Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

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 **Graham Levy** (Hydrology) for the NZ Transport Agency

Dated: 30 August 2012

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STATEMENT OF EVIDENCE OF GRAHAM LEVY FOR THE NZ TRANSPORT AGENCY

QUALIFICATIONS AND EXPERIENCE

1 My full name is Graham John Levy.

2 I am a Technical Director – Water Resources Engineering, in the firm of Beca Infrastructure Limited. I have had 37 years of professional experience in water resources engineering, and in the assessment of the hydrological and hydraulic effects of infrastructure projects on the water environment.

3 I have a Master of Engineering (Civil) degree from the University of Canterbury specialising in hydrology and hydraulics.[1] I am a Chartered Professional Engineer and a Member of IPENZ,[2] a member of the New Zealand Water and Waste Association, and a member of the New Zealand Hydrological Society.

4 I have experience in highway stormwater design and consenting from my involvement in many highway and motorway projects in Auckland, Bay of Plenty, Waikato, Hawke Bay, and Canterbury. I have also participated in the consenting of comprehensive stormwater management plans for a number of urban growth areas, including East Tamaki (Auckland), and Papamoa/Wairakei (Tauranga).

5 In 2008/09, I provided an expert review for the Kāpiti Coast District Council of their hydrological assessment of the Wharemauku Catchment, related to their defence in the Environment Court of flood hazard zoning in that catchment.

6 My evidence is given in support of the Notice of Requirement (*NoR)* and applications for resource consent lodged with the Environmental Protection Authority (*EPA)* by the NZ Transport Agency (*NZTA*) for the construction, maintenance and operation of the MacKays to Peka Peka Expressway (*the Project)*.

7 I am familiar with the area that the Project covers and the State highway and local roading network in the vicinity of the Project. I have visited most of the route, and all the areas where significant

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[1] Hydrology (in this context) encompasses the process of rain falling onto land, and estimation of the timing and magnitude of the resulting runoff to watercourses. Hydraulics encompasses the physics of determining the velocity, depth and extent of the flow in and adjacent to the watercourses, using the hydrological estimation of the flow reaching the watercourses over time.

[2] Institution of Professional Engineers New Zealand.

stormwater management infrastructure and waterway crossings will be built.

8 I am the reviewer of the Assessment of Hydrology and Stormwater Effects technical report which formed part of the Assessment of Environmental Effects (*AEE)* lodged in support of the Project.[3]

9 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

10 My evidence will deal with the following:

10.1 Executive summary;

10.2 Background and role;

10.3 The existing hydrological environment;

10.4 Design approach to stormwater management and watercourse crossings, hydrological and hydraulic modelling;

10.5 The interrelationship between construction stormwater and long term operational stormwater;

10.6 Assessment of stormwater discharge quality, hydrological and hydraulic effects of the Project;

10.7 Response to submissions;

10.8 Response to section 149G Key Issues Reports;

10.9 Proposed conditions; and

10.10 Conclusions.

[3] Technical Report 22.

EXECUTIVE SUMMARY

11 The proposed Expressway crosses a coastal plain, with the topography varying from sand dunes to areas of low-lying peat. Many of the low-lying areas are flood prone.

12 There are many watercourses flowing across the route from east to west, varying from minor drains through to urban and rural streams, with the largest watercourse being the Waikanae River. Some of these watercourse catchments extend up into the coastal hills, while others originate on the coastal plain.

13 The potential hydrological and hydraulic effects of the Project include:

13.1 Increased volume and peak rate of runoff from the Expressway footprint, leading to increased flooding outside the designation;

13.2 Loss of existing flood plain storage due to the Expressway embankment, leading to increased flood levels outside the designation;

13.3 Watercourse crossings potentially constraining the passage of flood flows (leading to increased flooding upstream), causing localised erosion of the bed, and inhibiting fish passage; and

13.4 Discharge of stormwater from the Expressway reducing water and sediment quality in receiving watercourses.

14 The Project has been designed as far as practicable to avoid these potential effects, and to minimise any residual effects. Design features to achieve this include:

14.1 The use of swales (planted in wetland species in low-lying areas, and grassed in more elevated dry sections of the route) for conveyance, treatment and attenuation of Expressway stormwater runoff;

14.2 Swales discharging attenuated flows to each watercourse encountered, to avoid concentrating discharges, and with appropriate protection of the outlets to avoid localised erosion;

14.3 The creation of offset flood storage areas to mitigate the effects of lost flood plain storage;

14.4 The use of wetlands for treatment and attenuation where swales are not suited to the topography or there are critical space constraints; and

14.5 The design of culverts with the invert set below natural watercourse bed level to facilitate fish passage, sized to minimise headloss[4] in major floods, and the inlets and outlets protected to avoid localised erosion.

15 Further, the design includes the following features to address other potential effects:

15.1 The Waikanae River bridge will span the full effective flood plain width to avoid constriction of flood flows, and Greater Wellington Regional Council (*GWRC*) has had the Waikanae waterway design independently peer reviewed;[5]

15.2 A residual overflow path from the Waikanae River to the Waimeha Stream, identified in the Kāpiti Coast District Council (*KCDC*) District Plan, will be managed through a much longer bridge at the Te Moana interchange than is needed for the Waimeha Stream and Te Moana Road, to provide an appropriate alternative flow path;

15.3 Watercourse diversions have been designed to achieve high quality ecological characteristics;

15.4 Where appropriate, flood offset storage areas (to which untreated Expressway stormwater runoff will not be discharged) will be wetland planted and designed to function as ecological areas;

15.5 The design takes climate change (increased rainfall and sea level rise) into account, in accordance with Ministry for the Environment (MfE) and KCDC guidelines; and

15.6 The designs for most of the route have been tested in the hydraulic models previously developed by KCDC and GWRC, to demonstrate that effects have been adequately addressed.

16 With these measures in place, it is my opinion that potential hydrological and hydraulic effects of the proposed Expressway will be largely avoided, and the residual effects will be local and minor.

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[4] "Headloss" is the loss of energy of the flow as it passes through a culvert or a watercourse reach. It is closely approximated to the change in water level from upstream to downstream.

[5] Technical Report 22, Appendix 22.H.

17 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

18 My role in the Project has been to provide leadership and guidance for the concept development and design work relating to all aspects of the Project's stormwater management, the hydraulic design of watercourse crossings, and the management of flood risk both for the proposed Expressway and where there are potential effects on land outside the proposed designation.

19 Specifically:

19.1 I was responsible for the technical oversight of all stormwater management and flood risk assessment work leading to the preparation of the AEE in respect of stormwater discharge, on behalf of the NZTA for the Project.

19.2 I was the reviewer of, and provided technical input during the investigation and design phase into, the preparation of Technical Report 22, which related to hydrology and stormwater management, and formed part of the AEE.

19.3 The hydrological and hydraulic modelling of the wider catchments, to test the effects of the proposed Expressway and performance of remedial measures, was undertaken by independent specialists who were already modelling these areas for KCDC and GWRC.[6] I was involved in the briefing of these specialists and in the review of their results, but they have been responsible for their own internal verification of their modelling analysis.

19.4 I have been involved in stakeholder and community consultation at various stages through the Project development process. This includes ongoing detailed technical discussions with KCDC and GWRC (Flood Protection), attendance at Project open days, and specific meetings with Waikanae On One (*WOO*). I have also provided technical input to responses to public queries.

[6] Wharemauku, Waimeha to Paetawa, by SKM for KCDC; Mazengarb by SKM and River Edge Consultants for KCDC; Waikanae River by River Edge Consultants for GWRC.

19.5 I have visited most parts of the proposed route, and the associated watercourses, as and where access allowed. I have focussed these visits on areas that are more sensitive to hydrological and hydraulic effects, and where the stormwater discharges might affect wetlands and watercourse ecology.

20 Hydrology and stormwater management inherently has strong interactions with a number of other disciplines, and the designs have been carried out with close coordination with other experts. In particular, my work has drawn on the work on alignment and earthworks design (**Mr Nancekivell**), aquatic ecology (**Dr Keesing**), wetlands and terrestrial ecology (**Mr Park**), landscape design (**Mr Evans**) and groundwater (**Ms Williams**), but has also involved working closely with many other specialists.

EXISTING ENVIRONMENT

21 The existing environment, in so far as it is relevant to the hydrological and hydraulic context of the Project, is described in Section 3 of Technical Report 22.

22 In summary, the route crosses a coastal plain, with a mix of sand dunes interspersed with low-lying peat flats and hollows. There are several larger watercourses that flow down from hill valleys in the east, plus local streams and drains originating on the plain or the western-facing hill slopes. The watercourse system is illustrated in Drawings CV-SW-010 and -011, and the watercourses and flood risk areas relative to the proposed Expressway are shown in more detail in Drawings CV-SW-022 to 031.[7]

23 The two largest catchments with watercourses crossing the route are, in order of size, the Waikanae River and Wharemauku Stream. However, some of the other watercourses also carry substantial flood flows. The mean and low flow characteristics of the main watercourses are set out in Appendix 22.C of Technical Report 22, while a full list of the crossings and their catchment areas is provided at Appendix 22.B of that Report.

24 Most of the watercourses are highly modified. The aquatic ecological values of the waterways have been assessed, as described in the evidence of **Dr Keesing**. Most are of low value and contain tolerant aquatic communities, although the Waikanae River has higher ecological values and more sensitive taxa. Despite the generally low value, in undertaking the design of stormwater management and waterway crossings we have assumed that the

[7] Refer Appendix 22.A of Technical Report 22. Drawings are included separately in Volume 5 of the AEE.

waterway ecology and fish passage need to be protected on all permanent waterways.

25 The following paragraphs describe the principal watercourses, in order from the south.

26 Whareroa Stream crosses SH1 by way of a culvert on the Raumati Straight, immediately south of the commencement of the proposed Expressway, and discharges through Queen Elizabeth Park to the coast. While the SH1 crossing of the main watercourse will not be affected by the Project, stormwater from the Poplar Avenue interchange area will discharge into tributary drains of the Whareroa Stream, within the Park.[8]

27 Wharemauku Stream has a catchment area of approximately 10km² and a 1% AEP[9] design flood (including climate change) of approximately 33m³/s at its crossing point with the proposed Expressway.[10] It rises in the coastal hills, and flows through Paraparaumu town centre, and through urban areas to the west, discharging to the coast. There are two significant tributary drains entering from the north (Drain 5) and south (Drain 7) that will also be affected by the Project. Drain 7 in particular has limited capacity downstream of the Expressway alignment, and extensive areas of flood plain that the Expressway will cross.

