M2PP-SAR-RPT-DL-GE-271

Scheme Assessment Report

Prepared for the New Zealand Transport Agency

By MacKays to Peka Peka Alliance

21 September 2012

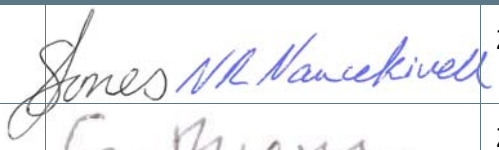
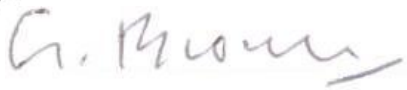
NZ TRANSPORT AGENCY
WAKA KOTAHI

1 MacKays to Peka Peka Expressway

Revision History

Revision N°	Prepared By	Description	Date
A	D Stirrat, L Coe, G Brown, Iain Smith, Eric Whitfield, Kiran Hira, N Nancekivell	Draft issue	05 Dec 2011
B	S Jones, N Nancekivell	Final Draft, incorporating NZTA comments.	21 Sep 2012

Document Acceptance

Action	Name	Signed	Date
Prepared by	Susan Jones, Noel Nancekivell		21 Sep 2012
Reviewed by	Geoff Brown Technical Director		21 Sep 2012
Approved by	Jim Bentley Alliance Project Manager		21 Sep 2012
on behalf of	MacKays to Peka Peka Alliance		

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Executive Summary

General

The MacKays to Peka Peka Expressway including Raumati Straight forms an approximately 18 kilometre length section of the Wellington Airport to Levin road of national significance, (RoNS). It is identified as a priority project within the NZTA's National Land Transport Programme.

The existing SH 1 in Kāpiti is the most direct north-south route and provides for both local and inter-regional movements. Currently vehicles on SH 1 face delays in Paraparaumu and Waikanae making journey times slow and unreliable. The Expressway is predicted to significantly improve safety throughout the whole network and improve travel times for through traffic between MacKays Crossing and Peka Peka, reducing the travel time in 2026 by seven minutes in the weekday morning peak and over ten minutes in the weekday evening peak. The provision of the Expressway will also generally provide travel time savings to local traffic. The overall network will operate with significantly improved travel times and journey time reliability for both local and Expressway traffic, relieving congestion and facilitating planned growth within the Kāpiti District.

Project Objectives

The project objectives, for the purpose of section 171 of the Resource Management Act 1991, are listed below. A the wider objectives including the guiding objectives are included in Appendix B.

The Project Objectives are:

- To:
  - enhance inter-regional and national economic growth and productivity;
  - enhance efficiency and journey time reliability from, to and through the Kāpiti District, Wellington's CBD, key industrial and employment centres, port, airport and hospital;
  - enhance safety of travel on SH1; and
  - appropriately balance the competing functional performance requirements of inter-regional and local traffic movements, recognising that modal and route choice opportunities need to be provided that enable local facilities and amenities in the Kāpiti Coast District to be efficiently accessed;

  by developing and constructing a cost optimised new State Highway alignment to expressway standards between MacKays Crossing and Peka Peka.
- To manage the immediate and long-term social, cultural, land use and other environmental impacts of the Project on the Kāpiti Coast District and its communities by so far as practicable avoiding, remedying or mitigating any such effects through route and alignment selection, expressway design and conditions.

- To integrate the expressway into the urban form of Kāpiti Coast District by taking into account current and future planned settlement patterns in route and alignment selection and expressway design and conditions.

Scheme Assessment Process

The Scheme Assessment design has focussed on developing the design of the preferred option to a level of detail where a scheme estimate can be prepared and the NZTA Board can approve the project for lodging the Notice of Requirement. The technical specialists will use the preferred option as the basis for their assessment of effects to be lodged as part of the Notice of Requirement and resource consent applications.

