND TRENDS

34 In this section of my evidence I summarise the results from Technical Reports 26 and 30 and discuss the ecological values of the waterways affected by the Project. In **Annexure G** to my evidence I have prepared a summary ecological sheet for each waterway

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16 These maps show the location of waterway enhancement areas and diversions for the Project.

17 Appendix M of the CEMP, pages 46-51.

affected by the Project. These summary sheets include a photograph of the site within the proposed designation.

Context

35 The Project is entirely located within the Foxton Ecological District which has physiographic landform and geology dominated by dynamic dune systems (Ravine, 1992). The Kāpiti Plains have low fertility with parent material of loess and areas of fine alluvium and sand (Leathwick *et al*, 2003). This landscape also includes poorly drained sites including estuaries, wetlands, dune lagoons and a few coastal swamp forest remnants (McEwen, 1987).

36 There are five major catchments within the Project area, these are: Whareroa, Wharemauku, Waimeha, Waikanae and Hadfield/Kowhai.[18] The headwaters of each derives from springs within the Raumati Escarpment (to the south) and coastal foothills (along the length of the alignment). The largest water body and catchment is the Waikanae.

37 Each catchment has multiple tributaries within the Kāpiti Plains, almost all of which are constrained within artificial channels and drains, formed historically as part of the conversion of the once extensive peat-dominated wetlands of the Kāpiti Coast to agricultural use.

38 Most of the stream channels crossing the Kāpiti Plains are maintained by GWRC, KCDC or landowners with a primary focus on flood management. This management is typically destructive, using excavators to clear channels of build-up of weed and sediment, and mowers to manage plant growth on stream banks. These activities have a significant effect on the quality of these waterways.

39 In total, 14 perennial waterways are crossed by the proposed Expressway alignment and all (as well as one other[19]) were investigated to determine their ecological values and likely effects as a result of the Project.[20]

40 There are a large number of lesser waterways (including minor tributaries and drains to the above) that are ephemeral[21] or which

18 Shown on Figure 1 of Technical Report 30, page 4.

19 Although not directly affected by the Project, the Whareroa Stream Tributary was investigated as it was a potential mitigation stream and was initially perceived to potentially be a reference stream.

20 **Whareroa Stream Catchment** (Whareroa Stream Tributary (Waterfall Road), Whareroa Drain); **Wharemauku Stream Catchment** (Drain 7 Lower, Drain 7 Upper, Wharemauku Stream); **Waikanae River Catchment** (Mazengarb Stream, WWTP Drain, Muaupoko Stream, Waikanae River); **Waimeha Stream Catchment** (Waimeha Stream, Ngarara Drain, Kakariki Stream, Smithfield Drain, Paetawa Stream); **Kowhai Stream Catchment** (Hadfield Drain / Kowhai Stream).

21 An **ephemeral** stream is a water discharge course that may have a formed channel but does not have aquatic habitat i.e. it is predominantly dry on the channel bottom

are entirely artificial and generally these features were not investigated.

Stream Function (and physical habitat)

41 The waterways crossed by the proposed Expressway are characterised by sandy soil, with channelised and sharply cut bank edges largely created as a result of ongoing drainage and channel modifications. The majority of the "drains" lie in pasture or within land overgrown with weeds. The drains have different levels of bank erosion, and have very little in the way of over-shading or indigenous riparian vegetation (i.e. aquatic habitat protection). The Waikanae River is an exception to this general description, being hard bottomed and far more "natural" in appearance, condition and function, although it is still managed to minimise flood risk and channel erosion through stop bank formation, and the use of rip rap and willow.

42 Typically, the lower reaches of the main stems of each waterway have wetted channel widths that range from 3 to 4 m, velocities under 0.1 m/s (i.e. very slow) and flows between 50 and 150 litres per second (i.e. low). Again the exception is the Waikanae River (15-30 m wide and 4.5 cumecs). These lower plains streams can have floodplains that extend beyond the channel to 100 m or more, although the Kakariki Stream has no significant floodplain. The physical parameters of the streams are recorded in Tables 6 - 9 of Technical Report 30.[22]

43 The physical habitat assessment (*PHA)* scores[23] are nearly all less than half the potential maxima, and are reflective of high levels of modification correlated with rural and urban land use patterns. Only the Waikanae River scored over 60% of the maximum potential.

44 The SEV functional condition scores ranged from 0.21 (Whareroa Drain) to 0.66 (Waikanae River). The reference score (0.78) is the maximum score expected of a waterway for the area and measured scores of the waterways in the Project area were compared to this reference score. When compared with the reference site, nine stream sites are below 50% of the reference,[24] a further 5 are below 70% expected functioning and only the Waikanae River is more than 75% functioning (see Table 2 below). A major factor influencing the SEV scores for most streams sampled is the absence of effective riparian margins (i.e. areas of native intact vegetation and absence of stock) and a lack of habitat diversity.

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unless sufficient rain has fallen in its catchment to cause surface flows or a raise to the surface of groundwater.

22 Pages 41 – 44.

23 Figure 3, page 44, Technical Report 30.

24 For example the Whareroa is 27% as functional as the local reference.

Table 2 SEV scores as a proportion of the reference functional score ranked from lowest to highest[25]

River sites	Mean SEV score	Proportion of reference
Whareroa Drain	0.283	36%
Ngarara Creek	0.291	37%
Drain 7 (Upper)	0.304	39%
Waimeha Stream	0.341	44%
Drain 7 (Lower)	0.362	46%
Mazengarb Stream	0.373	48%
Smithfield Drain	0.381	49%
Mazengarb Drain (WWTP)	0.389	50%
Hadfield / Kowhai	0.395	50%
Wharemauku Stream	0.437	56%
Kakariki Stream	0.454	58%
Muaupoko Stream	0.48	61%
Paetawa Drain	0.491	63%
Whareroa Tributary	0.544	69%
Waikanae River	0.664	85%
Reference	0.783	100%

Water Quality

45 The water quality data summarised in Technical Report 24 illustrates that waterways at or below the Expressway alignment are characteristic of lowland waterways draining predominantly agricultural land use. In other words, these waterways have elevated nutrient concentrations, some elevated bacteriological counts and low toxicant concentrations.

46 The water quality in general for all waterways is considered to be poor, except the Waikanae River (good) and Waimeha Stream (fair).[26] The waterways are poor because of the raised levels of nutrients, *E. coli*, metal contents (Cu, Pb, Al) and, in some cases, other contaminants, as well as lowered pH and dissolved oxygen.

Aquatic benthic invertebrates

47 Table 19 in Technical Report 30[27] shows the "quality" ranking of the benthic aquatic invertebrate taxa based on the Macroinvertebrate Community Indices (*MCI)*, and Quantitative MCI (*QMCI)* metrics and an estimation of the community tolerance based on the taxa

25 See Technical Report 30, Table 17, page 64.

26 Technical Report 24, pages 74-75 and Table 15, pages 46-47.

27 Refer to page 66.

assemblages present. This data corroborates the water quality findings that the systems are generally modified and reduced in condition. In all cases the aquatic communities present are tolerant of a wide range of aquatic environmental issues (the QMCI in all but the Waikanae River being under 5),[28] which means a current "fair" condition, indicating moderate pollution and a moderately tolerant community. Only the benthic faunal community of the Waikanae River contains species more sensitive to those potentially harmful environmental factors, and is an indicator of better aquatic health.

Fish

48 Tables 10, 11 and 21 and Appendix 30.F of Technical Report 30[29] represent the Freshwater Fish Data Base (*FFDB*) and the sampling results from the field work carried out for the Project. Following the lodgement of the NoR and the applications with the EPA, several errors have been identified in Tables 10 and 21. For clarity I have corrected and reproduced these tables in **Annexure B**.

49 In Table 3 below I present a summary of this data comparing FFDB data from each catchment with the data collected from sample sites at each proposed crossing.

Table 3 BML project sample data 2010 (Count), and FFDB records post 1990 (Y=present)

Common Name	Short fin eel	Long fin eel	Torrent fish	Koaro	Banded kokopu	Inanga	Giant kokopu	Shortjaw kokopu	Lamprey	Common bully	Giant bully	Crans bully	Red fin bully	Smelt	Black flounder	Brown trout
Hadfield Drain	1				21											
Paetawa Drain		10			7									8		
Smithfield Rd Drain	1	2														
Ngarara at Nga Manu	1	2								3				16		
Ngarara Drain at J. Smiths	1	1														
Ngarara (FFDB)	Y	Y			Y	Y	Y					Y				
Ngarara Trib (FFDB)	Y	Y			Y	Y					Y					
Waimeha	1									1						
Waimeha Stream (FFDB)	Y	Y				Y				Y	Y		Y			
Waikanae River	10	1				3				9			3		2	
Muaupoko Stream	3	1								2				8		

[28] Table 13, page 56, Technical Report 30.

[29] See pages 47, 48, 68 and 98-103.

Common Name	Short fin eel	Long fin eel	Torrent fish	Koaro	Banded kokopu	Inanga	Giant kokopu	Shortjaw kokopu	Lamprey	Common bully	Giant bully	Crans bully	Red fin bully	Smelt	Black flounder	Brown trout
Mazengarb @ Waste Water	61	15								1						
Mazengarb	3	2								11						
Waikanae River (FFDB)	Y	Y*	Y*			Y			Y	Y			Y	Y	Y	Y*
Wharemauku	2	16				2				5						
Drain 7	5	3				14										
Drain 7 Trib																
Wharemauku Stream (FFDB)	Y			Y				Y					Y*			
Whareroa Drain	1	4														
Whareroa Stream (FFDB)	Y*	Y			Y	Y*				Y			Y*			

*Means records from observation or hand netting (not EFM sampling). The shaded rows refer to FFDB records.

50 In my assessment I have used the FFDB to understand fish known to occur within each affected stream's wider catchment. Fish surveys carried out by BML were then used to understand fish presence within the potentially affected reach of each stream.

51 The FFDB is a compilation of all records obtained over many decades, at various sites and associated habitats throughout each catchment from the stream mouth to headwaters. The data came from a range of methods and was pooled over multiple years and seasons. This data provides broad context to each stream and an indication of those species that migrate through the study area.

52 However, not all fish observed in a stream are present throughout the entire streams length; some species being restricted to tidal water, others to slow flowing sections, others to steeper and higher altitude tributaries. Site specific surveys were therefore needed to understand species richness and relative abundances within the habitat potentially affected by the Project.

53 The FFDB must also be used with caution, as the surveys contained in it are typically focused on the higher value habitats of each stream which creates a bias in the results. Further, changes in fish presence with changing land-use are not always picked up through the sporadic sampling. For example, four fish species have been historically recorded (post 1990) in the Wharemauku Stream; short jaw kokopu, shortfin eel, koaro and red fin bully. Our survey (2010) carried out at reaches crossed by the road footprint did not record koaro, short jaw kokopu or red fin bully, but added three new species

not recorded in historical surveys (longfin eel, inanga, and common bully (two of these species are "at risk")). The only species in common between surveys was the shortfin eel.

54 In the case of the Wharemauku Catchment, the data found in the FFDB was collected at one site in a forested headwater and the fish found are a reflection of that habitat. Our data was collected at three sites on lowland sand plains in entirely artificial and channelised portions of stream and the fish found are a reflection of that habitat. It is therefore my opinion that those taxa found by our survey accurately reflect the fish expected to be found in the habitat potentially affected by this Project. The FFDB identifies several additional fish species that must pass through our study reach as they migrate to better habitat upstream.

55 Similarly the FFDB contains records of 6 species of fish, recorded at four sites, two in the tidal reaches above the small estuary and two in the forested headwaters of the Whareroa. However, sampling only identified two of these species but was carried out again on lowland sand plains in an entirely artificial and channelised tributary of the stream. Again, in my opinion the fish in the Whareroa Catchment recorded by our survey accurately reflect the fish expected to be found in the habitat potentially affected by the Project.

56 Thus, in establishing aquatic ecological values specific to the potentially affected stream reaches (presented in Table 4 below), I have focused on BML survey field data (and the fish Index of Biological Integrity (*IBI*) results), but acknowledge the potential for other fish species identified in historic records to be present at least periodically. Regardless of the site values, I consider all of the waterways with up-stream continuance of water (and aquatic habitat) to require continued fish passage.

57 From the IBI[30] fish analysis, only three waterways can be considered as "good": the Waikanae River, the Whareroa Tributary and the Kakariki River. Five of the waterways rank as "very poor", three are "poor" and four are "fair". In other words, the waterways of the Project area are generally poor fish habitat and retain a poor representation of the Region and of their historic content.

58 Nevertheless, there are valued fish taxa in the waterways. Table 21 in Technical Report 30[31] shows the fish sampled within survey sites that are "at risk" and declining regionally.[32] Predominantly those species were long fin eel, which were present at virtually all sites (except Upper Drain 7). Inanga are also present in 4 waterways, including: Lower Drain 7, Wharemauku, Waikanae River and

30 See Table 20, page 68 of Technical Report 30.

31 Page 69.

32 Townsend et al 2008 & Alibone et al 2010.

Whareroa Drain (these waterways were inadvertently omitted from Table 21 of Technical Report 30).[33] Banded kokopu are present, but only in appreciable numbers at Paetawa. Red fin bullies were only sampled in the Waikanae and giant kokopu only in the Wharemauku.

59 No short-jawed kokopu were found during the BML survey. The FFDB, shows only old records of this fish (1962, 1964, 1974, 1982) and only one individual from one waterway was recorded (in the Waikanae River). I note that Table 10 of Technical Report 30[34] doesn't record short jawed kokopu in the Waikanae River as it shows only data post 1990. I am of the opinion that these older records are too old to rely on (there are no records within the last 20 years). There is one other record of short jawed kokopu, from 1999 (one individual) in a tributary of the Wharemauku Stream not directly affected by the Project and so has not formed part of my values assessment.

Aquatic Ecological "value"

Regional Plan evaluation of waterway values in the Area

60 Appendix 1 of the Greater Wellington Regional Freshwater Plan (*RFWP*) recognises two waterways in the Project area as having ecologically significant river mouths, namely the Waimeha and Waikanae. From a freshwater perspective, these areas are well outside the designation, and are dealt with by **Dr De Luca** in her evidence.

61 Four waterways are recognised in the RFWP as having nationally threatened indigenous fish (and / or indigenous aquatic plants) in their catchments (Appendix 3 of the RFWP). Those are: Whareroa Drain, Wharemauku Stream, Muaupoko Stream, and the Waikanae River. The RFWP reports that the streams are listed based on the recorded presence of two fish species, short-jawed kokopu and koaro. However, these two species have only been recorded in one stream, the Wharemauku Stream. Short-jawed kokopu have only been recorded in the Wharemauku Stream once in 1982, and koaro has only been reported once in the Wharemauku Stream in the headwaters in 1999. Neither fish species has been recorded in the Whareroa Drain, Muaupoko Stream or Waikanae River. Based on the data supporting Appendix 3 to the RFWP, I do not consider that all of the recorded waterways (and all reaches of those waterways) have "significant" habitat.

62 However, every site does have at least one "At Risk" fish species present. As noted above, the BML surveys recorded Long fin eel in every stream surveyed, occurring in varying densities depending on habitat quality. Inanga were also recorded in two waterways

33 The corrected Table 21 is contained in **Annexure B**.

34 Page 47.

(Waikanae River and Wharemauku Stream). The Waikanae River also contained red fin bully.

63 My analysis using the IBI and based on recent data is that only the Waikanae River, within the proposed designation and nearby environs, can be considered as having "significant" fish values.

64 I do not consider that any waterway of the Project area has "natural character" (Appendix 2 of the RFWP) due largely to the high levels of morphological modification (riparian, bank, path and function).

65 Appendix 4 of the RFWP identifies that a portion[35] of the Waikanae River is important as trout habitat. That "portion" runs from the lower river at around Kauri Road end, up to around 1 km up steam of the Mangaone South Road end, and therefore includes the potentially affected reach of the Waikanae River.

Assessment of stream value

66 Currently, there are no accepted models or tools for determining stream value, although the Department of Conservation (*DOC*) is working on a stream ecological integrity rating system.[36]

67 In order to establish relative values, my assessment used a matrix of biological and physical habitat scores to develop an overall subjective assessment of value for each stream. The metrics I used were:

67.1 Taxa assemblages, with a focus on threatened species (fish);

67.2 Physical habitat rankings (PHA and SEV relative to a reference site); and

67.3 Benthic aquatic macroinvertebrates (specifically the taxa richness, Ephemeroptera, Plecoptera, and Trichoptera (*EPT)* assemblage, MCI and QMCI rankings).

68 My derived scores for each study reach were then compared to regional data, or where regional data was not available, they were assessed against a hypothetical reference stream or ideal state.

69 Since carrying out my assessment, I have refined this method as a result of ongoing consultation and to respond to matters raised in the Key Issues Reports. I have converted each relative "value" into a numerical score and summed those scores for each sampled section

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35 From the lower river at around Kauri Road end, to approximately 1 km up-steam of the Mangaone South Road end.

36 Schallenberg, M; Kelly, D.; Clapcott, J.; Death, R.; MacNeil, C.; Young, R.; Sorrell, B.; Scarsbrook, M. Approaches to assessing ecological integrity of New Zealand freshwaters. Science for Conservation series 307. Department of Conservation, Wellington.

of stream. This has added detail to the process summarised in Table 23 of Technical Report 30.[37] In Table 4 below I repeat the results of my original assessment and add a column with my revised values. I have attached the details which support this additional analysis as **Annexure A** to this statement.

70 This more detailed analysis has resulted in some changes to the values reported in Table 23 of Technical Report 30. Table 4 below provides an update to this table. The review does not change my overall opinion in regard to sensitivities or effects and mitigation (as discussed later in my evidence).

71 It still must be remembered that these are relative values and in general all of the waterways are highly modified with generally poor fauna and flora communities that reflect high sediment, nutrient and poor in-stream physical habitats.

Table 4 Tabulated summary of Aquatic Ecological Value

Regionally significant	PHA	(SEV)	Fish IBI	Threatened Fish*	Aquatic invertebrates	Compilation Result	Revised Result[38]
Hadfield Stream	L	L	L	Y	L	L	M
Paetawa Drain	L	L	L	Y	L	L	L
Smithfield Drain	L	L	L	Y	L	L	L
Kakariki Stream	L	L	L	Y	M	L	M
Ngarara Creek	L	L	L	Y	L	L	L
Waimeha Stream	L	L	L	Y	L	L	L
Waikanae River	H	M	M	Y	H	H	VH
Muaupoko Stream	M	L	L/M	Y	M	L/M	M
Mazengarb (WWTS)	L	L	L	Y	L	L	L
Mazengarb	L	L	L	Y	L	L	L
Wharemauku	L	L	M	Y	M	M	M
Lower Drain 7	L	L	L	Y	L	L	L
Upper Drain 7	L	L	L	Y	L	L	VL
Whareroa Drain	L	L	L	Y	L	L	VL
Whareroa Trib	M	L	M/L	Y	M	M	H

* Adapted from Strickland & Quarterman, (2001) and Alibone et al 2010.

37 Page 72.

38 Additional column added to original Table 23.

72 In considering section 6(c) of the RMA, I note that all of the waterways surveyed contained at least one species fish with a threat status.[39] In order to better assess relative importance of each waterway for fish species, I have considered both taxa presence and taxa abundance as a proportion of the total fish catch. This is shown in Table 5 below.

Table 5 Abundance and number of threatened species (fish) from survey data and the proportion they make of the total sample[40]

Site	Number of "threatened" fish taxa	Abundance of "threatened" fish taxa (count)	Proportion of total catch abundance that are "threatened taxa"
Hadfield Kowhai	0	0	0%
Paetawa	1	8	13%
Kakariki	1	2	7%
Ngarara	1	1	8%
Waikanae River	3	7	19%
Muaupoko	2	24	52%
Mazengarb (WWT)	1	15	17%
Mazengarb	1	2	3%
Wharemauku	2	35	39%
Lower Drain 7	0	0	0%
Whareroa drain	1	6	60%

73 Taking into account the full range of metrics, it is my opinion that a stream can be regarded as "significant" habitat for indigenous fish fauna when:

73.1 More than 10% of the total catch are threatened species (I consider that this quantum shows that the threatened species are resident and not a chance find at a location);

73.2 The total catch contained more than 20 individuals (Muaupoko, Wharemauku, Mazengarb WWTP, Whareroa trib, Waikanae River) (again, I consider that this number shows that the habitat is important for those taxa); and

73.3 The QMCI was above 5 ("Good") so as not to include sites which are opportunistic habitat for eel alone (eel being tolerant of higher levels of organic pollution than most other native fishes).

[39] Sampling found two threatened fish taxa in the Muaupoko and Wharemauku Streams and three in the Waikanae River.

[40] Data from Appendix 30.F, Technical Report 30.

74 Only the Waikanae River meets all these criteria.

75 I note, ironically, that the Mazengarb WWT waterway has a large number of long fin eel. However, with a QMCI of 1.7 (very poor), it is such a poor habitat that even with the presence of an "at risk" species, I cannot call such a habitat "significant".

76 It is my overall assessment that:

76.1 Only the Waikanae River is a significant waterway in terms of its habitat for aquatic fauna at the regional level;

76.2 The Wharemauku, Kakariki and the Whareroa are locally important waterways, but not regionally significant; and

76.3 All other waterways within the Project area are of low to very low ecological value, and are of low importance other than as potential conduits for movement of fish between the coast and their forested headwaters.

ASSESSMENT OF EFFECTS ON FRESHWATER ECOLOGY

77 In this section I consider the potential direct and indirect adverse effects of the following activities on streams at and downstream of the site of works:

77.1 Culverting;

77.2 Diversion;

77.3 Bridging;

77.4 Rock armouring;

77.5 Sediment discharge; and

77.6 Stormwater discharge.

Direct Impacts of Construction

78 The Project design proposes the installation of:

78.1 48 culverts (22 in "valued" perennial or intermittent waterways), (totalling 1,123 m);

78.2 9 diversions (totalling 1,525 m in length), with associated stream reclamation; and

78.3 Construction of 8 bridges together with the armouring of 472 m of stream bank.

79 Together these activities will directly affect **3,120 m** of perennial or intermittent waterways.

80 Details of all of these stream works can be found in Section 8.1.2 and Appendix C of Technical Report 26.[41] The waterway protection methodology for all in-stream works is described in the Erosion and Sediment Control Plan,[42] Appendix M.E. of the draft EMP, and in the evidence of **Mr Ridley**.

Culverts

81 Of the 48 culverts proposed, 26 will not affect perennial or intermittent watercourses and are therefore not considered to have adverse ecological effects.[43]

82 The remaining 22 culverts lie within perennial (permanent) or intermittent (seasonal) streams. Of these, 14 are new culverts and 8 are upgrades or replacements of existing culverts. For replacement culverts I have only considered the additional culvert length, and any additional armouring or headwalls has been considered when determining the scale of effect.

83 The length of stream works in each perennial or intermittent stream, associated with culverting is shown in Table 29 of Technical Report 26.[44] (I note the summed total length modified is incorrect in Table 29 and should read 1,123 m, not 1,119 m). In total there are 1,123 linear metres of stream affected by proposed culverting, headwalls, and armouring.

84 This linear stream effect amounts to an area of 2,807.5 m^2 of aquatic habitat (i.e. 0.28 hectares), the waterways ranging in widths from 0.8 to 8 m, with an average width of 2.5 m.

Diversions

85 It is my understanding that there are nine proposed diversions in perennial or intermittent streams totalling 1,525 m in length. While 1,525 m of stream will be reclaimed (i.e. lost) as a result of these diversions, the total length of the new diversion channels will be 2,971 m (1446 m longer than the length that will be lost). Table 30 of Technical Report 26[45] illustrates the loss, modification or creation of perennial or intermittent stream channels due to diversion, channel reclamation and new channel construction. **Annexure C** to

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41 Pages 105-112.

42 CEMP Appendix H, Volume 4.

43 These culverts include 20 culverts not being formed in existing streams but required to provide for flood management and for connections to stormwater treatment facilities; and 6 culverts located in ephemeral watercourses, i.e. farm drains and existing roadside depressions or swales that carry water in large rainfall events but are otherwise dry.

44 Page 107.

45 See page 108.

this evidence updates the "new diversion length column" in Table 30. It also identifies the diversions in which mitigation is recommended to occur.

86 With the exception of the Muaupoko Stream outlet and a section of the Waimeha main stem, all the diversions proposed consist of replacing straight, channelised farm drains. The proposed new diversion lengths and new sections of stream will incorporate meanders in their design, appropriate riparian planting, channel and bank formations that ensure depths and velocities are appropriate, appropriate substrate types and in-stream habitat cover. The draft EMP[46] sets out general stream diversion design guidelines and an indicative stream diversion plan (in Appendices M.E and M.F). The lengths of these "ecological" diversions are provided in Table 6 below.

87 In some respects, the diversions are both an adverse effect (the loss of those reaches), as well as an opportunity to remedy the current issues of habitat condition, by improvements to the newly created waterway (for example substrate renewal and native riparian planting). While diversions would be required as part of the Project, I consider that to mitigate for these effects the creation of habitat of greater value is required. The addition of valuable habitat aspects in the new proposed waterways provides mitigation and enhancement.

Bridges

88 Eight bridges are proposed along the length of the Expressway. In all cases these bridges cross perennial streams.

89 With the exception of the Waikanae River, all bridge structures will require no piers or piling within the wetted channel. All bridges will, however, require some armouring of the stream banks and bed to prevent movement of the stream and the risk of undermining the bridge foundations. Since lodgement,[47] an additional 160 m of constraining of the Waikanae River has been proposed by the Project team (which is akin to armouring the banks). This means that a total of 472 linear metres of armouring has been calculated to affect the existing stream edges.

The Waikanae River

90 Works in the Waikanae River are unique for this Project, as the NZTA and GWRC have agreed upon works above and beyond those required for formation of the Waikanae bridge, which aim to mitigate for wider flood issues in the Waikanae River. This will require expansion of the existing flood plain at the crossing location and affects the extent of flood plain works, the extent of works within the

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46 Appendix M to the CEMP.

47 The lodged application stated that 312 linear metres of armouring would be provided.

wetted channel, the length of the bridge and requirements for piers within the floodplain.

91 Section 4.5.1v of Technical Report 22 discusses the required works which include removal of an existing spur, temporary diversion and containment of the river during works, and stabilisation of the final channel under/near the bridge structures through the use of willow and rock rip-rap. Rip rap will be needed over a length 160 m.

92 I note that the length of works required in the Waikanae River is twice that of the estimate reported in Table 32 (page 110) of Technical Report 26,[48] and my mitigation calculations have been modified to account for this increase (see Table 6 and the proposed mitigation discussion below).

Rock Armouring

93 Rock armouring is required in most streams to stabilise banks below bridges and provide erosion control at the inlet and outlet of culverts. Rock armouring introduces a new substrate to these sand channels, and in my opinion this armouring can be seen as a positive element in these extremely uniform and highly managed channels. Once completed, armouring becomes useable, even valuable, hard substrate that provides safe stable habitat for some species of fish, and enables periphyton and bryophyte growth, and growth of some freshwater macro-invertebrate taxa.

Summary of Extent of Waterway Direct Effects

94 Table 6 presents the total extents of each of the works described above, by waterway.

Table 6 Extent of stream works in streams affected[49]

Watercourse Name / Sample Site	Ecological Value	Culverts (m)	Diversion (m)	Armouring (m)	Combined stream works (m)
Whareroa Drain	Very Low	41	-	-	41
Drain 7 (Lower)	Low	70	-	-	70
Drain 7 (Upper)	Very Low	120	-	-	120
Wharemauku Stream	**Moderate**	-	50	32	82
Mazengarb Stream	Low	144	-	-	144
Mazengarb Drains (WWTP)	Low	147	-	-	147
Muaupoko Stream	**Moderate**	21	30	-	51
Waikanae River	**Very High**	-	-	83(+ 160)	243
Waimeha Stream	Low	16	360	62	438

48 That is **160 m** instead of **83 m**.

49 From Table 32, Technical Report 26, page 110, but containing revised ecological values (as discussed in the evidence above). Note: as no effects are present in the Whareroa tributary, it is not present in the Table.

Ngarara Creek	Low	90	-	-	90
Kakariki Stream	Moderate	-	125	105	230
Smithfield Drains	Low	36	510	-	546
Paetawa Drains	Low	280	390	30	700
Hadfield Drain	Moderate	158	60	-	218
-		1,123	1,525	472	3,120

95 Using the values in Table 6 above, the magnitude of adverse effects were assessed by comparing the extent of area affected with the unaffected habitat area.

96 My assessment concluded that:

96.1 For four streams the magnitude of adverse effects will be negligible (Waikanae, Muaupoko, Wharemauku, Whareroa).

96.2 Three streams will have low effects (Mazengarb, Kakariki, Hadfield).

96.3 Four streams will have moderate effects (Drain 7, Waimeha, Ngarara, Paetawa).

96.4 The Smithfield system has high effects as 45% of its total length of would be affected by the Project.

97 However, when considering the magnitude of the effect against the value and sensitivity (tolerance), the significance of the adverse effect related to the construction activities for all of the stream areas surveyed (except one), is very low. The exception is Smithfield Drain where the significance of the effect, in terms of ecological loss, is considered to be "low" (the magnitude of effect being high).[50]

98 In terms of considering the potential adverse effect to indigenous fish alone, there is the potential for a high level of significant effect. This primarily relates to the potential to block passage via poorly installed culverts and poorly created diversions, as well as the potential to trap and cause mortality to fish in stream sections in which works (culverts and diversions) occur.

99 However, given the proposed management plans, standard engineering guides and the proposed installation monitoring, in my opinion this potential adverse effect will not eventuate.

Indirect Impacts of Construction

Discharge of Contaminants to Freshwater and Wetlands

100 Sediment discharge into waterways can be an issue during the construction phase, when fine soils from areas of open ground

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50 Tables 33 and 34 (page 111-112) in Technical Report 26 detail these conclusions.

associated with earthworks can be carried into waterways during rain events. However, it also needs to be recognised that a level of sediment is required by aquatic systems (for building material and food) and that the lowland systems require and are used to more sediment than upper reach habitats.

101 Adverse effects on freshwater habitats can occur when very large amounts of fine sediments are deposited in one event or there is a very prolonged period of high total suspended solids (*TSS).*[51] The effect of high TSS for short periods of time is usually minimal as fish and other invertebrates can avoid it my moving or using other "hiding" strategies; TSS rarely kills fauna.

102 Similarly, slowly accumulating sediments are also managed by the benthos. It is the large event depositions that bury and can kill benthic invertebrates and flora. Soft bottomed streams, as found in the majority in the Project area, usually contain species that are adapted to and tolerant of sediment deposition. It is the presence of this type and tolerance of the habitat and fauna which leads me to conclude that the ecological risks associated with sediment are small in all waterways except for the Waikanae River (which predominantly has a hard bottomed substrate and a related fauna[52]).

103 The potential sediment generation from the Project and the potential amount that may end up in the waterways has been calculated.[53]

104 The predicted increase from background levels in sediment generation varies from 0.4% to 25.3% additional in the waterways. The increase is typically around 4 or 5 tonnes over the construction period, except in the Waimeha (the 25% increase) where it is 0.77 tonnes. Most, or all, of this sediment will be in suspension and will be related to high rain fall events. Therefore most of the sediment will be dispersed within the "storm" water and it is unlikely, given the treatment devices and processes proposed (see the evidence of **Mr Levy** and **Mr Ridley**), to settle in any one stream location in any notable deposition layer.

105 However, those streams that pass into a wetland[54] will potentially be affected by that sediment. This issue is further discussed by **Mr Park** in his consideration of wetlands. I will mention however, that wetland substrates are organic, with large amounts of accumulated sediments, and the aquatic fauna are also well adapted to such deposits and conditions.

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51 Total Suspended Solids (sediments).

52 Technical Report 30, page 27, Table 6 page 42, Figure 3 page 45, and pages 51-58.

53 Appendix H.G of the Erosion and Sediment Control Plan rsets out the USLE Calculations

54 Such as the Kakariki Stream, Paetawa Drain, Smithfield Drain and Ngarara Creek in to the Te Harakeke/Kawakahia wetland.

Operational adverse effects

Stormwater Quality and Discharge

106 This is discussed in some detail in section 9.2 of Technical Report 26.[55] To address my initial concerns as to the potential for the generation and discharge of road related water borne contaminants (metals, petroleum products), predictive modelling of water quality was undertaken.[56] In particular, current and predicted inputs were modelled for the year 2031 with and without the proposed Expressway.