28 Wharemauku Stream is managed by KCDC, with stopbanks to contain moderate flood flows, but with extensive flooding beyond the stopbanks in larger floods. There are significant constraints to flood conveyance capacity downstream, meaning that wider flood risk is sensitive to any changes that affect flood peak flows and flood plain storage in the vicinity of the proposed Expressway crossing.

29 The Mazengarb Drain has a developing urban catchment, with flood conveyance capacity constraints downstream. The Drain ultimately discharges into the southern side of the Waikanae River near its mouth.[11]

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8 Technical Report 22, Section 3.2.1.

9 AEP – Annual Exceedance Probability – the probability that the given flow will be equalled or exceeded in any year. 1% AEP is equivalent to a 100 year average recurrence interval (ARI) or "return period".

10 Ibid, Section 3.3.2.

11 Ibid, Section 3.3.4.

30 There are several small drains between Mazengarb Drain and Otaihanga Road that take discharge from the KCDC wastewater treatment plant, and runoff from the former landfill.[12]

31 The Muaupoko Stream is a small stream with high ecological values in its upper reaches, that joins the Waikanae River from the south at the proposed location of the Expressway bridge over the River. A minor realignment will be required to the last 40 m of the Muaupoko Stream to provide space for the new Waikanae River bridge pier scour protection, and also to retain a good hydraulic and ecological connection with the Waikanae River.[13]

32 The Waikanae River has a catchment area of approximately 130 km², and a 1% AEP design flood (including climate change) of 480 m³/s. The catchment extends well into the coastal hills east of SH1, and flows relatively unhindered through the coastal plain to reach the coast immediately south of the Waikanae Beach urban area. The river corridor is managed by GWRC, which has built and maintains stopbanks, and manages river bed levels and gravel volumes, in the lower reaches (below SH1).[14]

33 To the north of the Waikanae River is the Waimeha Stream, which is a small spring-fed stream with a predominantly urban catchment. In an extreme flood event (above the design standard for GWRC's Waikanae flood protection works), or if the protection works were to fail, there would be surface flood flows from the Waikanae River into the Waimeha Stream. One such "residual overflow" path that is identified in the KCDC District Plan will be crossed by the proposed Expressway immediately south of the Waimeha Stream.[15]

34 Ngarara Creek and Kakariki Stream are both ecologically important streams that discharge to the regionally significant Te Harakeke / Kawakahia wetland. In the vicinity of the Project the streams pass through sand dune areas, but there are also reaches of these streams that pass through low-lying rural peat flats. Immediately upstream of the proposed Expressway crossing of the Kakariki Stream is the Nga Manu Nature Reserve.[16]

35 Paetawa Drain is the main drain in a rural drainage system taking flow from the western faces of the coastal hills. At the point that

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12 Ibid, Section 3.4.1 and 3.4.2

13 Ibid, Section 3.4.4.

14 Ibid, Section 3.4.5.

15 Ibid, Section 3.4.6 and 3.4.8. This overflow path is shown in Drawing CV-SW-027.

16 Ibid, Section 3.5.1-3.5.4.

the proposed Expressway will cross, the landform is low-lying peat flats, with an extensive flood plain. Paetawa Drain eventually discharges, by way of a highly modified drainage system, into Te Harakeke / Kawakahia wetland.[17]

36 Hadfields / Te Kowhai Stream is a steep watercourse flowing off the western slopes of the hills, with debris and gravel causing maintenance problems at the crossings of the NIMT[18] railway and SH1 at the foot of the hills.[19]

37 There are a number of existing wetlands along the Project route. Some of these will be directly affected by the Expressway footprint, but the alignment has been selected to avoid as many as practicable, particularly those of higher ecological value. The affected wetlands have been addressed in terms of their ecological value in the evidence of **Mr Park**, and in terms of their groundwater hydrology by **Ms Williams**. I have also taken them into account in designing surface water drainage and stormwater management devices, as described later in my evidence.

38 Baseline water and sediment quality sampling has been undertaken in many of the principal watercourses along the route, and the results are presented in Technical Report 24, *Baseline Water and Sediment Quality Investigation Report*.

DESIGN APPROACH, HYDROLOGICAL AND HYDRAULIC MODELLING

Conceptual approach

39 The design approach for stormwater and flood management is set out in Section 7 of the *Design Philosophy Statement*,[20] which formed part of the AEE lodged in support of the Project. In particular, this sets out the design guidelines used, design standards adopted, key assumptions, and the overall conceptual approach taken to the design and to effects mitigation.

40 One of the Guiding Objectives agreed with KCDC when it became part of the M2PP Alliance[21], was "That the Project is designed and constructed in a manner that:

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17 Ibid, Section 3.5.5.

18 North Island Main Trunk.

19 Technical Report 22, Section 3.5.6.

20 Technical Report 1. Refer also Technical Report 22, Sections 4.1 to 4.2.

21 Technical Report 1, Section 2.1, Guiding Objective 11 (page 6).

40.1 Conforms to the Kāpiti Coast District stormwater requirements and associated accepted best practice, in particular the Stormwater Management Strategy[22] and the policy of on-site hydraulic neutrality

40.2 Ensures the hills to coast stormwater flow (both surface and groundwater) is not impeded

40.3 Ensures the natural flows in wetlands are not impeded."

41 In the context of KCDC's Strategy, on-site hydraulic neutrality is interpreted in the context of this Project as not discharging at greater than 80% (urban) or 100% (rural) of existing peak flows, and not causing a significant increase in flood levels (due to loss of flood plain storage or constriction of watercourse crossings).

42 The design approach taken has been to avoid adverse off-site effects where practicable, but otherwise to remedy potential effects as an integral part of the design. The application of this approach to design has resulted in:

42.1 The use of swales for conveyance, as these also provide a means of treating stormwater to remove contaminants to a BPO[23] standard, and providing attenuation of peak flows to avoid increased flood peak flow or level in the receiving environment in up to the 1% AEP storm.

42.2 The provision of flood storage areas (either grassed or wetland planted) to provide additional attenuation where the swales are insufficient, and to provide offset or replacement storage for flood plain volume lost to the footprint of the Project works.

42.3 Providing a distinct separation between those swales and wetlands/storage areas specifically intended for the treatment and attenuation of Expressway stormwater runoff (which will capture contaminants and therefore not be suitable as "natural" areas), and those areas of offset flood plain storage (many of which will be wetland planted) that can become

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22 *Kāpiti Coast : Choosing Futures. Stormwater Management Strategy.* KCDC, May 2008.

23 Best Practicable Option. This is an internationally recognised approach that identifies the practical limit of treatment effort beyond which increasing cost and complexity exceeds the marginal additional benefits obtained. The BPO approach is adopted by the NZTA *Stormwater Treatment Standard for State Highway Infrastructure* (May 2010), and is applied explicitly or implicitly by most Regional and District Councils in New Zealand.

"natural" areas with ecological value, and that can therefore provide ecological as well as hydraulic mitigation.

42.4 The discharge of Expressway stormwater runoff wherever the route crosses a suitable watercourse, in order to keep discharge flows small and avoid concentrated discharges that might adversely affect flood risk or cause watercourse erosion.

42.5 Designing culverts, bridges and diversion channels to minimise hydraulic constrictions, provide unimpeded fish passage, and avoid erosion. We have also assessed the implications of culvert blockage, and in a few locations propose debris racks upstream of culverts to reduce the risk of blockage.

43 The design has taken into account climate change in accordance with MfE[24] and KCDC guidelines. This includes sea level rise of 0.8m, and rainfall increase of 16%, representing mid-range estimates to 2090. It also includes testing the implications for wider catchment flood risk of a storm of 1.5 times the climate change 1% AEP event.

44 The proposed drainage design is shown in plan in Drawings CV-SW-104 to 132.[25]

Expressway stormwater management[26]

45 Where the topography is low-lying – typically peat with moderate to high groundwater levels – wetland planted swales will be used. These have a similar cross-section to grassed swales, but the base will be densely planted with water-tolerant vegetation, as described in the NZTA Stormwater Treatment Standard for State Highway Infrastructure (the *NZTA Standard*).[27] Wetland swales achieve treatment in a similar manner to grassed swales (a combination of sedimentation and vegetative processes), but with typically longer retention times and greater levels of treatment. These swales are also highly suitable for achieving attenuation, by ponding larger storms to a higher level within the swale, with controlled release to

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24 Ministry for the Environment.

25 Technical Report 22, Appendix 22.A. Note all drawings in the CV-SW series are attached to the Technical Report Appendices, Volume 5 to the AEE. Not all drawing numbers in this range are used. Drawing CV-SW-100 sets out the key for the series.

26 Technical Report 22, Sections 4.3.2, 4.4.2, 4.5.2 and 4.6.2.

27 NZTA *Stormwater Treatment Standard for State Highway Infrastructure* (May 2010). Available on NZTA website at http://www.nzta.govt.nz/resources/stormwater-management/docs/201005-nzta-stormwater-standard.pdf

the receiving watercourse. Typical sections for the wetland swales (and for grassed swales described below) are shown in Drawing CV-SW-201.[28]

46 In sand dune areas, or where the topography does not allow flat grade swales to be used, the base of the swales will be grassed, and long term maintenance will require that this grass be mowed to maintain a dense sward that is typically in the range 50 to 250 mm high. An alternative approach would be to densely plant these swales with appropriate reeds that can tolerate both wet and dry conditions. These longitudinally sloping swales are less amenable to provision of flood peak attenuation, and this will be addressed either with intermediate bunds within the swales to constrain flow, or the use of additional ponding in wetlands and attenuation storage areas directly associated with the Expressway stormwater runoff.

47 In some instances, where swales cannot provide sufficient treatment, or there is a particularly sensitive receiving environment (e.g. Kakariki Stream upstream of the Te Harakeke/Kawakahia Wetland), then wetlands will also be used for secondary treatment and attenuation before discharge to the receiving environment. A typical wetland is shown in Drawing CV-SW-212.[29]

48 The target attenuation performance for operational discharge peak flows from the Expressway is to be 80% or less of pre-Expressway peaks, to take account of the cumulative volumetric effects of multiple developments in a catchment. This standard applies to the 50% AEP (2 year), 10% AEP (10 year) and 1% AEP storms, in accordance with the NZTA Standard. In practice, many of the swales achieve much greater attention than this, assisting in offsetting other potential flood effects of the Expressway.

49 The attenuation performance of the swales and wetlands has been tested in an InfoWorks CS hydrological and hydraulic model,[30] to confirm that flood peaks discharged from the Expressway footprint meet the attenuation criteria. It is important to recognise that, while peak discharge flow rates can be attenuated, there will inevitably be an increase in the volume of runoff from the proposed Expressway footprint, meaning that discharges continue for longer than under existing conditions.

50 The outlets from swales and wetlands will be designed to avoid erosion of the receiving watercourse, by means of appropriate outlet

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28 Technical Report 22, Appendix 22.A.