As part of the scheme assessment the Alliance under took work to review and confirm the principal route options for constructing an Expressway between MacKays Crossing to Peka Peka. This work was carried out in parallel to the development of the preferred option in the ' WLR' Corridor. A rigorous multi-criteria assessment (MCA) was undertaken to assess each of the four Expressway route options against a suite of criteria agreed by a panel of technical experts as being appropriate to fulfil the project objectives and statutory requirements. The preferred option as described in this report was the preferred corridor route following the evaluation process undertaken. As previously identified the number of properties required and the construction cost of building an expressway in the other corridors is significantly higher than for the WLR corridor.

Consultation has been undertaken by the Alliance with two public Expos in Nov 2010 and May 2011 plus numerous meetings with local groups and individual property owners. Key stakeholders have had on going and regular engagement to ensure that they are aware of issues as the design developed.

Development of the Preferred Option

The development of the preferred option has included a number of workshops involving a wide range of participants including KCDC staff, NZTA National office staff and specialist in the alliance. Meetings with NZTA asset staff have been held to ensure appropriate standards were being adhered to and maintenance issues addressed. A value engineering phase has also been undertaken to minimise the overall project cost while not compromising the guiding objectives the alliance members have agreed to.

The preferred option is summarised as follows:

- A 16 km, two lanes each way median divided Expressway. The median varies in width from 4 to 6 m and has a wire rope barrier; (2kms of Raumati Straight is being treated as a pavement rehabilitation and will not meet the RoNS guidelines for median width).
- Connectivity is provided to local roads at four locations, Poplar Avenue, Kāpiti Road, Te Moana Road and Peka Peka. The southern and northern interchanges have south facing and north facing ramps respectively. Both Kāpiti Road and Te Moana Road have full interchanges.

- The Expressway alignment severs the existing access to Nga Manu Nature Reserve and three properties at the eastern end of Smithfield Road. A new connecting road reinstates those accesses, commencing at Ngarara Road approximately in the location of the current Nga Manu access.
- A full length off road cycleway/walkway facility is provided parallel to the Expressway with two cross Expressway bridges in the urban area.

The Expressway corridor traverses the dune sands and swamp, typically containing peat deposits of the Kāpiti coastal lowlands. This area is located in an area with a high seismic hazard compared to many other parts of New Zealand. These conditions have influenced the proposed design and construction options detailed in the report.

The project contains 18 bridges in all, 10 of these are Expressway bridges over local roads or rivers and streams. Where the structures will be very visible to the public pier shapes have been developed to suit the urban design framework with shaped concrete piers provided in line with the folded edge barriers to hide the pier crosshead and provide a smooth transition between super structure and supports.

A new four lane road through rural and residential areas will inevitably have adverse effects on the existing landscape character and amenity of the areas close to the Expressway. While avoiding landscape and visual effects was a focus in the Expressway design process mitigation measures are addressed. These include ensuring final shaping of landforms – the cut faces and batter slopes, are well integrated with the surrounding area, form and design of earth bunds for noise and/or visual mitigation, and retention of significant areas of existing native and exotic vegetation and planting.

The Project Expected Estimate (P50) for this scheme is $637 million.

Recommendations:

i. This preferred option is adopted as the basis for the Scheme Estimate and preparation of Notice of Requirement and Resource Consents.

ii. The next stage of design (Target Outturn Cost) proceeds based on this preferred option.

1 Introduction

1.1 Problem Description

SH1 is the only continuous north-south arterial between MacKays Crossing and Peka Peka and it is the only road crossing of the Waikanae River. It also provides a high degree of local connectivity. The absence of a north-south local arterial, the significant amount of local access from SH1, and the lack of an additional Waikanae River crossing contribute to a significant amount of local traffic on SH1. In this sense, SH1 performs a local road function which erodes its ability to effectively perform its role of a National State Highway and Road of National Significance.

The geometry of SH1 is currently substandard with out of context curves and an inconsistent speed environment. The high degree of side access and local road connections create side friction which slows traffic on the highway and creates crash risks and other safety issues.

The Kāpiti Coast is one of the fastest growing districts in New Zealand, growing nearly 10% in five years to a population of 46,000 as at 2006. Its proximity to Wellington and high volumes of traffic for commuter, business and recreational purposes mean the Kāpiti state highway often operates beyond its capacity and can become severely congested at peak times especially at public holidays.