107 Because of the shift and re-distribution of traffic from the current alignment of SH1 and other roads to the proposed Expressway route, even without the storm water treatment of the run off as proposed, the modelled levels of contaminants discharged to the streams along the route reduce after the construction of the proposed Expressway. With the proposed swale and other stormwater treatments this quality is further improved.[57]

108 Despite the result appearing initially counter intuitive, I understand that the proposed Expressway will actually remove contaminants from entering the system (i.e. will not discharge to waterways) as the existing SH1 has no means to capture or treat of stormwater which currently discharges directly to streams.

PROPOSED MITIGATION

109 I conclude that while works within streams is unavoidable and in some places extensive, the significance of the adverse ecological effects will generally be small given the low value and generally tolerant systems that will be affected and the ability of some of the works to provide long term benefits.

110 However, there will be a loss or disturbance to some 3 km of freshwater habitat, a loss of stream length through extensive culverting, and extensive works in the Waikanae River bed will result in at least a short term loss of habitat and biota. In addition, the lengths of stream that will be culverted will be lost to any future opportunity for enhancement.

111 I have used the SEV tool to quantify the functional loss of stream habitat and to determine the ratios of mitigation (Ecological Compensation Ratio or ECR) which provide the basis for the necessary mitigation required to retain a balance of aquatic habitat across the Project through enhancement.

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[55] Page 127.

[56] See Technical Report 25.

[57] See pages 10-12, Technical Report 25.

112 The ECR that is derived through the SEV model differs for each stream depending on the type of works proposed, the functional health of the affected stream, and the maximum potential value of the mitigation site. For example, in the Waimeha Stream assuming a mitigation reach (be it diversion or enhancement) will achieve 80% of the reference value, installation of a culvert generates a ratio of 1:3.6 (3.6 m restoration for every 1 m of stream loss). Rip rap generates a ratio of 1:1.12 as this has a less drastic effect on the stream. A diversion generates a ratio of 1:0.99, assuming the new diversion reach can be created sufficiently well to attain a near reference condition.

113 The ECR values will be less for a more modified stream (e.g. Drain 7) or more for a higher value stream (e.g. the Waikanae River).

114 Tables 47, 48 and 49 in Technical Report 26[58] show the ECR for each stream for each type of effect (culvert, diversion, bridge) and the length of waterway affected.

115 It should be noted that, in calculating the ECRs, the proposed mitigation works were initially based within the affected waterways. However, continuing consultation with KCDC has resulted in a shift in focus for ecological mitigation to a smaller number of larger sites centred around diversions. This has occurred for the following reasons:

115.1 The opportunity to attain long areas of stream to enhance, rather than small fragments on existing streams (within the designation);

115.2 The potential need to continue to manage a number of existing waterways (bank modifications, digger access restricting riparian planting); and

115.3 Ongoing requirements in some waterways to maintain flood capacity.

116 Table 50 in Technical Report 26[59] summarises the extent of the in stream mitigation proposed as part of the Project, as at lodgement. Overall to mitigate the effect of the installation of culverts, armouring and diversions, **4,973 m** was calculated to be required. As a result of the additional rip rap proposed for the Waikanae River, the total mitigation required is now **5,246 m**.

117 Section 11.3.2 of Technical Report 26 provides some detail of a potential mitigation "package".[60] These measures include the

58 Pages 141-142.

59 Page 143.

60 Page 143.

enhancement of a range of streams that remain after the Expressway is developed, and the creation of new waterways in better ecological condition than those lost (i.e. diversions).

118 Through the process of ongoing consultation with Councils and preparation of this evidence, I have updated (post-lodgement) the array of diversions and waterway enhancement proposed in the AEE. Through that process I have increased the total extent of possible stream mitigation to account for the increased mitigation requirements discussed above. In particular:

118.1 Table 51 of Technical Report 26[61] states that **1,260 linear m** would be available for riparian re-vegetation. However, as set out in Table 7 below, there is now **2,971 m** of diversion suitable for ecological mitigation. This addition is due to the increased meander of new diversion systems in several larger areas associated with Drain 7 and Smithfield Drain.

118.2 Table 51 (Technical Report 26) also noted **880 m** of improvement from upstream and downstream culvert planting (20 m lengths). I have largely removed those smaller areas as being ecologically less important, and of less benefit than focusing on the larger areas.

118.3 Finally, I have identified approximately **2,306 m** of riparian / waterway restoration potential (see Table 7 below). This figure includes a large proportion of the Kakariki system.

119 Maps set out in **Annexure C** (Proposed Ecological Freshwater Mitigation) illustrate those areas referred to above and type of stream mitigation, the total linear length of which is **5,277 m**. Therefore the total length is approximately **31 m** more than that required by the ECR projected requirement. The proposed riparian mitigation will be 10-20 m wide (both sides)[62] and will result in roughly 17 ha of riparian planting. In my opinion this will meet the ECR requirement.

Table 7 Linear lengths of diversion and existing waterway enhancement for mitigation

FEATURE	Map codes (Annexure C)	TYPE	Diversion Length (m)	Waterway Enhancement length (m)
Upper drain7in 7	1W	water way		327

61 Page 144.

62 This width is required to offer sufficient benefits to the aquatic system. See Parkyn, S., W. Shaw & P. Eades (2000). Review of information on riparian buffer widths necessary to support sustainable vegetation and meet aquatic functions. *Auckland Regional Council Technical Publication 350*.

Lower Drain 7	2D	diversion		452
Mazengarb WWT drain	3D & 3W	diversion	293	148
Mauapoko	4D & 4W	diversion	31	44
Kakariki	5W	waterway		1010
Smithfield	5D	diversion	1373	
Paetawa	6D & 6W	waterway	54	171
Hadfield / Kowai	7D & 7D	waterway	1220	154
Sub Totals			2,971	2,306
Total				5,277

(Note: this Table should be read with the mitigation plans in **Annexure C** and in which the feature identification in the Table is made clear).

120 I also note that in addition to the stream mitigation that I recommend (as explained in Table 7 above and shown in **Annexure C**), there is also a significant array of other remedies and landscape enhancements provided for by the Project that also have aquatic benefits.[63]

121 I note that in identifying areas that are to be established for the purpose of ecological mitigation, I have not included a number of re-vegetation sites that are being established for other purposes. For example nearly 2,000 m of new waterway (with appropriate native planting) is proposed to connect the stormwater wetlands to adjacent streams. These treatment wetlands will be permanent features, and the wetlands and connecting channels will receive appropriate riparian planting. While I have not included these areas in my mitigation calculations, they will offer ecological habitat and general benefit.[64]

122 The ecological diversions are a critical component of the freshwater ecological mitigation. It is important that the diversions are not considered as flood management drains but as the reinstatement (and enhancement) of a stream system to replace an existing waterway lost as a result of the Project. The key to ensuring the success of the mitigation will be the maintenance of sufficient water in the channel, the development of the riparian vegetation and a general absence of typical drain maintenance activities (i.e. the clearing of macrophyte and sediments by digger along the stream bed).

123 I understand that this absence of waterway management may cause some perceived (or real) issue with the Council hydrologists in regard

63 See Technical Report 7, section 7.2, pages 29-34.

64 As an example, I note that the banks of the Kakariki and Wharemauku Streams will be reshaped to manage flood flows and to build in flood capacity. In these areas the disturbance will be remedied through new ecologically focused riparian re-vegetation.

to future "flood" management regimes. In part this issue is why I have recommended that the diversions for ecological gain are concentrated around the Smithfield (which comes within a large stormwater management basin area), Drain 7 and the Paetawa systems, so as to minimise the interaction of requirements to manage the waterway for flood minimisation with the ecological need to have a fully vegetated and complex channel and in-stream habitat.

ECOLOGICAL FRESHWATER MONITORING

Introduction

124 In order to establish potential construction effects on streams, stream monitoring is proposed and is a standard condition.[65] While the draft EMP proposed general monitoring of all waterways,[66] after further review I do not consider such an approach is required in this instance.

125 The potential effects of the Project on waterways are:

125.1 Complete loss of reclaimed stream channel through culverting (in which case effects are already known and will be mitigated elsewhere);

125.2 Complete loss of reclaimed stream channel due to diversion (in which case effects are already known and mitigation will occur within the new diversion channel); or

125.3 Potential discharges from earthworks to unmodified stream channels.

126 These situations require two separate approaches:

126.1 Construction effects monitoring (relating to discharge effects in remaining downstream water bodies); and

126.2 Mitigation success monitoring (for the diversion and culverts).

127 I have summarised the proposed monitoring requirements for each waterway in Table 8 below. **Annexure D** of my evidence is a proposed Ecological Baseline Monitoring Plan which sets out the full rationale behind those monitoring requirements.

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65 Proposed condition G.38.

66 Draft EMP, Appendix M of the CEMP, section 4.4.2, page 48

Table 8 Monitoring requirements

Waterway	Construction Monitoring	Mitigation Monitoring
Hadfield	N	N
Paetawa	Downstream only (benthic invertebrates & deposited sediment)	Yes (SEV)[67]
Smithfield	N	Yes (SEV)
Kakariki	Y (benthic invertebrates & deposited sediment)	Yes (SEV)
Ngarara	N	N
Waimeha	N	N
Waikanae	Y (benthic invertebrates, bully density, Periphyton, PHA, SEV)	N
Muaupoko	N	Yes (SEV, Fish passage)
Mazengarb (WWTP)	N	Yes (SEV)
Mazengarb	N	N
Wharemauku	N	N
Drain 7 (upper)	N	N
Drain 7 (lower)	N	Yes (SEV)
Whareroa Stream	N	N

Construction Effects Monitoring

128 I note that as many of the waterways will only experience minor earthworks in their proximity, they will therefore have a low risk of sediment contamination with a low risk of effect.[68] Furthermore, many waterways currently experience destructive annual maintenance by excavator, which is likely to mask any effects on benthic communities caused by sediment discharges from the Project.

129 Finally, the low QMCI values and other biological metrics in these waterways would make detecting changes of ecological significance unlikely.

130 Given the above discussion, I do not consider that construction monitoring is required in most channels. The only exceptions are:

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67 Stream Ecological Valuation.

68 I note that Section 5.3 of the Erosion and Sediment Control Plan discusses ongoing site monitoring by the Project team to ensure that erosion and sediment control measures have been installed correctly.

130.1 The Waikanae River due to the extensive earthworks proposed within the floodplain and channel and the high values of the river; and

130.2 The Kakariki Stream which discharges to the Te Hapua wetland, a regionally significant wetland system.

131 As noted earlier, I have developed an Ecological Baseline Monitoring Plan jointly with **Mr Fuller** which details a part of the requirements noted in the draft EMP provided in the application.[69] This Plan focuses on obtaining data on the Waikanae River and Kakariki and Paetawa Streams (as well as the potentially affected marine areas) to support the ongoing construction monitoring. A draft of this plan (and the rationale) has been provided to GWRC (first week of August 2012) and is attached to my evidence as **Annexure D**.

132 I do not recommend monitoring fish through construction as it is highly unlikely fish passage issues will arise at any of the proposed stream crossings and low levels of sediment deposition into streams during large rainfall events are unlikely to affect the species present in the lower reaches of these waterways. Moreover, "spot" fishing results are too variable and the fish themselves too mobile for construction monitoring to establish any causal link between fish presence and abundance and short term changes related to potential sediment discharges.

133 An exception to this is that I recommend (in the proposed Ecological Baseline Monitoring Plan) measuring fish density in the affected sections of the Waikanae River prior to construction to ensure we can assess the resultant post construction condition of the resident fish densities.[70]

Mitigation success monitoring

134 Ecological mitigation works are proposed associated with eight waterways[71] and I consider that post construction success monitoring is required at each site.

135 For diversions there will be a 2-5 year period where the substrate will "settle" and the riparian vegetation will establish. Therefore, I recommend mitigation success monitoring should be phased to cover:

135.1 Correct installation/establishment of the bank and channel form and hydrology;

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69 Section 4.4.1 (pages 47) in the draft EMP, Appendix M of the CEMP.

70 See **Annexure D**, section 4.5.11.

71 Upper and Lower Drain 7, Mauapoko, Mazengarb WWT, Kakariki, Smithfield, Paetawa and Hadfield/Kowhai. See also Table 8 and Annexure C.

135.2 Establishment of vegetation (including algae); and

135.3 Return of fauna.

136 The mitigation success monitoring should include a repeat of the full SEV analysis carried out as part of our assessment (this is reflected in the new draft baseline monitoring report appended here as **Annexure D** and to carry through to the revised EMP). The SEV tool measures fish, invertebrates, habitat and functions. However, because the new diversions must be established and colonised, success monitoring cannot occur until (in my opinion) three years post completion of riparian vegetation establishment and up to 10 years post construction. I suggest that there should be three phases of this monitoring:

136.1 A check immediately after successful planting and stabilisation of stream banks and bed to confirm suitability of habitat and maintenance of flows.

136.2 SEV data collected to confirm biological establishment has occurred (flora, and fauna) in the new channel. This should be carried out 2-3 years after successful habitat formation. If the full benefit has been achieved, then monitoring can cease at this point.

136.3 A further SEV analysis completed after a 5 year period (assuming benefits not reached after 2-3 years) and then 10 years after construction (assuming benefits had not been reached in the fifth year).[72]

137 The above processes will need to be set out in the final EMP provided to GWRC for certification prior to construction.[73]

RESPONSE TO SECTION 149G(3) KEY ISSUES REPORTS

138 The Key Issues Reports prepared by KCDC and GWRC raised several issues relating to aquatic ecological matters. I will address each in turn.

KCDC section 149G(3) Key Issues Report

139 KCDC mistakenly reported in section 3 that the displacement of streams summed 5 km.[74] As noted above, the total displacement by diversions is 1,525 m. In total the Project adversely affects approximately 3.12 km of waterway (as detailed in my evidence

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[72] This suggested programme detail has not been stipulated in the current draft EMP I recommend that this process be reflected in the post construction aquatic ecological monitoring programme set out in the EMP provided to GWRC for certification.

[73] In accordance with proposed consent condition G.34.

[74] Under the heading "Ecology, Wetlands, Streams and Ecological Corridors", page 9.

above). I note that the length of proposed mitigation works total just over 5 km.

GWRC section 149G(3) Key Issues Report

140 The GWRC Key Issues Report (*GWRC Report*) identified a number of freshwater issues which I will now address.

Further information regarding fish sampling

141 The GWRC Report seeks that further information is provided as to the species and numbers of fish found during the fish sampling investigations.[75] To address GWRC's concerns, I have included this information above (see paragraphs 48-59) and in **Annexure B** of my evidence. Prior to this evidence being completed, further information was provided to GWRC to clarify the issues discussed below.

142 GWRC (at paragraph 137) also seek further information as to the lengths of existing culverts which are to be replaced by new ones. Of the 22 culverts that lie within perennial streams, 8 are upgrades or replacements of existing culverts. For replacement culverts I have only considered the additional (new) culvert length and any additional armouring or headwalls as "new" habitat lost. That is, I have assumed that the existing length of culvert was already providing "culvert effects" and have added only the difference between new plus armouring and existing. (I have assumed armouring and headwall may be of the order of 20 m at either end of the culvert) (see Table 9 below).

Table 9: Summary table of changes in existing culvert length.

Catchment Name	Waterbody Name / Descriptions	Culvert Length Existing	Culvert Length New
1. Whareroa Stream	Drain off Whareroa (not discharging to water)	20	**0**
1. Whareroa Stream	Drain off Whareroa (not discharging to water)	50	**0**
1. Whareroa Stream	Drain off Whareroa	55	**30**
3. Waikanae River	Landfill Drain (middle wetland) - Landfill drain to Waikanae	75	**65**
4. Waimeha Stream	New outlet of Osbournes Drain to Waimeha Stream	15	**0**
4. Waimeha Stream	Urupa access culvert of Osbournes Drain	15	**0**
4. Waimeha Stream	Paetawa Drain trib upgraded under SH1	20	**12**
4. Waimeha Stream	Paetawa drain trib under SH1	25	**10**
Totals		275	**115**

[75] Paragraph 246.

143 It can be seen that 275 m of existing culvert length is proposed to be replaced by 115 m new culvert length. A further 160 m will be required for headwalls and armouring, meaning ultimately that the lengths of old and new culverts will balance.

144 At paragraphs 219 and 247 of the GWRC Report, GWRC state that they require more information on fish access to flood storage wetlands before they can assess their mitigation value. For clarification, I note that these diversion passages and the presence of the identified storage areas as fish habitat have not been used in calculating the quantum of mitigation required as identified by the ECR modelling. When Technical Report 26 was lodged, those areas were identified as providing potential mitigation. However, due to the uncertainty I have in the quantity of water they will have to support fish, I no longer consider that they may provide potential mitigation.

Protection of nationally threatened indigenous aquatic plants and freshwater fauna

145 Paragraph 78 of the GWRC Report notes that Policy 4.2.1.3 of the RFWP is a key policy relating to the Project,[76] and notes that Appendix 3 of the RFWP identifies a number of watercourses as habitat for nationally threatened native fish species. I have addressed this issue at paragraphs 60 to 65 above. For the reasons I set out earlier in my evidence, I consider that there is insufficient data to support the waterways identified in Appendix 3 (affected by the Project) as "significant", except for the Waikanae River.

Water bodies with important trout habitat

146 As set out at paragraph 79 of the GWRC Report, and discussed above, Appendix 4 of the RFWP identifies the Waikanae River as important habitat for trout. While this may be correct I note that this is an example of the RFWP including matters that are becoming outdated. In particular, I note that the RFWP does not recognise that trout are generally now accepted as being adverse to indigenous biodiversity (e.g. McIntosh et al 2009[77]).

Fish recorded in the study area and effect of discharges from earthworks

147 I note that in paragraph 196, the GWRC Report states (relying on Table 22.1 of the AEE) that there are banded kokopu recorded in the "catchments of the Whareroa, Wharemauku and Ngarara Streams and within a tributary of the Ngarara Stream". For clarification, in

[76] Policy 4.2.1.3 relates to the protection of nationally threatened indigenous aquatic plants and nationally threatened freshwater fauna.

[77] Angus R. McIntosh, Peter A. McHugh, Nicholas R. Dunn, Jane M. Goodman, Simon W. Howard, Phillip G. Jellyman, Leanne K. O'Brien, Per Nyström and Darragh J. Woodford. 2009. The impact of trout on galaxiid fishes in New Zealand. New Zealand Journal of Ecology (2010) 34(1): 195-206 © New Zealand Ecological Society.

terms of effects I note that banded kokopu were only found in the Paetawa Stream (which is part of the Waimeha Catchment), and Hadfield drain (in the Kowhai Catchment).[78]

Stream Works

148 Section 7.2 of the GWRC Report relates to "stream works". At paragraph 204, the extent of freshwater effects is set out quoting linear meters of effects and numbers of structures. I note that several of these numbers have changed since lodgement,[79] in particular:

148.1 Armouring of stream banks associated with bridge structures has increased from 312 m to 472 m; and

148.2 Culvert lengths have been corrected from 1,119 m to 1,123 m.

149 As a result of the above changes, the total affected area has changed from 2.9 km to 3.1 km.

150 At paragraphs 207-209, the GWRC Report identifies discrepancies between Tables 10 and 11 of Technical Report 30 and the accompanying text. I acknowledge that there are discrepancies and I have addressed the issues relating to the confusion as to the fish which have been historically recorded as present (post 1990) and which species have been recently sampled and where, in paragraphs 48-65 and Table 3 above. In addition, the presence of "threatened" fish species (in terms of at site and in wider catchment) has also been clarified in my evidence above.

151 In terms of the adequacy of determining fish values in each affected stream, I consider that the IBI analysis undertaken was accurate. That analysis forms the base of the fish values, in addition to threatened species population presence. In that regard, Table 21 of Technical Report 30 (presence of threatened species) was incorrect as it identified more threatened species at sites than was actually sampled as present.

152 As noted earlier, I have included updated versions of Tables 10, 11 and 21 of Technical Report 30 in **Annexure B** to my evidence.

Post construction monitoring

153 The GWRC Report states (at paragraph 211) that consent conditions should provide for post construction monitoring and assessment to occur of all new diversions, stream lengths and structures. In part I agree in that all stream diversions (of intermittent and perennial streams which have a goal of ecological mitigation) should be

[78] Refer to Table 21, page 68, Technical Report 30 and **Annexure B** of this evidence.

[79] As discussed earlier in my evidence.

monitored for diversion success. That success should not be expected (and therefore measured) for a number of years post construction (see paragraphs 134-137 above and Table 9).

Monitoring during construction

154 In response to the query raised at paragraph 231 of the GWRC Report regarding monitoring during construction, I do not consider that, in terms of construction effects, there will be a need to monitor fish passage at culverts (or bridges) or to monitor effects to fish of potential occasional sediment discharge (related to construction effects).[80]

Mitigation for loss of habitat

155 The GWRC Report suggests (at paragraph 221) that further detail as to the assumptions used for the "potential values" and effects is required. In particular, low ECRs are noted for diversions. This apparent low ECR requirement is due to the assumption that the future potential in stream value of the diversions will be high. This is because the diversions will result in the creation and enhancement of habitat and will have higher ecological value than the existing (and generally poor) condition of the reaches diverted. In these circumstances a low ECR will be generated by the model as a poor ecological area is replaced by an area with higher ecological value.

SEV

SEVi-P < SEVi-I[81]

156 There also seems to be some confusion in paragraph 221 of the GWRC Report regarding how the potential value of the affected streams can be less than the post affected areas (i.e. how SEVi-P < SEVi-I).

157 This is because the impacted reaches measured are soft bottomed, modified, poor condition systems with continuing bank erosion and other degenerating factors (annual digger management etc). Their future potential, under current management, is downward (low and getting lower). Placement of armouring and culvert structures or a new diversion section properly developed, as part of the Project, will actually bring improvements (i.e. hard substrates and stability), as well as negatives (e.g. loss of hyporheic habitat). In these poor condition low gradient streams, I consider that the culverts (and associated armouring etc) will bring values that will actually benefit the systems, which currently have no protection and no management that enhances their future condition. Hence, SEVi-P is less than SEVi-I.

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80 This was discussed earlier in my evidence.

81 This means the impacted(i) SEV sites potential (P) (future) condition is less than the impacted sites SEV value after the impact.

Calculation of SEV

158 The GWRC Report seeks (at paragraph 248) further information as to how the proposed length of 4,973 m of mitigation (now 5,246 m) was calculated.

159 This mitigation was identified as a result of the calculation of the SEV biometrics, the establishment of ECR values for the range of activities and consideration of a range of sites coupled with the array of possible mitigation sites. This process involved a substantial number of variables.

160 A range of assumptions were determined as to the potential values of variables based on expectations of the future state of affected areas as well as the potential values of the mitigation sites based on the expectations of outcomes of proposed management actions. A range of estimates was required for each affected SEV parameter in formulating each ECR. For example, an assumption must be made on how much gain in will be attained in each parameter with the addition of riparian vegetation. One cannot list all of the assumptions and estimation for every parameter (although assumptions are numerically evident in the spreadsheets). A level of trust in the professionalism of the modeller is required. **Annexure F** of this evidence provides a series of spread sheets that show the assumed losses and gains in SEV scores for impacted and mitigation sites which are then the base inputs for the ECR formula.

161 For diversions, I have worked from a zero current value and estimated a future value (SEVm-P). This future value is calculated and this requires an assumption that works are carried out appropriately and successfully and that the waterway will approximate a near reference site condition (reference site conditions are problematic in the Project catchments, being largely absent in terms of unmodified examples). It needs to be remembered that the ECR and SEV system is simply a modelling exercise to better "estimate" the array of factors and outcomes and so quantum.

162 The GWRC Report then notes[82] that regardless of the uncertainty they have in regard to the SEV model use, the proposed mitigation level falls short of the models required level. I disagree. As I have discussed above, due to the improvements I have recommended in regard to mitigation areas, the quantum of mitigation is now 33 m in excess of that modelled as required.

RESPONSE TO SUBMISSIONS

163 Approximately 60 of the submissions received in relation to the Project raise concerns regarding freshwater ecology. Most of the

[82] See paragraph 248.

submissions are very general[83] and I consider that my evidence, Technical Reports 26 and 30, the AEE and the draft EMP sufficiently address these general ecology issues and concerns.

164 There are however several more detailed and specific submissions and in the following sections of my evidence I respond to the issues raised by the following submitters:

164.1 Ruth McKenzie and Nga Manu Nature Reserve (*Nga Manu);*[84]

164.2 GWRC;[85]

164.3 DOC;[86] and

164.4 KCDC.[87]

Ruth McKenzie and Nga Manu Nature Reserve

165 As the submissions of Ms McKenzie and the Nga Manu raise essentially the same issues, I have addressed both of these submissions together.

166 These submissions raise issues in relation to freshwater ecology, in particular regarding the Kakariki Stream. Their concerns relate to:

166.1 Management of stormwater runoff from the expressway;

166.2 Effects on local waterways and hydrology; and

166.3 The re-alignment of the Kakariki Stream, and possible erosion issues.

Management of stormwater run-off

167 Concern is raised about the management of stormwater runoff, in particular in the vicinity of the Kakariki Stream. The submissions seek:

> *That stormwater run-off from the expressway is managed and monitored in such a way as to ensure the ongoing health of local water ways, including ensuring adequate water quality, riparian plantings where necessary, ponding areas, and management of fish migration. This should be developed in*

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83 For example, submissions from Friends of the Waikanae River (0059), Ms Hawkins (0072), Mr Hare (0207), Mrs Luhn (0271), Miss Vagg (0348), Mrs Beaufort (0434), Save Kapiti Inc. (0505), Raumati South Residents Association Inc. (0707).

84 Submitters 0046 and 0090 respectively.

85 Submitter 0684.

86 Submitter 0468.

87 Submitter 0682.

conjunction with the Greater Wellington Regional Council and Nga Manu Trust.[88]

168 The management of potential earthwork related and road run off discharges of contaminants to the Kakariki Stream are issues specifically discussed in the evidence of **Mr Ridley** and **Mr Levy**.

169 However, I have again reviewed the proposed stormwater systems, the proposals to protect the waterways and the predicted water quality results.[89] I have suggested establishing a monitoring regime in the Kakariki and Paetawa waterways especially with potential sediment discharge effects in mind. I have also suggested that the Kakariki become a focal point of aquatic mitigation.

170 As a result, the proposed monitoring and mitigation in relation to the Kakariki Stream has been developed further since lodgement of the Project with the EPA. That update is now provided in the Baseline Ecological Monitoring Plan (**Annexure D**), which also highlights those areas that require diversion mitigation success monitoring, and in **Annexure C** which shows the Kakariki Stream as a mitigation focus site. I consider the updated mitigation and monitoring proposal (along with further details in post construction monitoring and diversion design details) will adequately address these submitters' concerns.

Effects on local waterways and hydrology

171 The submissions assert that an inaccurate assessment has been made as to the condition of the Kakariki Stream and that the stream is "*in relatively good condition in comparison to many lowland rivers and streams nationwide*".[90]

172 I have ranked the Kakariki Stream as of "moderate" value (with more locally important macroinvertebrate fauna and limited but relatively important fish values). I accept that the Kakariki Stream is one of the more ecologically important waterways crossed by the Project. I do not agree that my assessment provides an inaccurate impression of the ecological value of the Stream.

173 I consider that the actions proposed to manage the structures crossing the Stream, and the construction discharges and operational storm water discharges,[91] together with the remedial and mitigation actions I have proposed, will in fact improve the ecology of the Kakariki Stream (and Smithfield tributary).

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88 Section 1 of Submissions 0046 and 0090.

89 Table 37, Technical Report 26, page 120 shows a summary of the expected sediment change by catchment.

90 Section 2 of Submissions 0046 and 0090.

91 CEMP Appendix H, Volume 4 and Technical report 25, volume 3; evidence of **Mr Levy**; and evidence of **Mr Ridley** "proposed ESCP measures" section.

174 Both submissions seek to ensure that "*the expressway design does not compromise the hydrology and ecological values of the ecosystems in the vicinity of Nga Manu.*"

175 Given its importance in providing fish habitat, I agree that fish passage be maintained in the Kakariki Stream and that the hydrology and ecological values are not compromised by the Project.

176 I have assessed the effects of the diversion, bridging, riprap and discharges and have accounted for those effects in my proposed mitigation. That mitigation includes the NZTA:

176.1 Acquiring the lower Kakariki Stream reach to Ngarara Road;

176.2 Rehabilitating the riparian and in-stream ecology;

176.3 Creating an extensive length of improved functioning Smithfield "drain";

176.4 Revegetating the diversions in dense native riparian vegetation; and

176.5 Heavily planting the surrounding "storage" area in native wetland plantings.[92]

177 I propose an effects monitoring programme (starting with the baseline monitoring programme) that has a focus on the Kakariki Stream for construction effects[93] and a process of up to 10 years to measure mitigation actions success (in both the Kakariki and Smithfield diversion).

178 I note that the conditions involving aquatic mitigation require a full EMP to be developed. Proposed condition G.34(c), which relates to the EMP, requires that ecological monitoring will achieve various outcomes that include:

178.1 Confirmation that adverse effects are as predicted; and

178.2 Ensure mitigation requirements are undertaken and monitored to ensure success is achieved; and

178.3 Carry out monitoring in a manner that confirms mitigation objectives are met.

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92 Shown on the mitigation plans set out at **Annexure C** of this evidence, and on Appendix M.C (Terrestrial and Freshwater Ecological Mitigation Sites), Appendix M.E (Stream Diversion Design Guidelines) and Appendix M.F (Indicative Stream Diversion Plan) of the draft EMP.

93 See **Table 10** later in my evidence.

179 Proposed condition WS.5 requires the preparation of a mitigation (revegetation) strategy for stream modifications and structures, which include the Kakariki and Smithfield modifications.

180 Lastly, I have recommended that there be better reference in a condition to the need for a full ecological diversion methodology (design) plan and stipulation of the outcomes required. I discuss this further in the Proposed Conditions section of my evidence below.[94]

181 For the various reasons discussed above, I consider that the Project will not compromise the ecological values of the ecosystems in the vicinity of Nga Manu.

Re-alignment of Kakariki Stream

182 Both submissions (section 3) seek that the diversion of the Kakariki Stream be reconsidered or that an independent assessment be provided "*to show that the proposed re-alignment will not have any adverse effects on the stability of the banks of the stream or result in any additional erosion.*"

183 I cannot comment as to the effects on bank stability. However in relation to the realignment, where the new channel follows the mitigation diversion principals and methods drafted in the EMP (Appendices M.E and M.F), then there will be only temporary adverse effects followed by an ecological outcome that is better than the existing condition of the Kakariki Stream.

Greater Wellington Regional Council (*GWRC*)

184 The submission from GWRC largely seeks further clarification in a number of areas, including Technical Report discrepancies and mitigation and monitoring methods. From further correspondence from GWRC,[95] I understand that, in relation to freshwater ecology, the issues referred to in its submission are the same as those raised in the GWRC Key Issues Report (which I have addressed earlier in my evidence).

185 Following lodgement of its submission, GWRC provided a Without Prejudice Discussion Document (dated 22 August 2012) which provides further clarification of the GWRC submission. I note that section 9 of that document discusses mitigation and offsetting. It states that GWRC considers that in designing the ecological mitigation package:

> "*...the aim should be no net loss of biodiversity and preferably a net gain. The Standard on Biodiversity Offsets developed by the Business and Biodiversity Offsets Programme (BBOP)*

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[94] This is reflected in additional wording proposed in condition WS.5 (see **Annexure E**).

[95] GWRC's Discussion Document, dated 22 August 2012 (para 3).

should be applied. This approach is consistent with that agreed in the Transmission Gully project."

186 In response I note that there is as yet no standard in New Zealand regarding offsetting. DOC is co-ordinating the development of a potential good practice standard regarding successful offsetting under the BBOP system as one form of mitigation.

187 Furthermore, the Transmission Gully Project Board of Inquiry did not determine a method for mitigation, nor did it support a "no net loss" approach to mitigation.

188 For freshwater systems, the SEV model used uses the same approach as the BBOP style accounting model in that it develops a currency (functional system condition) and provides differentials between future conditions of the impacted and mitigation areas and then applies a time-lag multiplier. I am firmly of the opinion that the 5 km of proposed mitigation stream work "offsets" the 3km of adversely affected stream way to achieve an ecological benefit.