29 Technical Report 22, Appendix 22.A.

30 Technical report 22, Appendix 22.D.

alignment and localised erosion protection works, and using a mix of rock and appropriate riparian vegetation (as shown conceptually in Drawing CV-SW-203).

Offset flood storage areas

51 In addition to managing Expressway runoff, it has been necessary to offset the loss of existing flood plain storage in areas where the Expressway footprint will fill in parts of the existing flood plain. The design principle adopted is to excavate below existing ground level in or adjacent to the affected flood plain areas, to create additional flood storage volume between the normal water level in the adjacent watercourse, and the design flood level. Where this excavation will result in a normally wet base, it will be wetland planted, whereas drier areas will be either landscape planted, or grassed (with some grassed areas returning to pastoral grazing).

52 A constraint on this excavation has been that in many areas it would be undesirable to excavate below the normal groundwater table, as this would reduce the local groundwater level, and potentially affect the hydrology of any nearby wetlands, or increase the risk of settlement of nearby houses. These matters are dealt with in the evidence of **Mr Park** (in regard to wetlands), **Ms Williams** (in regard to groundwater levels), and **Mr Alexander** (in regard to ground settlement).

53 A consequence of this constraint is that in many cases the available excavation depth will be limited, and hence the footprint will be correspondingly larger to achieve the required offset volume. The detailed design of the offset storage areas will make use of further results from ongoing groundwater monitoring, and the swale designs will be optimised, with a view to reducing the footprint required for offset storage/attenuation while not significantly changing local groundwater levels.

54 In the vicinity of the Peka Peka interchange a different approach is proposed for offsetting loss of flood plain storage, by collecting and significantly attenuating the peak flow from several hill tributaries of the Paetawa Drain. These flows can be channelled through an area between the ramps, the existing SH1 and the main Expressway alignment, and will discharge through a throttled outlet back to Paetawa Drain. Dry weather flows will be unconstrained (with fish passage maintained), but flood flows will be constrained and will pond above existing ground, without needing any excavation. (This area is shown as Offset Storage Area 13A in Drawing CV-SW-129.)

Watercourse crossings

55 The design approach for watercourse crossings involves the following elements:

55.1 There will be bridges over the larger watercourses, including Wharemauku Stream, Waikanae River, Waimeha Stream, Kakariki Stream and Paetawa Drain. In all cases there will be a clear span across the main channel, with piers (where required for multi-span bridges) being located on the flood plain, outside permanent water flow.

55.2 There will be box culverts over six of the medium-sized watercourses, ranging in waterway cross-section from 2 x 1 m up to 5 x 3 m.

55.3 The remaining smaller crossings will use pipe culverts ranging in size from 600 to 1800 mm diameter.

56 Bridge crossings will include provision of rock armouring under the bridge footprint (channel and flood plain) to avoid erosion, as lack of light will preclude the establishment of robust riparian and flood plain vegetation. The rock will transition into the natural channel form upstream and downstream to avoid the risk of end erosion.

57 Particular effort has gone into the design for the Waikanae River bridge, including several rounds of detailed discussion and exchange of data and designs with the GWRC Flood Protection team. This process included an independent peer review of the river works design, undertaken by water and soil engineer Mr Gary Williams[31] The proposed design for the river works is shown in Drawing CV-SW-391, with more detail shown in Drawings 392, 393 and 394.[32] River bank vegetation will comprise willows inter-planted with natives, in accordance with the GWRC/KCDC Environmental Strategy for the river.[33]

58 Box culverts will have the invert set below natural watercourse bed level, and will include gravel beds to provide a resemblance of natural bed form and to facilitate fish passage (as illustrated in Drawing CV-SW-304).[34] Rock/gravel inlet and outlet transitions will assist in avoiding a bed discontinuity between the upstream and downstream watercourse and the culvert.

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31 This is attached to Technical Report 22 as Annexure 22.H.

32 Technical Report 22, Appendix 22.A.

33 Waikanae River Environmental Strategy, GWRC/KCDC, March 1999, (currently being updated).

34 Technical Report 22, Appendix 22.A.

59 Pipe culverts will be set below the natural watercourse bed level by typically 20% of their diameter. This will allow water to pond through the culvert, and over time natural bed sediment will accumulate in the invert, creating a semblance of a natural channel. As for box culverts, protected transitions will avoid the risk of bed discontinuities. In both cases flood capacity design will take into account the effect of sedimentation of the inverts.

Waikanae River overflow path[35]

60 As described earlier in my evidence, there is a residual overflow path from the Waikanae River to the Waimeha Stream that will be crossed and blocked by the Expressway embankment. This overflow path would only be activated in a flood event in excess of the Waikanae River protection works design standards, or by a failure of the protection works. Nevertheless, provision needs to be made to address this eventuality.

61 The hydraulic model of the Waikanae River has been used to refine the potential overflows in such an event. The appropriate design case selected has been a 1% AEP flood, with failure of the stopbank at the critical location. However, due to the design proceeding in parallel with the refinement of the overflow scenarios, the overflow path design has been based on an earlier iteration, which is now shown to equate to a 0.5% AEP (200 year) storm; i.e. the design is slightly conservative. The overflow resulted in a 26 m^3/s flow reaching the Expressway, which is additional to the 9.7 m^3/s flow arising from the Waimeha catchment itself (1% AEP storm), although the overflow is likely to arrive slightly later than the peak flow from Waimeha catchment so the combined peak flow crossing the Expressway by way of the floodway plus the Waimeha Stream is only 32 m^3/s.

62 The proposed solution is to capture the overflow into a floodway that directs it along the eastern toe of the Expressway embankment (with a 1 m stopbank to contain it on the eastern side against adjacent properties), and under an extension of the interchange bridge south of Te Moana Road, eventually discharging into the Waimeha Stream in a similar location to the current discharge. The floodway would cross the two south-facing interchange ramps, and then Te Moana Road. The risk of overflow across Te Moana Road would be unchanged from at present. The existing flow paths in this area are shown in Drawing CV-SW-027, while the proposed design (including the stopbank and the bridge) is shown in Drawing CV-SW-120.

[35] Technical Report 22, Section 4.5.1(vi) at page 81.

63 The floodway path has been tested in the Waimeha hydraulic model, which shows that there would be no increase in flood levels outside the Project designation in the design event plus Waikanae overflow.

Watercourse diversions

64 There will be a number of places where watercourse diversions and realignments will occur. In most cases these will be relatively minor and local; for instance associated with improving alignment at culverts and bridges to avoid the risk of localised erosion, or to optimise culvert alignment.

65 The five most significant areas where watercourses will be diverted or realigned are described below.

65.1 The Waikanae River, which is described in more detail in paragraph 57 of this evidence.[36]

65.2 At Muaupoko Stream, the outlet from the stream to the Waikanae River will be realigned to follow the upstream edge of the proposed rock protection for the Waikanae River bridge (as shown in Drawings CV-SW-391, 392 and 394). The realigned stream will include reinstatement of a natural bed and riparian planting.[37]

65.3 At Kakariki Stream bridge on the main Expressway alignment, where a smoother curve has been adopted to reduce the risk of stream bank erosion.[38]

65.4 At Smithfield Drain, where the proposed Expressway alignment is over the top of the current drain for about 500 m. The realigned drain will be specifically designed to provide appropriate fish passage and habitat, including edge stabilisation and riparian planting (as shown in drawing CV-SW-231). This realigned drain will pass through a proposed offset storage area which will include extensive wetland planting over approximately 6.8 ha, creating a significant new ecological area (as illustrated in Drawing CV-SW-125).[39]

65.5 In the general vicinity of Peka Peka Road, there will be several watercourse diversions associated with the interchange (as illustrated on Drawings CV-SW-129, 130 and

[36] Technical Report 4.5.1v. (pages 76-81).

[37] Technical Report 22, Section 4.5.2v (page 88).

[38] Technical report 22, Section 4.6.1ii. (page 93).

[39] Technical Report 22, Section 4.6.2vi. (page 100).

131). These changes address areas where Project works conflict with existing watercourse locations, and also facilitate the provision of Offset Storage Area 13A (as described in paragraph 54 of this evidence, and illustrated on Drawing CV-SW-129).[40]

Wider catchment modelling

66 KCDC and GWRC have hydrological and hydraulic models of the wider urban and rural catchments, covering most of the area from Poplar Avenue to Peka Peka Road, and these have been used to test the hydraulic effects of the design. The estimated Expressway discharges generated in the InfoWorks model,[41] as well as the loss of flood plain footprint to the Expressway embankment, and the proposed offset storage areas, have been incorporated into the KCDC and GWRC models. These models have also incorporated the proposed culvert and bridge watercourse crossings along the route. The models have been used to test the wider effects of the designs, to demonstrate that hydraulic neutrality has been achieved.[42]

67 As a result of the wider catchment modelling, some areas were identified where there were effects on flood risk and flood levels outside the proposed designation. As a consequence, the design was amended (usually by providing greater attenuation in swales, or increased off-set storage) to reduce these effects to being only localised and minor.

68 For general flood levels away from the Expressway, these design amendments would result in no increase in flood levels in the 10 year and 100 year floods. In the immediate vicinity of watercourse crossings, some local increase in flood levels would still occur, but in most cases this will be limited to the proposed designation corridor, and where they extend outside the designation they are within watercourses and the level differences are minor.

69 In the Waikanae River, the proposed realignment and upgrade of the main channel more than offsets the hydraulic constriction arising from piers (and associated debris rafts) in the watercourse. If sediment partially backfilled the upgraded channel over time, to return to a similar bed form as at present, then there would be potential for a marginal increase in flood level immediately upstream of the bridge in extreme flood events. This change would be of the order of a few centimetres, well within the freeboard provision of

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40 Technical Report 22, Section 4.6.2 vii. (page 100).

41 Technical Report 22, Appendix 22.D.

42 Technical Report 22, Appendices 22.E to 22.H.

the protection works, and would not materially change flood risk on flood plains in the upstream area.

Operation and maintenance

70 The operation and maintenance of the proposed stormwater works will be critical to retaining their effectiveness long term. Maintenance responsibility for the stormwater system and watercourse crossings will become the responsibility of NZTA, and will be incorporated into their existing highway maintenance programme and contract.

71 It would not be appropriate to prepare a completely separate maintenance specification for this Project, as many aspects of the maintenance (frequency, nature etc.) will already be part of the existing State highway maintenance contract. However, it will be necessary to prepare specific maintenance procedures for some of the devices and facilities that are included in this Project but are not currently represented in the maintenance contract. Those specifications can only be prepared following the detailed design of the works. Standard operation and maintenance procedures for all the devices on this Project are provided in the NZTA Stormwater Standard, and also in other similar guidelines, and would form the basis of any operation and maintenance specifications.