The majority of movement within the district is via private vehicles. With the significant growth expected to occur in Kāpiti over the next twenty years, private vehicle use is expected to grow. This is especially the case for movement within Kāpiti for which rail travel is not a realistic choice.

The demand for road-based freight movement is expected to grow significantly in the coming years, both as through traffic and within Kāpiti, particularly with the anticipated development of the Paraparaumu Airport Business Park. Stop-start conditions along the existing SH1 increase the operating costs for freight providers. The large amount of road freight movement contributes to a degraded urban environment in Paraparaumu and Waikanae town centres.

As a result of the above, SH1 between MacKay's Crossing and Peka Peka has a significant crash history with 399 crashes reported over the five year period 2005 to 2009 including four fatalities. A significant portion of these crashes are loss of control / head on in midblock locations, likely to be attributable to the substandard geometry and inconsistent speed environment on the existing highway. Intersections between SH1 and key local arterials have a history of vehicles failing to give way resulting in injury crashes, contributing to SH1's poor crash history.

1.2 Report Purpose

This report has been prepared for the New Zealand Transport Agency (NZTA) by the MacKays to Peka Peka (M2PP) Alliance to describe the "preferred option", for the MacKays to Peka Peka Expressway.

An Options Assessment was carried out in early 2011, which resulted in a preferred option. This preferred option has had further design development, to allow completion of Scheme Assessment Report. The Scheme Assessment design forms the basis of the Scheme Estimate, and also the basis on which the specialist assessments will be prepared for the Notice of Requirement and applications for resource consents.

1.3 Land Transport Management Act

The Land Transport Management Act (LTMA) provides the legal framework for managing and funding land transport activities. The purpose of the LTMA is to contribute to the aim of achieving an affordable, integrated, safe, responsive and sustainable land transport system. The LTMA:

- provides an integrated approach to land transport funding and management
- improves social and environmental responsibility in land transport funding, planning, and management
- provides the NZTA with a broad land transport focus
- improves long-term planning and investment in land transport, including planning and investment in coastal shipping and rail
- ensures that land transport funding is allocated in an efficient and effective manner
- improves the flexibility of land transport funding by providing for alternative funding mechanisms.

The LTMA also defines the function of the NZTA and the roles of:

- regional councils, for land transport planning, programming and funding
- regional transport committees (and their composition).

The LTMA also provides for:

- the development of a National Land Transport Strategy
- regional land transport strategies
- a Government policy statement on land transport funding 2009/10-20018/19 (GPS).

The project has been assessed against the five key objectives of the Land Transport Management Act (2003). The project will support national and regional economic development by ensuring improved connectivity between Wellington and the rest of the North Island. It will also provide improved connectivity, route security and access for freight supply chains for the Paraparaumu Airport and Kapiti Town Centre which are significant regional developments.

In 2011-14, the NZTA will focus on five priorities:

- Plan and deliver the roads of national significance (RoNS)
- Improve the road safety system
- Improve the efficiency of freight movements
- Improve the effectiveness of public transport
- Improve customer service and reduce compliance costs.

NZTA use these priorities to shape the transport sector over time, in support of the government's policy direction. They also help guide their organisation asthey develop and deliver services and infrastructure to New Zealanders. In addition,NZTA will deliver a number of key work programmes towards the following areas of focus:

- Value for money in all they do
- Rebuilding Christchurch
- Growing Auckland.

1.4 Approach

Option development for the M2PP Expressway has taken place in stages and has been reported on in two earlier reports, the Scoping Report dated 8 October 2010 and the Options Report dated 13 June 2011. Reference should be made to these reports for full details of the process and options considered.

At the Scoping Report stage, options were developed for different connectivity and alignment alternatives for the route. These were assessed by a multi-criteria assessment (MCA), and a short list of three connectivity options and seven alignment options was identified.

Subsequently, through workshops, further investigation and further detail being developed around local road crossings, some changes were made to the Scoping Report shortlist of options, with a revised list of options taken forward into the Options Report stage. The revised list of options was one connectivity option (south facing ramps at Poplar Avenue, north facing ramps at Peka Peka and full interchanges at Kāpiti Road and Te Moana Road) and 12 sub-options, two at each of six locations along the Expressway route.