Department of Conservation

189 The DOC submission is neutral, although it notes that the AEE and supporting technical documents are comprehensive, and that the proposed route avoids areas of significant indigenous vegetation. The submission primarily focuses on the wetlands affected by the Project, which is responded to in **Mr Park's** evidence. It raises only one particular point of interest regarding aquatic ecology which is in regard to the surface water flows of waterways.[96]

190 I note that the issue raised of groundwater changes potentially causing loss in wetland surface water may also apply to small perennial waterways. While I considered this effect to be of potential concern, I understand from the evidence of **Ms Williams** that there will be no substantial effects (<0.1 m) in groundwater level or flow direction 50-70 m from any edge of the proposed Expressway.

191 Within 50 m of embankments, Ms Williams predicts a potential change of 0.3-0.5 m in groundwater level and potential flow changes towards storm water retention areas (where these are dug lower than the water table) I understand that in accordance with the Groundwater Level Management Plan, piezometers will be used to measure groundwater changes in wetlands. I consider that this monitoring may also assist in prediction of flow changes in waterways where measured wetlands are located close to streams.

192 I consider that the risk of changes in groundwater affecting flow in waterways will be low, given that embankments are generally

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[96] DOC submission, Section A.

perpendicular to waterways and the potential effect therefore spatially limited.

193 DOC has also requested "conditions requiring fish passage to be provided and maintained for freshwater ecosystems". I concur with that need.[97] Proposed conditions G.11b and WS.4 and WS.8 also specifically require fish passage to be achieved when placing culverts in waterways.

Kāpiti Coast District Council

194 KCDC's submission appears to generally accept the extent of effects on freshwater ecology and supports the proposed mitigation of those effects.[98] However, the submission raises a number of matters relating to freshwater ecology which I will now address.

Mitigation shortfall

195 At paragraph 44, KCDC notes a numerical shortfall in the total quantum of mitigation (in linear meters) of the proposed aquatic mitigation as set by the ECR. As I have detailed earlier in my evidence, any shortfall has been rectified by my further (post-lodgement) mitigation review. There is no longer a shortfall.

Consideration of upstream ecology

196 At paragraphs 46 and 47, KCDC suggests that the assessment does not adequately consider the upstream ecology (i.e. upstream of the Project) where the ecological condition of freshwater bodies is well above average (e.g. Waikanae and Kakariki Stream).

197 In relation to the up-stream reaches of affected streams, I acknowledge that my research has been limited to observation and the literature review I undertook when looking into the freshwater ecology in the vicinity of the Project.

198 However, I note that the KCDC submission focuses on fish species access upstream. In regard to fish, I have discussed earlier the wider FWFDB findings and the need for passage and movement to better habitats upstream through the areas of Project work. Culverts installed as part of the Project are required to enable fish passage[99] and sediment discharges from earthworks are required to be managed in accordance with the Erosion and Sediment Control Plan.[100]

199 However, I have also assessed and concluded that the aquatic systems affected by the Project are already challenged and tolerant of a wide range of discharged compounds and that the risks of

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97 See also Technical Report 26, page 154, 11.7.4d.

98 Submission at paragraphs 44-45.

99 Refer proposed conditions G.11b, WS.4, and WS.8.

100 Refer proposed conditions E.1 – E.12.

interference with current fish migrations is low. In my opinion, potential upstream adverse effects, by and large, are constrained to ensuring native fish access (up and down stream). I believe that with proper management of earthworks discharges, diversions, culvert installation, bridging and the enhancement of riparian areas upstream populations of fish will not be adversely affected by the Project.

200 KCDC also seeks that an appropriate condition be in place to ensure that construction works do not occur in or adjacent to streams during whitebait season (generally August to November).[101] I support the inclusion of a condition directed to address that issue and I have suggested proposed wording for such a condition in **Annexure E** - see new proposed condition WS.9. This condition could be used to regulate both in-stream works and earthworks adjacent to a potential migration passage waterway.

201 The condition, to my mind, will allow construction flexibility but will also ensure that adverse effects (from in-stream works and discharges) to fish migrations are minimised.[102]

Stream diversions

202 At paragraphs 49 and 51, KCDC seeks further information around the mitigation of diverted stream length and detail on appropriate riparian planting.

203 I have discussed the location of mitigation of diverted stream lengths earlier in my evidence. The lengths are identified on the Proposed Ecological Freshwater Mitigation maps provided as **Annexure C**.

204 The detailed design of the diversions and riparian planting has not been completed (that would normally occur when the EMP is finalised and certified) but I agree that there needs to be certainty that the work undertaken will provide appropriate mitigation. In accordance with proposed condition G.34, the EMP will set out the permanent mitigation measures, including restoration planting. When finalised, the EMP will be submitted to GWRC for certification prior to construction works beginning. In addition, proposed conditions WS.3 and WS.5 address the need for diversion designs that establish appropriate flows and riparian re-vegetation.

205 Paragraphs 50 and 52 of the submission seek clarification around the adaptive management regime proposed to mitigate adverse ecological effects on freshwater. **Mr Fuller** addresses adaptive management in his evidence.

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101 KCDC submission, para 47.

102 Proposed condition WS.9 requires the consent holder to develop a specific programme and methodology to manage mitigation of fish outside the period 1 March to 31 July, such programme to be certified by the GWRC prior to any relevant works commencing.

206 I note that in relation to adaptive management, KCDC seeks that upstream and downstream monitoring should occur, not only for the Kakariki Stream but also for other stream diversions. In response, I note that proposed condition G.34(c) requires mitigation success monitoring, and I have discussed the proposed monitoring programme earlier in my evidence. I consider that this addresses KCDC's concerns.

Effects on the Waikanae River

207 Paragraphs 53-59 of the submission seek further detail in relation to the adverse effects resulting from the works in the Waikanae River and at the confluence with the Muaupoko Stream. In particular, KCDC states:

> *The application provides insufficient detail on the effects in this area and more careful thought needs to be given to how adverse effects can be mitigated, including how to integrate works associated with the Expressway with flood protection works managed by the Greater Wellington Regional Council.*

208 The bridge over the Waikanae River is not proposed to have a pier or support structure within the live channel; this will be within the floodplain.[103] In order to achieve this and to ensure the security of the abutments, a range of river bank and river bed works are required. The impacts of this work were discussed earlier in my evidence,[104] and I have accounted for the additional armouring and channel management effects in the mitigation quantum and in terms of monitoring the actual level of effects in the proposed monitoring plan (**Annexure D**).

209 Regarding mitigation of adverse effects in relation to the Waikanae River, there is likely to be a requirement for vehicle access and continual maintenance regimes and other aspects of flood management around the proposed bridge area. The current vegetation regime is focused on flood management aspects and largely involves willow trees (there may also be some capacity for native inter-planting).[105] This precludes me from recommending riparian enhancement or other ecological mitigation adjacent to and downstream of the proposed bridge structures. Therefore, while I recommend no ecological mitigation associated with the Waikanae River itself, I note that mitigation is proposed along the Mauapoko Stream and at its confluence with the Waikanae River, (as discussed in the following paragraphs).

210 In regard to the Muaupoko Stream diversion, my understanding is that the lower (approximately) 200 m is required to be moved (east)

[103] Technical Report 22, Section 4.5.1v. Technical Report 4, section 2.1.6.

[104] Refer paragraphs 90-92.

[105] Evidence of **Mr Evans**.

so as to not discharge under the proposed bridge and near the bridge piles and abutments.[106] This diversion will cut through the well developed channel and riparian vegetation of the lower Muaupoko, possibly the best habitat area on this tributary. In moving the confluence east, a shortened length of stream will result.

211 I consider it very important that the confluence be natural and without any impediments to fish migration, and that the channel and bed be created as natural in shape and form (meander) as possible and that the riparian restoration be as compete and of the type that currently exists. I understand that these factors will be finalised during detailed design and will be included in the EMP as a detailed diversion plan. I consider that this will ensure appropriate restoration is achieved.

212 KCDC's submission notes[107] that there has been a spring recorded at the confluence of the Waikanae River and Mauapoko Stream and that this spring is of spiritual significance to local Iwi. I was unaware of a spring at that specific location, however, I understand from Mr Kamo (BML cultural advisor) that there was or is a spring associated with the lower Mauapoko but that its position has changed over time.

213 The Cultural Impact Assessments prepared for the Project[108] mention the following springs:

213.1 The Te Puna-o-Rongomai spring[109] (Cultural impact report, page 9) said to be located to the east of the Weggery Homestead within the Takamore wāhi tapu;

213.2 Waikaukau spring; whose location is between the base of the dune to the southern side of the Takamore Urupā and the Weggery driveway.

214 However, I have not been able to find any other reference in those documents to a spring near the Maupoko confluence with the Waikanae River.

PROPOSED CONDITIONS

215 In my opinion, resource consent conditions related to freshwater ecology are required to ensure that:

215.1 Culverts are installed correctly;

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[106] See drawings CV-SW-392 and 393.

[107] KCDC submission, paragraph 56.

[108] Technical Reports 11 and 12, which are referred to in KCDC's submission (footnote 4).

[109] Page 9, Technical Report 11.

215.2 Discharges (construction and operation) are managed appropriately to minimise discharge of contaminants;

215.3 Only those areas of riparian and waterway described in the AEE as affected are so affected;

215.4 Stream diversions are undertaken correctly so as to add the required level of habitat value and not remove value;

215.5 Construction effects are monitored(with appropriate triggers and responses identified); and

215.6 The mitigations required are undertaken and monitored to ensure their success.

216 The proposed resource conditions lodged with the AEE generally cover these matters, and are further described below.[110] For ease of reference, I have set out the conditions I discuss below in **Annexure E** of my evidence (in which I also make any suggested amendments).

217 Proposed condition G.19 is a general condition requiring the preparation of plans and includes reference to an EMP which identifies the management of key environmental effects. A draft EMP has been submitted in the lodged application and should form the basis of any revised EMP.

218 Proposed condition G.34(a) requires the finalisation and submission of such an EMP. It describes the EMP's purpose as being "*to outline the ecological management programme to protect, reduce and remediate, impacts on the environment during the construction phase of the Project*". I support this intention. I also support the requirement that the EMP is required to document the "*permanent mitigation measures, such as restorative planting, and the mechanisms by which to develop relevant mitigation and restoration plans for terrestrial and freshwater habitat*". In my opinion, that process has been advanced since lodgement and the mitigation aspects for aquatic effects (i.e. quantum and location) that would contribute to a revised EMP have been detailed in my evidence above.[111]

219 Proposed condition G.34(b) requires that the EMP detail the monitoring to be undertaken pre, during and post construction as outlined in proposed conditions G.38 – G.40.

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110 The designation conditions do not specifically address ecological matters except to state the Landscape Management Plans need to be cognisant of and in line with ecological aspects (condition DC.54).

111 See **Annexure C** and discussion on mitigation earlier in my evidence.

220 The lodged draft EMP has a monitoring section[112] which outlines the general approach. However, the information regarding monitoring which I have set out earlier in this evidence, and the Ecological Baseline Monitoring Plan set out in **Annexure D** *supersedes* a portion of that draft in terms of the details of what, where and how monitoring should be undertaken in terms of the freshwater systems.

221 Proposed condition G.34(c) recognises the need to undertake mitigation success monitoring. This is an important requirement to ensure that the mitigations proposed and undertaken (especially the stream diversion habitat creations) succeed.

222 Proposed condition G.38 requires the implementation of monitoring as set out in the EMP. This condition requires 1 year's baseline data (i.e. pre-construction), monitoring during construction and 2 years' post construction monitoring at each waterway identified in the AEE. I support those time periods (noting that the baseline monitoring undertaken between now and construction will build on the existing data which formed the basis of my assessment). I also note that these are "effects" monitoring time frames, not mitigation success monitoring time frames.

223 The draft EMP lodged with the application requires baseline and construction monitoring on all the streams.[113] However, I consider that only two of the waterways require "effects" monitoring – the Kakariki Stream, and Waikanae River.

224 Table 10 below summarises the monitoring of construction effects and mitigation success which I consider should be undertaken.[114]

Table 10 Summary of proposed construction activity in each watercourse and anticipated monitoring requirements

Waterway	Key works	Construction Monitoring	Fish rescue	Post construction monitoring
Hadfield Drain	▪ Drain realignment & works on existing culverts @ SH1 and NIMT crossings.	Nil	Yes	-
Paetawa Stream	▪ Bridge main channel ▪ Drain realignment & works on existing culverts @ SH1 and NIMT crossings ▪ Focus site for stream mitigation & riparian	Macroinvertebrates, Sediment	Yes	SEV

112 Section 4.4 page 56 – 4.4.3, page 60.

113 Refer section 4.4 of the draft EMP.

114 For the rationale and baseline monitoring plan as revised, see **Annexure D** to this evidence.

Waterway	Key works	Construction Monitoring	Fish rescue	Post construction monitoring
	planting.			
Smithfield Drain	▪ Significant drain realignment ▪ Extensive flood storage works ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV
Kakariki Stream	▪ Bridge ▪ Diversion ▪ Major roading works in proximity ▪ Upstream realignments (Smithfield) ▪ Focus site for stream mitigation & riparian planting.	Macroinvertebrates, Sediment	-	SEV
Ngarara Creek	▪ Culvert crossing.	Nil	Yes	-
Waimeha Stream	▪ Three bridges ▪ Major interchange ▪ Diversions of small drains to south.	Nil	-	-
Waikanae River	▪ Bridge ▪ Flood plain widening ▪ Temporary channel diversions ▪ Armouring and willow planting ▪ Extensive landscape planting.	Geomorphology, Periphyton, Macroinvertebrates, Fish densities	-	-
Muaupoko Stream	▪ Diversion at confluence with Waikanae ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV Fish passage
Mazengarb (WWTP) Drain	▪ Culverted crossing. ▪ Focus site for stream mitigation & riparian planting.	Nil	-	SEV
Mazengarb Stream	▪ Culvert crossing.	Nil	Yes	-
Wharemauku Stream	▪ Bridged.	Nil	-	-

Waterway	Key works	Construction Monitoring	Fish rescue	Post construction monitoring
Drain 7 Lower	▪ Minor drain realignment & culverted crossing ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV
Drain 7 Upper	▪ Minor drain realignment & culvert crossing.	Nil	Yes	-
Whareroa Drain	▪ Drain realignment & works on existing culverts at SH1 and NIMT crossings.	Nil	-	-
Whareroa Stream Tributary	▪ No works due to revised project extent.	Nil	-	-
Te Harakeke Wetland	▪ Potential sedimentation.	Macroinvertebrates, Sediment, Contaminants	-	-

225 Proposed condition G.40 requires an "adaptive management approach" to be taken. In particular, it requires provision of baseline information, development of trigger limits and taking an "adaptive" response should a trigger level be exceeded (which includes determining what caused the trigger event, and resolving the problem, followed by continued monitoring). It also provides that triggered exceedences during construction should not be considered immediately as non-compliance but rather as a management trigger. I agree with that approach as waterway effects during construction may be temporary and it is the post construction that is most relevant.

226 Proposed erosion and sediment control condition E.9 identifies the need to inform the Project ecologists, in the event of a management system failure so that the resultant effects can be assessed. I consider that this is an appropriate and necessary consent condition.

227 Proposed conditions WS.1-WS.5, WS.7 and WS.8 are relevant to freshwater ecology (see **Annexure E**). I generally support these conditions subject to the following:

227.1 Proposed condition WS.5 requires the preparation of a re-vegetation and mitigation strategy for the stream modifications and structures. I understand this condition's purpose is to ensure that the diversions of stream systems is undertaken so as to provide effective functional aquatic habitat. Consequently this condition forms one of the cornerstones of the aquatic mitigation I envisage as required. With that in mind, I recommend additional wording that ensures the target of the mitigation is identified in the re-vegetation and mitigation strategy see proposed condition WS.5(a) (**Annexure E**).

227.2 The proposed condition WS.5 also, in my opinion needs to identify the quantum of ecological mitigation (my evidence has shown a need for approximately 5.2km). This proposed change is also now shown in **Annexure E**.

Overall consideration of the conditions

228 In reviewing again the proposed conditions lodged with the application, I have considered whether the conditions:

228.1 Identify the need to avoid adverse effects on ecological values wherever practicable;

228.2 Address the need to remedy effects;

228.3 Identify the areas that may be affected;

228.4 Ensure a system to minimise effects;

228.5 Require the monitoring of construction effects and how such effects will be measured; and

228.6 Require the appropriate ecological mitigation to occur, and ensure the monitoring of the success of that mitigation.

229 In my opinion, the proposed conditions generally achieve all of the above requirements. In particular, the EMP is the principal method for addressing the monitoring of construction effects and of the quantum and form of mitigation and monitoring of the success of mitigation. As the design of the Project is finalised, the EMP will need to be updated with more specific requirements before being submitted to the Manager for certification.

230 Mr Fuller also addresses ecological requirements of consent conditions and in his evidence. Our recommendation is for the conditions to recognise the quantum of ecological mitigation required and the mechanisms by which it will be achieved.[115] Prior to being finalised the EMP should be updated to include the maps set out in **Annexure C**.

231 The EMP should also be updated to make better reference to the stream diversion methodology for ecological mitigation, and in particular the outcomes required in the diversion of waterways for ecological mitigation. This could be achieved by appending a stream diversion guidance document (or plan) for each ecological mitigation

115 Refer also to the amendment to WS.5, as contained in **Annexure E**.

diversion to ensure the ecological outcomes are achieved as required by the EMP. Appendix M.E of the draft EMP has begun this documentation, however I note that this provides general ecological guidance and is not yet detail-specific to each of the ecological mitigation diversions.

232 This requirement (for detailed specific diversion creation guidance) is very important as I understand there may be some tension between flood protection and ecological issues. In particular, there is the potential for GWRC or KCDC to follow the current drain maintenance protocol in the stream diversions (i.e., a digger removing sediments and in-stream vegetation). Such drainage management would compromise the successful development of both the riparian vegetation and the in-stream ecological conditions.

233 In relation to the proposed conditions, I consider that the quantum of stream mitigation required by the ECR modelled output should be specified, I have proposed an amendment to Condition WS.5 (set out in **Annexure E**) which achieves this.

234 Finally, the proposed conditions do not currently restrict the time of works in any stream. Regardless of the limited fish species found in the surveys, there are a range of migrating fish species that pass through most of the identified streams, several of which are of greater conservation value. Therefore some consideration of the needs of migrating fish needs to be taken into account. Accordingly, I propose the addition of new condition WS.9 which I have set out in **Annexure E**.

CONCLUSIONS

235 It is my opinion that overall adverse aquatic ecological effects from the Project will be low to very low.

236 The nine proposed waterway diversions are opportunities to reset stream banks and substrate, and to bring about riparian enhancement. The proposed culverts will not impede and may, in some cases, improve the current fish passage.

237 My conclusions are supported by the aquatic benthic community biometrics reported, the SEV functionality scores, the apparent diminished fishery, and the low ECR ratios that were derived from the SEV analysis for each activity within these streams and associated mitigation sites.

238 Utilising the ECR ratio, approximately 5 km of restorative and enhancement actions should be provided to mitigate for an approximate loss or change of around 3 km. Given the current environmental conditions, the robustness of the aquatic community assemblages and existing values, in my opinion, the proposed

mitigation would represent a net aquatic ecological gain over the existing and current predictable future condition of those waterways.

239 Furthermore, through added road runoff protections (swales, wetland etc), the longer term water quality of the local waterways and consequently their longer term faunal condition would appear, by contaminate load calculations, to be better off than under the current regime. This outcome would be another benefit of the Project.

240 To ensure that the above outcomes are achieved as a result of the Project, I recommend that the monitoring programme which I have provided as **Annexure D** is undertaken.

Vaughan Francis Keesing
6 September 2012

REFERENCES CITED:

Alibone, R; Bruno, D; Hitchmough, R; Jellyman, D; Ling, N; Ravenscroft, P; Waters, J. 2010. Conservation status of New Zealand freshwater fish, 2009. New Zealand Journal of Freshwater water and Marine Research, published 27th September 2010.

Joy, M. 2005. A fish index of biological integrity (IBI) for the Wellington Region. Prepared for the Wellington Regional Council.

Rowe, D; Collier, K; Hatton, C; Joy, M; Maxted, J; Moore, S; Neale, M; Parkyn, S; Phillios, N; Quinn, J. (2008). Stream ecological valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying mitigation. Technical Publication No. 302. Second Edition, June 2008. First edition prepared for Auckland Regional Council by NIWA.

Townsend AJ, de Lange PJ, Duffy CAJ, Miskelly CM, Molloy, J, Norton, D 2008. New Zealand threat classification manual. Wellington, Department of Conservation.

ANNEXURES:

A - Summary metrics for value assessment.

B - Revised Tables from Technical Report 30 (Tables 10, 11 and 21).

C - Freshwater mitigation – location of waterways in which enhancements and other mitigation actions are proposed.

D - Proposed Ecological Baseline Monitoring Plan and rationale behind the monitoring required.

E - Proposed resource consent conditions.

F - Reduced SEV-ECR calculation spreadsheets.

G - One page summary ecological sheets for each waterway affected.

ANNEXURE A: SUMMARY METRICS FOR VALUE ASSESSMENT

Stream	Physical Habitat			SEV			FISH IBI			Richness			% EPT Abundance			MCI		QMCI		Revised Assessment
	Score	% of reference	Rating	Score	% of Reference	Rating	Score	% regional mean	Rating	Score	% regional mean	Rating	Score	% regional mean	Rating	Score	Rating	Score	Rating	
Hadfield Drain	0.41	48%	M	0.40	50%	M	18	64%	P	24	120%	M	17%	39%	L	87	L	4.6	fair	M
Paetawa Drain	0.16	19%	VL	0.49	63%	M	30	107%	F	15	75%	L	20%	46%	L	88	L	4.4	fair	M
Smithfield Drain	0.32	37%	L	0.38	49%	M	16	57%	VP	18	90%	L	6%	13%	VL	70	VL	2.7	poor	L
Kakariki Stream	0.26	30%	L	0.45	58%	M	37	132%	G	19	95%	L	21%	49%	L	77	L	4.5	fair	M
Ngarara Drain	0.35	41%	L	0.29	37%	L	16	57%	VP	11	55%	L	9%	21%	VL	75	L	4.3	fair	L
Waimeha Stream	0.30	35%	L	0.34	44%	M	14	50%	VP	15	75%	L	13%	31%	VL	78	L	4.7	fair	M
Waikanae River	0.57	66%	H	0.66	85%	H	40	143%	G	34	170%	H	53%	123%	M	116	H	6.4	excellent	VH
Muaupoko Stream	0.38	44%	M	0.48	61%	M	32	114%	F	24	120%	M	25%	58%	L	88	L	4.2	fair	H
Mazengarb (WWTP	0.49	57%	M	0.39	50%	M	22	79%	P	5	25%	VL	0%	0%	VL	41	VL	1.7	poor	L
Mazengarb Stream	0.48	56%	M	0.37	48%	M	22	79%	P	12	60%	L	8%	19%	VL	68	VL	4.5	fair	L
Wharemauku Stream	0.26	(30%	L	0.44	(56%	M	28	(100%	F	31	(155%	H	26%	(60%	L	90	M	3.7	poor	M
Drain 7 Lower	0.27	(31%	L	0.36	(46%	M	22	(79%	P	9	(45%	VL	11%	(26%	VL	60	VL	3.0	poor	L

Drain 7 Upper	0.06	(7%	VL	0.30	(39%	L	16	(57%	VP	11	(55%	L	9%	(21%	VL	73	VL	2.5	poor	L
Whareroa Drain	0.07	(8%	VL	0.28	(36%	L	16	(57%	VP	13	(65%	L	15%	(36%	VL	81	L	3.7	poor	L
Whareroa Str (Waterfall Rd	0.41	(48%	M	0.54	(69%	H	36	(129 %	G	30	(150 %	H	30%	(69%	L	96	M	4.3	fair	H

For PHA and SEV Ranking - very low (0-20%), low (21-41%), moderate (42-61%), high (62-82%), very high (83-100%).

Where ratings are other than Low-High: Poor = low, fair = moderate, good = high, very good / excellent = very high. For ratings set against the mean regional value (i.e. richness and EPT): 50% and below = very poor, 50-100% = low, 100-149 = moderate, >150% = high.

To attain a summed score (total values - very low = 0, low = 1, moderate = 2, high = 3, very high = 4.

Summed scores	Summary outcome of value
0-5	very low
5-10	low
10-15	moderate
15-20	High
20-25	very high

ANNEXURE B: REVISED TABLES FROM TECHNICAL REPORT 30 (TABLES 10, 11 AND 21)

Table 10. Historic observations from NIWA's National Freshwater Fish Database

Technical Name	Anguilla australis	Anguilla dieffenbachii	Cheimarrichthys fosteri	Galaxias brevipinnis	Galaxias fasciatus	Galaxias maculatus	Galaxias argenteus	Galaxias postvectis	Geotria australis	Gobiomorphus cotidianus	Gobiomorphus gobioides	Gobiomorphus basalis	Gobiomorphus huttoni	Retropinna retropinna	Rhombosolea retiaria	Salmo trutta	
Common Name	Short fin eel	Long fin eel	Torrent fish	Koaro	Banded kokopu	Inanga	Giant kokopu	Shortjaw kokopu	Lamprey	Common bully	Giant bully	Crans bully	Red fin bully	Smelt	Black flounder	Brown trout	COUNT
Hadfield (no records																	-
Ngarara Stream Catchment	Y	Y			Y	Y	Y			Y		Y	Y				8
Waimeha Stream Catchment	Y	Y				Y				Y	Y		Y	Y			7
Waikanae River Catchment	Y	Y*	Y*			Y			Y	Y			Y	Y	Y	Y*	10
Wharemauku Stream Catchment	Y			Y				Y					Y*				4
Whareroa Stream Catchment	Y*	Y			Y	Y*				Y			Y*				6
All Catchments Combined	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**16**

(NOTE: Yellow eyed mullet & estuarine triple fin removed from tables)

Table 11. Summary of species caught within each stream catchment sampled by EFM (BML 2010.)

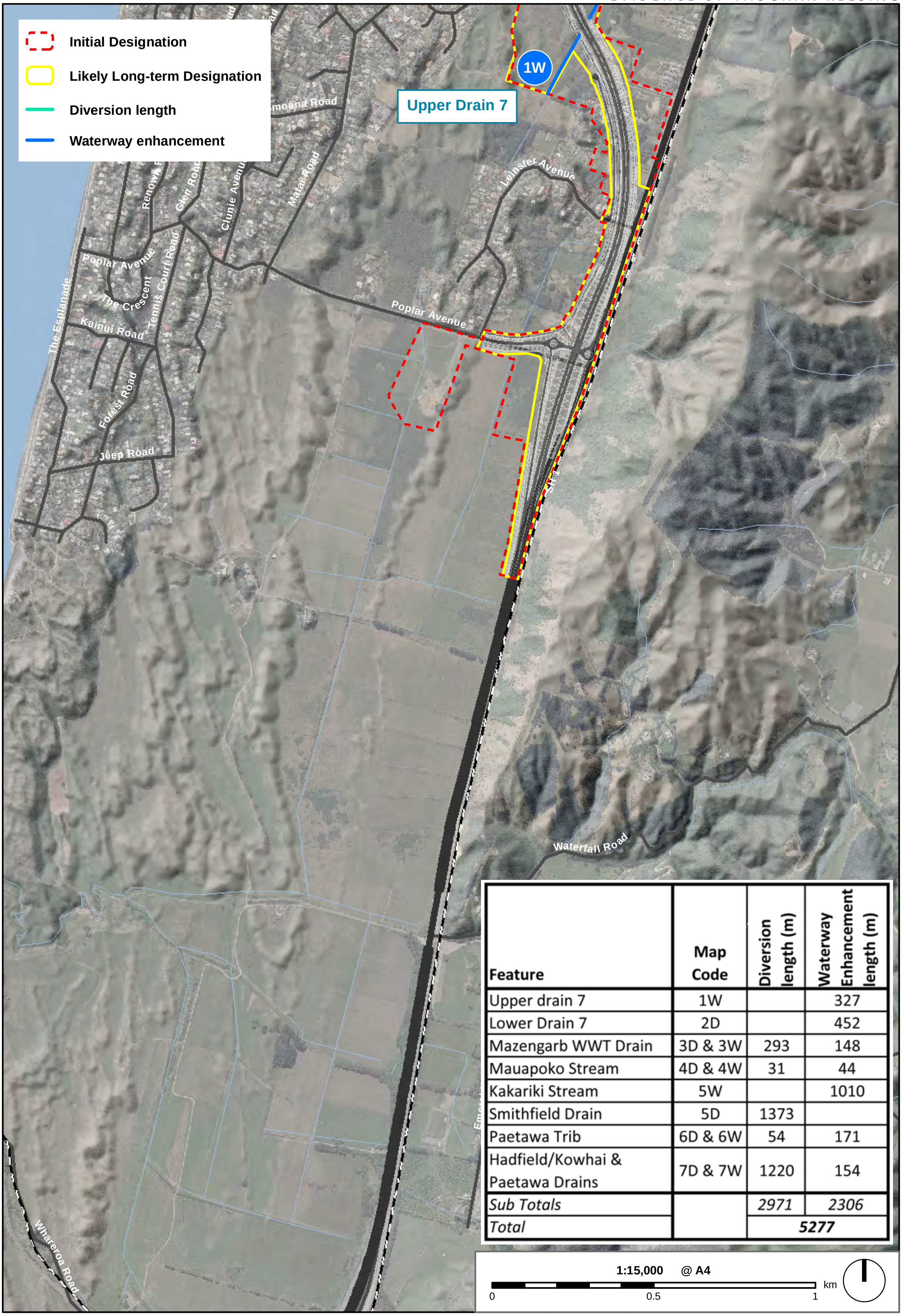
Common Name	Short fin eel	Long fin eel	Torrent fish	Giant kokopu	Koaro	Banded kokopu	Inanga	Shortjaw kokopu	Lamprey	Common bully	Giant bully	Crans bully	Red fin bully	Smelt	Black flounder	Brown trout	***Whitebait***	***Eel (unidentified***	***Elver (sp unknown***	COUNT
Hadfield Drain	1					21												***1***	***2***	2
Hadfield Combined	**Y**					**Y**											**-**	**-**	**-**	**2**
Paetawa Drain		10				7								8					***48***	3
Smithfield Rd Drain	1	2																***4***		2
Ngarara Stream at Nga Manu	1	2								3				16			***1***		***7***	4
Ngarara Tributary	1	1																***4***	***6***	2
Ngarara Combined	**Y**	**Y**				**Y**				**Y**				**Y**			**-**	**-**	**-**	**5**
Waimeha Stream	1									1									***8***	2
Waimeha Combined	**Y**									**Y**							**-**	**-**	**-**	**2**
Waikanae River	10	1					3			9			3		2		***1***		***8***	6
Muaupoko Stream	3	1								2				8			***23***		***9***	4
Mazengarb Drain @ Waste Water	61	15								1									***13***	3
Mazengarb Drain	3	2								11									***18***	3
Waikanae Combined	**Y**	**Y**					**Y**			**Y**			**Y**	**Y**	**Y**		**-**	**-**	**-**	**7**
Wharemauku Stream	2	16					2			5									***6***	4
Drain 7 Upper	5	3					14										***33***	***1***	***4***	3
Drain 7 Lower																		***3***		0
Wharemauku Combined	**Y**	**Y**					**Y**			**Y**							**-**	**-**	**-**	**4**
Whareroa Drain	1	4																***1***	***2***	2
Whareroa Combined	**Y**	**Y**																		**2**
All Catchments Combined	**Y**	**Y**				**Y**	**Y**			**Y**			**Y**	**Y**	**Y**		**-**	**-**	**-**	**8**

Table 21. Fish sampled within survey sites (BML 2010 classified as 'at risk' or 'declining)'.

Site Name	Threatened fish species (Alibone et al 2010
Hadfield Kowhai Stream	long fin eel
Paetawa Drain	Banded kokopu, long fin eel,
Kakariki Stream	long fin eel, giant kokopu*
Ngarara Creek	long fin eel
Waikanae River	long fin eel, red fin bully
Muaupoko Stream	long fin eel
Mazengarb (WWTP	long fin eel
Mazengarb Drain	long fin eel
Wharemauku Stream	long fin eel
Lower Drain 7	long fin eel, Inanga,
Whareroa Drain	long fin eel,
Whareroa Tributary	long fin eel,

"At Risk" (Townsend et al 2008 "Declining" (Alibone et al 2010 * based on a survey undertaken by DOC,1999.)