72 The establishment of the planted areas, and particularly wetlands, swales and offset storage areas, will require a longer than normal contract maintenance period to ensure they are properly established and functioning before regular State highway maintenance takes over. This could be between 2 and 5 years from initial planting.

73 The offset storage areas should become self-sustaining once established. However, the swales and treatment wetlands will need to be monitored for build-up of sediment and other contaminants, and will need to be excavated and re-established from time to time – at typically greater than 20 year intervals.

Summary

74 Through the use of the design approaches outlined above, most hydrological and hydraulic effects of the Project have been avoided. However, there will be some minor residual effects, as set out below.

RELATIONSHIP BETWEEN CONSTRUCTION AND OPERATIONAL PHASES

75 My evidence addresses the long term operational effects of stormwater and flood risk management and stream crossings. In regard to the construction phase, **Mr Goldie** and **Mr Ridley** address

the construction methodology and the management of erosion and sediment control respectively. I have not directly assessed these elements.

76 I have had some input to the stormwater management for the constructor's lay-down areas, particularly for the main lay-down area at Otaihanga Road. Stormwater from this area will be treated using an existing pond that will be upgraded.

77 In transitioning from the construction phase stormwater management to the permanent works, it is important that the earthworks are fully stabilised for any given area, and that the permanent works or some form of transitional works are in place. The proposed conditions of consent address the process for decommissioning of the works at conditions E.3.l and E.7. At that time, any transitional works will need to be able to convey stormwater safely to the outlets, without causing erosion. Later in this evidence I have proposed new conditions of consent relating to management of the operational stormwater discharge (conditions SW.1 and SW.2), which address these matters.[43] Therefore, at any given time, the consent holder will be operating under one or other of these sets of conditions.

78 In relation to works in waterways, proposed conditions WS.1 to WS.8 address the construction, stabilisation and operational phases, which fully covers the transition from the construction stage management to the long term operation.

ASSESSMENT OF HYDROLOGICAL AND HYDRAULIC EFFECTS OF THE PROJECT

79 The potential hydrological and hydraulic effects of this Project have been addressed as far as practicable through the design process. Put another way, measures to avoid or mitigate these effects are an integral part of the Project design. There remain some residual effects which I describe below in my assessment of effects.

Water quantity - flood risk

80 Peak flows and flood levels are an area where the Project has the potential to have adverse effects. Increased impervious area (due to expressway pavement) inherently results in increased runoff volume, and increased peak flow rates. Expressway embankment construction in a flood plain has the potential to increase flood level upstream.

[43] These proposed conditions are contained in **Annexure A** to this evidence.

81 The proposed design has enabled these potential effects to be avoided, as described earlier in the evidence, through the use of attenuation in swales and wetlands, and the provision of offset storage.

82 The performance of the design has been tested in the KCDC and GWRC flood models for most areas. For the southern end (around Poplar Avenue, and the northern end (north of Peka Peka Road), there are no current hydraulic models. Therefore the design for those areas has been carried out in accordance with the same philosophy and methodology as for other parts of the Project, in order to address potential effects.

Watercourse low flows

83 The works will not directly affect low flows in watercourses, as Expressway stormwater discharges will be a consequence of storm events. Low flows tend to reflect the influence of shallow groundwater discharge throughout the catchment. The principal element of the Project where there could be an effect on low flows would be as a result of change to groundwater levels.

84 The design of the stormwater management areas (ponds, wetlands and offset storage) has specifically sought to minimise changes in groundwater level, as outlined earlier in my evidence. Groundwater studies are described in more detail in the evidence of **Ms Williams**. Given the approach to the design, any effects will be minor and localised.

Water quality[44]

85 Effects of stormwater discharge on water quality are outlined in Technical Report 25 *Contaminant Load Assessment*. It concludes that development of the proposed Expressway, with stormwater treatment, is likely to lead to an overall improvement in the contaminant loads (sediment, zinc, copper and TPH) discharging to the receiving environment from almost all catchments along the Project extent relative to existing levels (except the Wharemauku and Waimeha Stream catchments – as discussed below).

86 This is largely due to a change in the roading network where traffic will be moved from the existing SH1 (where there is no stormwater treatment) onto the proposed Expressway (which will provide stormwater treatment). This overall decrease relative to existing will occur despite the predicted overall increase in traffic volumes from existing to the 2031 traffic predictions.

[44] Technical Report 22, Section 5.4.

87 The contaminant loads generated in the Wharemauku Stream catchment will increase primarily due to the increased traffic on Kāpiti Road, which is not treated. Only the interchange area of Kāpiti Road is able to be treated in the proposed Expressway stormwater system, as the areas to the east and west are serviced by separate KCDC stormwater systems that cannot be practicably drained to the Project device.

88 Currently the Waimeha Stream catchment does not receive any runoff from the existing SH1, but will receive treated Expressway runoff. Further, there will be increased traffic on Te Moana Road, which will only be treated in the immediate vicinity of the Expressway interchange. Therefore this catchment will receive some of the contaminants that are currently discharged into other adjacent catchments.

89 The ecological implications of these localised increases in contaminant load are addressed in the evidence of **Dr Keesing**.

Watercourse crossings[45]

90 Watercourse crossings have been explicitly designed to pass the 1% AEP storm (with climate change) with only minor headloss (to minimise flooding), to maintain fish passage, and to avoid erosion at the inlet and outlet transitions.

Climate change[46]

91 The Expressway has been designed using climate change predictions as defined by KCDC, and in general accordance with MfE guidelines. The Expressway is well above even the more extreme predictions of sea level rise, and the waterway capacity has been tested to well above the predictions of increased rainfall intensity (50% versus 16% from MfE). The effects of the Expressway on the surrounding environment will be insensitive to climate change. The effects of the climate change on the Expressway will be minor.

RESPONSE TO SUBMISSIONS

92 I have reviewed those submissions that raise matters relevant to my expertise and evidence. There are over 130 submissions in this category. Many follow common themes, and I have therefore grouped my response on the basis of either specific issues or specific locations. Many cover matters already addressed in my evidence, and I have therefore limited my response to any new issues or particular areas where further information will assist in addressing the matter raised.

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[45] Technical Report 22, Section 5.3.

[46] Technical Report 22, in particular Sections 3.1.7, 4.2.3 (ii) and 5.1.4.

93 Common themes include climate change, and general comments on reduced water quality in streams, the effects of diversions and river works (including the Waikanae River), and the effects on flood risk. I have already addressed these matters in this evidence and for brevity will not repeat that discussion here.

Flood risk – southern end

94 The southern end of the Project passes through a flood prone area both south and north of Poplar Avenue. Ms Hagar and Mr Laird (056) note the existing poor drainage and possibility of increased flood risk. The Project is not able to address the underlying drainage issues, but has considered the potential changes to flood risk.

95 This area is not covered by the hydraulic models described in Technical Report 22. I have subsequently undertaken a manual assessment of changes to flood risk in this area, and can confirm that there will be a slight reduction in flood risk to properties north of Poplar Avenue, due to replacement of the existing culvert under Poplar Avenue with a slightly larger one, and a slight lowering of the minimum level of Poplar Avenue at which overflow of flood waters to the south would occur. This has the consequence of a very minor increase in flood level within the low-lying farmed areas of that corner of QE Park. Apart from this, the works in the area will not change drainage patterns.

96 Mrs Ashford (198) and Mr Harrison (323) identify another low-lying area north of Leinster Avenue, with drainage problems. We have specifically identified the need to provide improved drainage for this area, which will follow along the western side of the Expressway to Drain 7.

Raumati Manuka wetland

97 The Raumati Beach Residents Association (707) particularly noted the importance of the Raumati Manuka Wetland. The Project seeks to avoid the most valuable core wetland area. Wetland 0A and offset storage 0C are sited north of the Expressway, adjacent to Drain 7, in an area that I understand from Mr Park and from my own observation to be of much lower quality. Offset storage 0B, if required, would be achieved by excavating hard fill adjacent to the Manuka Wetland, rather than in the Wetland itself. The intention is that the linkage between the Manuka Wetland and Drain 7 be left undisturbed.

98 The Association also seeks confirmation of Culvert 11, further downstream on Drain 7. This will be a 3m x 2m box, either on the current drain alignment, or possibly on a slightly adjusted alignment to reduce the culvert length.

Flood risk – Wharemauku

99 The area between Drain 7 and the Wharemauku is the subject of a number of submissions, including some related to flooding. Mr and Mrs Waterson (267), Mr Fawthorpe (318), Mr and Mrs Love (470 and 606), and Mr Jones (709) have all commented in various ways on the existing flood risk, and on both flood risk and water table / drainage issues.

100 Much of this area is already poorly drained and flood prone, and as a result the Project team has put considerable effort into identifying and addressing issues. We propose large areas of offset storage to mitigate flood risk, but have been constrained in doing so by the need to limit drawdown of the water table to avoid the risk of settlement of houses in nearby areas, including the properties of some submitters. This has required relatively shallow excavation, and careful control of water table with outlet weirs, resulting in a large footprint for the offset storage to achieve the required volumes and performance. All Expressway stormwater will be captured, treated, attenuated, and discharged directly to Dain 7 and to the Wharemauku Stream.

101 Through the groundwater modelling (by Ms Williams) and design and flood modelling (under my supervision), I am satisfied that we are able to implement a solution that will address the potential effects, and will therefore not result in adverse effects on flood risk and drainage in this area.

102 Mr Schulz (718) particularly focusses on the need to protect Kiwi Pond, which is adjacent to the existing cycleway along Wharemauku Stream. The Project will include this wetland at the edge of a much more extensive wetland area than exists at present, with enhanced planting.

103 St Heliers Capital (644) owns property on the northern side of the Wharemauku Stream, including the proposed Wetland 4 adjacent to Kāpiti Road. The submitter suggests that the proposed wetland should be moved south and placed adjacent to the Wharemauku Stream. The suggested location would require the removal of 10m to 15m high sand dunes. While the option of bringing the stormwater along this route was considered during the investigations phase, it was discounted on engineering and other grounds. A significant factor in selecting the location adjacent to Kāpiti Road is that the lowest lying area being treated, and the one with the highest contaminant loads, is at the Kāpiti Road interchange, and locating the wetland close to that point is more effective.

Flood risk - Muaupoko Stream

104 Mr and Mrs Lattey (466) raise the matter of flooding associated with the Muaupoko Stream.

105 They comment that a proposed 1.05m culvert will discharge from a tributary upstream of an existing twin culvert on the main stream that already regularly overtops after heavy rain. To clarify, the proposed new side culvert will be part of a connection under the Expressway footprint that is intended to maintain the link from the Muaupoko Stream flood plain through to two flood storage areas to the west, and is sized to provide free interchange of surface floodwaters between these flood storage areas, as happens at present. Thus it will not contribute to increased hydraulic load on the existing twin culvert.