The assessment of the shortlisted options to determine the preferred option was both quantitative and qualitative, and involved:

- Feedback from the Expo 1 consultation, (Expo 1 commenced 0n 28th Nov 2010, where the alignment options were presented with 2 options for the southern connection and an east and west option through Waikanae)
- Further investigation and design to provide more clarity of the options
- Multi criteria assessment of the options
- Assessment of option costs

- Management team review of all the above and recommendation to the Project Alliance Board
- Sign off from NZTA Highways Value Assurance Committee, VAC and the NZTA Investment & Operation committee.

Following the above assessment, a preferred option was selected and has been carried forward for the Scheme Assessment Report design.

The Scheme Assessment stage has involved the following activities:

- Technical design development of the preferred option
- Further geotechnical investigation
- Traffic modelling and analysis
- Value Improvement Process, to review the design details and assess areas where value could be improved
- Further consultation on the design details, through Expo 2 in May 2011, where more detail was provided, particularly around the under and over options where the Expressway crosses the local road
- Meetings with representatives of NZTA specialists to gain further understanding of design criteria
- Safety in Design workshop
- Noise modelling and consideration of options for mitigation
- Value engineering
- Preparation of Scheme Assessment drawings, design reports and cost estimate.

1.5 Background to the Project

The MacKays to Peka Peka Expressway including Raumati Straight forms an approximately 18 kilometre length section of the Wellington Airport to Levin road of national significance, (RoNS). It is identified as a priority project within the NZTA's National Land Transport Programme.

The MacKays to Peka Peka Alliance, (M2PP) has been engaged to deliver the Expressway. The Alliance consists of NZTA, Beca, Fletchers, Higgins and the Kāpiti Coast District Council with Boffa Miskell, Incite and Goodman Contractors as supporting participants. The Alliance is tasked with finding solutions that:

- achieve the intent of NZTA's RoNS Guidelines and Standards;
- are responsive in terms of function and design to aspirations of the Kāpiti communities spanned by the Expressway; and,
- provide long term solutions to transport and land use growth pressures in Kāpiti and the wider region.

The Kāpiti Coast is a fast growing district, and together with its proximity to Wellington and high volumes of traffic for commuter, business and recreational purposes, the

existing state highway often operates beyond its capacity and can become severely congested at peak times.

The NZTA is developing the Expressway so that efficient access to and from the local road network is also provided. This is a challenging task on the Kāpiti Coast where an effective, parallel local road network does not exist.

1.6 Project Objectives

Project objectives have been developed for this project. These objectives have included NZTA's wider objectives for the RoNS, objectives that are consistent with the requirements of the RMA and the objectives developed by the Project Alliance Board. These objectives are included in Appendix B.

1.7 Topographic Survey

The site corridor was flown in July 2010 and the resultant aerial photography was used to produce a digital terrain model (DTM) and orthophotography. This DTM had a relative accuracy of ±0.1m for x, y & z coordinates and it was used to generate 0.5m contours across the site. The orthophotography has a ground sample distance (GSD) of 0.05m (each pixel in the image represented a 5cm square on the ground). This mapping used approximately 62 control points that were coordinated by GPS. Additional survey verification was undertaken along the site corridor, as well as a number of areas that required infill survey due to the ground detail not being visible due to vegetation. These were completed by land-based survey techniques.

2 Site Description and Constraints

The following description of the existing environments identifies potential facts that will influence decisions for the project both for construction and long term maintenance and operation. Where possible current and future constraints and opportunities have been identified for the context of the project. Those factors in relation to the surrounding community and environment that have informed project design or may influence future mitigation requirements are also summarised.

2.1 Existing Environment Description

The following gives a brief description of the geographic area that the project crosses, divided into four sectors, as described below:

- Sector 1 – Raumati South: from MacKays Crossing to just north of Raumati Road
- Sector 2 – Raumati/Paraparaumu: from north of Raumati Road to north of Mazengarb Road
- Sector 3 – Otaihanga/Waikanae: from north of Mazengarb Road to north of Te Moana Road, including the proposed upgrading of Otaihanga Road/SH1 intersection
- Sector 4 – Waikanae North: from north of Te Moana Road to north of Peka Peka Road.