ANNEXURE C: FRESHWATER MITIGATION: LOCATION OF WATERWAYS IN WHICH ENHANCEMENTS AND OTHER MITIGATION ACTIONS ARE PROPOSED TO OCCUR



Feature	Map Code	Diversion length (m)	Waterway Enhancement length (m)
Upper drain 7	1W		327
Lower Drain 7	2D		452
Mazengarb WWT Drain	3D & 3W	293	148
Mauapoko Stream	4D & 4W	31	44
Kakariki Stream	5W		1010
Smithfield Drain	5D	1373	
Paetawa Trib	6D & 6W	54	171
Hadfield/Kowhai & Paetawa Drains	7D & 7W	1220	154
Sub Totals		*2971*	*2306*
Total		*5277*	

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NZ TRANSPORT AGENCY WAKA KOTAHI

Mackays to Peka Peka

PROPOSED ECOLOGICAL FRESHWATER MITIGATION

ANNEXURE C-1

Feature	Map Code	Diversion length (m)	Waterway Enhancement length (m)
Upper drain 7	1W		327
Lower Drain 7	2D		452
Mazengarb WWT Drain	3D & 3W	293	148
Mauapoko Stream	4D & 4W	31	44
Kakariki Stream	5W		1010
Smithfield Drain	5D	1373	
Paetawa Trib	6D & 6W	54	171
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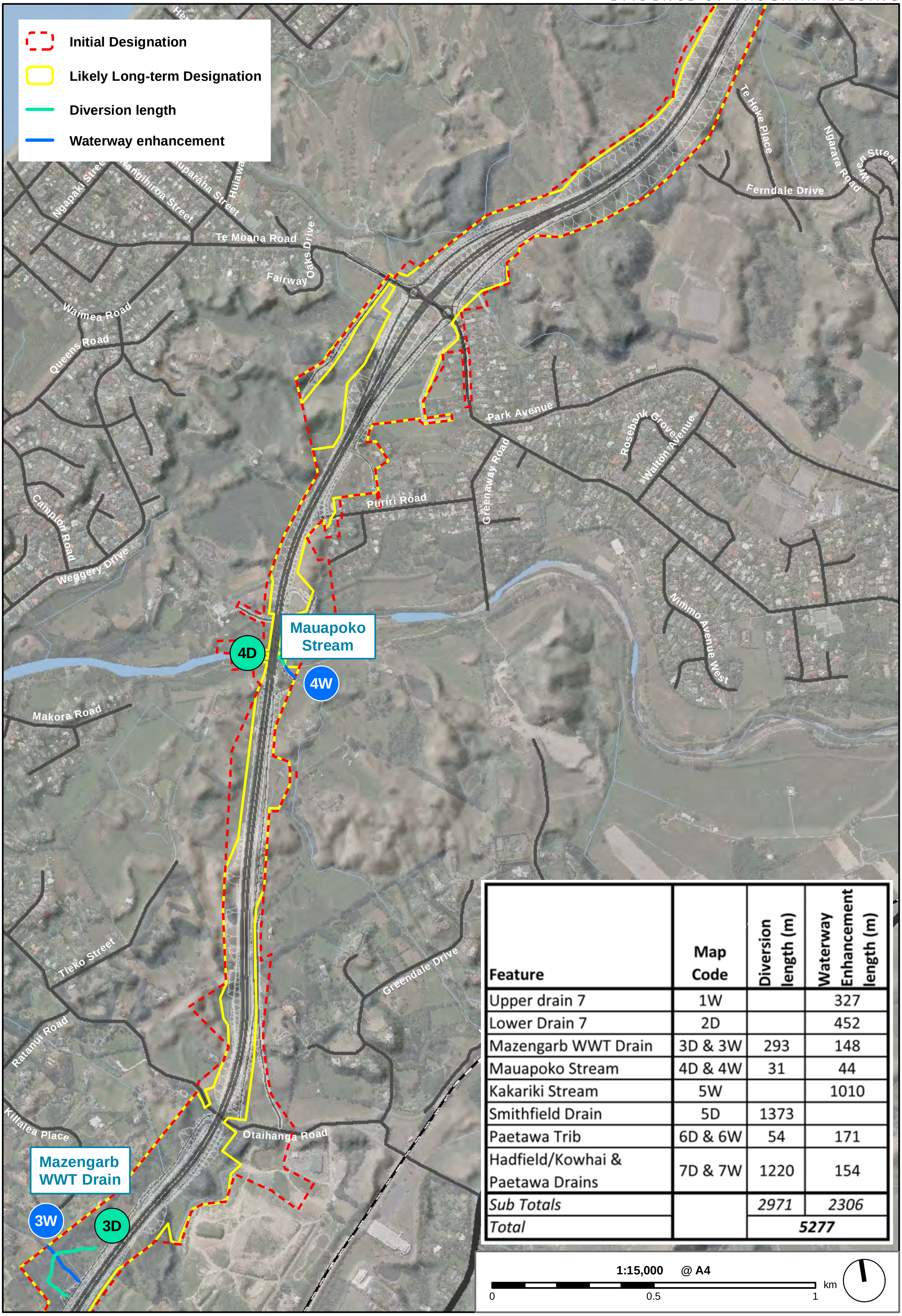
NZ TRANSPORT AGENCY

Mackays to Peka Peka

PROPOSED ECOLOGICAL FRESHWATER MITIGATION

ANNEXURE C-2



Feature	Map Code	Diversion length (m)	Waterway Enhancement length (m)
Upper drain 7	1W		327
Lower Drain 7	2D		452
Mazengarb WWT Drain	3D & 3W	293	148
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Paetawa Trib	6D & 6W	54	171
Hadfield/Kowhai & Paetawa Drains	7D & 7W	1220	154
Sub Totals		*2971*	*2306*
Total		***5277***	

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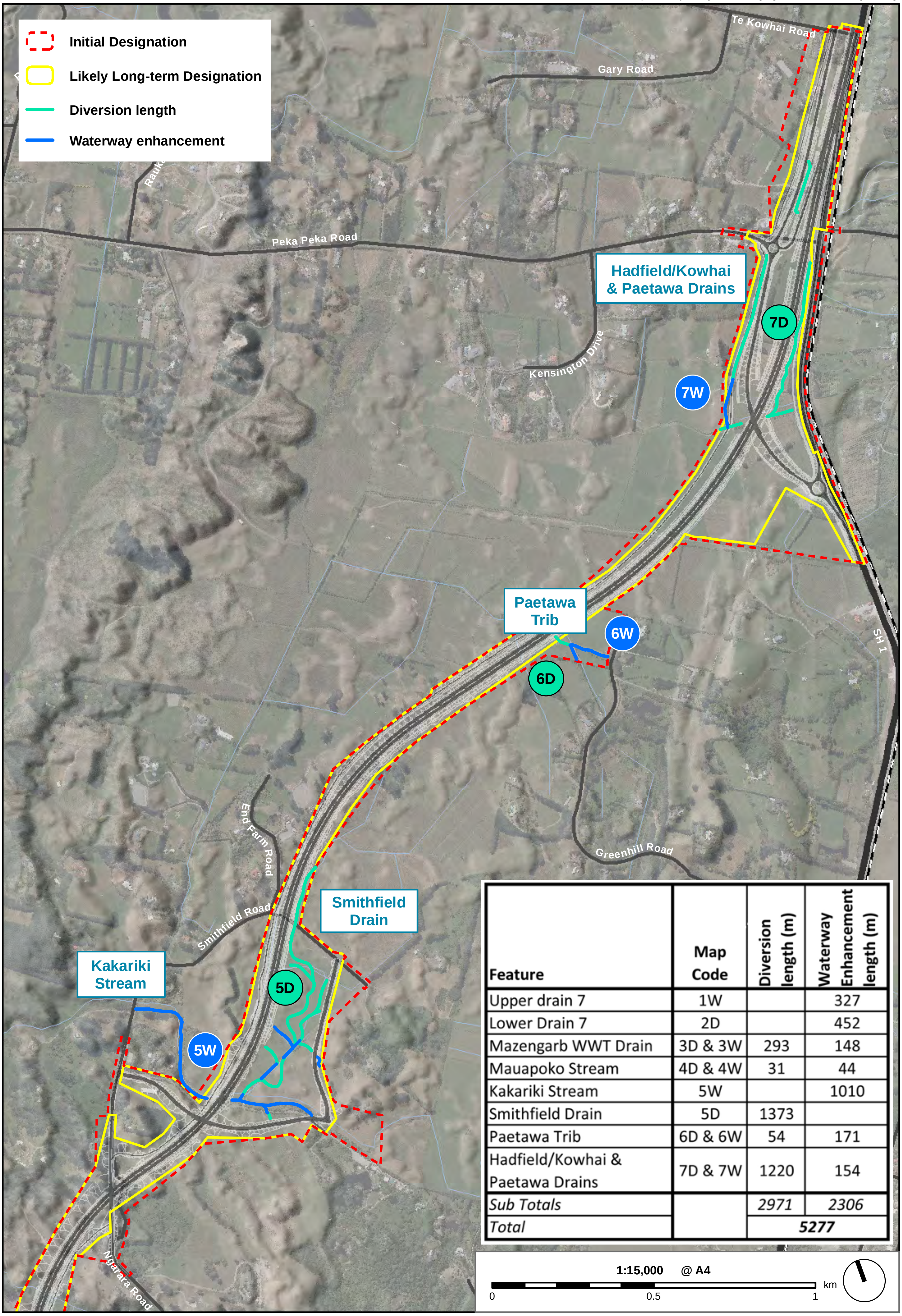
PROPOSED ECOLOGICAL FRESHWATER MITIGATION

ANNEXURE C-3



Feature	Map Code	Diversion length (m)	Waterway Enhancement length (m)
Upper drain 7	1W		327
Lower Drain 7	2D		452
Mazengarb WWT Drain	3D & 3W	293	148
Mauapoko Stream	4D & 4W	31	44
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Paetawa Trib	6D & 6W	54	171
Hadfield/Kowhai & Paetawa Drains	7D & 7W	1220	154
Sub Totals		*2971*	*2306*
Total		***5277***	

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NZ TRANSPORT AGENCY
Mackays to Peka Peka

PROPOSED ECOLOGICAL FRESHWATER MITIGATION

ANNEXURE C-4

ANNEXURE D: PROPOSED ECOLOGICAL BASELINE MONITORING PLAN AND RATIONALE BEHIND THE MONITORING REQUIRED

MACKAYS TO PEKA PEKA EXPRESSWAY
BASELINE ECOLOGICAL MONITORING PLAN

Summary of Past Sampling Effort,
Requirements for Additional Baseline Monitoring (aquatic and marine)

DRAFT FOR DISCUSSION

Submitted to
MacKays to Peka Peka (M2PP) Alliance

By
Boffa Miskell Ltd

Report Number W09181E
August 2012

1 INTRODUCTION

This baseline ecological sampling plan has been prepared in anticipation of Resource Consent approvals for the MacKays to Peka Peka State Highway Project (the Project). An application for consents has been lodged with the Environmental Protection Authority (*EPA*) for this project; however a decision on the application will not be received before the beginning of 2013. Due to the very short time frames between receipt of consent (if granted) and programmed commencement of construction, there is an imperative to commence baseline sampling this winter so that several seasons of data can be collected before construction starts.

We note that comprehensive aquatic and marine studies were carried out in all water bodies as part of the assessment of ecological effects for this Project (Boffa Miskell 2012) and (Boffa Miskell 2012). The locations of sampling sites, a summary of sampling results are presented in Section 2 of this report. Details of the methods used form Section 3.

We believe this earlier work is sufficient as a baseline for construction or post construction monitoring that may be required in most but not all waterways. For some water bodies analysis of the data and our understanding of stream and river values suggest that additional baseline sampling will be needed. This sampling is required to target construction monitoring of specific effects on high value systems and to measure recovery of certain ecological systems. Section 4 describes the additional sampling that is required to compile a robust baseline data set for construction and post construction monitoring.

In summary the objectives of the baseline sampling are:

- To accurately describe existing in-stream biota and habitat quality, so that any changes during and at the completion of construction can be identified and appropriate strategies put in place to remedy or mitigate adverse effects.
- To establish both impact and control sites in appropriate locations so that it is possible to determine whether any recorded changes to water quality, in-stream biota, or habitat quality are attributable to this Project or are the result of other activities within the affected catchments.

2 SAMPLING CARRIED OUT FOR THE AEE

Development of an assessment of ecological effects for the Project involved ecological investigations of all the perennial streams and drains that will be crossed by the project and the major coastal outlets. All sampling was carried out as per the methods provided in the following sections. Except where identified all sampling was carried out at the location where the proposed Project alignment crosses the waterway (culvert or bridge), or at the catchment coastal discharge points. The sample site locations and details are as follows.

Table 1 Detail of each sampled waterway (listed north to south)

	Northing (NZTM)	Easting (NZTM)	Altitude a s l (m)	Distance from coast (m)	Catchment area (ha)	Total length of waterway (m)
Kowhai Stream Catchment						
1. Hadfield Kowhai Stream	1750515	405017	8	3,100	330	2,000
Waimeha Stream Catchment						
2. Paetawa Drain	1750050	405351	8	2,900	148	1,500
3. Smithfield Drain	1750602	405340	6	1,700	32	640
4. Kakariki Stream	1750249	405141	7	2,040	1,192	6,500
5. Ngarara Creek	1750249	405141	7	1,540	164	900
6. Waimeha Stream	1752040	405204	2	1,300	218	2,200
Waikanae River Catchment						
7. Waikanae River	1750139	405239	2	1,900	13,005	12,000
8. Otaihanga Wetlands	1750116	405331	7	1,967	4	na
9. Muaupoko Stream	1750139	405241	2	2,020	-	5,100
10. Mazengarb (WWTP)	175010	405341	6	2,430	17	600
11. Mazengarb Stream	1755351	405351	6	2,650	378	4,560
Wharemauku Stream Catchment						
12. Wharemauku	1745933	405452	3	2,450	1,008	6,400
13. Drain 7 Lower	1745927	405506	3	2,020	151	2,000
14. Drain 7 Upper	1745928	405506	5	1,420	44	890
Whareroa Stream Catchment						
15. Whareroa Drain	1745908	405642	6	3,200	179	450
16. Whareroa Trib (Waterfall Rd)	1745913	405719	14	2,500	179	2,600
Whareroa Stream Catchment						
17. Waimeha Stream Mouth	-	-	0	0	1,754	-
18. Waikanae Estuary	-	-	0	0	13,400	-
19. Wharemauku Stream Mouth	-	-	0	0	1,203	-

Sampling type used in each waterway is presented in the Table 2.

Table 2: Sampling methods used in each water body.

Name	SEV	PHA	EFM	Macro-invertebrates	Sediment Sampling	Water Quality Sampling	Other (photo, site visit
Hadfield Drain Catchment							
Hadfield Drain	✓	✓	✓	✓	✓	✓	✓
Waimeha Stream Catchment							
Paetawa Stream	✓	✓	✓	✓			✓
Smithfield Drain	✓	✓	✓	✓			✓
Kakariki	✓	✓	✓	✓	✓	✓	✓
Ngarara Drain	✓	✓	✓	✓			✓
Waimeha Stream	✓	✓	✓	✓	✓	✓	✓
Waikanae River Catchment							
Waikanae River	✓	✓	✓	✓	✓	✓	✓
Waikanae River Upper *		✓				✓	
Muaupoko Stream	✓	✓	✓	✓			✓
Mazengarb (WWTP)	✓	✓	✓	✓			✓
Mazengarb Stream	✓	✓	✓	✓	✓	✓	✓
Wharemauku Stream Catchment							
Wharemauku	✓	✓	✓	✓	✓	✓	✓
Drain 7 Wharemauku	✓	✓	✓	✓		✓	✓
Upper Drain 7	✓	✓	✓	✓			✓
Whareroa Stream Catchment							
Whareroa Drain	✓	✓	✓	✓			✓
Whareroa Trib	✓	✓	✓	✓			✓
Wetlands							
Otaihanga Wetlands*			✓				Mudfish
Raumati Manuka Wetland*							Mudfish
River Mouth and Estuary							
Waimeha Stream Mouth (Ngarara Estuary)		✓		✓	✓		✓
Waikanae Estuary		✓		✓	✓		✓
Wharemauku Stream Mouth		✓		✓	✓		✓

* Sampling not within project footprint

In summary:

- 16 sites fished by EFM[1];
- Mud fish traps set at 2 wetlands, over 7 nights;
- 15 sites sampled for aquatic macro invertebrates;
- 15 full SEV protocol sample sites;
- 8 sites sampled for baseline water quality and sediment;
- 6 sites sampled for storm water contaminants in first flush rainfall events.

The results of this sampling is summarised in Section 3.

[1] Electric Fishing Machine

D R A F T

2.1 METHODOLOGIES USED TO DATE

The following sampling methods were used for the Ecological Impact Assessment for the Project (i.e. MacKays to Peka Peka Expressway Technical Reports 26 & 30). For a number of streams the data collected is proposed to form part of the baseline data for construction and post construction monitoring.

2.1.1 RIVER ENVIRONMENT CLASSIFICATION (REC)

The REC (NIWA 2004) database was used to measure the different lengths of each streams and to determine the REC class within affected sections of each of the waterways. Since the REC system does not recognise first order streams, the LINZ GIS data set (NZMS 260 TOPO maps) was used to generate an additional class of first order intermittent/ephemeral streams.

Water sheds (catchment) were defined using GIS and topography layers and were divided into the various sub-catchment and catchment areas. The catchment sizes were calculated and these sizes assisted in determining requirements for fish passage. For this site, catchments greater than $10km^2$ are generally considered large enough to maintain flows that sustain fish.

2.1.2 SEV – HABITAT DESCRIPTIONS

Stream Ecological Valuation (SEV) was carried out according to the revised methodology (Version 10) issued by NIWA on November 2011 (Storey et al, 2011). The data that was collected was analysed using the supplied SEV worksheets (Version 2.1, 2011).

Both field sampling and data analysis were carried out by BML Staff who have completed Wellington Regional Councils SEV training course.

The SEV system was applied to assist the valuation of the water bodies along the proposed alignment. At each of the 15 SEV sample sites listed in Table 1, a range of physical habitat characteristics were recorded using standard SEV field sheets. These characteristics included width, depth, velocity, and clarity of the stream, substrate composition, riparian vegetation and shade, temperature, dissolved oxygen, pH, and conductivity.

This data was combined with the other biological criteria (presence/absence of fish species etc) and analysed using the SEV Worksheets (V.9 Updated December, 2009).

The SEV analysis requires reference streams. A reference stream is a stream of a type that is representative of the area, and which is in pristine or near pristine condition, i.e. with values that are not influenced by human occupation and land use. In the absence of real stream examples, the SEV tool allows for the generation of a hypothetical stream with natural meander, regenerating native riparian cover with natural substrate for the area, and which shows what the potential for the 'real' sites and what measure they should be to be considered "fully" functional.

All waterways within the study area are highly modified and none were suitable. After a review of potential reference sites on the Kāpiti Coast and discussions with the Department of Conservation (DOC), Greater wellington Regional Council (GWRC) and Kapiti Coast District Council (KCDC) staff it was decided that the model reference sites provided with the SEV workbook were not sufficiently representative of the channels waterbodies within the study area and could not be used. The decision was made to modify the SEV from the Kakariki Stream (which scored well in some metrics) to improve some of the scores including riparian habitat.

Data was analysed in accordance with the methods described in the SEV manual (Rowe et.al. 2008). The latest version of the SEV calculator was used (designated as Version 8.2, dated 23 December, 2009)

2.1.3 FRESHWATER FISH

Mudfish

Mudfish were surveyed independently by a recent graduate, at two potentially affected wetlands (the Raumati Manuka Wetland and Otaihanga Landfill wetlands). 4 mm mesh Gee minnow traps were used as described in mudfish monitoring methodology (Ling et al. 2009)). This monitoring technique gives qualitative information on mudfish within a wetland.

In the Raumati Manuka wetland the traps were set for three nights, from the 6th to 9th of December, while at Otaihanga they were set for five nights, on the 9th, 13th, 20th, 21st, 22nd of December

Freshwater fish

EFM sampling was carried out by NIWA certified operators using a Kainga 300 backpack electro-fishing machine using the following methodology:

1) A suitable sample reach was selected. Sampling began at the downstream end of the reach and proceeded upstream;
2) Sampling at each study reach consisted of 10 runs targeting habitat and cover features. Habitat and cover features included riffles, logs and dams of loose debris, overhanging and trailing vegetation, beds of aquatic plants, bank undercuts, and boulders;
3) Each run was typically 5 m in length and the width of the stream. If the stream was more than 1.5 metres wide it was fished in two parallel runs;
4) Fishing was multiple pass depletion fishing, with a minimum of four passes, continuing until no fish were caught;
5) Fish from each run were captured by scoop net and downstream stop net and transferred to buckets. They were then be counted, identified, their length measured, and returned to their habitats, once EFM fishing of that reach was complete; and
6) Once a run had been finished, the samplers moved upstream to the next run and repeated steps C to E. Each run was separated by at least 5-6 metres of un-fished stream.

Extent of EFM fish sampling

Stream Name	Metres fished (+/- 10m)
Upper Drain 7	165 m
Lower Drain 7	170m
Wharemauku Stream	260m
Mazengarb Stream	130m
Mazengarb at WWTP	85m
Muaupokau	160m
Waikanae	200m
Waimeha	260m
Ngarara Drain	170m
Kakariki	195m

Stream Name	Metres fished (+/- 10m)
Smithfield Drain	185m
Paetawa Stream	180m
Hadfield Kowhai	105m

We note that other fishing methods, especially night spot-lighting and baited trapping are often used to ensure a full range of species are caught. We did not use any other method because we considered the effort and catch results were sufficiently representative of the fauna present to support an assessment of effects. The sampling returned 11 of the 15 historic species (recorded in the freshwater fish database post 1990). Those species not observed during this sampling were typically found in more cobbled streams or faster flowing waters (Crans bully, torrent fish) at higher altitude, or were species typically found closer to the coast than the Project alignment (e.g. mullet). Those fish of higher catchment position not caught, but in the historic records were “rare” occurrences, i.e. short jaw kokopu, giant kokopu, giant bully and lamprey.

The significance of individual species was assessed using the conservation threat status for indigenous freshwater fish (Allibone et al. 2010) and by evaluating their occurrence in the Wellington Region using data from the New Zealand Freshwater Fish Database (NIWA n.d.)

The value of the fish communities was assessed by comparison with other streams in the region and is summarized in Table 3. This included evaluation using IBI, (the Fish Index of Biological Integrity (Joy 2005) and classification following the regional ranking system of Strickland and Quarterman (2001) set out in Table 4.

Table 3 Attributes and Integrity Classes for the Wellington IBI (after Joy, 2005)

Total IBI score	Integrity class	Attributes
50 – 60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present. Site is above the 97th percentile.
42 - 49	Very good	Site is above the 90th percentile of all Wellington sites species richness is slightly less than best for the region.
36 - 41	Good	Site is above the 70th percentile of Wellington sites but species richness and habitat or migratory access reduced some signs of stress.
28 - 35	Fair	Score is just above average but species richness is significantly reduced habitat and or access impaired.
18 - 27	Poor	Site is less than average for Wellington region IBI scores, less than the 50th percentile, thus species richness and or habitat are severely impacted.
6 - 17	Very poor	Site is impacted or migratory access almost non existent
0	No fish	Site is grossly impacted or access non existent

Figure 1 The distribution of IBI scores across the 600 sites used to calibrate the IBI in the Wellington region (from Joy, 2005)

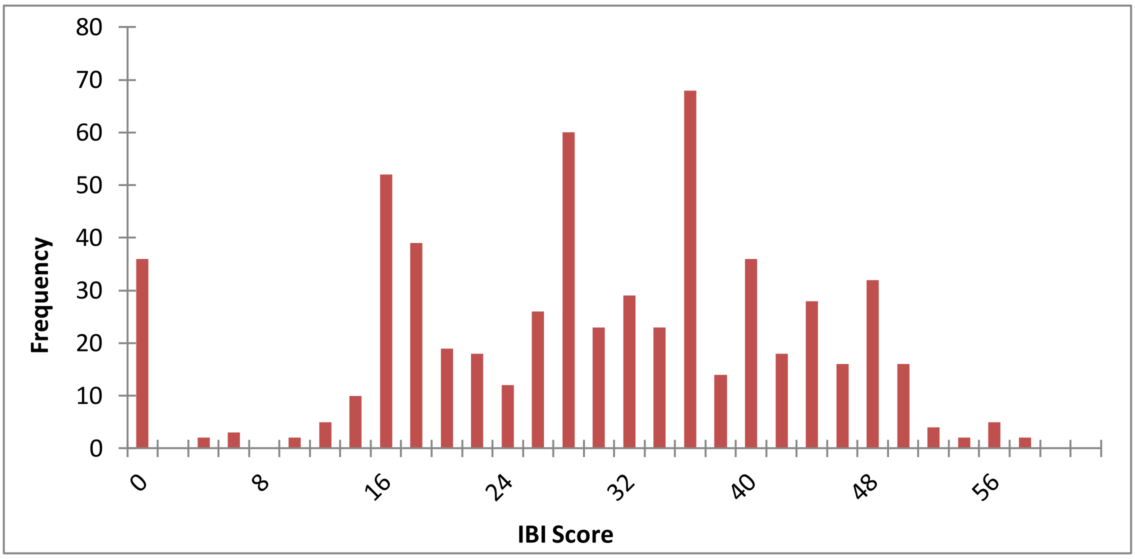


Table 4 Stream Reach Importance rankings for fish in the Wellington Region. (Modified from Strickland and Quarterman 2001).

Ranking	Description	Criteria
Very important	Outstanding value. Both high conservation value AND high diversity.	Supports at least one acutely threatened species; OR at least one chronically threatened plus two at risk species; AND more than five native migratory fish.
Important	High value. Either high conservation value OR high diversity.	Supports at least one acutely threatened species; OR at least one chronically threatened plus two at risk species; OR more than five native migratory fish.
NE	Non-exceptional conservation or diversity values.	No acutely threatened species; less than one chronically threatened plus two at risk species; five or fewer native migratory fish.

2.1.4 AQUATIC MACROINVERTEBRATES

Communities were sampled using the MfE sampling protocol 'C2' (soft-bottomed, semi-quantitative). This involved the use of a 0.5 mm kick net, using the national standard kick-sampling protocol 'C2' described by Stark *et al* (2001). Species were identified to the lowest possible taxa (sufficient for MCI allocation) and abundances were recorded as quantitative sampling as per Stark 1998 (Protocol P3).

Samples were forwarded to a lab (Ryder Consulting) for identification. Species were identified to MCI level and abundance records were full count (Method P3).

The results for each sample sites three replicates were both averaged to give mean values and confidence intervals, and pooled to give total taxa counts and abundances for the sample site.

The following six invertebrate indices were calculated for each replicate at each site and averaged. These biotic indices use the tolerances of New Zealand macroinvertebrate taxa to assess water quality and the health of aquatic habitats.

- Total abundance;
- Taxa Richness;
- EPT taxa;
- EPT abundance;
- Macroinvertebrate Community Index (MCI); and
- Quantitative MCI (QMCI).

2.1.5 WATER QUALITY

During the collection of the SEV and Physical Habitat (PHA) data, basic water quality measurements, pH, dissolved oxygen, turbidity, temperature and total suspended solids (TSS) were recorded in the field by BML. During ecological investigations, BML used a TPS 90FLT Field Lab Multimeter and an Insite IG3150 to carry out basic water quality parameters.

Environmental Laboratory Services (ELS) also undertook an extensive water and sediment quality study in eight streams which is analysed and described in the Baseline Water and Sediment Quality Investigation (BECA, 2011). Table 5 summarises the sampling protocol and regime which was developed in consultation with BML ecologists.

An attempt was made to carryout water quality sampling at the same locations sampled by the ecological investigations. For various reasons this could not always be achieved, however, these differences were not considered to affect the ecological findings or assessment.

Table 5 Summary of water quality data collected and purpose

Purpose	Method	Parameters	Comments
Baseline Sediment Sampling	Grab sampling and lab analysis	Heavy metals, nutrients, hydrocarbons	Assess current fine sediment quantities in stream substrate
Baseline water quality	Wet and dry weather grab samples (2 rounds)	Field parameters, visual observations, heavy metals, nutrients, hydrocarbons (lab analysis)	To provide an overall picture of water quality for the different streams to be used as a baseline for assessing effects.
Water quality during rain events	Grab sampling and lab analysis	Total suspended sediment, turbidity, selected heavy metals	To determine water quality of selected streams during rain events – to determine contaminants released during first flush of a rainfall following a dry period.

2.1.6 MARINE SAMPLING

Intertidal estuarine sampling was based on the Estuarine Environmental Assessment and Monitoring National Protocol (Cawthron Institute 2002). A total of four sites were surveyed comprising: one site at the Waimeha Stream mouth (Ngarara Estuary), two sites (north and south) at the Waikanae Estuary, and one site at the Wharemauku Stream mouth. Sampling and assessment of the sites were undertaken on 31st May and 1st June 2011, during fine weather conditions and within two hours either side of low tide (approximately 15:20 pm on 31st May 2011 and 15:56 pm on 1st June 2011).

At each of the Waimeha, Waikanae North and Wharemauku sites, a 50 m x 30 m grid (subdivided into 10 15 m x 10 m smaller grids, identified as A to J) was established using GIS prior to entering the field. The 10 smaller grids (A to J) were then subdivided into six 5 m x 5 m grids (identified as 1 to 6). Sampling was undertaken at one of the randomly selected 5 m x 5 m grids (1 to 6) within each 15 m x 10 m grid (A to J) (Figure 2).

The following analyses were undertaken for each of these sites:

- To assess infaunal abundance and diversity a sediment core (haphazardly placed) was collected from each site using a 13 cm diameter × 10 cm deep (area = 1,327 cm^3) PVC tube. The tube had a tapered leading edge and a metal handle on the top to facilitate penetration. Individual tubes were manually driven into the sediment, removed with core intact and the contents bagged. Samples were processed at each site by washing the contents of each sample through a 0.5 mm sieve using seawater from the estuaries. All material retained on the sieve were carefully removed and placed into a labelled plastic container, preserved in 60-70% ethanol. Cawthron Institute invertebrate experts processed the samples, extracting and identifying the macrofauna present.
- A 0.50 m x 0.50 m (0.25 m^2) quadrat was used to sample epifauna (surface dwelling) and macroalgae. The quadrat was haphazardly placed at each site approximately 0.5 m from which cores were taken. All organisms occurring within the quadrat were identified to species level and counted. Macroalgal cover was estimated on the basis that a 5 x 5 cm area equates to 1 % cover. Crab/worm holes at the sediment surface were also counted.
- A redox discontinuity layer (RDL) sample was collected to assess the sediment anoxic layer at each site. A 60 mm diameter PVC cylinder was driven into the sediment to a depth of 8-10 cm and capped before extracting the cylinder. After collection, the core was cut in half lengthways and the depth of the start of the anoxic sediment layer measured using a 30 cm ruler where present (generally visible as a dark black (anoxic) zone, relative to lighter oxygenated sediment).
- A surface sediment (top 2 cm) sample was collected for contaminant and sediment grain size analyses. Using a garden trowel, the sediment samples from grids A to E (shown on Figure 2) were combined to form a composite sample, as were samples from F to J. The two composite samples were each divided in half, with one half of each being sent to Hill Laboratories for analysis of copper, lead, zinc, high molecular weight polycyclic aromatic hydrocarbons (HMW PAHs), and total organic carbon (TOC) and the other half sent to Cawthron Institute for sediment grain size analyses.