106 These submitters comment that there has not been any serious analysis of the Muaupoko catchment. I disagree. This area is part of the flood plain from the Waikanae River[47], and is included as such in the GWRC model that was used for the Project analysis. The stormwater wetland and the culverts were incorporated into the model, and effects assessed. There has been no separate modelling of the Muaupoko Stream without the influence of the Waikanae River. However, my understanding is that the Waikanae flooding will be the more severe event, and the design mitigates those effects. It would be possible, as part of detailed design, to refine the modelling in this area to separately consider Muaupoko flows, and make any necessary adjustments to the design to mitigate local effects.

Waikanae Christian Holiday Park

107 This submission (477) relating to "El Rancho" raised questions about increased flood risk, low-lying poorly drained land, and matters related to availability of flood free land. Mrs Leonard-Taylor (594) also comments on flood risk for the El Rancho access.

108 The proposed river channel realignment will encroach into flood plain land that El Rancho currently owns, over a length of about 200m. The primary reason for selecting the proposed river alignment is that it is close to that identified by GWRC as its long term preferred alignment, and I agree with GWRC that it is an appropriate alignment. The new river bank will be protected with vegetation.

109 The positioning of the northern bridge abutment, and the channel realignment, will not change the flood risk to the remaining El

[47] Technical Report 22, Appendix 22.F. This has several maps showing the extent of flooding in this area.

Rancho land, as it will increase overall river hydraulic capacity. The only exception is that the access route to El Rancho will be under the bridge on the flood plain, and therefore susceptible to flooding in approximately the 2 year flood event. For safety reasons it will therefore be necessary for El Rancho to have alternative access available out to Weggery Drive.

110 The remaining low-lying land at El Rancho will still be flood prone. The discharge from the Expressway will be treated and attenuated before discharge from offset storage 9A, into a drainage path on the flood plain on El Rancho land, which discharges to the Waikanae River main channel. I would not expect this discharge to increase the flood risk on this land.

Flood risk – Puriri Road area

111 A number of the residents in the Puriri Road area have commented on potential effects on flood risk and drainage, given the high water table in this area, and the history of flooding. Specific submissions from this area include Mr and Mrs Deardon (261), Ms Pomare (309), Mr and Mrs Sisarich (328, 331), Mrs Aregger (382), Miss Robertson (563), Dr Sullivan (675), and Mr and Mrs Harris (713).

112 This is another area where the Project team have recognised there are challenges relating to high water table and flood risk, and have put considerable effort into arriving at a solution that takes into account groundwater, ecology of remaining wetland areas, flood risk, drainage and land settlement. In particular, the "Tockers Pond" area is low relative to flood levels in the Waikanae River, and the KCDC stormwater system draining this area has limited capacity, and is dependent on pumps to discharge to the Waikanae River when the river level is high.

113 The design has several features to address these issues. In particular, the philosophy has been to retain the exiting drainage and flood levels, and to keep the expressway stormwater separate from local drainage in the low-lying area. The design does not explicitly seek to remedy existing problems.

114 The Expressway runoff will be contained in a separate wetland (9), lined to avoid discharge to the ground, and with the normal water level set at the existing normal water level in this area. It has been designed to achieve a very high level of attenuation (peak discharge just 9% of pre-Expressway flows off the same footprint). The outlet will be connected to the existing KCDC pipe in Puriri Road. A new pipe from the wetland to the KCDC system will make provision for other adjacent properties, which currently have no or poor drainage, to connect. It will also facilitate the management of drainage levels in this area.

115 To maintain hydraulic neutrality, there will also be offset storage provided adjacent to but hydraulically separated from wetland 9, which will function as part of the local flood storage in this area.

Flood risk – Te Moana / Waimeha

116 A number of submitters comment on flood risk in the Te Moana Road and Waimeha Stream area, including the matter of flood overflow from the Waikanae River. These include Mr and Mrs Pears (004), Mrs Laing (337), Mr and Mrs Baxter (422), Waikanae On One (514), Mr and Mrs Starke (589, 690), Mrs Leonard-Taylor (594), Ms Hinkley (673), Dr O'Sullivan (675) and Mrs Pilaar (726).

117 The Waikanae River overflow has been recognised in the design, with an equivalent overflow path created by having significant additional flood capacity under the Te Moana interchange bridges, and constraining the path with a low bund to avoid affecting adjacent houses on Te Moana Road. This avoids the Expressway becoming a barrier. The proposed works do not materially affect the risk of overflow, or the sections of the overflow path upstream of the bund.

118 The waterway provided for the Waimeha Stream is the full capacity of the existing stream, so will not affect flood risk either upstream or downstream.

119 Mr Harding (595) notes that the GWRC floodway is nominally for an overflow capacity of 80m³/s, whereas the Project overflow design is 26m³/s (he incorrectly states it is 20m³/s). He notes that GWRC is currently reviewing the overflow, but has not yet determined an updated overflow rate. In response I note that the "current" GWRC estimate is based on 1997 modelling, which has been superseded by several subsequent updates of its Waikanae River model, using updated flow data and river cross-sections, and taking into account recent river works. The Project analysis was undertaken using the updated GWRC model and was carried out by the same modelling specialist as updated the model for GWRC.

120 The Project team is in ongoing discussion with GWRC on this matter. However, in the absence of seeing any alternate up to date work to the contrary produced by other parties, I am satisfied that the breach flows used by the Project are appropriate for assessing the effects of the Expressway embankment on the overflow path.

Nga Manu area

121 Mrs McKenzie (046) and Mr Benseman (090) raise matters related to the hydrology and waterways in the area of Nga Manu. Mr Hare (207) raises the matter of hydrology and contaminant discharge.

122 The Project has sought to avoid changes to flood levels. This is in part achieved through the creation of a large offset storage wetland area (11) north of Nga Manu, on the opposite side of Kakariki Stream and slightly downstream. The stream invert and gradient, and the normal water level will not be materially changed in Kakariki Stream.

123 There is a proposed minor realignment of Kakariki Stream at the bridge site. This is to reduce the risk of erosion on an existing tight bend, and to slightly improve hydraulic efficiency. The works will include provision of erosion protection.

124 The stormwater treatment wetlands in this area are being kept separate from the offset storage wetland, to avoid contamination of the larger wetland areas. Stormwater will only be discharged to the offset storage wetland after treatment in swales or treatment wetlands.

125 On the basis of the above, in my opinion there is nothing proposed that would adversely affect the hydrology of the Nga Manu area, or increase the risk of flooding of the Nga Manu access.

Flood risk – Peka Peka

126 Dr Bills (243) identifies drainage and flood risk in the Peka Peka area. The area north of Peka Peka Road is not covered by the KCDC flood model. Subsequent to lodgement of the AEE, I have carried out a manual assessment of how the Expressway might affect flood risk. My conclusion is that offset storage is not required, because the Expressway footprint north of Peka Peka Road is substantially outside the flood prone area, and the stormwater discharge is attenuated. South of Peka Peka Road there will be substantial attenuation and offset storage provided in area 13A that will avoid any increase in flood risk, and this has been tested in the hydraulic model.

127 There are substantial drainage channels in this area (Hadfields / Te Kowhai Drain, and Paetawa Drain) that the attenuated Expressway stormwater can be discharged to.

Tsunami

128 Many submitters raise the matter of tsunami risk, including Ms Bunch (124), Save Kāpiti Inc (505) and Ms Mills (543). Some suggest it may impact the Expressway, or the Expressway might funnel flows.

129 The Expressway will be located within the inland margin of the yellow zone identified by KCDC[48] (risk associated with the largest possible tsunami) where it crosses the Waikanae River, and at the Waimeha Stream. In both these locations the Expressway is elevated well above the level of a tsunami. At the Waikanae River, because the full flood plain width is bridged, the Expressway would make minimal difference to a tsunami (in terms of funnelling flows).

130 At Waimeha Stream, there will be a wide bridge span, but the southern portion of the flood plain will be blocked by the Expressway embankment. This will shield some properties to the southeast along Te Moana Road, and would limit any influx to the area of Te Moana Road and the Waimeha Stream. At this inland limit of the tsunami influence, the effect of the Expressway on the influx will be minor in terms of funnelling, due to reduced depth and energy in the flow.

131 In all other areas the Expressway is well inland of the risk zone. All public access routes that would be used for evacuation will be retained.

Kāpiti Coast District Council

132 The KCDC submission (682) has a section 6 relating to hydrology and stormwater (their paragraphs 73 to 81). The submission is strongly supportive of the approach taken by the Project. However, it does raise some residual matters, to which I respond below.

133 At paragraph 74, the extent of long term designation is raised. It is my understanding that the long term designation will include all the stormwater features and the offset storage areas, and that NZTA will have long term operational and maintenance responsibility for these. In accordance with its paragraph 81, a designation condition could be added that the final designation include the offset storage areas. The exception to this would be offset storage wetland 6A, which is an existing flood area including the Otaihanga landfill, and it would not be appropriate to pass responsibility for this area to NZTA.

134 At paragraphs 75 and 76, KCDC notes the need to update the modelling (undertaken to confirm hydraulic neutrality), and to address areas not covered by the modelling. I have addressed the model update below (paragraphs 148 and 149) and in the proposed additional conditions.[49] Previously in my evidence, I have specifically reviewed the two areas the models do not cover: Poplar

[48] http://www.kapiticoast.govt.nz/Our-District/cdem/Tsunami/Tsunami-Evacuation-Maps/

[49] See proposed conditions SW.1 and SW.2 contained in **Annexure A**.

Avenue (paragraph 95) and north of Peka Peka Road (paragraph 126).

135 In paragraph 77, KCDC seeks clarification of some specific matters. These are variously matters of detail, or have been addressed elsewhere in my evidence, or will be adequately covered by conditions of consent. In summary:

135.1 Culvert 8 and offset storage at Poplar Ave – refer to paragraphs 94 to 95 of my evidence;

135.2 Clarification of the size of culverts 11 and 21 - refer to the relevant drawings[50] - these will be confirmed at detailed design;

135.3 Effects of culvert 14 and Wetland 5 on Mazengarb Stream – this has now been addressed in design, and will be confirmed by an updated hydraulic model;

135.4 Muaupoko Stream – refer to paragraphs 104 to 106 of my evidence);

135.5 Culvert 25.3 - this has now been addressed in design, and will be confirmed by an updated model; and

135.6 Offset storage north of Peka Peka Road – refer to paragraphs 126 to 127 of my evidence.

136 In paragraphs 78 and 79, KCDC recommends conditions of consent. I agree that specific conditions are appropriate, and that in broad terms they would follow the principles set out in KCDC's submission. I have provided new proposed conditions later in this evidence which, in my opinion, address the requirements from KCDC.[51]

137 In paragraph 80, KCDC notes the importance of not disturbing the ground in offset storage wetland 6A. Apart from the construction of the new culvert and inlet, there is no intention to undertake works in the area upstream.