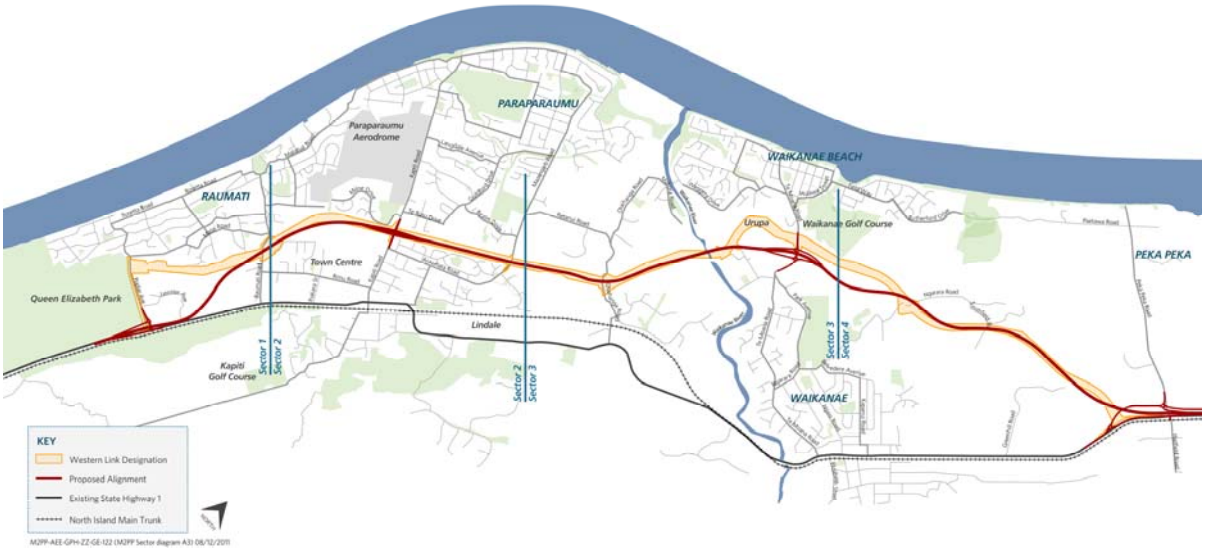

Figure 2.1 – MacKays to Peka Peka Sector Diagram

2.1.1 Sector 1 Raumati South

Poplar Avenue marks a change in the landscape character within this sector. South of Poplar Avenue is the QE Regional Park on the west side of the proposed Expressway, with some grazing and coastal and inland dunes backed by wetlands. North of Poplar Avenue there is suburban development around the street network with a large undeveloped area in and adjacent to the historic designation for the Western Link Road and its predecessors.

The nature of the topography within Sector 1 is such that the residential areas to the west of the Western Link Road (WLR) designation are largely masked by the dune landform (except where the houses are on the dune ridge). The residential enclave at Leinster Avenue is somewhat elevated by the dune form it sits on. There are residential properties that currently front onto SH1. These are typically long parcels of land that extend westward.

Raumati South peatlands (i.e. the wetlands surrounding Te Ra school) are ecologically significant with regard to their relatively high wetland plant diversity. A number of species found within these wetlands are considered to be locally uncommon.

2.1.2 Sector 2 Raumati/Paraparaumu

The topography of this sector consists of unmodified dunes, separated by low lying interdunal peat swamps.

The majority of this sector is urban, however it changes to semi-rural residential north of Mazengarb Road. The Paraparaumu town centre is located in this sector which is a significant feature for the District, given that it provides civic, retail, service, office and employment for much of the Kāpiti coast.

A large residual area of land (zoned town centre) separates the current civic area from the edge of the designated corridor. The Paraparaumu airport is also adjacent (separated by a residentially developed dune) and it is planned to grow substantially as a regional commercial base.