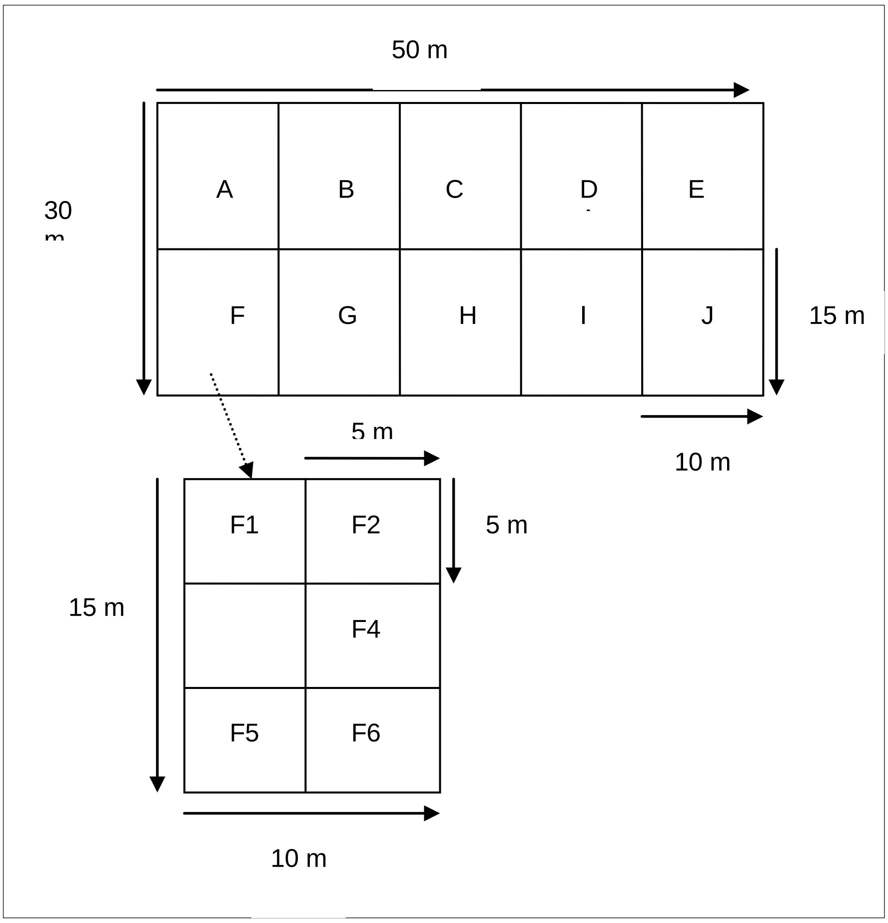


Figure 2: Schematic showing intertidal experimental design.

3 SUMMARY OF RESULTS

A summary of all biological data collected using the methods described above is provided in the following tables and figures. This data has been developed into summary sheets describing each of the waterways under consideration and these can be found in **Attachment 2**.

These data are used in Section 4 to determine which streams will require construction and post construction monitoring, and to then determine if additional baseline sampling is required.

Table 6 summarises the origins and current terrestrial vegetation surrounding each waterway, and whether the channel undergoes regular maintenance. Maintenance typically involved the removal of build-ups of stream macrophytes (monkey musk, water cress, buttercup, willow weed, blackberry) from the stream bed and margins by excavator, and / or mowing of the stream margins. It also reports the aquatic habitat value conclusion from Technical Report 30. However, that value in Table 6 (below) represents the revised value reported in the evidence of Dr Keesing (EPA Project Board of Inquiry Hearing).

Table 6 Habitats and maintenance - Freshwater

Score	Origin	Riparian	Managed (KCDC / GWRC/ Landowner)	Relative Value
Hadfield Drain / Kowhai Stream	Formed drain	Pasture, weedland, pine	None apparent	M
Paetawa Stream	Formed drain	Pasture, weedland	Occasional maintenance by landowners	L
Smithfield Drain	Formed drain	Pasture	KCDC in upper section, landowner in lower	L
Kakariki Stream	Natural stream (channelised)	Revegetation (Part)	None apparent	M
Ngarara Creek	Formed drain	Pasture, weedland, macrocarpa treeland	Annual maintenance by landowner	L
Waimeha Stream	Natural stream (channelised)	Urban, pasture, weedland	Twice annual excavation (GWRC)	L
Waikanae River	River (channelised)	Willow, revegetation	Flood works, willow & riprap (GWRC)	VH
Muaupoko Stream	Natural stream	Revegetation	None	M
Mazengarb (WWTP) Drain	Formed drain	Weedland (blackberry)	Occasional excavation (KCDC)	L
Mazengarb Stream	Natural stream (channelised)	Pine over weeds	Downstream of sample site (KCDC)	L
Wharemauku Stream	Natural stream (channelised)	Grassland and water weeds (mown)	Mown (KCDC)	M
Drain 7 Lower	Formed drain	Pasture / willows	Twice annual excavation	L
Drain 7 Upper	Formed drain	Weedland / willows	Twice annual excavation	VL
Whareroa Drain	Formed drain	Pasture	Excavation as required (GWRC/Landowner)	VL
Whareroa Stream Tributary (Waterfall Road)	Stream	Pasture	None apparent	H

Table 7 below summarises the scores derived for each waterway over the seven key metrics that were considered in the assessment of effects. Table 8 then presents the same data but as a percentage of the reference site value; or as a percentage of the Regional mean (Joy 2005) and (GWRC 2008).

Table 7 Sampling scores (key metrics for stream assessment)

Score	Physical Habitat	SEV Score	FISH IBI	Richness	% EPT Abundance	MCI	QMCI
Hadfield Drain	0.41	0.40	18	24	17%	87	4.6
Paetawa	0.16	0.49	30	15	20%	88	4.4
Smithfield Drain	0.32	0.38	16	18	6%	70	2.7
Kakariki	0.26	0.45	37	19	21%	77	4.5
Ngarara Drain	0.35	0.29	16	11	9%	75	4.3
Waimeha	0.30	0.34	14	15	13%	78	4.7
Waikanae	0.57	0.66	40	34	53%	116	6.4
Muaupoko Stream	0.38	0.48	32	24	25%	88	4.2
Mazengarb (WWTP)	0.49	0.39	22	5	0%	41	1.7
Mazengarb Stream	0.48	0.37	22	12	8%	68	4.5
Wharemauku	0.26	0.44	28	31	26%	90	3.7
Drain 7 Lower	0.27	0.36	22	9	11%	60	3.0
Drain 7 Upper	0.06	0.30	16	11	9%	73	2.5
Whareroa Drain	0.07	0.28	16	13	15%	81	3.7
Whareroa Stream	0.41	0.54	36	30	30%	96	4.3
Reference Site / Regional Mean	0.86	0.78	28	20	43%	-	-

Table 8 Scores as % of reference site or regional mean (key metrics for stream assessment)

% of Reference / Regional Mean	Physical Habitat	SEV Score	FISH IBI	Richness	% EPT Abundance	MCI	QMCI
Hadfield Drain	(48%)	(50%)	(64%)	(120%)	(39%)	(82%)	(83%)
Paetawa	(19%)	(63%)	(107%)	(75%)	(46%)	(83%)	(79%)
Smithfield Drain	(37%)	(49%)	(57%)	(90%)	(13%)	(66%)	(48%)
Kakariki	(30%)	(58%)	(132%)	(95%)	(49%)	(73%)	(82%)
Ngarara Drain	(41%)	(37%)	(57%)	(55%)	(21%)	(71%)	(77%)
Waimeha	(35%)	(44%)	(50%)	(75%)	(31%)	(73%)	(85%)
Waikanae	(66%)	(85%)	(143%)	(170%)	(123%)	(110%)	(115%)
Muaupoko Stream	(44%)	(61%)	(114%)	(120%)	(58%)	(83%)	(75%)
Mazengarb (WWTP)	(57%)	(50%)	(79%)	(25%)	(0%)	(38%)	(30%)
Mazengarb Stream	(56%)	(48%)	(79%)	(60%)	(19%)	(64%)	(80%)
Wharemauku	(30%)	(56%)	(100%)	(155%)	(60%)	(85%)	(67%)
Drain 7 Lower	(31%)	(46%)	(79%)	(45%)	(26%)	(56%)	(53%)
Drain 7 Upper	(7%)	(39%)	(57%)	(55%)	(21%)	(68%)	(45%)
Whareroa Drain	(8%)	(36%)	(57%)	(65%)	(36%)	(76%)	(66%)
Whareroa Stream	(48%)	(69%)	(129%)	(150%)	(69%)	(90%)	(78%)
As a proportion of:	*Reference Site*	*Reference Site*	*Regional Mean*	*Regional Mean*	*Regional Mean*	*Regional Mean*	*Regional Mean*

Figure 3 presents the community composition of macroinvertebrates in each waterway as a percentage of abundance within each taxonomic group. Figure 4 presents community composition as the percentage of taxa present within each taxonomic group. Both provide insights into the health of the waterways.

Figure 3 Macroinvertebrate community composition (% abundance) at each sampled site.

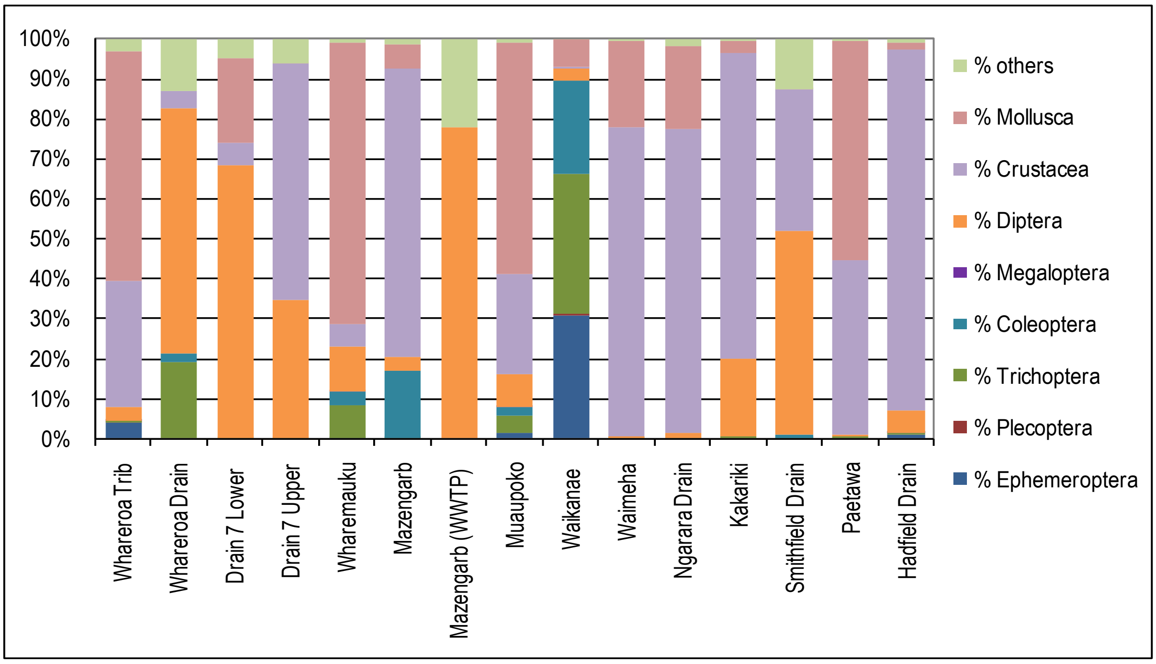
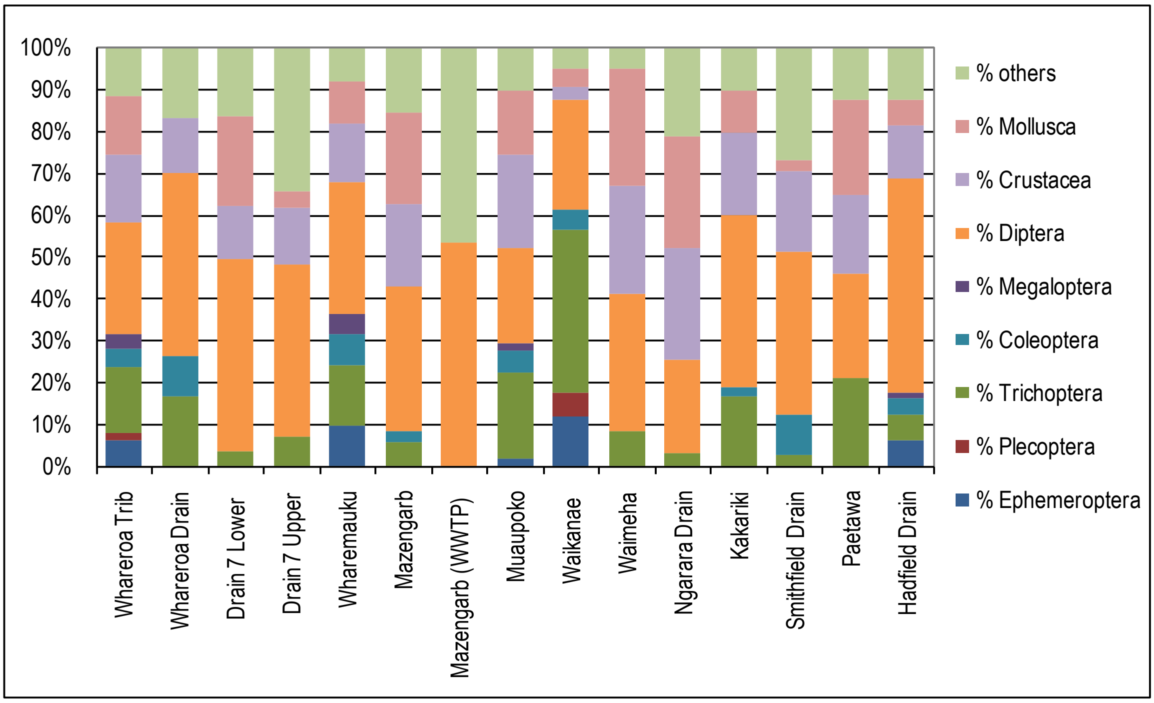


Figure 4 Macroinvertebrate community composition (% Taxa) at each sampled site.



The most highly represented taxa in terms of abundance across all sites (with the exception of the Waikanae River) are Crustacea and Mollusca, and in particular *Paricalliope* which have no MCI value, and *Potomopyrgus* with an MCI value of 2.1. Diptera (midge larvae) dominate in some waterways. Only the Waikanae River had a varied assemblage with EPT fauna, in particular Trichoptera and Ephemeroptera making up the greater proportion of the species within the samples.

3.2 ESTUARIES & STREAM MOUTHS

Three marine environments were sampled. All of the three marine habitats studied had high ecological values, although the Waikanae Estuary was markedly different in a number of respects.

The Waimeha and Wharemauku Streams discharge to high energy, open sandy beaches, affording significant and rapid dilution and removal of any sediment and stormwater discharges.

The Waikanae Estuary is lower energy and has more potential to accumulate sediment and associated contaminants. Therefore, it is particularly important to ensure that construction and operational phase stormwater discharged to the Waikanae River from the Project is treated to a high standard to protect the ecological values of the estuary and the adjacent marine reserve.

A summary of key metrics is provided in the following figures.

Figure 5: Proportion of average abundance of dominant intertidal taxa.

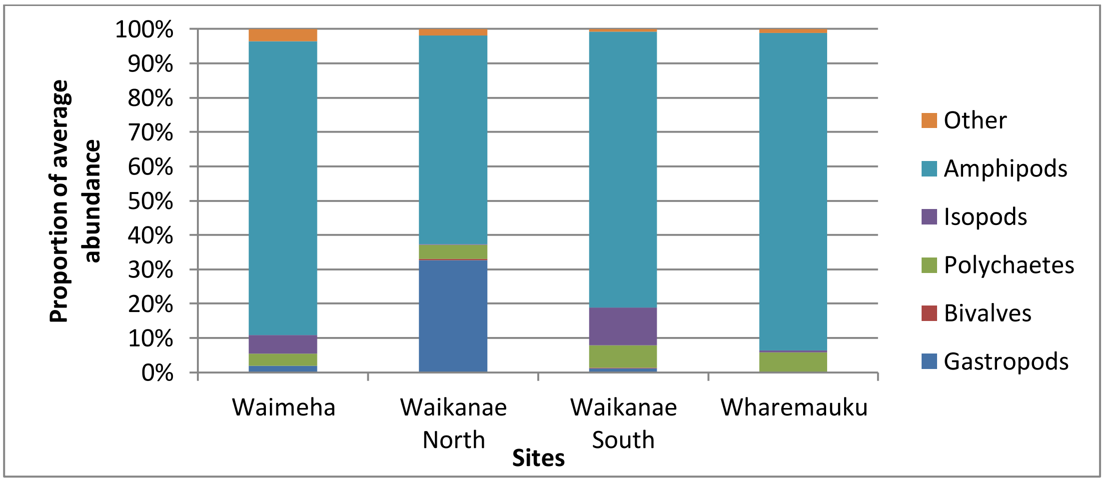


Figure 6: Average abundance of dominant intertidal taxa.

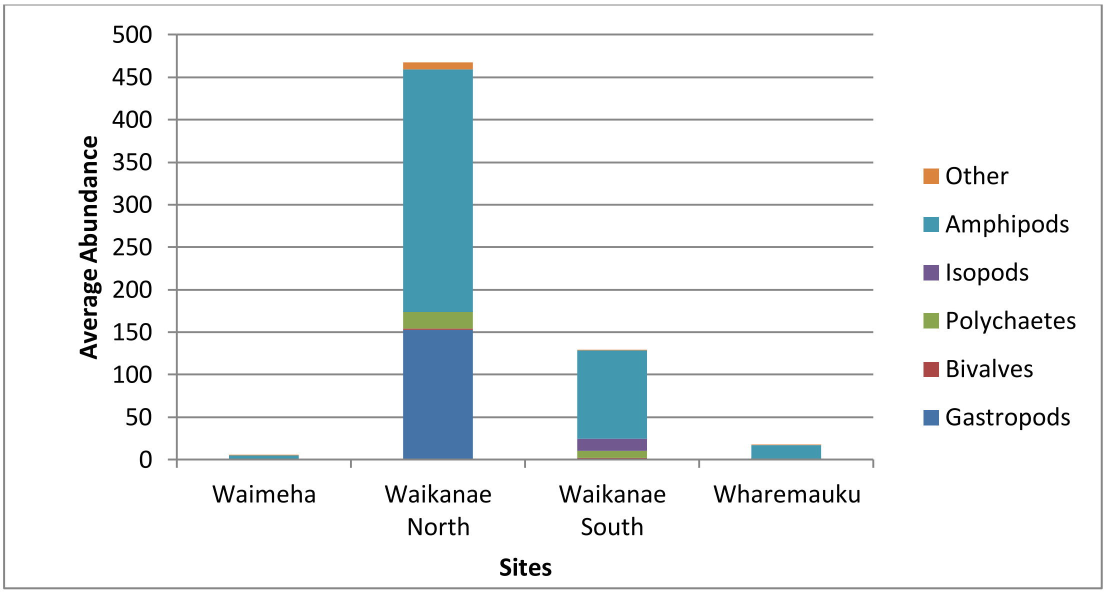


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Figure 7: Average species richness.

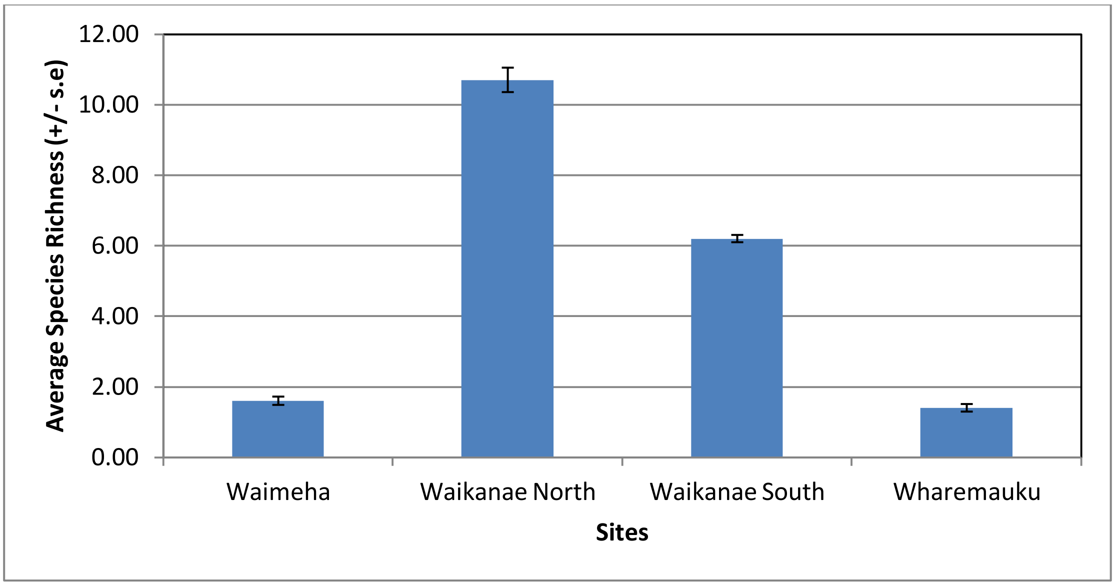
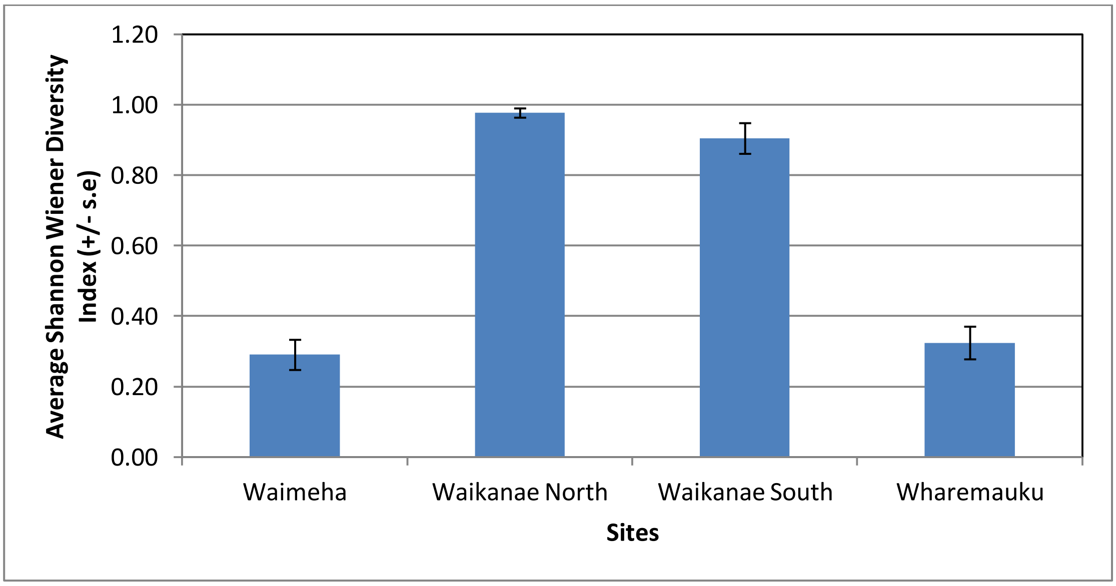


Figure 8: Average Shannon Wiener Diversity Index.



4 ADDITIONAL BASELINE SAMPLING REQUIREMENTS

4.3 CONSTRUCTION MONITORING RATIONALE

Identification of waterways that should or can be monitored during construction is challenging for this site for a number of reasons. Most of the waterways traversed by the proposed Project alignment are highly modified and many are constructed drains.

In terms of stream value and habitat quality all streams and drains have QMCI's that are below 5, with some as low as QMCI 1.7. Biota found in these waterways are typically robust and resilient to change. In these waterways a change in QMCI from 3.0 to 2.0 is a change from poor to poor, and is unlikely to be an ecologically meaningful change.

Many of the waterways traversed are open to the sky, surrounded by pasture and weedlands, and are highly enriched by rural discharge or urban stormwater leading to excessive macrophyte and periphyton growth. This situation is managed by KCDC, GWRC and landowners through annual excavation using diggers and/or mowers. In these streams this ongoing maintenance will cause dramatic variability in macro-invertebrate and fish abundance, and stream bed and sedimentation, which will, in our opinion, mask any potential discharge effects during construction.

Finally, a majority of potentially affected streams have a silt/sand substrate. Given the discharges from earthworks are also likely to be silt and sand, monitoring of these waterways is unlikely to detect meaningful change unless the change is gross (which modelling suggests is unlikely).

These factors will make measuring significant adverse changes that can be ascribed to the project, problematic in most waterways. These factors have directed our thinking for construction site monitoring and therefore baseline monitoring requirements.

Table 9 summarises both the scope of potential construction activity within or adjacent to each watercourse and our assessment of the construction and post construction monitoring that is likely to be required. Table 10 assesses the sufficiency of existing data against these likely construction effects, and identifies the recommended additional baseline studies that are required.

In summary it is proposed that the current levels of data collection are sufficient for most watercourses. Additional baseline sampling is, however, recommended in relation to the three most ecologically important environments along the route; (i) for streams entering Te Harakeke Wetland, (ii) for the site of significant channel modifications in the Waikanae River, and (iii) for the Waikanae Estuary. In each of these areas additional baseline monitoring is recommended for the following specific purposes.

- For Kakariki Stream additional sampling is proposed to determine current levels of sediment movement, organic and inorganic, to and through the Te Harakeke wetland as a baseline for potential construction discharges.
- For the Waikanae River additional sampling is proposed that will accurately describe existing river morphology, habitat and biota so that the recovery of the River can be monitored following the extensive channel modifications that are proposed at the bridge crossing.
- For the Waikanae Estuary the highly variable nature of estuarine environments requires an additional year of baseline sampling to provide a sufficiently robust data set for construction monitoring of potential discharges during construction.

Table 9: Summary of proposed construction activity in each watercourse and anticipated monitoring requirements.

Waterway	Key works	Anticipated Construction Monitoring	Anticipated fish rescue (diversions & culverts)	Anticipated Post construction monitoring
Hadfield Drain / Kowhai Stream	▪ Drain realignment & works on existing culverts at SH1 and NIMT crossings.	Nil	Yes	-
Paetawa Stream	▪ Bridge main channel ▪ Drain realignment & works on existing culverts at SH1 and NIMT crossings. ▪ Focus site for stream mitigation & riparian planting.	Macroinvertebrate Sediment	Yes	SEV
Smithfield Drain	▪ Significant drain realignment ▪ Extensive flood storage works ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV
Kakariki Stream	▪ Bridge ▪ Diversion ▪ Major roading works in proximity ▪ Upstream realignments (Smithfield) ▪ Focus site for stream mitigation & riparian planting.	Macroinvertebrate Sediment	-	SEV
Ngarara Creek	▪ Culverted crossing.	Nil	Yes	-
Waimeha Stream	▪ Three bridges ▪ Major interchange ▪ Diversions of small drains to south.	Nil	-	-
Waikanae River	▪ Bridge ▪ Flood plain widening ▪ Temporary channel diversions ▪ Armoring and willow planting ▪ Extensive landscape planting.	Geomorphology Periphyton Macroinvertebrate Fish densities	-	-
Muaupoko Stream	▪ Diversion at confluence with Waikanae ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV Fish passage
Mazengarb (WWTP) Drain	▪ Culverted crossing. ▪ Focus site for stream mitigation & riparian planting.	Nil	-	SEV
Mazengarb Stream	▪ Culverted crossing.	Nil	Yes	-
Wharemauku Stream	▪ Bridged	Nil	-	-
Drain 7 Lower	▪ Minor drain realignment & culverted crossing ▪ Focus site for stream mitigation & riparian planting.	Nil	Yes	SEV
Drain 7 Upper	▪ Minor drain realignment & culverted crossing.	Nil	Yes	-
Whareroa Drain	▪ Drain realignment & works on existing culverts at SH1 and NIMT crossings.	Nil	-	-
Whareroa Stream Tributary (Waterfall Road)	▪ No works due to revised project extent	Nil	-	-
Waikanae Estuary	▪ Potential sedimentation	Macroinvertebrate Sediment Contaminants	-	-

Table 10: Sufficiency of data collected to date and justification for additional baseline study.

Site Code	Sampling rationale
Kowhai- Stream /Hadfield Drain Catchment	
Hadfield Drain	Minimal effect on highly modified channel. Continued maintenance of stream by excavator makes monitoring of construction effects impractical. Sufficient data.
Waimeha Stream Catchment	
Paetawa Drain	Continued maintenance of stream by excavator makes monitoring of construction effects impractical. Sufficient data for post construction monitoring of stream restoration.
Smithfield Drain	All existing channel diverted therefore construction monitoring not required. Sufficient data for post construction monitoring of stream restoration.
Kakariki Creek	Significant earthworks in this catchment have the potential to impact on Te Harakeke wetland. **Additional baseline study required to determine current levels of sediment movement and deposition along these channels to the wetland.**
Ngarara Stream	Minimal effect on highly modified channel. Continued maintenance of stream by excavator makes monitoring of construction effects impractical. Sufficient data.
Waimeha Stream	Continued maintenance of stream by excavator make monitoring of construction effects impractical. Sufficient data.
Waikanae River Catchment	
Waikanae River	Highest value waterway on the alignment. Extensive channel modification beneath proposed bridge requires monitoring to confirm recovery of river biota. **Additional baseline study required to describe river morphology and fish population densities.**
Muaupoko Stream	Existing drain to be replaced with a new channel. Construction monitoring therefore not required. Sufficient data for post construction monitoring of stream restoration and for fish passage.
Mazengarb Drain WWTP	Minimal effect on highly modified channel. Continued maintenance of stream by excavator make monitoring of construction effects impractical. Sufficient data.
Mazengarb Stream	Minimal effect on highly modified channel. No construction monitoring required. Sufficient data.
Wharemauku Stream Catchment	
Wharemauku Stream	Stream avoided by bridging. No construction monitoring required. Sufficient data.
Drain 7 (lower)	Existing drain to be replaced with a new channel. Construction monitoring not required. Sufficient data for post construction monitoring of the new channel required, to confirm mitigation success.
Drain 7 (upper)	Minimal effect on highly modified channel. No construction monitoring required. Sufficient data.
Whareroa Stream Catchment	
Whareroa Drain	Minimal effect on highly modified channel. No construction monitoring required. Continued maintenance of stream by excavator make monitoring of construction effects impractical. Sufficient data.
Whareroa Tributary	Not affected by works.
Estuaries and Stream Mouths	
Waimeha	Sufficient data. High energy beach. No construction monitoring proposed.
Waikanae	Potential discharges of contaminants (including sediment) to be monitored. **Additional baseline study required to provide full coverage existing sediment and contaminant deposition in estuary.**
Wharemauku	Sufficient data. High energy beach. No construction monitoring proposed.

Proposed sampling at each sample site is summarised in Table 11.

Table 11: Summary of monitoring requirements.

Purpose	Site Code	Description
Potential effect of sediment discharge on Te Harakeke wetland.	Paetawa Drain	
	PAD-I	Pit samplers (deposited sediment) / macro-invertebrates / visual observation
	Kakariki Creek	
	KAC-Control	Pit samplers (deposited sediment) / macro-invertebrates / visual observation
	KAC-E1	Pit samplers (deposited sediment) / macro-invertebrates / visual observation
	KAC-E2	Pit samplers (deposited sediment) / macro-invertebrates / visual observation
Recovery of Waikanae River following channel reconstruction	Waikanae River	
	WAR-Control	Fish densities, periphyton, river geomorphology, macro-invertebrates.
	WAR-E1	Fish densities, periphyton, river geomorphology, macro-invertebrates.
Potential effect of contaminants on Waikanae estuary	Waikanae estuaries	
	WAE-E1	Sediment and contaminants / macro-invertebrates.
	WAE-E2	Sediment and contaminants / macro-invertebrates.

The proposed study reaches are centred on the locations described in Table 12. The final locations may be subject to refinement to ensure security of monitoring equipment, access issues, and safe access during rainfall events. Maps identifying the locations of these sites are included in **Attachment 1**.

Table 12: Monitoring site descriptions and locations (North to South)

Site Code	Description	Provisional Location (NZMG)	
		Northing	Easting
Aquatic / Streams			
Paetawa Drain			
PAD-I	Downstream Effect (above confluence with Kakariki)	1773139	5475448
Kakariki Creek			
KAC-C	Upstream Control (Nga Manu).	1773587	5474770
KAC-E1	Downstream Effect 1 (Ngarara Road bridge)	1773181	5475330
KAC-E2	Entry to Te Harakeke wetland	1772430	5475753
Waikanae River			
WAR-C	Upstream Control	1771092	5472920
WAR-E1	Within works (recovery - upper)	1770726	5472867
Waikanae estuaries			
WAE-E1	Immediate river / estuary junction	1768450	5473080
WAE-E2	Near mouth of estuary	1768980	5473330

The methodologies to be used are described in the following sections.