138 In regard KCDC's paragraphs 88 to 89, the Expressway will partially fill a minor tributary north west of the landfill adjacent to Otaihanga Road that includes some wetland. This will truncate the northern branch of the drain leading along the toe of the landfill towards culvert 17, and is shown on Drawing CV-SW-116, at about chainage 9100m. The surface drainage from a small residual catchment area

[50] CV-SW-108 and CV-SW-118

[51] Refer proposed conditions SW.1 and SW.2.

in the west of 0.89ha will be piped directly to an existing wetland area near the outlet of Culvert 17, via a proposed 600mm diameter pipe. Apart from this, there are no changes proposed to surface water drainage from the landfill.

Greater Wellington Regional Council

139 The GWRC submission (684) noted key areas or topics it wished to focus on,[52] including "hydrology", but contained no substantive technical matters requiring my response. It was understood that GWRC's earlier Key Issues Report more specifically identified issues to be addressed (and I respond to that Report later in my evidence).

140 However, I have received a supplementary document entitled *GW Submission on McKays to Peka Peka Project. Without Prejudice – Discussion Document*, dated 22 August 2012 (*Discussion Document*), which provided further detail on the matters raised in GWRC's submission. That document raises a number of matters under section 2, *Flood Management and Protection*, which I will now address.

141 I have participated in a number of meetings with the Flood Protection team from GWRC during the course of preparing the AEE for this Project, and subsequent to lodgement. There have been a number of matters discussed and either agreed or still requiring resolution of detail. The Discussion Document identifies many of these matters.

142 For ease of reference, I have attached to my evidence (as **Annexure B)** a table that lists the matters raised in the GWRC Discussion Document, and provides a response from the M2PP Project team to those matters. As some of these matters/responses are outside my area of expertise, I note that the table includes input from other experts in the Project team,[53] but are compiled here for completeness with the appropriate experts identified in each case.

Transpower NZ Ltd

143 The submission from Transpower (178) seeks that access is retained to structures and that drainage patterns do not have adverse effects on tower foundations.[54]

144 As far as I can determine, the main location where these matters arise is in the vicinity of offset storage area 11, near the Kakariki Stream. The Project design has specifically recognised the presence

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52 Refer GWRC submission page 4, 5th-7th bullet points.

53 For example, Mr Evans on landscaping.

54 Transpower submission, paragraph 11 and Attachment A.i.(d).

of two transmission towers in the offset storage wetland. The small dunes on which these are located will be retained, and access will be provided from the realigned Smithfield Road. Therefore, the matters raised by Transpower will be addressed.

Wetland maintenance and nuisance effects

145 Several submitters, including Ms Pomare (309), Dr O'Sullivan (675) and Mrs Palmer (725), raise matters related to nuisance insects. This is clearly a matter that needs to be accounted for in both the design and the maintenance of wetlands. In general, the locations that will have permanent water will be areas that are low-lying and already prone to standing water. Further, as pointed out by many submitters, the Kāpiti area is known for its wetlands, many of which have been lost, and there is strong interest in many quarters in reinstating and restoring wetland areas.

146 The design of wetlands will take into account best practice to avoid the risk of stagnant areas and nuisance insect and odours, as set out in a number of guidelines, including the Christchurch City Council *Waterways and Wetlands Design Guide*, and publications from overseas.[55]

147 Mrs McKenzie (046) and other submitters raise the matter of responsibility for maintenance. The proposed stormwater treatment and attenuation wetlands, and the offset storage area, will remain in NZTA ownership, and it will retain responsibility for maintenance and these matters are addressed in the evidence of **Mr Park** and **Mr Evans**.

Updating models

148 The Raumati Beach Residents Association (707) and other submitters suggest that the hydraulic models be updated. For clarification I note that there are a number of aspects of the design that have proceeded beyond that included in the models, and there were some minor points where the models indicated full hydraulic neutrality had not been achieved. It was not practicable in the time frames to bring the models fully up to date and close out all issues prior to lodgement with the EPA, because design refinement was continuing as the AEE reports were being prepared. Where design details have changed subsequent to the modelling, or outstanding matters have needed to be addressed after the modelling had been completed, I have carried out manual analysis and used my own judgement as to whether it will be possible to achieve the target of hydraulic neutrality, and am satisfied this is the case.

[55] For example, limiting shallow margins where breeding occurs, providing habitat for predators, and providing for water level fluctuation to disrupt breeding.

149 Further changes in design detail are likely to occur, both as the design process continues, and potentially in response to outcomes from the Board of Inquiry process. It will therefore be necessary to use the hydraulic models to test the final design against performance criteria, including demonstrating hydraulic neutrality. The most appropriate way to achieve this is through a condition that sets out the performance criteria and specifies that the models be used to demonstrate compliance. I have recommended additional consent conditions SW.1 and SW.2 for this purpose (see **Annexure A**), and these are now proposed as part of the Project.

RESPONSE TO SECTION 149G KEY ISSUES REPORTS

150 I have read the key issues reports prepared by KCDC (dated 8 June 2012) and GWRC (dated 11 June 2012). In this section of my evidence I will comment on or respond to matters relevant to my area of expertise (or cross-reference to where my evidence already addresses such matters).

GWRC Key Issues Report

151 In section 4.1 of the Report, there is reference to the damming of flood flows. Paragraph 121 refers to Culvert 17, where the proposed design provides slightly more flood storage behind a culvert than occurs under existing circumstances, where the existing culvert is undersized. The Report appears, at paragraph 125, to conclude that the effect is *de minimus*. I concur with this conclusion.

152 At paragraph 122 of the Report, there is reference to the proposed design holding back flood waters at Culvert 38, and a consequent increase in flood level of 2.09m. The Report concludes that a consent may be required to dam. It states that there is no information on the extent of ponding during normal flows, or for floods of 5% or 10% AEP. That is not strictly correct. The extent of inundation in the 10% and 1% AEP are shown in Figures on pages 26 and 28 of Appendix 22.G of Technical Report 22. The extent in these events is similar, and hence the 5% AEP (which is between these) will be similar also.

153 The function of the storage area behind Culvert 38 is described in paragraph 4.6.2.vii of Technical Report 22. In this instance it is important to recognise that the purpose of the ponding is for flood peak attenuation. Under normal flows the waterway will flow unimpeded, and fish passage will be provided through the culvert, and through the upstream channels in the flood storage area. It will only be during storm events that water will build up behind the culvert inlet, and be temporarily ponded. The ponding will be

entirely within the designation, and the "dam" will be formed by the Expressway formation and one of the proposed ramps.

154 As a result of matters raised in the GWRC's Report, the Board of Inquiry (BOI) subsequently issued a section 92 RMA request for further information which, amongst other things, sought further information about the culverts 17 and 38.[56]

155 The NZTA's formal response has advised that GWRC and NZTA representatives have since met and agreed that:

155.1 Culvert 17 does not require a water permit under Rule 16 of the RFP as it meets the permitted activity criteria for small dams under Rule 26; and

155.2 Culvert 38 does require a water permit for damming under Rule 16 of the RFP, and a land use consent for the works under Rule 49 (both to be applied for once the BOI has issued a decision on the main application).[57]

KCDC Key Issues Report

156 This Report includes comment on natural hazards, and on the effects of the Expressway on flood hazard. It notes that the design has adopted the principle of hydraulic neutrality.[58] The matters that are raised have all been addressed in the design approach and described in the AEE and associated technical reports, particularly (in regard to my area of expertise) in Technical Report 22.

PROPOSED CONDITIONS

157 I support the proposed conditions relevant to my area of expertise as contained in the lodged applications.[59] In summary, the conditions relevant to my area of expertise are primarily contained within the regional consents, conditions WS1 to WS8, plus the general conditions for both the district and the regional consents, conditions DC.1 and G.1 respectively.

158 Proposed conditions DC.1 and G.1 require the works to be built in general accordance with the documentation of the application. This is appropriate because, as is the normal course in projects of this

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56 Request dated 7 August 2012.

57 Refer response dated 28 August 2012 (paragraph 3) from NZTA to the BOI's section 92 request.

58 KCDC Key Issues Report, page 8.

59 AEE, Chapters 32 and 33. An extract from the conditions as lodged, where relevant to my evidence, is attached to my evidence as **Annexure A** for ease of reference. I have also identified proposed changes in that Annexure.

nature, the final works may well vary in matters of detail as a result of ongoing investigation and detailed design. For that reason, conditions are also required to identify the key outcomes required of the design, which must accord with the basis of the application. I address this further later in this section of my evidence.

159 Proposed conditions WS.1 to WS.8 relate to culverts and to works in watercourses. These conditions address the key issues of protection of the watercourse from erosion, and provision of fish passage. However, they are primarily "operational" in nature, requiring actions during long term operation (WS.4) and during the construction period (WS.8). There is one condition relating to the design (WS.3) which is quite general in nature. I propose that there be specific wording added as Condition WS.3A relating to the provision of fish passage, and I have inserted suggested wording in the conditions in **Annexure A** to my evidence.

160 I note that operational stormwater discharge from the permanent works is a permitted activity under the Wellington Regional Freshwater Plan, and in particular Rule 2 (Section 5.3). The conditions under this Rule require that the discharge is not from a stockyard (Rule 2, Condition (1)), industrial or trade premises (Condition 2), earthworks (Condition 3a), and that it meets certain performance criteria. These include conditions relating to water quality (Condition 3b), erosion at the point of discharge (Condition 4) and altering the course of a natural stream or river (Condition (5).

161 In my opinion, the design approach for stormwater management proposed for this Project will meet the performance criteria for a permitted activity under Rule 2 of the Regional Freshwater Plan, because the design addresses stormwater quality (through treatment) and avoidance of erosion (through stabilisation of outlets). Therefore no conditions of consent have previously been proposed.

162 However, recognising that the proposed conditions as lodged do not explicitly state the principles behind the stormwater design that enable it to satisfy the permitted activity criteria, and that there have been submissions from a number of parties on the matter of hydrological, water quality and flood effects, I have prepared a series of conditions that could address this matter.

163 **Annexure A** to my evidence contains conditions SW.1 and SW.2 which express the underlying design principles that should be adopted by the Project in order to achieve the outcomes described in the AEE, and more particularly in Technical Report 22, in regard to operational stormwater quality and hydraulic neutrality.