The remainder of the route, except at the north end, is constrained by residential development which has been built up to the WLR designation edge for considerable lengths of the route through this sector.

2.1.3 Sector 3 Otaihanga/Waikanae

The topography in this sector consists of medium scale sand dunes and the lower lying alluvial terraces of the Waikanae River.

The land use includes a diverse mix of residential, rural residential and semi-urban settlement as well as the Waikanae River corridor.

This sector includes a large number of culturally and ecologically significant sites including the Maketu Tree, Wāhi tapu/urupa area at Waikanae, wetlands of high value and a number of waterways.

2.1.4 Sector 4 Waikanae North

This sector has an open rural character for most of its length. The topography is undulating with large dunes south of Ngarara Road and small dunes and peat swamps to the north. It contains a large freshwater wetland complex with important hydrological and habitat connections including the Nga Manu Nature Reserve.

This sector includes the Waikanae Urban Edge Plan Change 79 and Ngarara Plan Change 80. These plans seek to manage the expansion of residential development in the area north of Waikanae, and rezone land north of Waikanae from rural to residential to allow for a mix of residential and commercial development.

2.2 Māori History and Cultural Values

Te Runanga o Ati Awa ki Whakarongotai Inc is the mandated iwi authority representing the tribal interests of Ngati Awa hapu on the Kāpiti Coast. The area of jurisdiction of this iwi extends from the Whareroa Stream at the southern end of QE Park, to the Kukutauaki Stream, north of Peka Peka Road. Within this large rohe, the Takamore Trust has mandated responsibility for the area of significant cultural values between the Waikanae River and Te Moana Road (referred to as the Takamore cultural heritage precinct). This area is regarded by Māori as a Wāhi tapu, and includes an urupa that is contained within an area registered with the New Zealand Historic Places Trust as a Wāhi tapu.

Ngāti Toa also has interests in Queen Elizabeth Park, while Ngāti Raukawa and Muaupoko have a long association with the Kāpiti area.

The cultural landscape of the Kāpiti Coast is characterised by a number of important factors that incorporate tangible and intangible values. For Te Ati Awa ki Whakarongotai, the cultural landscape embodies the stories, myths and legends of its communities. Landscape features such as mountains, rivers, wetlands and the life forms they support provide the medium for which the stories that bind people to their surroundings have been conveyed throughout the generations.

The Cultural Impact Assessments undertaken for this Project by Te Ati Awa ki Whakarongotai and the Takamore Trust identify specified areas and landscape features within the Project area that have particular cultural significance, characterised by a range of interconnected cultural values. These areas include, but are not limited to, the Takamore cultural heritage precinct, water bodies, Māori owned land blocks and QE Park.

In May 2011, the Takamore Trust, with assistance from the Alliance, prepared a number of constraints maps to identify sites of cultural importance within the Takamore cultural heritage precinct. These sites include the Maketu tree, Takamore urupa, Tuku Rakau Village and the registered Wāhi Tapu.

The proposed M2PP Expressway corridor is not preferred by Te Ati Awa ki Whakarongotai as it presents significant challenges for the protection of cultural and natural heritage sites. The iwi would prefer to see an upgrade of the existing State Highway network as it is already heavily modified and therefore the probability of impacts on unknown archaeology as well as areas of ecological importance is considerably low.

The Takamore Trust has yet to reach a final position on the Expressway alignment through the Takamore cultural heritage precinct area. This is due largely to the apparent scale of impacts that this option presents. Notwithstanding this, it is important to note that the two alignment options considered to date are superior to the earlier WLR route though the registered Takamore Wāhi tapu area.