4.4 KAKARIKI AND PAETAWA STREAMS - TE HARAKEKE WETLAND

4.4.7 PURPOSE

- The purpose of baseline sampling is to determine the current degree of sediment deposition and movement within the two contributing streams to the Te Harakeke wetland (the Paetawa and Kakariki streams) against which to measure any additional discharge that may occur during construction.
- It is expected that any discharge from the construction site to these streams and the wetland will be of sands and silts which will be largely indistinguishable from the current stream beds. This means that visual observations will not be effective except if there is a major event that block channels and/or overtops banks and deposit materials onto the adjacent floodplains or within the wetland.
- Sampling is proposed at four sites as follows:
  - KAC-control - a control site upstream of works in the Kakariki Stream,
  - KAC-E1 - an impact site immediately downstream of works and immediately upstream of the confluence with the Paetawa,
  - PAD-E1 - an impact site in the Paetawa upstream of the confluence with the Kakariki, and
  - KAC-E2 - a site at the point the Kakariki Stream enters the Te Harakeke wetland.

4.4.8 DEPOSITED SEDIMENTS

Description

- This is the primary tool for determining effects on Te Harakeke wetland and the feeding streams of the Kakariki and Paetawa.

Method

- Baseline Sampling will be carried out in Spring (as the wet season) and in summer (as the dry season) with at least two full months collection in each season.
- Baseline Sampling will be carried out by the installation of pit samplers as per (Sterling and Church 2002) and (Diplas et al. 2008).
- At each of the four sample sites 5 pit samplers will be installed.
- At each check of the sampler, the sampler will be lifted, all sediments collected and analysed in the lab for dry weight, grain size, and organic vs. inorganic content.
- At each visit signs of sediment deposition on stream banks will be visually recorded and photographed.

Frequency

- Pit samplers will be monitored monthly, or in the event of a rainfall exceeding 8 mm/24 hrs.
- Sampling following a rainfall event will only occur once water flows clear.

Duration

- Baseline monitoring will continue until construction commences.

4.4.9 MACRO-INVERTEBRATES

Description

- Sampling of macro-invertebrates will be carried out downstream of each suspended sediment sampling site. It will be used to determine if, at any point, deposition of sediments have an adverse effect on the robust communities currently present in these streams.

Method

- Communities of freshwater macroinvertebrates will be sampled following a period of stable flow of no less than 1 week.
- The sampling technique will follow the national standard protocol C2 (soft-bottomed, semi-quantitative) (Stark et al. 2001). This acknowledges that some parts of the Kakariki Stream channel has some areas of gravel and sand substrate, silts and muds are the predominant stream bed material throughout the catchment.
- Species will be identified to MCI level.
- Presence of algae, periphyton and aquatic macrophytes will be recorded and their relative abundance described.
- Each site will be photographed.

Frequency

- Four times pre-construction over two seasons.
  - Summer – February and March.
  - Winter – July and August.

Duration

- Monitoring will cease after four sampling runs.

4.5 WAIKANAE RIVER

- It is expected that fish and invertebrate communities and the periphyton cover upon which these communities rely will be largely lost within the 160 m reach of river that will be subject to flood plain widening, armouring and creation of bridge abutments.
- The purpose of baseline sampling is to establish a baseline of species abundance and distribution, and river geomorphology against which to measure recovery of the river biota following channel modifications.
- Sampling is proposed at two sites as follows:
  - WAR-control - a control site immediately up river of works which has the same river morphology and is therefore representative of the Waikanae River;
  - WAR-E1 - the section of the River affected by channel works.

4.5.10 Geomorphology

Description

- Pre construction measure of benthos, physical habitat against which to correlate the presence and distribution of in stream biota which are governed in the main by depth, velocity and substrate.

Method

- Cross sections and transects will be used to measure depth profile and substrate profile across the river so that the physical habitat can be accurately described at both the control and impact sites.
- Methods will generally follow Jowett (2010) developed for instream flow incremental method (IFIM).

Frequency

- Sampling will occur once in December following a period of stable flow of no less than 1 week.

4.5.11 Freshwater Fish

Description

- Recovery or persistence of resident populations of freshwater fish requires establishment of population density and distribution with in the affected reach, together with a baseline to ensure delays in recovery are not related to other catchment activities.

Method

- Depletion fishing over the full length of the affected reach and control reach by EFM.
- Catch is measured, weighed, and potentially tagged before return to capture site.
- Densities of fish by species (m^2) will be calculated from depletion records.

Frequency

- Sampling will occur once in December following a period of stable flow of no less than 1 week.

4.5.12 Macro-invertebrate

Description

- Macro-invertebrates re-colonisation (diversity and density) will be used as indicators of successful re-establishment of habitat.

Method

- Sampling will follow the C3 protocol (hard-bottom quantitative) surber sampling[2].
- This will involve three transects across the affected reach, and three across the control reach.
- In each transect, 5 sub samples will be located equidistant across the wetted channel.

Frequency

- Sampling will occur once in December following a period of stable flow of no less than 1 week.

4.5.13 Periphyton

Description

- Sampling of periphyton will be carried out to confirm re-colonisation of appropriate periphyton species and the absence of inappropriate species, within the affected reach.

Method

- Sampling will be done by measured area, hard substrate scrapings and visual quadrates (Biggs 2000), (Biggs and Kilroy 2000).
- Samples will be analysed in a lab for species, chlorophyll A, and total biomass.

Frequency

- Sampling will occur once in December following a period of stable flow of no less than 1 week.

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[2] Stark et al 2001. Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Working Group report 1. Prepared for the Ministry for the Environment.

4.6 WAIKANAE ESTUARY

The objectives of the estuarine baseline monitoring programme to be carried out in the Waikanae Estuary is to establish robust baseline ecological data against which “during construction” and “post-construction” ecological monitoring data can be compared.

Ecological surveys will comprise assessment of;

- Benthic invertebrate assemblages, both epifaunal and infaunal;
- Sediment quality (analysis of copper, lead and zinc in surficial sediment);
- Depth of redox discontinuity layer;
- Sediment grain size.

The monitoring programme is based on the Estuarine Environmental Assessment and Monitoring National Protocol (Cawthron Institute 2002).

- Two sites will be surveyed within the Waikanae Estuary (Figure 1). Due to the changeable nature of the mouth of the estuary, the sites are indicative at this stage and may need to be altered in the field.
- Monitoring will be carried out within two hours either side of low tide in June/July 2012 and repeated in January/February 2013.
- At each site a 50 m x 30 m grid (subdivided into 10 15 m x 10 m smaller grids, identified as A to J) will be established using GIS prior to entering the field. The 10 smaller grids (A to J) are then subdivided into six 5 m x 5 m grids (identified as 1 to 6). Sampling will be undertaken at one of the randomly selected 5 m x 5 m grids (1 to 6) within each 15 m x 10 m grid (A to J) (2).

The following analyses will be undertaken for each of these sites:

- To assess infaunal abundance and diversity a sediment core (haphazardly placed) will be collected from each site using a 13 cm diameter × 10 cm deep (area = 1,327 cm^3) PVC tube. Samples will be processed at each site by washing the contents of each sample through a 0.5 mm sieve using seawater from the estuaries. All material retained on the sieve will be removed and placed into a labelled plastic container, preserved in 60-70% ethanol. Cawthron Institute benthic invertebrate taxonomists will process the samples, extract and identify the macrofauna present.
- A 0.50 m x 0.50 m (0.25 m^2) quadrat will be used to sample epifauna (surface dwelling) and macro-algae. The quadrat will be haphazardly placed at each site approximately 0.5 m from where cores were taken. All organisms occurring within the quadrat will be identified to species level and counted. Macroalgal cover will be estimated on the basis that a 5 x 5 cm area equates to 1 % cover. Crab/worm holes at the sediment surface will also be counted. A photographic record of each quadrat will also be collected.
- A redox discontinuity layer (RDL) sample will be collected to assess the sediment anoxic layer at each site. A 60 mm diameter PVC cylinder will be driven into the sediment to a depth of 8-10 cm and capped before extracting the cylinder. After collection, the core will be cut in half lengthways and the depth of the start of the anoxic sediment layer measured where present.
- A surface sediment (top 2 cm) sample will be collected for contaminant and sediment grain size analyses. Using a garden trowel, the sediment samples from grids A to E will be combined to form a composite sample, as will be samples from F to J. The two composite samples will then each divided in half, with one half of each being sent to a certified

Laboratory for analysis of copper, lead, zinc, high molecular weight polycyclic aromatic hydrocarbons (HMW PAHs), and total organic carbon (TOC) and the other half sent to Cawthron Institute for sediment grain size analyses.

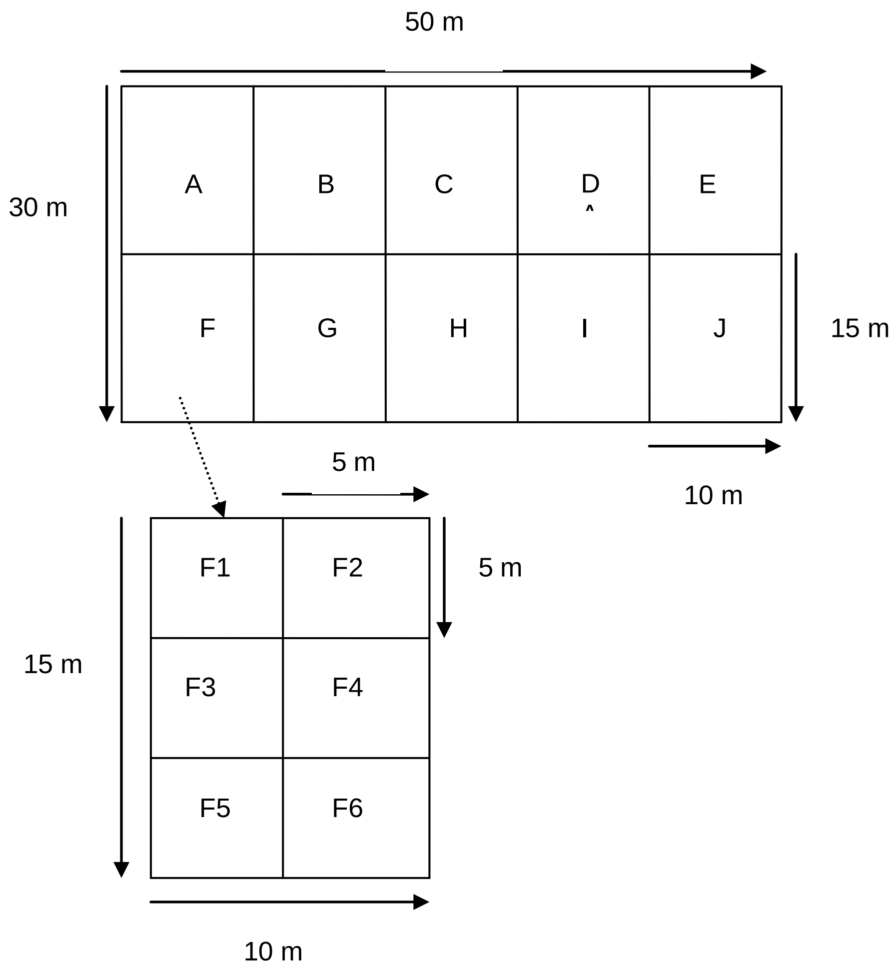


Figure 2: Schematic showing intertidal experimental design.

Data will be collated in a single spreadsheet and analysed using multivariate permanova statistical techniques (using PRIMER software).

5 REPORTING

A report (produced for NZTA and subsequently submitted to GWRC and KCDC Councils) documenting the location, access instructions, the physical characteristics of each sampling sites and the results of the work will be prepared in advance of construction monitoring sampling commencing. It will include details of the sampling that has already been carried out and the results.

BIBLIOGRAPHY

Allibone, R, B David, R Hitchmough, D Jellyman, N Ling, P Ravenscroft, and J Waters. 2010. “Conservation status of New Zealand freshwater fish, 2009.” *New Zealand Journal of Marine and Freshwater Research* First published on: 27 September 2010.

Biggs, B.J.F. 2000. “New Zealand periphyton guidelines: detecting, monitoring and managing enrichment of streams.” Wellington.

Biggs, B.J.F and K.C. Kilroy. 2000. “Stream periphyton monitoring manual.” Wellington.

Boffa Miskell. 2012. “Technical Report 30: Freshwater Habitat and Species Description and Values.”.

Boffa Miskell. 2012. “Technical Report 30: Marine Habitat and Species - Description and Values.”.

Cawthron Institute. 2002. “Estuarine Environmental Assessment and Monitoring: A National Protocol.” Sustainable Mangaement Fund Project.

Diplas, P, AR Kuhnle, RJ Gray, DG Glysson, and ET Edwards. 2008. “Sediment transport measurements; In Sedimentation Engineering, Ed. Garcia, M. H.”.

GWRC. 2008. “Annual freshwater quality monitoring report for the Wellington region, 2007/08..”.

Joy, M 2005. “A fish Index of Biological Integrity (IBI) for the Wellington Region.” Prepared for the Wellington Regional Council by Mike Joy, Massey University.

Ling, N, L O’Brien, R Miller, and M Lake. 2009. “Methodology to survey and monitor New Zealand mudfish species.” Department of Conservation and University of Waikato, Hamilton..

NIWA. 2004. “New Zealand River Environment Classification.”.

NIWA n.d. “Freshwater Fish Database.” in *Unpublished database*.

Rowe et.al. 2008. “Stream ecological valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying mitigation.”.

Stark, J D. 1998. “SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data..” *New Zealand Journal of Marine and Freshwater Research* 32: 55-66.

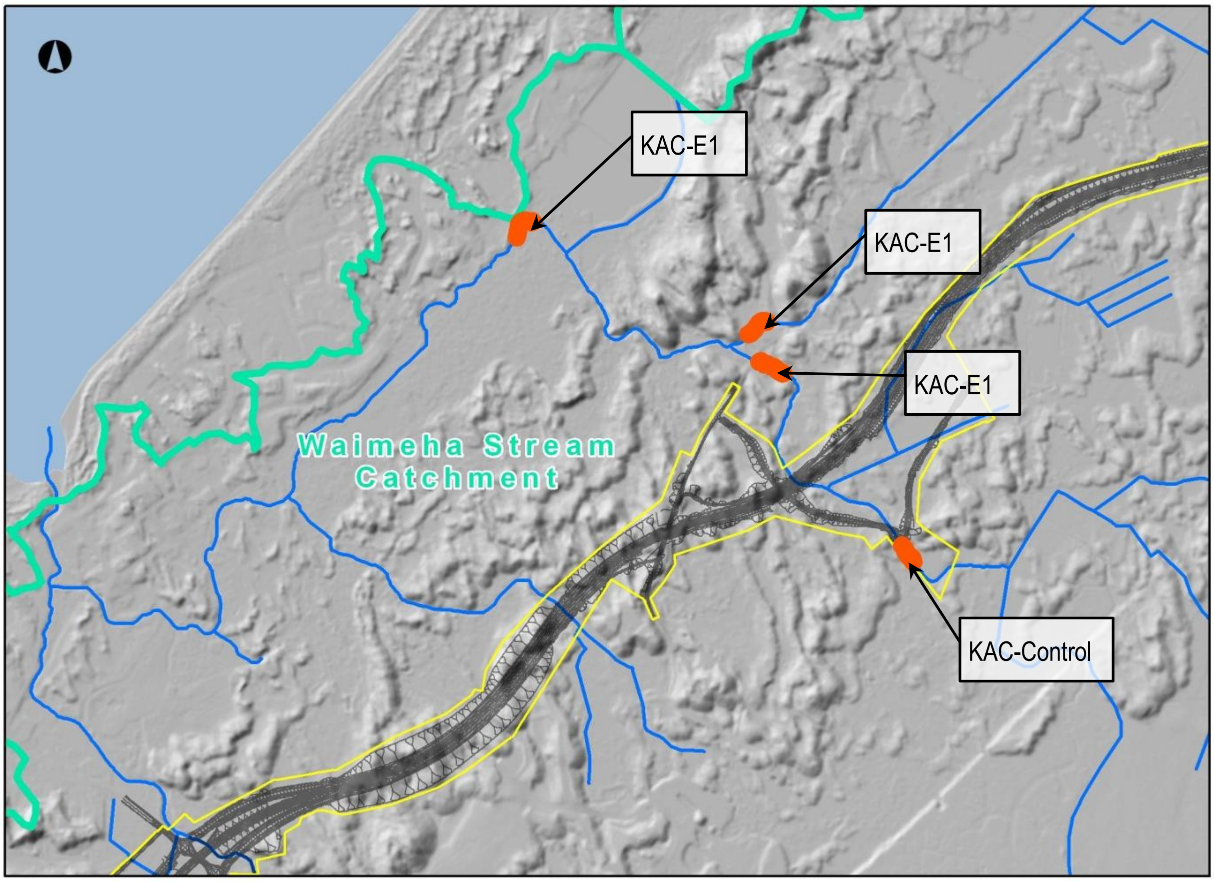
Stark, J.D., I.K.G. Boothroyd, J.S. Harding, J.R. Maxted, and M.R. Scarsbrook. 2001. “Protocols for sampling macroinvertebrates in wadeable streams.”.

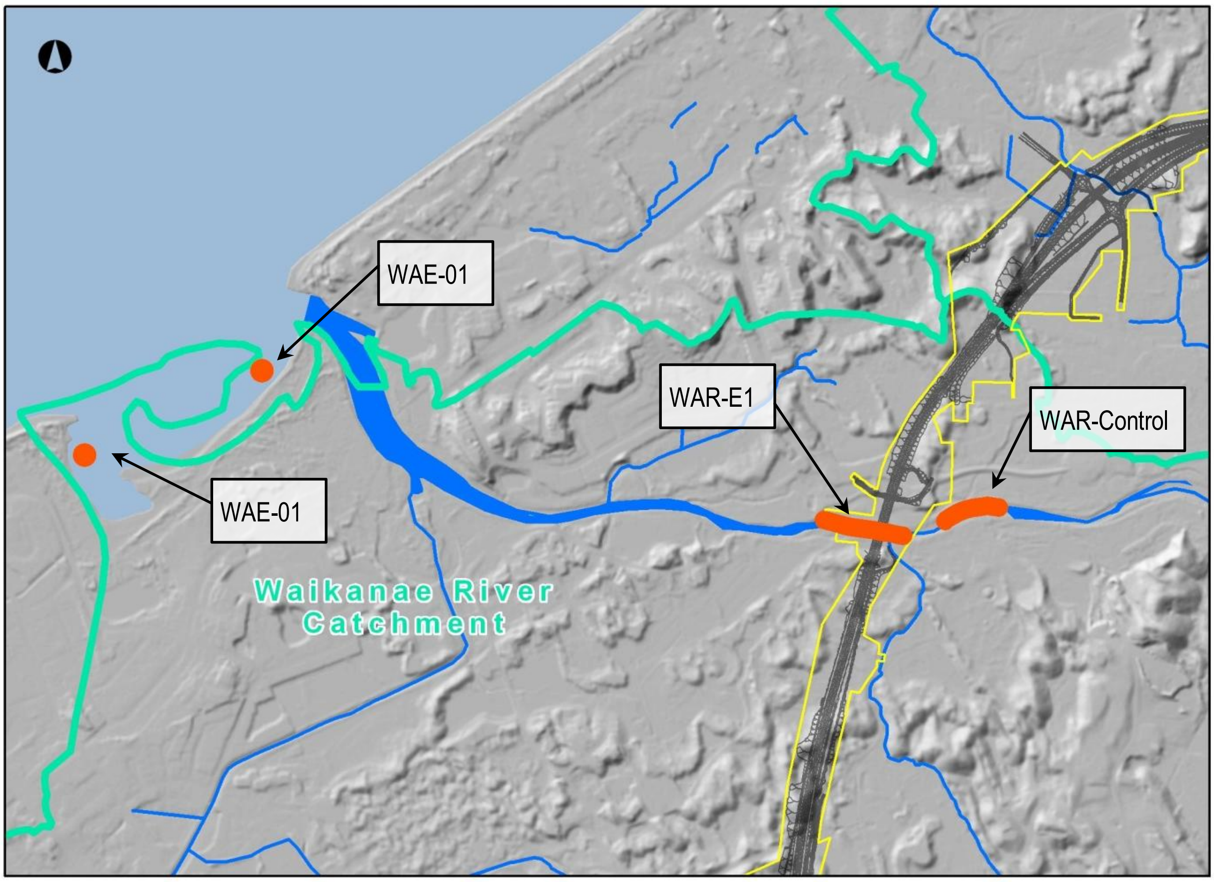
Sterling, S M. and M Church. 2002. “Sediment trapping characteristics of a pit trap and the Helley-Smith sampler in a cobble gravel bed river.” *Water Resour. Res* (38(8)):1144.

Strickland, R and A Quarterman. 2001. “Review of freshwater fish in the Wellington Region.” Prepared for Wellington Regional Council by Cawthron Institute. July 2001.

ATTACHMENT 1: SITE LOCATIONS FOR ADDITIONAL BASELINE SAMPLING

Overview of Additional Sample Site Locations





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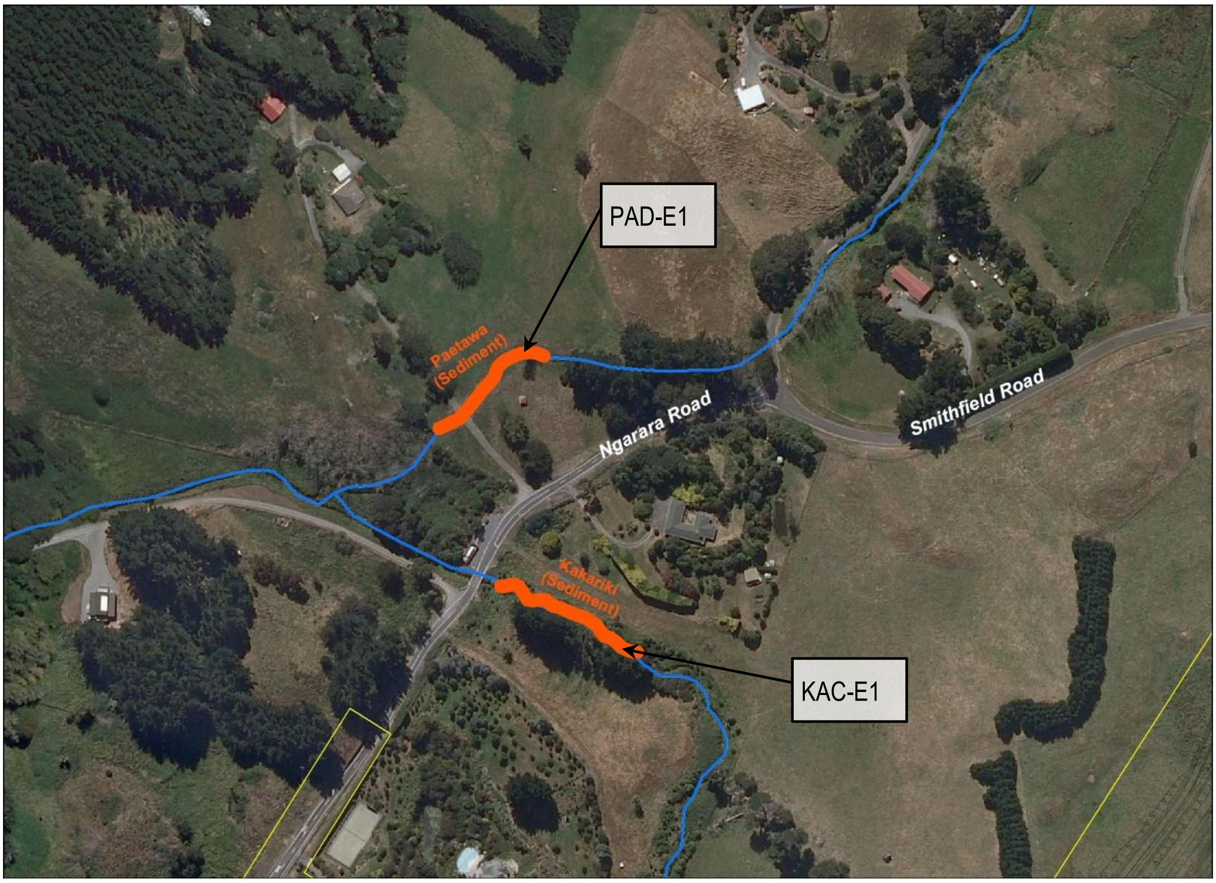
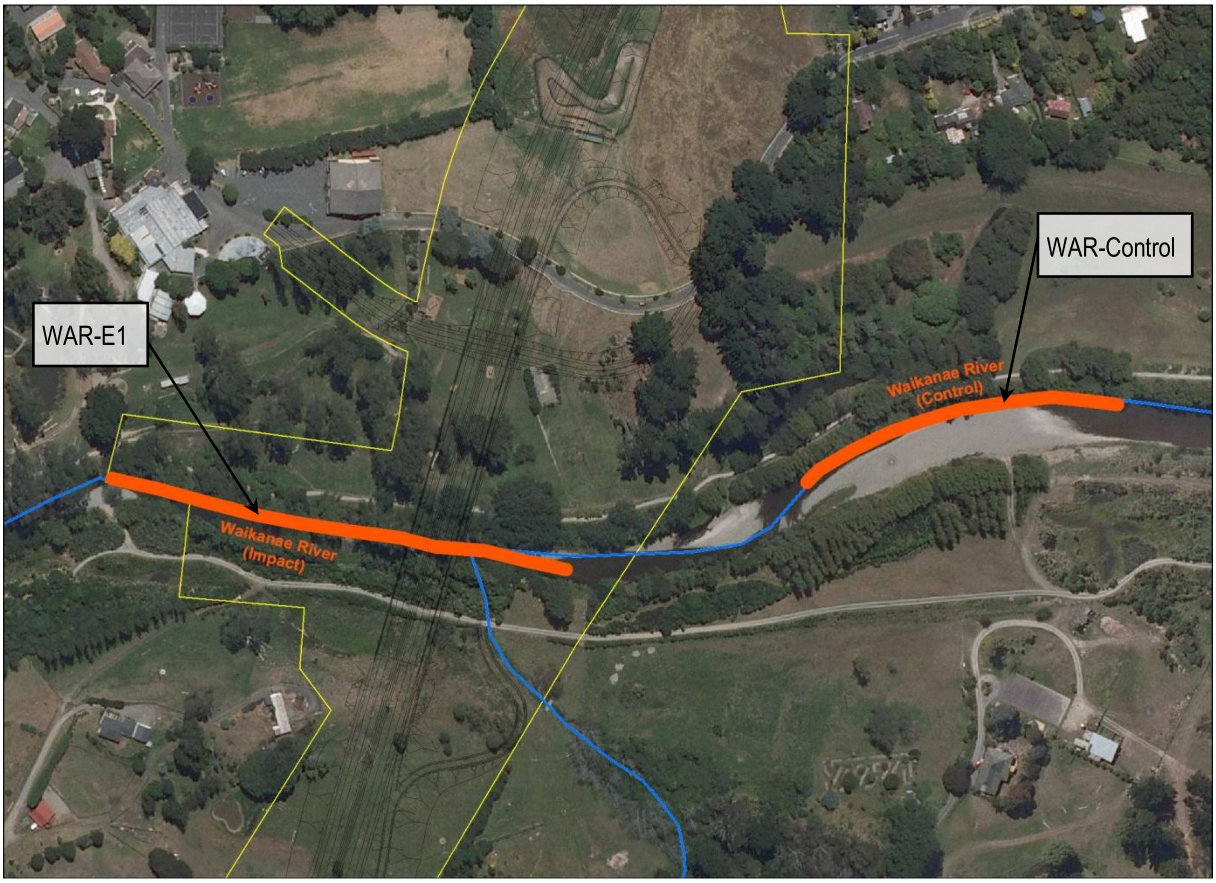
Kakariki Stream and Paetawa Drain Sample Sites.



D R A F T

Te Harakeke and Waikanae River Sample Sites



Waikanae Estuary Sample Sites.

D R A F T

ATTACHMENT 2: SUMMARY SHEETS FOR EACH WATERCOURSE

D R A F T

ANNEXURE E: PROPOSED RESOURCE CONSENT CONDITIONS

This Annexure contains relevant resource consent conditions proposed in the AEE. It also shows in redline form (strikeout and underlying) any changes now proposed.

	Management Plans
G.19	The management of key environmental effects associated with the construction phase of the Project shall be detailed within environmental management plans that are included in the appendices to the CEMP (draft Plans were submitted with the applications). The finalised management plans shall be submitted to the Manager for certification at least 15 working days before the commencement of construction. Works shall not commence until the consent holder has received the Manager's written certification for the management plan(s). This suite of management plans consist of: a) Erosion and Sediment Control Plan b) Groundwater (Level) Management Plan c) Settlement Effects Management Plan d) Contaminated Soils and Groundwater Management Plan e) Ecological Management Plan
	Ecological Management Plan
G.34	a) The consent holder shall finalise, submit and implement through the CEMP, the Ecological Management Plan (EMP). The EMP shall be submitted to the Manager for certification at least 15 working days prior to works commencing. The purpose of the Plan is to outline the ecological management programme to protect, reduce and remediate impacts on the environment during the construction phase of the Project. This EMP shall also document the permanent mitigation measures, such as restoration planting, and the mechanisms by which to develop relevant mitigation and restoration plans for terrestrial and freshwater habitat. b) The EMP shall detail the monitoring to be undertaken pre-construction, during construction and post-construction as outlined below in Condition G.38 – G.40. c) The EMP shall provide information on how the following outcomes will be achieved: i. Minimise loss of valued vegetation and habitats; ii. Minimise construction effects on freshwater and the marine environments; iii. Minimise effects on identified wetlands resulting from hydrological changes to water tables; iv. Minimise effects on fish during stream works; v. Minimise disturbance of nationally threatened or at-risk birds

	(as listed by the most up to date Department of Conservation threat classification lists) during breeding periods; vi. Re-establish affected lizard habitat and minimise lizard mortality resulting from construction of the Project; vii. Carry out monitoring in a manner that will confirm that adverse effects are as predicted; any exceedance is identified; and appropriate actions are undertaken to rectify; viii. Ensures that mitigation requirements are undertaken and monitored to ensure success is achieved; and ix. Carry out monitoring in a manner that confirms that mitigation meets objectives.
G.35	The EMP shall be prepared by suitably qualified and experienced ecologist, and shall implement the principles and outcomes sought by the Ecological Impact Assessments (Technical Reports 26 – 31). The EMP shall be prepared in accordance with: a) NZTA's Environmental Plan; b) The Conservation Management Strategy for the Wellington Conservancy; and c) The Greater Wellington Pest Management Strategy (2009).
G.36	The EMP shall be consistent with the Landscape Management Plan (LMP) that is required to be certified by KCDC under the designation conditions.
G.37	At least 15 working days before submitting the EMP to GWRC for certification, the Consent Holder shall submit a copy of the draft EMP required by Condition G.34 to KCDC for comment. Any comments received shall be supplied to the Manager when the EMP is submitted, along with a clear explanation of where any comments have not been incorporated and the reasons why.
	Ecological Monitoring – General
G.38	Monitoring shall be carried out in accordance with the EMP as required by Condition G.34 in order to: a) collect baseline information on vegetation, wetlands, freshwater and marine ecology for 1 year prior to construction work starting; b) collect ecological information on vegetation, wetlands, freshwater and marine ecology during construction work; c) collect ecological information on vegetation, wetlands, freshwater and marine ecology for 2 years post construction works completion.
G.39	All ecological monitoring required under the EMP shall be managed by a suitably qualified and experienced ecologist. The results of all monitoring carried out pursuant to the EMP shall be: a) available for inspection during normal office hours where such data is available; b) submitted to the Manager at quarterly intervals for certification

	that the appropriate monitoring has been undertaken; c) submitted to the Director-General of Conservation and KCDC for information; and d) summarised and submitted as part of the annual report required under Condition G.14.
G.40	An Adaptive Management approach shall be taken to responding to ecological effects as outlined in the EMP. The Adaptive Management monitoring shall seek to: a) Provide a level of baseline information of pre-construction vegetation, wetlands, freshwater and marine habitats in order to develop 'trigger' levels; b) Undertake monitoring during construction to observe whether 'trigger' levels are exceeded and to determine the effectiveness of the environmental management methods; and c) In the event that trigger levels are exceeded an Adaptive Management approach shall be enlisted that will seek to: i. Investigate a plausible cause-effect association with the Project; should the event be linked to the project the following steps will be undertaken: A. Identify the on-site practice that is generating the effect; B. Seek to alter the operational measure in consultation with GWRC; C. Undertake further monitoring to assess the effectiveness of the altered on-site practice. ii. If the trigger level exceedance is not attributable to works associated with the Project, the consent holder shall not be held liable for any remediation or mitigation works; iii. Trigger level exceedances during construction should be treated as management triggers and not compliance triggers in the first instance.
	General Conditions
WS.1	The consent holder shall use natural rock and soil material, where practicable, to reclaim the stream bed. All fill material shall be placed and compacted so as to minimise any erosion and/or instability insofar as it is practicable.
WS.2	The consent holder shall seek to ensure that all construction works authorised by this permit to be undertaken in the dry bed of the stream, and are completed before the flow of the stream is diverted back into the stream bed.
WS.3	The consent holder shall design and construct all permanent diversions in a manner that seeks to maintain stream flows (both volume and velocity) in a similar state to its natural state at the time of commencement of Work.
WS.4	The works shall be regularly inspected and maintained by the consent holder so that:

	a) the waterway within the culverts remains substantively clear of debris; b) any erosion of the stream banks or bed that is attributable to, and is within 20m up or downstream of, the stream works authorised by this consent are remedied as soon as practicable by the consent holder; and c) fish passage through the structure is not impeded. ***Explanatory Note****: Maintenance does not include any works outside the scope of the application. Any additional works (including structures, reshaping or disturbance to the stream bed) following completion of the construction works as proposed in the application may require further resource consents.*
	Pre-construction Conditions
WS.5	The consent holder shall prepare and implement a revegetation and mitigation strategy for the stream modifications and structures authorised by this consent. The strategy shall be submitted to the Manager at least 15 working days prior to any Work commencing. The revegetation and mitigation strategy shall include, but not be limited to: a) The quantum in total of stream mitigation required (at least 5.25km), the target SEV scores of the final enhancements and a plan of the location and lengths of waterways to be enhanced; b) details, methods, timing and responsibilities for revegetation of all exposed areas of stream bank or dewatered channel or culvert fill slopes as a result of this consent, including the methods for the protection of such areas; c) planting plan and schedules; and d) monitoring and maintenance processes and procedures, including for replacement of dead plants, for a period of three years from completion of construction.
	Conditions During Construction
WS.6	Unless otherwise agreed in writing with the Manager, all temporary stream crossings shall be removed within not more than two years of their installation.
WS.7	Unless otherwise agreed in writing with the Manager, upon removal of any temporary crossing, the consent holder shall reinstate the stream bed to, as far as practicable, a natural state to closely match the upstream and downstream riparian and instream habitats and visual appearance.
WS.8	The structures erected as part of the Work shall be regularly inspected and maintained by the consent holder in accordance with NZTA's operational and maintenance manual and maintenance programme, so that: a) the waterway within or over the culverts and fords remains

	substantively clear of debris; b) any erosion of the stream banks or bed that is attributable to the stream works authorised by this consent are remedied as soon as practicable by the consent holder; and c) fish passage through culverts is not impeded.
WS.9	The EMP shall require that for any works that will occur within the wetted channel of any stream outside of the period from 1st March to 31st July, the consent holder shall, in consultation with the Council, develop a specific programme and methodology to manage migration of native fishes. The programme and methodology shall be developed with reference to the Freshwater Fish Spawning and Migration Calendar (Hamer 2007) and the programme shall be certified by the Council prior to the relevant works occurring.