164 I recommend that these two conditions be added into the draft regional consent conditions.

CONCLUSIONS

165 The proposed MacKays to Peka Peka Expressway will increase the runoff volumes to local watercourses, will fill areas of flood plain storage, and will result in culverts and bridges being built on local watercourses.

166 The stormwater and watercourse crossing design has been prepared to address the potential effects of these activities such that residual effects will be localised and minor.

167 There are mechanisms available through existing maintenance contracts and operational procedures for NZTA to effectively maintain the stormwater management and watercourse crossing works to assure their long term performance.

Graham Levy
30 August 2012

ANNEXURE A:

RELEVANT PROPOSED CONDITIONS CONTAINED IN LODGED APPLICATION[60]

Designation Conditions	
DC.1	a) Except as modified by the conditions below, and subject to final design, the Project shall be undertaken in general accordance with the information provided by the Requiring Authority in the Notice of Requirement dated [insert date] and supporting documents being: i) Assessment of Environmental Effects report, dated [insert date] ii) Plan sets: 1. CV-SP -100 – 160: Scheme plans; 2. CV-GP-101-136: Geometric plans; 3. CV-SC-001-004: Cross sections; 4. CV-EW-100-232: Earthworks; 5. CV-BR-100-970: Bridges; 6. CV-GE-100-140: Structural – General; 7. GI-PR-01-18: Land Requirement Plans; 8. CV-MF-100-132: Lighting, Marking and Signage; 9. CV-CM-101-412: Construction Methodology; 10. Urban & Landscape Design Framework (Technical Report 5); 11. Landscape & Visual (Technical Report 7)- Appendix A & B; 12. Stormwater & Hydrology (Technical Report 22) – Appendix 22.A; 13. Erosion & Sediment Control (CEMP Appendix H) – Appendix H.B, H.C, H.D, H.E, H.F, H.H, H.I, H.R. b) For the avoidance of doubt, none of these conditions prevent or apply to works required for the ongoing operation or maintenance of the Project following construction such as changes to street furniture or signage over time. Depending upon the nature of such works, outline plans or outline plan waivers may be required. c) Where there is conflict between the documents listed above and these conditions, these conditions shall prevail.

[60] Proposed edits and amendments as described in my evidence are shown as strikeout (deleted) and underlined (new text)

General – Resource Consent Conditions	
G.1	The Project shall be undertaken in general accordance with the plans and information submitted with the application as documented as consent numbers [INSERT GWRC REFERENCE NUMBERS HERE], subject to such amendments as may be required by the following conditions of consent. The plans and information include: a) Assessment of Environmental Effects report, dated [XXXX] April 2012 b) Plan sets: i. CV-SP -100 – 160: Scheme plans; ii. CV-GP-101-136: Geometric plans; iii. CV-SC-001-004: Cross sections; iv. CV-EW-100-232: Earthworks; v. CV-BR-100-970: Bridges; vi. CV-GE-100-140: Structural – General; vii. GI-PR-01-18: Land Requirement Plans; viii. CV-MF-100-132: Lighting, Marking and Signage; ix. CV-CM-101-412: Construction Methodology; x. Urban & Landscape Design Framework (Technical Report 5); xi. Landscape & Visual (Technical Report 7)– Appendix A & B; xii. Stormwater & Hydrology (Technical Report 22) – Appendix 22.A; xiii. Erosion & Sediment Control (CEMP Appendix H) – Appendix H.B, H.C, H.D, H.E, H.F, H.H, H.I, H.R. Where there is conflict between the documents lodged and the conditions, the conditions shall prevail.

Conditions for earthworks and discharges to land – General	
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.3A	Culverts and bridges on watercourses with permanent flow shall be designed to facilitate fish passage, in accordance with GWRC publication *Fish Friendly Culverts and Rock Ramps in Small Streams* or equivalent industry standard methods. Ephemeral and intermittent watercourses do not require fish passage.
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) 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; b) planting plan and schedules; and c) 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.
Proposed new stormwater conditions	
SW.1	Operational stormwater discharge from the Expressway shall meet the following performance criteria: a) Expressway stormwater shall be treated before discharge to the receiving environment in accordance with the NZTA publication *Stormwater Treatment Standard for State Highway infrastructure*, 2010, or equivalent industry standard methods. b) The peak rate of stormwater discharge from the Expressway at any point shall not exceed 80% (urban areas) or 100% (rural areas) of the pre-Expressway peak discharge from the same footprint, in each of the 50%, 10% and 1% AEP critical duration storm events.
SW.2	The effects of the Expressway embankment, water crossing and stormwater discharge on flood risk shall be addressed in the following manner: a) Any loss of flood plain storage due to the fill embankment shall be offset by: i. provision of equivalent alternative flood storage volume; or ii. attenuating runoff; or iii. removing downstream constraints; or iv. a combination of the above. b) Flood risk shall be assessed against the 1% AEP storm, with climate change to 2090 (mid-range) estimated. c) Culvert and bridge waterway crossings shall be designed so that any increase in flood risk in the 1% AEP storm is either contained within the designation, or is localised within the flood plan, minor, and no more than 50mm above existing flood levels. d) The combined effects of filling, waterway crossings and Expressway stormwater discharge shall be assessed through the use of hydrological and hydraulic modelling.

ANNEXURE B:

FLOOD PROTECTION RELATED MATTERS RAISED BY GWRC, WITH RESPONSES BY THE M2PP PROJECT TEAM

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
GWRC 2.3 – Specific Issues			
1	GW has discussed with NZTA's Consultants the need for 2 piers as opposed to one for each span of the Waikanae River bridge. The Consultants justification for the 'two-pier requirement was that 2 piers were required for earthquake design requirements. Presumably this will have to be the case for all new bridges in NZ if the need for 2 piers is simply linked to the earthquake design requirements - what is it that makes it "the only possible solution" in this instance - is this explained in the documentation? If it is simply that it is the cheaper option then this should be noted, not linked only to some earthquake design parameters. GW would prefer 1 pier as opposed to 2.	As noted in the minutes of a meeting held between GWRC Flood Protection and Alliance representatives[61], designing twin piers is "not the only possible solution" but is considered to be the most appropriate, taking many factors into account. Among the reasons for selecting the twin pier option are: 1. High seismicity of the area due to nearby active faults. The hazard factor for Wellington is three to two times greater than for other parts of the country where a large 4 lane highway bridge would be located (such as Auckland, Christchurch etc.) 2. There is a risk of liquefaction, which will be addressed by extensive ground improvement. 3. High standards are required to maintain the Life-line link in a 1/2500 years earthquake event. This is a higher standard than would be the case for other structures such as for local road standard bridges used for the proposed Western Link Road, which would be at 1/1000 years. 4. The combination of these factors makes this design unique in NZ to date. 5. Using a larger single pier would require a big pile cap for 5 to 6 large diameter piles, which would encroach into the proposed river channel.	Bridge designer Graham Levy

[61] Minutes of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 4.1

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
		6. The construction of large diameter pile group and big pile cap may require the temporary diversion of the river channel. Use of twin piers does not require such a large pile cap. 7. Twin piers provide a ductile, efficient, robust and economical solution for such high seismic demands as compared to single large pier option. Hydraulically, the AEE is based on the modelling of the effects of the twin piers, including allowance for substantial debris rafting.	
2	Required clearance for heavy equipment under the Waikanae River bridge	Data was provided to GWRC following a November 2011 coordination meeting, showing machine access and clearances, and is attached to the meeting minutes[62]. There is at least 5m of clearance over most of the flood plain, which is adequate for construction equipment.	Graham Levy
3	Clearance for El Rancho access road, and effects of sediment build-up on this access.	The bridge has been raised slightly on the northern side of the Waikanae River to provide a minimum clearance for the El Rancho access of 4.5m. Maintenance of the access after a flood event will be the responsibility of NZTA.	Noel Nancekivell
4	The figures for clearances beneath the bridge and from the El Rancho access road conflict in TR1 p49 and p51 and with CV-SW-93.	There is an inconsistency. Technical Report 1[63] indicates a height of 1.2m on p49 and 1.6m on p51. These values are incorrect. The correct value for the Waikanae River is 2.2m minimum freeboard as shown on drawing No CV-SW-393, attached to Technical Report 22. (Note there is no drawing CV-SW-93.)	Noel Nancekivell

[62] Minutes `of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 4.2

[63] TR1 is the Design Philosophy Statement (AEE, Volume 3)

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
5	Berm drainage patterns under and around the bridge. The finished ground level/rip-rap level under the bridge should be at berm level to facilitate access under the bridge.	Agreed. It is the intention of the design to have the riprap flush with the existing ground on the berm under the Waikanae River bridge, and to retain existing berm drainage. This is shown on Drawing No. CV-SW-393, attached to Technical Report 22, although there is not a specific note on the drawing stating that intent.	Graham Levy
6	Drainage issues and maintenance of the El Rancho access road.	Stormwater from the access road will drain to the flood plain, as it does at present. Routine maintenance will be the responsibility of El Rancho.	Graham Levy
7	The proposal for NZTA maintenance under the bridge needs to be clarified. Are they going to clean up rubbish and debris on a regular basis and control noxious plants to the same standard as GW will maintain the balance of the area? We suspect in practice NZTA will probably be more likely to fix up the rip-rap after major floods and GW will do the rest. However NZTA should be making a contribution to this. GW remains concerned about the long term look of this area - debris, vandalism, drainage etc, and these items need to be addressed.	This will be in accordance with NZTA practice elsewhere on the State highway network. A hand-marked plan identifying the areas that NZTA would maintain (rip-rap associated with bridge foundations) and that GWRC would maintain (all river works upstream and downstream) was attached to the minutes of the coordination meeting[64].	NZTA
8	GW is responsible for the long term maintenance of the river transition areas around the Waikanae River Bridge. When will the construction maintenance period end?	The construction maintenance period is not yet defined. For planting it is likely to be 2 to 5 years from implementation, to confirm vegetation is well established.	Andy Goldie

[64] Minutes of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 2.1

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
9	Discussions have occurred with NZTA's consultants regarding possible cost share for the planted channel transition component (which is the Waikanae River realignment to fit the GW design channel downstream of the Waikanae River bridge) with details to be sorted later. Has this been addressed in the documentation?	Not in the AEE. This is not a matter for the consent. It is a matter for agreement between the M2PP Alliance and GWRC. At a coordination meeting it was agreed that there would be a cost share and that details would be agreed at a later date[65].	Graham Levy
10	Property ownership post construction - especially regarding the River Corridor - what is the size, and where is, the area of land NZTA is acquiring to be transferred to GW? Are there any special maintenance responsibilities or rating impacts (if it is rateable will the value be affected by the bridge?) attached to the land?	At a coordination meeting it was agreed that title of land purchased by NZTA for river works would pass to GWRC. The details of how this would be achieved were to be agreed at a later date[66]. Matters of detail relating to ratings and valuations will be part of reaching that agreement, and is not a matter for consent.	NZTA
11	Has provision been made for services to be attached to the bridge to avoid them needing to be undergrounded beneath the river in the future?	The following allowance has been made for future services to pass under the bridge in between the Super Tee beams with oversize sleeves in the abutments and crosshead beams. 1. 6-Ø100mm duct for telecommunications below northbound outer shoulder. 2. 5-Ø100mm ducts, 4 for telecommunications and 1 for gas below southbound outer shoulder. 3. 2-Ø300mm water pipes.	Bridge designer