2.3 Factors affecting choice of options and long term decisions on operation

Table 2.1 – Factors affecting choice of options and long term decisions on operation

Constraint Area	Sectors			
	1	2	3	4
Cultural/Archaeological	■ Potential for unknown sites in QE Park, further work required to investigate ■ Wetlands and streams	■ Potential for unknown sites in this sector, further work required to investigate; ■ Wetlands and streams	■ Maketu Tree, registered Wāhi tapu site, Takamore urupa, Taku Rakau Village site, and a range of other sites and localities of cultural significance; ■ Wetlands and streams, including wetlands west of Takamore urupa.	■ Potential for unknown sites in this sector, further work required to investigate. ■ Wetlands and streams, with Harakeke and Kawakahia wetlands of particular cultural importance to iwi.
Environmental	■ Air Quality concerns relating to schools being located in close proximity to Expressway for QE Park alignment option; ■ Ecology – there are a number of wetlands and peatland areas with moderate ecological values through this sector.	■ Air Quality – retirement village located approx. 200m from proposed alignment in this sector only known sensitive receptor. ■ Ecology – four wetland areas, Wharemauku Stream, 'Drain 7' and Mazengarb Stream which provide habitat for native fish species;	■ Air Quality – limited constraints in this sector; ■ Ecology – significant number of ecological areas in this sector.	■ Air Quality – limited constraints in this sector; ■ Ecology – significant number of ecological areas in this sector.
Land use & Planning	■ Existing designations for schools, QE Park and Western Link Road; ■ QE Park gazetted 'reserve' under Reserves Act; ■ Ecological areas identified on District Plan maps.	■ Existing designations for Western Link Road, Paraparaumu Sewage Treatment Plant, Otaihanga Landfill and Plantation Reserve. ■ Andrews Pond (wetland) is an identified ecological area noted on District Plan maps; ■ Paraparaumu Town Centre development;	■ Heritage items including Greenaway homestead and Maketu grave site; ■ Existing designations including the Western Link Road, Otaihanga Landfill; ■ Several ecological areas noted in this sector; ■ QEII covenants;	■ Existing designations including the Western Link Road, ■ Ecological areas identified on District Plan maps; ■ Outstanding landscape areas identified on District Plan maps; ■ QEII covenants; ■ Plan Changes 79 and 80 –set

Constraint Area	Sectors			
	1	2	3	4
		■ Paraparaumu Airport development – Plan Change 73.	■ Plan Changes 79 and 80 –set urban 'edges' for future growth of the district and provide for neighbourhood and hamlet style residential development.	urban 'edges' for future growth of the district and provide for neighbourhood and hamlet style residential development.
Urban Design	■ Existing designation has formed a barrier between east-west communities; the Expressway may represent an opportunity to connect these neighbourhoods.	■ Council development plans for the Town Centre; ■ Paraparaumu Airport proposed development; ■ Residential and commercial areas constrain the designated route on both sides.	■ This sector is predominantly rural-urban therefore urban design constraints limited.	■ This sector is predominantly rural-urban therefore urban design constraints limited.
Social and Community	■ The proximity of schools and residential areas in this area results in moderate to significant social constraints on the project. ■ Social constraints in relation to property acquisition and associated displacement effects.	■ The proximity of the residential areas to the Expressway alignment.	■ Social constraints in relation to property acquisition and associated displacement effects. ■ Recreational values associated with the river corridor.	■ Social constraints in relation to property acquisition and associated displacement effects. ■
Landscape & Visual	■ The existing designation currently runs along the sand dunes through this sector. Any excavation works on the dunes will modify the visual landscape. ■ QE Park is an open 'undeveloped' area, this forms a distinct change from the residential area to the north of Poplar Ave.	■ Existing designation located along the top of a 10-20m high sand dunes. These currently screen the residential area (located east of the Airport) from the designated route;	■ Dunelands through this sector; ■ Low lying Waikanae River corridor and recreational corridor.	■ Dunelands through this sector.