ANNEXURE F: SEV AND ECR CALCULATION SPREADSHEETS

Annexure F

SEV –ECR base calculation spread sheets. These sheets are a sub set of the total and are reduced in terms of labels related to the SEV process but are the complete data for the assumptions around changes in the factors of effects and due to proposed mitigation. The data here is only for those systems in which mitigation diversions are recommended. The various numbers other than the measured "current value" for factors are estimates of the result of either the impact or of the mitigation action. The cell colourings just highlight substantive changes from the current or affected.

Hadfields/Kowhai Stream

		Reference Value	Current Value	Potential	Impact Culvert	Impact Armour	Mitigate Diversion
Function category	**Variable (code)**	**KC Ref 1**	**Hadfields Drain/Kowhai**	**Hadfields Drain/Kowhai**	**Hadfields Drain/Kowhai**	**Hadfields Drain/Kowhai**	**Hadfields Drain/Kowhai**
	Vbed	1.00	1.00	0.70	0.10	0.50	1.00
	Verosn	1.00	0.70	1.00	1.00	1.00	1.00
	Vimper	1.00	0.50	0.50	0.50	0.50	0.50
Hydraulic	=	**1.00**	**0.43**	**0.43**	**0.28**	**0.38**	**0.50**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
Hydraulic	=	**0.55**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
	Vbarr	1.00	0.00	1.00	1.00	1.00	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	**1.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Vbed	1.00	1.00	1.00	0.10	0.50	1.00
Hydraulic	=	**1.00**	**1.00**	**1.00**	**0.10**	**0.50**	**1.00**
	Hydraulic function mean score	**0.89**	**0.41**	**0.66**	**0.39**	**0.52**	**0.68**
	Vshade	0.94	0.51	0.94	1.00	0.50	0.94
	Vdepth	1.00	0.80	0.80	0.80	0.80	0.80
	Vveloc	0.90	0.90	0.90	0.90	0.90	0.90
	Vlength	0.40	0.80	0.80	0.80	0.80	0.80
biogeochemical	=	**0.85**	**0.67**	**0.89**	**0.92**	**0.67**	**0.89**
	Vdod	1.00	0.51	0.51	0.51	0.51	1.00
biogeochemical	=	**1.00**	**0.51**	**0.51**	**0.51**	**0.51**	**1.00**
	Vcanop	0.85	0.54	0.99	0.00	0.50	0.99
	Vdecid	0.94	0.45	0.78	0.00	0.40	0.78
biogeochemical	=	**0.45**	**0.42**	**0.60**	**0.00**	**0.40**	**0.60**
	Vtrans	0.10	1.00	1.00	0.10	0.20	1.00
	Vretain	0.02	1.00	1.00	0.10	0.20	1.00
biogeochemical	=	**0.00**	**1.00**	**1.00**	**0.01**	**0.04**	**1.00**
	Vsurf	1.00	0.10	0.33	0.10	0.20	0.33
biogeochemical	=	**1.00**	**0.10**	**0.33**	**0.10**	**0.20**	**0.33**

	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vrough	1.00	0.10	0.50	0.10	0.40	1.00
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
biogeochemical	=	**0.70**	**0.17**	**0.30**	**0.17**	**0.27**	**0.47**
	Biogeochemical function mean score	**0.67**	**0.48**	**0.61**	**0.28**	**0.35**	**0.72**
	Vgalspwn	1.00	0.00	0.50	0.00	0.00	0.50
	Vgalqual	1.00	0.25	1.00	0.00	0.00	1.00
	Vgobspwn	1.00	0.10	0.10	0.10	0.20	0.10
habitat provision	=	**1.00**	**0.05**	**0.30**	**0.05**	**0.10**	**0.30**
	Vphyshab	1.00	0.48	1.00	0.00	0.00	1.00
	Vwatqual	0.72	0.26	0.37	0.00	0.00	0.60
	Vimper	1.00	0.50	0.50	0.10	0.50	1.00
habitat provision	=	**0.93**	**0.43**	**0.72**	**0.03**	**0.13**	**0.90**
	Habitat provision function mean score	**0.97**	**0.24**	**0.51**	**0.04**	**0.11**	**0.60**
	Vfish	0.60	0.30	0.30	0.30	0.30	0.30
Biodiversity	=	**0.60**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
	Vmci	0.70	0.30	0.40	0.30	0.30	0.70
	Vept	1.00	0.40	0.50	0.40	0.40	1.00
Biodiversity	=	**0.85**	**0.35**	**0.45**	**0.35**	**0.35**	**0.85**
	Vvert	0.60	0.30	0.30	0.30	0.30	0.30
	Vinvert	1.00	0.59	0.59	0.59	0.59	0.59
Biodiversity	=	**0.80**	**0.44**	**0.44**	**0.44**	**0.44**	**0.44**
	Vripcond	0.60	0.10	0.70	0.10	0.10	0.70
	Vripconn	1.00	0.20	0.70	0.10	0.20	0.70
	Vripar	0.80	0.50	0.80	0.00	0.00	0.80
Biodiversity	=	**0.80**	**0.27**	**0.73**	**0.07**	**0.10**	**0.73**
	Biodiversity function mean score	**0.76**	**0.34**	**0.48**	**0.29**	**0.30**	**0.58**
Sum of scores (maximum value 16)		**12.54**	**6.33**	**9.20**	**4.51**	**5.58**	**10.52**
Overall mean SEV score (maximum value 1)		**0.783**	**0.395**	**0.575**	**0.282**	**0.349**	**0.657**

Paetawa

Function category	**Variable (code)**	Reference Value **KC Ref 1**	Current Value **Paetawa Drain**	Current Potential **Paetawa Drain**	Impact Culvert **Paetawa Drain**	Impact Armour **Paetawa Drain**	Mitigate Diversion **Paetawa Drain**
	Vbed	1.00	0.54	0.54	0.10	0.50	0.54
	Verosn	1.00	1.00	1.00	1.00	1.00	1.00
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	**1.00**	**0.77**	**0.77**	**0.55**	**0.75**	**0.77**
	Vfpwidth	1.00	0.70	0.70	0.70	0.70	0.70
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
Hydraulic	=	**0.55**	**0.55**	**0.55**	**0.55**	**0.55**	**0.55**

	Vbarr	1.00	0.30	0.30	0.30	0.30	0.30
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	**=**	**1.00**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
	Vbed	1.00	0.54	0.54	0.10	0.50	0.54
Hydraulic	**=**	**1.00**	**0.54**	**0.54**	**0.10**	**0.50**	**0.54**
	Hydraulic function mean score	**0.89**	**0.54**	**0.54**	**0.38**	**0.53**	**0.54**
	Vshade	0.94	0.95	0.95	1.00	0.95	0.95
	Vdepth	1.00	0.70	0.70	0.70	0.70	0.70
	Vveloc	0.90	1.00	1.00	1.00	1.00	1.00
	Vlength	0.40	0.40	0.40	0.40	0.40	0.40
biogeochemical	**=**	**0.85**	**0.83**	**0.83**	**0.85**	**0.83**	**0.83**
	Vdod	1.00	0.25	0.30	0.30	0.40	0.75
biogeochemical	**=**	**1.00**	**0.25**	**0.30**	**0.30**	**0.40**	**0.75**
	Vcanop	0.85	0.06	0.70	0.00	0.60	0.70
	Vdecid	0.94	0.00	0.00	0.00	0.00	0.00
biogeochemical	**=**	**0.45**	**0.06**	**0.70**	**0.00**	**0.60**	**0.70**
	Vtrans	0.10	1.00	1.00	1.00	1.00	1.00
	Vretain	0.02	0.40	0.40	0.10	0.10	0.60
biogeochemical	**=**	**0.00**	**0.40**	**0.40**	**0.10**	**0.10**	**0.60**
	Vsurf	1.00	0.80	1.00	0.10	0.40	1.00
biogeochemical	**=**	**1.00**	**0.80**	**1.00**	**0.10**	**0.40**	**1.00**
	Vfpwidth	1.00	0.70	0.70	0.70	0.70	0.70
	Vrough	1.00	0.70	0.80	0.70	0.70	1.00
	Vfreq	0.10	0.40	0.40	0.40	0.80	0.40
biogeochemical	**=**	**0.70**	**0.60**	**0.63**	**0.60**	**0.73**	**0.70**
	Biogeochemical function mean score	**0.67**	**0.49**	**0.64**	**0.33**	**0.51**	**0.76**
	Vgalspwn	1.00	1.00	1.00	0.00	0.00	1.00
	Vgalqual	1.00	0.25	0.75	0.00	0.00	0.75
	Vgobspwn	1.00	0.80	0.80	0.10	0.10	0.80
habitat provision	**=**	**1.00**	**0.53**	**0.78**	**0.05**	**0.05**	**0.78**
	Vphyshab	1.00	0.19	0.19	0.87	0.20	0.19
	Vwatqual	0.72	0.90	0.90	1.00	0.90	1.00
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	**=**	**0.93**	**0.57**	**0.57**	**0.94**	**0.57**	**0.59**
	Habitat provision function mean score	**0.97**	**0.55**	**0.67**	**0.49**	**0.31**	**0.68**
	Vfish	0.60	0.50	0.50	0.50	0.50	0.50
Biodiversity	**=**	**0.60**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**
	Vmci	0.70	0.30	0.50	0.40	0.50	0.70
	Vept	1.00	0.22	0.22	0.22	0.22	0.22
Biodiversity	**=**	**0.85**	**0.26**	**0.36**	**0.31**	**0.36**	**0.46**
	Vvert	0.60	0.50	0.50	0.50	0.50	0.50
	Vinvert	1.00	0.52	0.52	0.52	0.52	0.52
Biodiversity	**=**	**0.80**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**

	Vripcond	0.60	0.10	0.50	0.10	0.50	0.70
	Vripconn	1.00	1.00	1.00	0.10	1.00	1.00
	Vripar	0.80	0.10	0.80	0.10	0.10	0.80
Biodiversity	**=**	**0.80**	**0.40**	**0.77**	**0.10**	**0.53**	**0.83**
	Biodiversity function mean score	**0.76**	**0.42**	**0.53**	**0.35**	**0.48**	**0.58**
Sum of scores (maximum value 16)		**12.54**	**7.86**	**9.50**	**5.85**	**7.68**	**10.41**
Overall mean SEV score (maximum value 1)		**0.783**	**0.491**	**0.594**	**0.366**	**0.480**	**0.650**

Smithfield

		Reference Value	Current Value	Current Potential	Impact Culvert	Impact Armour	Mitigate Diversion
Function category	**Variable (code)**	**KC Ref 1**	**Smithfield Drain**	**Smithfield Drain**	**Smithfield Drain**	**Smithfield Drain**	**Smithfield Drain**
	Vbed	1.00	0.50	0.50	0.10	0.50	0.60
	Verosn	1.00	0.20	0.70	1.00	1.00	1.00
	Vimper	1.00	0.30	0.30	0.30	0.30	0.30
Hydraulic	**=**	**1.00**	**0.11**	**0.18**	**0.17**	**0.23**	**0.24**
	Vfpwidth	1.00	1.00	1.00	1.00	1.00	1.00
	Vfreq	0.10	0.80	0.40	0.40	0.40	0.80
Hydraulic	**=**	**0.55**	**0.90**	**0.70**	**0.70**	**0.70**	**0.90**
	Vbarr	1.00	0.30	0.30	0.30	0.30	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	**=**	**1.00**	**0.30**	**0.30**	**0.30**	**0.30**	**1.00**
	Vbed	1.00	0.50	0.50	0.10	0.50	0.60
Hydraulic	**=**	**1.00**	**0.50**	**0.50**	**0.10**	**0.50**	**0.60**
	Hydraulic function mean score	**0.89**	**0.45**	**0.42**	**0.32**	**0.43**	**0.69**
	Vshade	0.94	0.01	0.60	1.00	0.10	0.94
	Vdepth	1.00	0.80	0.80	0.80	0.80	0.80
	Vveloc	0.90	1.00	1.00	1.00	1.00	1.00
	Vlength	0.40	0.80	0.80	0.80	0.80	0.80
biogeochemical	**=**	**0.85**	**0.44**	**0.73**	**0.93**	**0.48**	**0.90**
	Vdod	1.00	0.04	0.10	0.11	0.11	1.00
biogeochemical	**=**	**1.00**	**0.04**	**0.10**	**0.11**	**0.11**	**1.00**
	Vcanop	0.85	0.00	0.60	0.00	0.00	0.70
	Vdecid	0.94	0.00	0.30	0.00	0.00	0.78
biogeochemical	**=**	**0.45**	**0.00**	**0.51**	**0.00**	**0.00**	**0.43**
	Vtrans	0.10	1.00	1.00	0.10	0.20	1.00
	Vretain	0.02	1.00	1.00	0.10	0.20	1.00
biogeochemical	**=**	**0.00**	**1.00**	**1.00**	**0.01**	**0.04**	**1.00**
	Vsurf	1.00	0.06	0.39	0.10	0.20	0.85
biogeochemical	**=**	**1.00**	**0.06**	**0.39**	**0.10**	**0.20**	**0.85**
	Vfpwidth	1.00	1.00	1.00	1.00	1.00	1.00
	Vrough	1.00	0.70	0.40	0.10	0.40	1.00
	Vfreq	0.10	0.80	0.80	0.80	0.80	0.80

biogeochemical	=	0.70	0.83	0.73	0.63	0.73	0.93
	Biogeochemical function mean score	0.67	0.39	0.58	0.30	0.26	0.85
	Vgalspwn	1.00	1.00	0.25	0.00	0.00	1.00
	Vgalqual	1.00	0.75	0.75	0.00	0.00	1.00
	Vgobspwn	1.00	0.10	0.10	0.10	0.20	0.80
habitat provision	=	1.00	0.43	0.14	0.05	0.10	0.90
	Vphyshab	1.00	0.37	0.63	0.71	0.29	0.84
	Vwatqual	0.72	0.00	0.04	1.00	0.00	0.97
	Vimper	1.00	0.30	0.30	0.00	0.30	0.30
habitat provision	=	0.93	0.26	0.40	0.60	0.22	0.74
	Habitat provision function mean score	0.97	0.34	0.27	0.33	0.16	0.82
	Vfish	0.60	0.30	0.30	0.30	0.30	0.30
Biodiversity	=	0.60	0.30	0.30	0.30	0.30	0.30
	Vmci	0.70	0.10	0.40	0.20	0.40	0.50
	Vept	1.00	0.10	0.40	0.10	0.20	0.80
Biodiversity	=	0.85	0.10	0.40	0.15	0.30	0.65
	Vvert	0.60	0.30	0.30	0.30	0.30	0.30
	Vinvert	1.00	0.64	0.70	0.64	0.64	1.00
Biodiversity	=	0.80	0.47	0.50	0.47	0.47	0.65
	Vripcond	0.60	0.30	0.10	0.10	0.10	0.60
	Vripconn	1.00	0.80	0.70	0.10	0.10	1.00
	Vripar	0.80	0.00	0.40	0.00	0.00	1.00
Biodiversity	=	0.80	0.37	0.40	0.07	0.07	0.87
	Biodiversity function mean score	0.76	0.31	0.40	0.25	0.28	0.62
Sum of scores (maximum value 16)		12.54	6.10	7.29	4.69	4.75	11.96
Overall mean SEV score (maximum value 1)		0.783	0.381	0.456	0.293	0.297	0.747

Kakariki

Function category	Variable (code)	Reference Value KC Ref 1	Current Value Kakariki	Current Potential Kakariki	Impact Culvert Kakariki	Impact Armour Kakariki	Mitigate Diversion Kakariki
	Vbed	1.00	0.50	0.50	0.10	0.50	0.50
	Verosn	1.00	0.70	0.70	1.00	1.00	0.70
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	1.00	0.60	0.60	0.55	0.75	0.60
	Vfpwidth	1.00	0.40	0.40	0.40	0.40	0.40
	Vfreq	0.10	0.40	0.50	0.40	0.40	0.80
Hydraulic	=	0.55	0.40	0.45	0.40	0.40	0.60
	Vbarr	1.00	1.00	1.00	1.00	1.00	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	1.00	1.00	1.00	1.00	1.00	1.00
	Vbed	1.00	0.50	0.50	0.10	0.50	0.60

Hydraulic	**=**	**1.00**	**0.50**	**0.50**	**0.10**	**0.50**	**0.60**
	Hydraulic function mean score	**0.89**	**0.63**	**0.64**	**0.51**	**0.66**	**0.70**
	Vshade	0.94	0.70	0.70	1.00	0.70	0.90
	Vdepth	1.00	0.80	0.80	0.80	0.80	1.00
	Vveloc	0.90	1.00	1.00	1.00	1.00	1.00
	Vlength	0.40	0.40	0.40	0.40	0.40	0.40
biogeochemical	**=**	**0.85**	**0.72**	**0.72**	**0.87**	**0.72**	**0.85**
	Vdod	1.00	0.15	0.40	0.20	0.20	0.80
biogeochemical	**=**	**1.00**	**0.15**	**0.40**	**0.20**	**0.20**	**0.80**
	Vcanop	0.85	0.20	0.30	0.10	0.20	0.70
	Vdecid	0.94	0.50	0.80	0.00	0.50	0.90
biogeochemical	**=**	**0.45**	**0.15**	**0.18**	**0.10**	**0.15**	**0.39**
	Vtrans	0.10	1.00	1.00	1.00	1.00	1.00
	Vretain	0.02	0.30	0.30	0.10	0.30	0.80
biogeochemical	**=**	**0.00**	**0.30**	**0.30**	**0.10**	**0.30**	**0.80**
	Vsurf	1.00	0.30	0.60	0.10	0.20	1.00
biogeochemical	**=**	**1.00**	**0.30**	**0.60**	**0.10**	**0.20**	**1.00**
	Vfpwidth	1.00	0.40	0.40	0.40	0.40	0.40
	Vrough	1.00	0.70	0.70	0.10	0.70	0.70
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
biogeochemical	**=**	**0.70**	**0.50**	**0.50**	**0.30**	**0.50**	**0.50**
	Biogeochemical function mean score	**0.67**	**0.35**	**0.45**	**0.28**	**0.34**	**0.72**
	Vgalspwn	1.00	0.00	0.00	0.00	0.00	0.00
	Vgalqual	1.00	0.75	0.75	0.70	0.00	0.75
	Vgobspwn	1.00	0.80	0.80	0.10	0.20	0.80
habitat provision	**=**	**1.00**	**0.40**	**0.40**	**0.05**	**0.10**	**0.40**
	Vphyshab	1.00	0.30	0.40	0.30	0.40	0.80
	Vwatqual	0.72	0.70	0.80	1.00	0.70	1.00
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	**=**	**0.93**	**0.58**	**0.65**	**0.65**	**0.63**	**0.90**
	Habitat provision function mean score	**0.97**	**0.49**	**0.53**	**0.35**	**0.36**	**0.65**
	Vfish	0.60	0.60	0.60	0.60	0.60	0.60
Biodiversity	**=**	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**
	Vmci	0.70	0.10	0.30	0.10	0.20	0.70
	Vept	1.00	0.11	0.20	0.11	0.11	0.40
Biodiversity	**=**	**0.85**	**0.11**	**0.25**	**0.11**	**0.16**	**0.55**
	Vvert	0.60	0.60	0.60	0.60	0.60	1.00
	Vinvert	1.00	0.40	0.50	0.40	0.40	1.00
Biodiversity	**=**	**0.80**	**0.50**	**0.55**	**0.50**	**0.50**	**1.00**
	Vripcond	0.60	0.30	0.60	0.10	0.30	0.80
	Vripconn	1.00	1.00	1.00	0.10	1.00	1.00
	Vripar	0.80	0.10	0.40	0.10	0.10	0.80
Biodiversity	**=**	**0.80**	**0.47**	**0.67**	**0.10**	**0.47**	**0.87**

	Biodiversity function mean score	**0.76**	**0.42**	**0.52**	**0.33**	**0.43**	**0.75**
Sum of scores (maximum value 16)		**12.54**	**7.26**	**8.36**	**5.72**	**7.16**	**11.45**
Overall mean SEV score (maximum value 1)		**0.783**	**0.454**	**0.523**	**0.358**	**0.448**	**0.716**

Maupoko

Function category	**Variable (code)**	Reference Value **KC Ref 1**	Current Value **Muaupoku Stream**	Current Potential **Muaupoku Stream**	Impact Culvert **Muaupoku Stream**	Impact Armour **Muaupoku Stream**	Mitigate Diversion **Muaupoku Stream**
	Vbed	1.00	0.70	0.70	0.10	0.50	0.70
	Verosn	1.00	0.70	0.70	1.00	1.00	1.00
	Vimper	1.00	1.00	1.00	0.10	1.00	1.00
Hydraulic	=	**1.00**	**0.70**	**0.70**	**0.06**	**0.75**	**0.85**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
Hydraulic	=	**0.55**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
	Vbarr	1.00	0.30	1.00	1.00	1.00	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	**1.00**	**0.30**	**1.00**	**1.00**	**1.00**	**1.00**
	Vbed	1.00	0.70	0.70	0.10	0.50	0.70
Hydraulic	=	**1.00**	**0.70**	**0.70**	**0.10**	**0.50**	**0.70**
	Hydraulic function mean score	**0.89**	**0.48**	**0.65**	**0.34**	**0.61**	**0.69**
	Vshade	0.94	0.40	0.40	1.00	0.40	0.80
	Vdepth	1.00	1.00	1.00	1.00	1.00	1.00
	Vveloc	0.90	1.00	1.00	1.00	1.00	1.00
	Vlength	0.40	0.40	0.40	0.40	0.40	0.40
biogeochemical	=	**0.85**	**0.60**	**0.60**	**0.90**	**0.60**	**0.80**
	Vdod	1.00	1.00	1.00	1.00	1.00	1.00
biogeochemical	=	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Vcanop	0.85	0.32	0.70	0.00	0.32	0.80
	Vdecid	0.94	0.05	0.20	0.00	0.05	0.90
biogeochemical	=	**0.45**	**0.31**	**0.63**	**0.00**	**0.31**	**0.44**
	Vtrans	0.10	0.10	0.10	0.10	0.20	0.10
	Vretain	0.02	0.02	0.02	0.10	0.02	0.02
biogeochemical	=	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**
	Vsurf	1.00	0.13	0.98	0.13	0.13	0.98
biogeochemical	=	**1.00**	**0.13**	**0.98**	**0.13**	**0.13**	**0.98**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vrough	1.00	0.70	0.70	0.10	0.70	0.70
	Vfreq	0.10	0.40	0.40	0.80	0.80	0.40
biogeochemical	=	**0.70**	**0.37**	**0.37**	**0.30**	**0.50**	**0.37**
	Biogeochemical function mean score	**0.67**	**0.40**	**0.60**	**0.39**	**0.43**	**0.60**
	Vgalspwn	1.00	1.00	1.00	0.00	0.00	1.00

	Vgalqual	1.00	0.75	0.75	0.00	0.00	0.75
	Vgobspwn	1.00	1.00	1.00	0.10	0.50	1.00
habitat provision	=	**1.00**	**0.88**	**0.88**	**0.05**	**0.25**	**0.88**
	Vphyshab	1.00	0.44	0.44	0.63	0.20	0.64
	Vwatqual	0.72	0.30	0.30	1.00	0.30	0.50
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	=	**0.93**	**0.55**	**0.55**	**0.81**	**0.42**	**0.69**
	Habitat provision function mean score	**0.97**	**0.71**	**0.71**	**0.43**	**0.34**	**0.78**
	Vfish	0.60	0.53	0.53	0.53	0.53	0.53
Biodiversity	=	**0.60**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**
	Vmci	0.70	0.30	0.40	0.30	0.30	0.70
	Vept	1.00	0.54	0.60	0.54	0.60	0.90
Biodiversity	=	**0.85**	**0.42**	**0.50**	**0.42**	**0.45**	**0.80**
	Vvert	0.60	0.53	0.53	0.53	0.53	0.53
	Vinvert	1.00	0.72	0.80	0.72	0.72	1.00
Biodiversity	=	**0.80**	**0.63**	**0.67**	**0.63**	**0.63**	**0.77**
	Vripcond	0.60	0.10	0.40	0.10	0.10	0.60
	Vripconn	1.00	0.80	1.00	0.10	0.80	1.00
	Vripar	0.80	0.20	0.40	0.00	0.20	0.90
Biodiversity	=	**0.80**	**0.37**	**0.60**	**0.07**	**0.37**	**0.83**
	Biodiversity function mean score	**0.76**	**0.49**	**0.58**	**0.41**	**0.49**	**0.73**
Sum of scores (maximum value 16)		**12.54**	**7.68**	**9.90**	**6.20**	**7.65**	**10.84**
Overall mean SEV score (maximum value 1)		**0.783**	**0.480**	**0.619**	**0.388**	**0.478**	**0.677**

Mazengarb WWT

Function category	**Variable (code)**	Reference Value **KC Ref 1**	Current Value **Mazengarb (WWTP)**	Current Potential **Mazengarb (WWTP)**	Impact Culvert **Mazengarb (WWTP)**	Impact Armour **Mazengarb (WWTP)**	Mitigate Diversion **Mazengarb (WWTP)**
	Vbed	1.00	0.50	0.50	0.10	0.50	1.00
	Verosn	1.00	0.20	1.00	1.00	1.00	1.00
	Vimper	1.00	0.50	0.50	0.50	0.50	0.50
Hydraulic	=	**1.00**	**0.18**	**0.38**	**0.28**	**0.38**	**0.50**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
Hydraulic	=	**0.55**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**
	Vbarr	1.00	0.00	1.00	1.00	1.00	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	**1.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**
	Vbed	1.00	0.50	0.50	0.10	0.50	0.50
Hydraulic	=	**1.00**	**0.50**	**0.50**	**0.10**	**0.50**	**0.50**
	Hydraulic function mean score	**0.89**	**0.22**	**0.52**	**0.39**	**0.52**	**0.55**

	Vshade	0.94	1.00	1.00	1.00	0.70	1.00
	Vdepth	1.00	0.80	0.80	0.80	0.80	0.80
	Vveloc	0.90	0.80	0.80	0.80	0.80	0.80
	Vlength	0.40	0.40	0.40	0.40	0.40	0.40
biogeochemical	**=**	**0.85**	**0.83**	**0.83**	**0.83**	**0.68**	**0.83**
	Vdod	1.00	0.70	0.70	0.70	0.70	0.70
biogeochemical	**=**	**1.00**	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**
	Vcanop	0.85	0.99	0.99	0.00	0.90	1.00
	Vdecid	0.94	0.40	0.78	0.00	0.40	1.00
biogeochemical	**=**	**0.45**	**0.79**	**0.60**	**0.00**	**0.72**	**0.50**
	Vtrans	0.10	0.40	0.40	0.10	0.20	0.60
	Vretain	0.02	1.00	1.00	0.10	0.20	1.00
biogeochemical	**=**	**0.00**	**0.40**	**0.40**	**0.01**	**0.04**	**0.60**
	Vsurf	1.00	0.16	0.36	0.10	0.24	0.80
biogeochemical	**=**	**1.00**	**0.16**	**0.36**	**0.10**	**0.24**	**0.80**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vrough	1.00	0.40	0.60	0.10	0.40	1.00
	Vfreq	0.10	0.40	0.40	0.40	0.40	0.40
biogeochemical	**=**	**0.70**	**0.27**	**0.33**	**0.17**	**0.27**	**0.47**
	Biogeochemical function mean score	**0.67**	**0.53**	**0.54**	**0.30**	**0.44**	**0.65**
	Vgalspwn	1.00	0.00	0.50	0.00	0.00	0.50
	Vgalqual	1.00	0.25	1.00	0.00	0.00	1.00
	Vgobspwn	1.00	1.00	1.00	0.10	0.20	1.00
habitat provision	**=**	**1.00**	**0.50**	**0.75**	**0.05**	**0.10**	**0.75**
	Vphyshab	1.00	0.57	0.70	0.77	0.31	1.00
	Vwatqual	0.72	0.42	0.42	1.00	0.40	0.42
	Vimper	1.00	0.50	0.50	0.50	0.50	0.50
habitat provision	**=**	**0.93**	**0.52**	**0.58**	**0.76**	**0.38**	**0.73**
	Habitat provision function mean score	**0.97**	**0.51**	**0.67**	**0.40**	**0.24**	**0.74**
	Vfish	0.60	0.37	0.37	0.37	0.37	0.37
Biodiversity	**=**	**0.60**	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**
	Vmci	0.70	0.00	0.00	0.00	0.00	0.40
	Vept	1.00	0.00	0.10	0.20	0.00	0.40
Biodiversity	**=**	**0.85**	**0.00**	**0.05**	**0.10**	**0.00**	**0.40**
	Vvert	0.60	0.37	0.37	0.37	0.37	0.37
	Vinvert	1.00	0.00	0.00	0.00	0.00	0.00
Biodiversity	**=**	**0.80**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**
	Vripcond	0.60	0.10	0.70	0.10	0.10	0.70
	Vripconn	1.00	0.80	0.80	0.10	0.80	0.80
	Vripar	0.80	1.00	0.80	0.00	0.00	0.80
Biodiversity	**=**	**0.80**	**0.63**	**0.77**	**0.07**	**0.30**	**0.77**
	Biodiversity function mean score	**0.76**	**0.30**	**0.34**	**0.18**	**0.21**	**0.43**
Sum of scores (maximum value 16)		**12.54**	**6.23**	**8.00**	**4.91**	**6.06**	**9.30**