[65] Minutes of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 1.2 bullet 3

[66] Minutes of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 1.2 bullet 2

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
		4. 1-Ø400mm waste water pipe. 5. There are a number of Ø300mm stormwater pipes for bridge deck drainage.	
12	TR26 p108 states "the Waikanae Bridge will have 5 spans, one of which crosses the Waikanae River with piers located to each side of the existing channel. Associated with construction of this bridge will be large scale earthworks to widen the existing floodplain, which is being carried out on instruction from GWRC." GW has not "instructed" that works be carried out. Realignment of the Waikanae River is proposed as mitigation for the raised water levels resulting from the proposed Waikanae River bridge constriction, and was recommended by Gary	This is a misunderstanding in Technical Report 26, the Ecological Impact Assessment, as to the process by which the channel realignment was decided on. That report is not the definitive one in regard to that matter, or how the works will perform hydraulically. The key technical report in this regard is Technical Report 22. The initial waterway design proposed a shorter length of main channel realignment downstream of the bridge, and modelling demonstrated that this provided adequate hydraulic capacity. However, the peer review undertaken for GWRC[67] suggested extending the channel widening further downstream on the right (northern) bank, in accordance with the GWRC long term design alignment, and GWRC requested that this be adopted. M2PP complied with this request[68].	Graham Levy
	Williams in his review of the proposed works for NZTA. The River is narrower than the design river corridor at this location, but widening the river is not part of the current GW works programme and would not be carried out if not required as part of the works. Additionally, GW is not in a position to 'instruct' that any works be carried out as part of this project if the works are not required by NZTA.		

[67] Technical Report 22, Appendix 22.H

[68] Minutes of Alliance/GWRC FP Coordination meeting held on 3 November 2011, item 1

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
Landscaping issues around the Waikanae River Bridge, including:			
13	Recommending that the willow line along the river bank right bank, downriver of the bridge is a minimum width of 5m. On the southern side of the track willows only should be planted.	This was agreed with GWRC following a meeting on 14 February 2012 and their email response (Sharyn Westlake) of 21 February 2012. A plan was prepared For Discussion with GWRC, dated 13 February 2012 for the meetings with GWRC. The plan in Technical Report 7 (TR7) is based on the outcome of the discussions with GWRC but is more illustrative (a concept) than the plan used in the discussions. Section 10.8.3, pages 87-88 of TR7 outlines the planting to be carried out as agreed by GWRC following the meetings with them. It states willows along the edge but the following bullet point states poplar (**not willow**) and native species planted either side of walkway. This needs to be corrected. However the planting concept (Figure 38A in Appendix A, TR7) illustrates the planting and correctly states "Willows interplanted with indigenous species as agreed with GWRC". While it does not show willow planting ***only*** on southern side of track as stated in the report text, Figure VS10, Appendix B, TR7 does show this. Given that TR7 forms part of the AEE for the NOR, detailed planting plans are inappropriate and instead would be finalised at detailed design phase in consultation with GWRC and in accordance with the Landscape management Plan (LMP) as per proposed condition DC.54.	Boyden Evans Graham Levy
14	The adjacent footpath (right bank downriver of the bridge) should be moved away from the river's edge to accommodate this 5m (min.) width of willow planting.	This was agreed with GWRC following meetings as noted above. While this point is not specifically stated in TR7, it was taken into account preparing Figures 38A and VS10. The path shown in CV-SW-392 is indicative only and the landscape plan in this area takes precedence.	Boyden Evans Graham Levy

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
15	The Friends of the Waikanae River are keen to remove poplars from the river bank. GW Operations suggest that Matsudana willows are planted for visual screening (interplanted with natives) on the north side of the track. GW's main criterion for 'proposed trees' is that they have good root growth.	Planting with matsudana willows and interplanting with natives was agreed with GWRC following meetings and is shown on Figures 38A and VS10 of TR7. However, in these figures, most of the existing large poplars situated on the riverbank are being retained, with the only trees removed being those needed to facilitate construction of the bridge. While Friends of Waikanae River may be keen to remove poplars from the river bank the Alliance's visual expert (Mr Evans) maintains that it is important to retain as many of them to help visually 'anchor' and integrate the bridge in the landscape. As noted in TR7, the effects of the Expressway on visual amenity and landscape character, particularly the bridge, are 'extreme' and 'very high' respectively. These trees are important to retain in at least the short and medium terms if this can be achieved in terms of not affecting GWRC's river management. It is noted the submission from Friends of Waikanae River (No. 59) does not mention that the existing poplars should be removed.	Boyden Evans Graham Levy
16	GW has survey cross-sections through the proposed site. The sight lines for these need to be kept clear with a minimum width of 3m.	These will be taken into account, and if sight lines do become blocked, it will be easy to remedy.	Graham Levy Boyden Evans
17	GW has a survey mark on left bank near proposed bridge which probably will need to be relocated - depending on location relative to the proposed bridge.	This will be very easily addressed at the detailed design / construction stage.	Graham Levy Boyden Evans

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
18	The extent of riprap under the bridge varied between Boffas landscape plans (discussed) and plan CV-SW-392 C - to be checked/resolved.	This is matter of detail for final design. However, as of the current stage, the engineering drawing (CV-SW-392) should be taken as being definitive on the matter of extent of rip-rap.	Graham Levy
Issues relating to technical Report 22 "Assessment of Hydrology and Stormwater Effects" including:			
19	NZTA propose to carry out a blockage risk assessment for each culvert and where there is blockage risk, identify the implications, and any appropriate mitigation. This is to be included in evidence to the BOI. GW would like to see this assessment to evaluate the potential effects of the expressway.	This assessment has been carried out subsequent to lodging the AEE, and was discussed with GWRC on 29 August 2012. This included explanation of how the assessment had been carried out, and that 5 culverts would need debris barriers (or equivalent provisions) immediately upstream of the culvert inlets, to reduce the risk of blockage.	Graham Levy
20	KCDC overdesign scenarios for the final Waikanae River channel design have not been modelled - including effects on culverts.	The Waikanae River has been tested in a 2500 year flood, which is 1.48 times a 100 year flood. Therefore, strictly speaking it has not been tested for the KCDC overdesign of 1.5 times the 100 year storm but this difference is immaterial. The Waikanae culverts were also tested in a 2500 year flood, and these are primarily flow balancing culverts, so are governed by flows in and out of flood storage, not direct local catchment runoff, with implications of blockage being low. They have also been separately assessed for blockage risk. The other culverts in this model are in the Mazengarb catchment, and these were tested at 1.5 times a 100 year storm. Therefore, to all intents and purposes, the Waikanae River channel and the culverts have been tested in the KCDC overdesign event.	Graham Levy

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
21	Impacts of changing watercourse lengths on flood levels need to be assessed.	The major diversions have been modelled hydraulically. The other localised changes of channel length (e.g. at bridges and culverts) are relatively small, and manual checks have been carried out to confirm that the hydraulic effects of minor diversions are minimal. In detailed design, any diversions will be checked in the models, and performance is addressed by proposed conditions SW.1 and SW.2.	Graham Levy
22	Changes to diverted streams need to be identified and assessed.	The five main diversions have been described in Technical Report 22, and have been assessed. The minor ones inherently have minor effects. The nature of the culverts and waterways at these locations are described and assessed in the AEE.	Graham Levy
23	Detailed design needs to include evaluation of changed velocity effects.	Agreed, where there are substantive changes. The standard approach has been to maintain a similar waterway capacity in diversions and realignments as is in the existing waterway, so there are unlikely to be areas where there is a substantive change in velocity.	Graham Levy
24	Calculations for culvert design capacity need to include allowance for sedimentation and this needs to be addressed as a maintenance issue.	The design does include such provision. Sedimentation of the base is part of the design for fish passage purposes, as described in Technical Report 22 (page 58). Maintenance is covered by a proposed condition of consent (WS.4).	Graham Levy
25	Effect of sedimentation on attenuation/storage pond capacity needs to be evaluated. Also needs to be addressed with regard to maintenance.	The attenuation storage areas are all off-line, and sedimentation will be a slow process over many years before a substantive change is observed. Monitoring will be included in maintenance inspections and procedures.	Graham Levy

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
26	Differences in flood water depths caused by the Expressway need to be provided to determine the impacts of the Expressway on flood depths. Also 'difference' information required for flows and velocity.	Level difference information was not presented in plans in Technical Report 22 because the objective was to have zero or minimal difference (i.e. nothing to report), except where the change is within the designation. Flow and water level differences along modelled watercourses are presented in Technical Report 22 appendices 22.E, 22.F and 22.G, and velocities in the Waikanae River are also presented in 22.F.	Graham Levy
27	Information on the effect of the combination of the stopbank, the Waimeha Bridge floodway, and appropriate design of Te Moana interchange needs to be provided to assess the impacts of the Expressway. This information needs to include downstream impacts, and other results (e.g. long-sections), and depth changes, velocities, and flows on inundation maps.	This is described in Technical Report 22, at 4.5.1.vi, vii and viii. The 2D modelling of the combined Waikanae River breach plus Waimeha flows through the floodway and interchange are described in Appendix 22.G, with background on the breach scenarios used provided in Appendix 22.F.	Graham Levy
28	Revised modelling for changed Wetland 5 will need to be provided during the design stage to ensure flooding in the Mazengarb Drain does not increase.	This will be done as part of detailed design. Manual checking indicates it can be achieved, and proposed conditions SW.1 and SW.2 address this in principle.	Graham Levy
29	Different channel roughness values have been used for riprap under bridges in different Consultant's models - consistency in approach should be applied and channel roughness values increased under the bridge for the Waikanae River model.	This is a minor effect, but can be checked in final design.	Graham Levy

No.	Issues raised by GWRC on Flood Management and Protection	M2PP response	Relevant expert
30	Hydraulic models should be independently technically reviewed.	This was considered not to be necessary. The models were from GWRC and KCDC, and had been calibrated by those organisations. The Alliance modelling was undertaken by the same modellers as developed the original models, and responsibility for review is with the organisations undertaking the modelling. The results have been reviewed by M2PP design team.	Graham Levy