Overall mean SEV score (maximum value 1)		0.783	0.389	0.500	0.307	0.379	0.581

Upper Drain 7

Function category	Variable (code)	Reference Value KC Ref 1	Current Value Upper Drain 7	Current Potential Drain 7 Upper	Impact Culvert Drain 7 Upper	Impact Armour Drain 7 Upper	Mitigate Diversion Drain 7 Upper
	Vbed	1.00	0.50	0.70	0.10	0.50	0.70
	Verosn	1.00	0.20	1.00	1.00	1.00	1.00
	Vimper	1.00	0.90	0.90	0.90	0.90	0.90
Hydraulic	=	**1.00**	**0.32**	**0.77**	**0.50**	**0.68**	**0.77**
	Vfpwidth	1.00	1.00	1.00	1.00	1.00	1.00
	Vfreq	0.10	0.10	0.40	0.40	0.40	0.40
Hydraulic	=	**0.55**	**0.55**	**0.70**	**0.70**	**0.70**	**0.70**
	Vbarr	1.00	0.30	1.00	1.00	1.00	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	=	**1.00**	**0.30**	**1.00**	**1.00**	**1.00**	**1.00**
	Vbed	1.00	0.50	0.70	0.10	0.50	0.70
Hydraulic	=	**1.00**	**0.50**	**0.70**	**0.10**	**0.50**	**0.70**
	Hydraulic function mean score	**0.89**	**0.42**	**0.79**	**0.57**	**0.72**	**0.79**
	Vshade	0.94	0.09	0.94	1.00	0.60	0.94
	Vdepth	1.00	1.00	1.00	1.00	1.00	1.00
	Vveloc	0.90	1.00	1.00	1.00	1.00	1.00
	Vlength	0.40	0.80	0.80	0.80	0.40	0.80
biogeochemical	=	**0.85**	**0.51**	**0.94**	**0.97**	**0.70**	**0.94**
	Vdod	1.00	0.00	0.00	0.00	0.00	0.00
biogeochemical	=	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Vcanop	0.85	0.04	0.20	0.00	0.40	0.80
	Vdecid	0.94	0.27	0.40	0.00	0.20	0.78
biogeochemical	=	**0.45**	**0.03**	**0.16**	**0.00**	**0.36**	**0.49**
	Vtrans	0.10	1.00	1.00	0.10	0.20	1.00
	Vretain	0.02	1.00	1.00	0.10	0.20	1.00
biogeochemical	=	**0.00**	**1.00**	**1.00**	**0.01**	**0.04**	**1.00**
	Vsurf	1.00	0.06	0.39	0.10	0.20	0.53
biogeochemical	=	**1.00**	**0.06**	**0.39**	**0.10**	**0.20**	**0.53**
	Vfpwidth	1.00	1.00	1.00	1.00	1.00	1.00
	Vrough	1.00	0.16	0.20	0.10	0.40	0.70
	Vfreq	0.10	0.10	0.40	0.80	0.80	0.40
biogeochemical	=	**0.70**	**0.42**	**0.53**	**0.63**	**0.73**	**0.70**
	Biogeochemical function mean score	**0.67**	**0.34**	**0.50**	**0.29**	**0.34**	**0.61**
	Vgalspwn	1.00	0.00	0.50	0.00	0.00	0.50
	Vgalqual	1.00	0.25	1.00	0.00	0.00	1.00
	Vgobspwn	1.00	0.10	0.10	0.10	0.20	0.80

habitat provision	**=**	**1.00**	**0.05**	**0.30**	**0.05**	**0.10**	**0.65**
	Vphyshab	1.00	0.07	1.00	0.73	0.30	1.00
	Vwatqual	0.72	0.00	0.00	1.00	0.00	0.00
	Vimper	1.00	0.90	0.90	0.90	0.90	0.90
habitat provision	**=**	**0.93**	**0.26**	**0.73**	**0.84**	**0.38**	**0.73**
	Habitat provision function mean score	**0.97**	**0.15**	**0.51**	**0.45**	**0.24**	**0.69**
	Vfish	0.60	0.30	0.30	0.30	0.30	0.30
Biodiversity	**=**	**0.60**	**0.30**	**0.30**	**0.30**	**0.30**	**0.30**
	Vmci	0.70	0.00	0.10	0.00	0.10	0.50
	Vept	1.00	0.09	0.10	0.09	0.10	0.80
Biodiversity	**=**	**0.85**	**0.05**	**0.10**	**0.05**	**0.10**	**0.65**
	Vvert	0.60	0.30	0.30	0.30	0.30	0.30
	Vinvert	1.00	0.14	0.20	0.14	0.14	0.80
Biodiversity	**=**	**0.80**	**0.22**	**0.25**	**0.22**	**0.22**	**0.55**
	Vripcond	0.60	0.60	0.70	0.10	0.10	0.70
	Vripconn	1.00	0.20	0.70	0.10	0.20	0.70
	Vripar	0.80	0.10	0.80	0.00	0.10	0.80
Biodiversity	**=**	**0.80**	**0.30**	**0.73**	**0.07**	**0.13**	**0.73**
	Biodiversity function mean score	**0.76**	**0.22**	**0.35**	**0.16**	**0.19**	**0.56**
Sum of scores (maximum value 16)		**12.54**	**4.87**	**8.60**	**5.53**	**6.14**	**10.43**
Overall mean SEV score (maximum value 1)		**0.783**	**0.304**	**0.537**	**0.345**	**0.384**	**0.652**

Lower Drain 7

Function category	**Variable (code)**	Reference Value **KC Ref 1**	Current Value **Drain 7**	Current Potential **Drain 7**	Impact Culvert **Drain 7**	Impact Armour **Drain 7**	Mitigate Diversion **Drain 7**
	Vbed	1.00	0.50	0.50	0.10	0.50	0.50
	Verosn	1.00	0.20	0.70	1.00	1.00	0.70
	Vimper	1.00	1.00	1.00	0.10	1.00	1.00
Hydraulic	**=**	**1.00**	**0.35**	**0.60**	**0.06**	**0.75**	**0.60**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vfreq	0.10	0.80	0.80	0.80	0.80	0.80
Hydraulic	**=**	**0.55**	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**
	Vbarr	1.00	0.30	0.40	0.30	0.30	1.00
	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	**=**	**1.00**	**0.30**	**0.40**	**0.30**	**0.30**	**1.00**
	Vbed	1.00	0.50	0.50	0.10	0.50	0.50
Hydraulic	**=**	**1.00**	**0.50**	**0.50**	**0.10**	**0.50**	**0.50**
	Hydraulic function mean score	**0.89**	**0.39**	**0.48**	**0.21**	**0.49**	**0.63**
	Vshade	0.94	0.55	0.55	1.00	0.55	0.80
	Vdepth	1.00	0.70	0.70	0.70	0.70	0.70

	Vveloc	0.90	0.80	0.80	0.80	0.80	0.80
	Vlength	0.40	0.40	0.40	0.40	0.40	0.40
biogeochemical	=	**0.85**	**0.59**	**0.59**	**0.82**	**0.59**	**0.72**
	Vdod	1.00	0.28	0.40	0.28	0.28	0.83
biogeochemical	=	**1.00**	**0.28**	**0.40**	**0.28**	**0.28**	**0.83**
	Vcanop	0.85	0.50	0.70	0.00	0.50	0.70
	Vdecid	0.94	0.10	0.30	0.00	0.10	0.70
biogeochemical	=	**0.45**	**0.48**	**0.60**	**0.00**	**0.48**	**0.46**
	Vtrans	0.10	0.70	0.70	0.10	0.10	0.70
	Vretain	0.02	0.20	0.30	0.10	0.20	0.80
biogeochemical	=	**0.00**	**0.14**	**0.21**	**0.01**	**0.02**	**0.56**
	Vsurf	1.00	0.20	1.00	0.10	0.20	1.00
biogeochemical	=	**1.00**	**0.20**	**1.00**	**0.10**	**0.20**	**1.00**
	Vfpwidth	1.00	0.00	0.00	0.00	0.00	0.00
	Vrough	1.00	0.55	0.70	0.10	0.70	0.80
	Vfreq	0.10	0.80	0.80	0.80	0.80	0.80
biogeochemical	=	**0.70**	**0.45**	**0.50**	**0.30**	**0.50**	**0.53**
	Biogeochemical function mean score	**0.67**	**0.36**	**0.55**	**0.25**	**0.34**	**0.68**
	Vgalspwn	1.00	0.00	0.00	0.00	0.00	1.00
	Vgalqual	1.00	0.25	0.75	0.00	0.00	0.75
	Vgobspwn	1.00	1.00	1.00	0.10	0.30	1.00
habitat provision	=	**1.00**	**0.50**	**0.50**	**0.05**	**0.15**	**0.88**
	Vphyshab	1.00	0.31	0.40	0.31	0.40	0.80
	Vwatqual	0.72	0.40	0.50	1.00	0.40	0.70
	Vimper	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	=	**0.93**	**0.51**	**0.58**	**0.66**	**0.55**	**0.83**
	Habitat provision function mean score	**0.97**	**0.50**	**0.54**	**0.35**	**0.35**	**0.85**
	Vfish	0.60	0.20	0.30	0.20	0.20	0.40
Biodiversity	=	**0.60**	**0.20**	**0.30**	**0.20**	**0.20**	**0.40**
	Vmci	0.70	0.10	0.20	0.10	0.10	0.60
	Vept	1.00	0.20	0.20	0.10	0.10	0.60
Biodiversity	=	**0.85**	**0.15**	**0.20**	**0.10**	**0.10**	**0.60**
	Vvert	0.60	0.30	0.40	0.30	0.30	0.50
	Vinvert	1.00	0.40	0.50	0.40	0.40	0.80
Biodiversity	=	**0.80**	**0.35**	**0.45**	**0.35**	**0.35**	**0.65**
	Vripcond	0.60	0.10	0.30	0.10	0.10	0.70
	Vripconn	1.00	1.00	1.00	0.10	1.00	1.00
	Vripar	0.80	0.10	0.30	0.00	0.10	0.80
Biodiversity	=	**0.80**	**0.40**	**0.53**	**0.07**	**0.40**	**0.83**
	Biodiversity function mean score	**0.76**	**0.28**	**0.37**	**0.18**	**0.26**	**0.62**
Sum of scores (maximum value 16)		**12.54**	**5.79**	**7.76**	**3.78**	**5.77**	**10.77**
Overall mean SEV score (maximum value 1)		**0.783**	**0.362**	**0.485**	**0.236**	**0.360**	**0.673**

ANNEXURE G: SUMMARY SHEET FOR EACH WATERWAY AFFECTED BY THE PROJECT

1. Hadfield Drain/Kowhai Stream

Origins

- Assume was a natural stream but historically channelized and modified. Cuts through large areas of peats and consolidated sands.
- Little or no maintenance apparent.

Summary of Values

At location of alignment, low value.

- Bed of gravel and sand with sediments. Stream surrounded by dairy and pine shelterbelts.
- Physical Habitat = L. SEV = 0.4 (50% of reference site).
- Riparian vegetation = pasture, weedland, mature pine
- An MCI of 77 (fair) and QMCI of 4.7 (fair).
- Two species of fish. IBI score of 18 (poor).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	short fin eel (1), banded kokopu (21)
FFDB 1990 to present (full stream)	No data for this water body

General Description

At the alignment the waterway lies under a shelterbelt pine canopy, stock fenced, with an understory of rank grass, ferns and areas of blackberry. At the time of sampling the existing culvert entrance beneath SH1 was inundated with monkey musk limiting flow.

The stream has sharply channelised banks (stable) typical of a managed farm drain, with a pebbled sandy substrate in some locations and sediment deposits in others. Stream depth varies from 0.3 to 0.4 m, with an average channel width of 1.5 m.

The habitat is very simple with relatively uniform run (20%), pool (80%) with low velocity flow.

Eventual removal of plantation pines is likely to have a significant effect on this waterway which would obscure any construction effects.

Scale of works

- Channel realignment and replacement of existing culverts at SH1 / NIMT.
- Reclamation and diversion to a new channel in some areas. Small areas of planting but not a primary site for mitigation.

Works Monitoring

- Ecologically we do not believe monitoring is justified during construction.
- Fish recovery will be needed at any diversion.

Mitigation Monitoring

- No mitigation works proposed.

2. Paetawa Drain

Origins

- A main drain of a network of drains cut through large areas of peat.
- This and associated drains regularly cleared by landowner to maintain stream flows.

Values

At location of alignment, low value.

- Physical Habitat = L. SEV = 0.49 (63% of reference site).
- Bed of deep muds and sediments. Stream surrounded by dairy, both sides.
- Riparian vegetation = weedland and pasture.
- An MCI of 88 (fair) and QMCI of 4.4 (fair).
- Three species of fish and IBI score of 30 (fair).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	Banded kokopu (7), long fin eel (8), smelt (8)
FFDB 1990 to present (full stream)	No data for this water body

General Description

The Paetawa Drain is a channelised waterway, sourced from within a predominantly plantation pine catchment east of SH1. At the sampling site the drain waterbody runs through pasture, partially stock fenced but stock access is apparent.

Stream bank vegetation is made up of pastoral weeds (almost entirely covering the waterway over the summer months) with occasional Carex geminata. Much of the stream banks are under cut, heavily grazed and pugged. The substrate is deep mud (up to 50 cm) over sand. The water is made up of pools with occasional runs.

Downstream of the sampling site this drain waterbody combines with a number of other lowland farm drains before entering Ngarara Stream and to eventuate as part of the Te Harakeke / Kawakahia Wetland system. The Paetawa Drain is regularly cleared to maintain stream flows.

Scale of works

- Some significant lengths of diversion to new channels.
- Bridge crossing over main channel.
- Focus area for stream and wetland mitigation (upstream).

Works Monitoring

- Proposed to monitor bugs immediately prior to confluence with Kakariki Stream.
- Fish rescue will be needed at all diversions.

Mitigation Monitoring

- Monitoring of diversion success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.

3. Smithfield Drain

Origins

- Formed drain through large areas of peat.
- Evidence of some historical maintenance and recent KCDC maintenance north of Smithfield Road.

Values

At location of alignment, low value.

- Bed of silts and peats. Stream surrounded by dairy.
- Physical Habitat = L. SEV = 0.38 (49% of reference site).
- Riparian vegetation pasture, weedland.
- An MCI of 70 (poor) and QMCI of 2.7 (poor).
- 2 species of fish and IBI score of 16 (very poor).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	Shortfin eel (1), longfin eel (2)
FFDB 1990 to present (full stream)	No data for this water body

General Description

Highly modified drain cut through peatlands which would originally have been extensive wetlands. The drain is choked with aquatic weeds, and surrounded by wet pasture with Juncus.

Deep muds predominate and there is unrestricted cattle access.

Scale of works

- Some significant lengths of diversion to new channels (almost entire length).
- Large flood storage area through which a new stream will pass will be the focus for stream and wetland mitigation in this area.

Works Monitoring

- Main drain is either diverted into new channels or untouched. Ecologically we do not believe monitoring is justified during construction.
- Fish rescue will be needed at all diversions.

Mitigation Monitoring

- Monitoring of diversion success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.

4. Kakariki Stream

Origins

- Natural stream but channelised along an access road.
- Subject of extensive historical riparian planting by councils and community groups.

Values

At location of alignment, low value.

- Bed of silts and peats. Stream surrounded by dairy.
- Physical Habitat = L. SEV = 0.454 (58% of reference site).
- Riparian vegetation Pasture, weedland / exotic scrub (gorse).
- An MCI of 77 (Fair) and QMCI of 4.5 (Fair).
- 4 species of fish and IBI score of 37 (good).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	longfin eel (2), shortfin eel (1), common bully (3),smelt (16), waitbat & elver (8).
FFDB 1990 to present (full stream)	long fin eel*, short fin eel, banded kokopu, giant kokopu, inanga , Cran's, common, giant and redfin bully.

General Description

At the sampling site, the Kakariki Stream is a channelised stream with high quality upstream components, which add to its potential ecological values. The habitat type consists of 80% run and 20% back water combined with in-stream macrophyte (monkey musk, watercress, water pepper) which provides good fish cover. The substrate type consists of fine gravels, and sands with fine sediments (not anoxic).

Water quality monitoring show elevated turbidity, low dissolved oxygen and pH indicative of organic matter and degradation.

Connects Nga Manu to Te Harakeke wetland. Nga Manu Nature Reserve has undertaken riparian planting along both sides of the Stream at the location of the sampling site.

Scale of works

- Will be crossed by two bridges and a small associated diversion.
- Focus area for stream and wetland mitigation upstream.

Works Monitoring

- Sampling bugs upstream and downstream of works and at Te Harakeke Wetland.

Mitigation Monitoring

- Monitoring of riparian revegetation success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.

5. Ngarara Creek

Origin

- Formed drain through peats and sand country.
- Maintained by excavator, recent plantation pine clearance at sample site.

Values

At location of alignment, low value.

- Bed of silts and peats. Stream surrounded by dairy.
- Physical Habitat = L. SEV = 0.294 (37% of reference site).
- Riparian vegetation Pasture / weedland / Macrocarpa treeland
- An MCI of 75 (Poor) and QMCI of 4.3 (Fair).
- 2 species of fish and IBI score of 16 (very poor).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	longfin eel (1), shortfin eel (1), elver (6)
FFDB 1990 to present (full stream)	long fin eel*, short fin eel, banded kokopu giant bully, inanga

General Description

Occasional ferns and mahoe occur on stream banks, but recent clearing of the plantation pine has damaged the riparian vegetation and rendered much of the stream bank unstable. The sampling site was separated by a low gradient culvert under a farm track, which allows for fish passage.

Downstream of the culvert the drain has deeply incised banks with still backwater and pool habitat under pine forest. The pool habitat of this portion of the waterbody, combined with the excessive pine leaf litter, traps suspended solids, rendering the water dark red/brown in colour. The stream bed sediments consequently have become highly anoxic in this zone, and while the in-stream debris would normally provide good habitat for fish, the water quality is severely degraded.

The average depth is 0.1m. Max depth is 0.27 m, with average width of 1.6m, with a substrate of silt/sand.

The upstream section of Ngarara Creek is subject to regular stream maintenance to improve flows. At the time of this survey, the stream had recently been cleared

Scale of works

- Will be culverted.

Works Monitoring

- Ecologically we do not believe monitoring is justified.
- Fish rescue will be needed at all diversions.

Mitigation Monitoring

- No mitigation works proposed.

6. Waimeha Stream

Origins

- Natural spring fed stream but moved from original alignment and channelised.
- Twice annual stream maintenance by excavator to remove weeds and maintain flows (photo taken immediately post clearance).

Values

At location of alignment, low value.

- Bed of muddy substrate over sand. Stream urbanised south bank, farmland and regeneration on north bank.
- Physical Habitat = L. SEV = 0.34 (44% of reference site).
- Riparian vegetation, grasses & weedland with some revegetation upstream.
- An MCI of 78 (Poor) and QMCI of 4.7 (Fair).
- 2 species of fish and IBI score of 14 “very poor”. Recent disturbance may have affected score.

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	shortfin eel (1), common bully (1), elver (9)
FFDB 1990 to present (full stream)	Shortfin eel, longfin* eel, giant and banded kokopu, inanga, common bully, redfin bully* and giant bully

General Description

A large (5 m wide) stream in a mix of urban back yard and rural land. Parts of the urban section of this stream has a riparian vegetation buffer and is a backyard feature for many bordering properties. Downstream riparian vegetation was made up of pasture grass (grazed to the edge), *Carex geminata* and blackberry, with a few willows. No riparian fencing was present. Along the sampled reach, the habitat consists of run pool 80%/20% flow. Water quality studies show elevated nutrients, bacteriological counts.

The Waimeha Stream is listed by GWRC as containing habitat for threatened indigenous fish species and being habitat for six or more indigenous fish species in the catchment, and is listed as having inanga spawning habitat in the catchment.

Scale of works

- Three bridges will cross floodplain. Close proximity to large area of earthworks associated with Te Moana interchange.
- Stream works associated with floodplain management and installation of bridge embankments.

Works Monitoring

- Ecologically we do not believe monitoring is justified. Assume will continue to be managed by GWRC as at present

Mitigation Monitoring

- No mitigation works proposed.

7. Waikanae River

Origins

- A natural river, but areas subject to GWRC gravel extraction, rip rap and willow management, floodplain modification.

Values

- Bed of gravels.
- Highest value in the alignment, regionally recognised and ecologically significant.
- Physical Habitat = M. SEV = 0.66 (85% of reference site).
- Riparian vegetation Native shrubs, grasses, weedland, willow.
- An MCI of 116 (Good) and QMCI of 6.4 (Excellent).
- 6 species of fish and IBI score of 40 (good).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (1), short fin eel (10), common bully (9), red fin bully (3),Inanga (3), flounder (2), whitebait & elver (10)
FFDB 1990 to present (full stream)	long fin eel*, short fin eel, common bully, red fin bully*,Inanga*, flounder, yellow eyed mullet, Torrentfish*, brown trout, lamprey, inanga*,

General Description

The river width ranges from 15-20 m wide at the proposed Waikanae River bridge location. The substrate is made up of a combination of cobbles, pebbles and gravels, with excellent fish habitat provided by the presence of pool, run, riffle and cascades throughout the channel length.

The river is buffered by KCDC Council reserve-land until it reaches the coast. Riparian vegetation within the sampling site is made up of native forest (much of which is enhancement planting by local community groups), exotics (willows) and flood control planting.

Water quality sampling suggests generally good quality, with just periodic exceedences of zinc, nutrients, E Coli and acid soluble aluminium. SKM (2010) state the background soil concentrations of aluminium are the likely cause of the elevated levels of this metal in storm water. SOE faunal studies have returned a range of results since 1999.

Scale of works

- Construction of bridge piers and channel widening for flood control. Will require temporary diversions of the channel over approx 160 m metres.
- The new floodplain and terrace risers will be treated in relation to amenity and flood management.

Works Monitoring

- Within works area to monitor recovery following diversions.
- At estuary to monitor potential construction effects.

Mitigation Monitoring

- No mitigation works proposed.

8. Muaupoko Stream

Origins

At location of works, natural stream but may have been channelised.

No obvious maintenance by excavator.

Values

- Bed of sands.
- Physical Habitat = M. SEV = 0.48 (61% of reference site).
- Riparian vegetation = pasture / restoration planting (8-10 yrs old)
- An MCI of 88 (Fair) and QMCI of 4.2 (Fair).
- 5 species of fish and IBI score of 32 (fair).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (1), short fin eel (3), common bully (2), Inanga (23), smelt (8), elver (9).
FFDB 1990 to present (full stream)	No specific recordings

General Description

At the sampling site, long pasture grasses and exotics (willow and blackberry) dominate the bank side vegetation. This portion of the stream had stable vegetated banks, and in-stream macrophyte provided good fish cover

Below the culvert/public walkway, the stream flows through part of the Waikanae River restoration area, with riparian plantings of planted species, amongst occasional willow.

This portion of the stream has very unstable sand banks with no vegetation. The stream measures approximately 2m wide with depths ranging from 0.30–0.70 m. The stream substrate consists of fine gravels, sand with areas of fine mud deposits.

Scale of works

- Diversion of the lower 30-50 m of stream above the confluence with the Waikanae.

Construction monitoring

- Fish rescue will be needed at diversion.

Mitigation monitoring

- Monitoring of diversion success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.
- In addition, fish passage from the Waikanae to Muaupoko through new confluence channel

9. Mazengarb Drain (WWTP)

Origins

Formed drain through sand country associated with waste water treatment plant.

The channel is maintained by excavator annually or biannually to maintain flow and control weeds.

Values

- Low value drain flowing through highly modified wetland dominated by blackberry.
- Bed of muds.
- Physical Habitat = L. SEV = 0.39 (50% of reference site).
- Riparian vegetation weedland (blackberry)
- An MCI of 41 (Poor) and QMCI of 1.7 (Poor).
- 3 species of fish and IBI score of 22 (poor).

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (15), short fin eel (61), common bully (1), elver (13).
FFDB 1990 to present (full stream)	No specific recordings

General Description

Receiving the outflows of the treatment plant the surveyed section of the drain is a regular sided, 5-8m wide, 0.5m deep, soft bottomed drain surrounded by a pine plantation (riparian). More recently the riparian pine has been thinned (chopped down) and the stream is relatively open along its riparian edges. The bed has deep muddy and algae drifts over a sandy-muddy bottom with numerous woody debris. While abundant in eel the general water and habitat condition is poor and habitat variety (substrate, water and bank) low.

Scale of works

- Culverted crossing.
- Focus area for stream replanting and a new wetland area.

Construction Monitoring

- Ecologically we do not believe construction monitoring is justified.

Mitigation monitoring

- Monitoring of diversion success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.

10. Mazengarb Stream

Origin

- Drain through peats.
- No obvious maintenance at site of works

Values

- Bed of muds. Stream urbanised.
- Physical Habitat = L. SEV = 0.37 (48% of reference site).
- Riparian vegetation pasture, weedland, exotic treeland (macrocarpa)
- An MCI of 68 (Poor) and QMCI of 4.5 (Fair).
- 3 species of fish and IBI score of "poor".

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (2), short fin eel (3), common bully (11), elvers (18)
FFDB 1990 to present (full stream)	No specific data for this site

General Description

A natural stream that has been extensively modified upstream of works by upgrade works at SH1 and NIMT, stream diversion works through a series of large open artificial ponds, and a residential subdivision.

The Mazengarb Stream is a tributary of the Waikanae River. It has a number of point source discharges of contamination in its catchment including potentially the Otaihanga Landfill and Paraparaumu Waste Water Treatment Plant, with the WWTP Drain entering the Mazengarb Stream just downstream of the sampling location.

At the sampling location, the stream flows beneath an old stand of macrocarpa and pine, with a thick mat of *Tradescantia fluminensis* covering the stream banks to the water's edge. The substrate is predominantly muds over sand.

Water quality is generally 'poor' with many water quality parameters and metal contaminants at levels which did not meet the relevant guideline values. In general, the stormwater samples had low dissolved oxygen, and elevated E coli, acid soluble aluminium (Al), and both dissolved copper (Cu) and zinc (Zn).

Scale of works

- Stream to be culverted.

Construction monitoring

- Ecologically we do not believe monitoring is justified.
- Fish rescue will be needed at all diversions.

Mitigation monitoring

- No mitigation works proposed.

11. Wharemauku Stream

Origin

- Natural stream that has been channelized and modified for flood capacity associated with urbanisation of catchment.
- Regularly maintained by mower.

Values

- Bed of gravels. Stream urbanised.
- Physical Habitat = M. SEV = 0.44 (56% of reference site).
- Riparian vegetation pasture / macrophyte weedland
- An MCI of 90 (Fair) and QMCI of 3.7 (Poor).
- 4 species of fish and IBI score of "poor".

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (16), short fin eel (2), inanga (2), common bully (5), elver (6)
FFDB 1990 to present (full stream)	Yellow eyed mullet, shortfin eel, longfin eel*, torrent fish*, koaro, giant kokopu banded kokopu, inanga*, shortjaw kokopu, lamprey, redfin bully*, smelt, black flounder

General Description

The Wharemauku Stream is a highly modified urban drain, channelised and influenced by urban (Paraparaumu Town) and industrial activities, as well as discharge from adjoining drains from peat lands and residential areas.

The substrate comprises embedded cobbles and sand with a run/pool habitat with little instream debris. Despite being highly modified, the Wharemauku Stream does provide valuable habitat and is a known migratory pathway for many native fish species.

Riparian vegetation consists of grasses and water weeds e.g. water pepper, Willow weed, swamp willow herb (but there are no shade trees).

Water quality is generally 'poor' with some evidence of localised degradation of the stream bed sediments. Acid soluble aluminium and dissolved copper and dissolved zinc were also elevated relative to the ANZECC (2000) guideline at the 95% level of detection.

Scale of works

- No earthworks in close proximity due to bridging and allowance for future roading underpass and walkway and flooding.

Works monitoring

- A potential issue is effect on aquifer and stream flows of forming significant flood storage areas to the south.
- Ecologically we do not believe monitoring is justified.

Mitigation monitoring

- No mitigation works proposed.

12. Drain 7 (lower)

Origins

- A formed drain in peat.
- No signs of regular maintenance, but known to have been historically managed by KCDC.

Values

- Physical Habitat = L. SEV = 0.36 (46% of reference site).
- Riparian vegetation Pasture / willows
- An MCI of 90 (Fair) and QMCI of 3.7 (Poor).
- 3 species of fish and IBI score of "poor".

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (3), short fin eel (5),inanga (14), whitebait (33), elvers (4)
FFDB 1990 to present (full stream)	No specific data for this site

General Description

Very low value, vegetation highly modified weed field. Freshwater community highly robust and unlikely to be adversely affected.

Scale of works

- One crossing by culvert (in location of existing culvert).
- A diversion from a linear channel to meandering stream for ecological mitigation west of M2PP alignment is proposed.
- A focus site for stream restoration and use of flood storage for wetland development.

Works Monitoring

- No monitoring of construction effects on in stream values proposed.

- Fish rescue will be needed at all diversions.

Mitigation Monitoring

- Monitoring of diversion success at 4 and 10 years following successful establishment of riparian planting and stabilisation of stream bed and banks.

13. Drain 7 (upper)

Origins

- A formed drain in peat.
- Regularly maintained by excavator (annually or bi-annually) managed by machine to maintain flows and control weeds.

Values

- Physical Habitat = L. SEV = 0.3 (39% of reference site).
- Riparian vegetation Pasture / willows
- An MCI of 90 (Fair) and QMCI of 3.7 (Poor).
- 3 species of fish and IBI score of "poor".

Catchment	Fish species
BML 2010 / 2011 (project footprint only)	long fin eel (3)
FFDB 1990 to present (full stream)	No specific data for this site

General Description

Very low value, vegetation highly modified weed field. Freshwater community highly robust and unlikely to be adversely affected.

Scale of works

- Extent of earthworks in vicinity is small.
- One crossing by culvert (in location of existing culvert).

Works Monitoring

- No monitoring of construction effects on in stream values proposed.
- Fish rescue will be needed at all diversions.

Mitigation Monitoring

- No mitigation works proposed.

14. Whareroa Drain

Origin

- At the site of works, an historic drain cut through peat swamps in QE Park.
- Regularly maintained by excavator.

Values

- Physical Habitat = L. SEV = 0.28 (36% of reference site).
- Riparian vegetation Pasture / shrubs (manuka, gorse)
- MCI 81 (Poor), QMCI 3.7 (Poor)
- Fish IBI is 16 (Very poor)

General Description

These headwater drains are seasonally wet depressions and in most cases summer dry or ephemeral.

Where they lie along SHI and NIMT they are managed as part of road infrastructure.

These drains form the northern headwaters of a more natural stream which discharges to the coast, although waterbody connections are almost entirely subsurface flows.

Scale of works

- Alignment only affects the small drain to the north. Potential for sediment to move down these channels to the main stem is minimal and we consider risk of direct and indirect effects are negligible.

Works Monitoring

- No construction monitoring is proposed.

Mitigation Monitoring

- No mitigation works proposed.

15. Whareroa Stream

No longer affected by project footprint

Origin

- Probably a natural stream but highly modified and channelised.
- Regularly maintained by excavator.

Values

- Physical Habitat = L. SEV = 0.54 (69% of reference site).
- Riparian vegetation Pasture / shrubs (gorse)
- MCI Fair (96), QMCI Fair (4.3)
- Fish IBI = Good (36)

General Description

The natural stream that receives flows from these drains is valued as one of the better waterways along the alignment; however, it will not be directly affected.

Scale of works

- Nil

Works Monitoring

- Nil

Mitigation Monitoring

- No mitigation works proposed