Constraint Area	Sectors			
	1	2	3	4
Geology and Ground Conditions	■ Thick peat (2 – 6m deep) can be found from the edge of the foothills and across QE Park; ■ Sand dunes located between Poplar Ave and Raumati Road – peat is located at the base of the sand dunes.	■ Isolated peat pockets found between the sand dunes; ■ High sand dunes; ■ Alluvial deposits found near Wharemauku Stream; ■ Otaihanga landfill located adjacent to alignment.	■ Shallow peat deposits; ■ Sand dunes; ■ Waikanae River corridor has low-lying alluvial terraces on either side.	■ Predominately sand dunes south of Smithfield Road. ■ Peat deposits typically between 2 – 4m deep.; ■ Fault Hazard – identified at the northern end of this sector.
Stormwater/Hydrology	■ Drain 7 and Poplar Ave flood levels constrain development levels of the Expressway; ■ Existing secondary flow paths constrain development as these need to be maintained to ensure adjacent areas do not flood; ■ Groundwater levels – high ground water levels will affect runoff treatment opportunities.	■ Existing flood levels are a constraint for further development; ■ Existing secondary flow paths; ■ Wharemauku and Mazengarb Streams – will be required to maintain flood flow levels; ■ KCDC identified flood storage area; ■ High groundwater levels – particularly in areas where grade separation is proposed to separate Expressway and local roads. ■ Flat longitudinal gradients constrain potential flood discharge levels.	■ Existing flood levels are a constraint for further development; ■ Bridge waterways – Waikanae River with an active bed (creating a scour risk); ■ Existing secondary flow paths; ■ KCDC identified flood storage area; ■ High groundwater levels; ■ Interaction of stormwater with Otaihanga Landfill – will constrain stormwater infiltration in this area.	■ Existing flood levels are a constraint for further development; ■ Existing secondary flow paths; ■ High groundwater levels; ■ Flat longitudinal gradients constrain potential flood discharge levels.

2.4 Crash Records

NZTA's Crash Analysis System (CAS) was interrogated to determine the reported crash history for the five-year period 2006 to 2010 along SH1 from MacKays Crossing to Peka Peka and at each of the key intersections within the Project area on the local road network. The results of this assessment are summarised below.

The **Tables 2.2** and **2.3** below summarise the reported crash history on SH1 from MacKays Crossing to Peka Peka.

Table 2.2 – Annual Distribution of Crashes on SH1 MacKays Crossing to Peka Peka

Year	Fatal	Serious	Minor	Non-Injury	Total
2006	2	6	19	48	75
2007	1	3	15	68	87
2008	0	2	18	54	74
2009	0	2	17	66	85
2010	1	4	14	73	92
TOTAL	**4**	**17**	**83**	**309**	**413**

Table 2.3 – Crash Type SH1 MacKays Crossing to Peka Peka

Crash Type	Number of Reported Crashes	Percentage of Reported Crashes
Overtaking Crashes	44	11%
Straight Road Lost Control/Head On	55	13%
Bend – Lost Control/Head On	41	10%
Rear End/Obstruction	114	28%
Crossing/Turning	145	35%
Pedestrian Crashes	9	2%
Miscellaneous Crashes	5	1%
TOTAL	**413**	**100%**

In the five-year period (2006 to 2010) a total of 413 crashes were reported on SH1 between MacKays Crossing and Peka Peka. Of these, four of the crashes involved fatalities, 17 resulted serious injuries and 89 resulted in minor injuries, with 309 non-injury crashes. One of the fatal crashes occurred at the SH1 / Hadfield Road intersection, near the Peka Peka intersection and involved a vehicle failing to give way turning right into Hadfield Road. Two of the fatalities occurred at midblock locations and involved loss of control or crossing / turning. One of the fatalities involved a pedestrian walking with

traffic near Greenhill Road north of Waikanae. The crash report states that the pedestrian appears to have jumped in front of the vehicle's path and was hit.

Of the 17 serious injury crashes, six were lost control type crashes, five occurred while a vehicle was turning or waiting to turn across traffic to the right, and three were head-on type crashes. Others were the result of overtaking, queuing, or turning to the left.

Over half of the minor injury crashes involved right turns, loss of control type crashes, or rear end type crashes. Many other minor injury crashes were over taking, head on or other turning and crossing type crashes.

Of the 413 reported crashes, 43% occurred in urban, 50kph sections of SH1. The remainder occurred in peri-urban or rural 70, 80, or 100kph sections of SH1.

2.5 Surrounding Transport Network

The transport network within the Project area includes, Kāpiti Coast Airport, the existing State Highway 1 (SH1), the local road network, the North Island Main Trunk line (NIMT) railway, bus networks, walkways, cycleways and bridleways. Further information on the existing transport network is contained in the *Assessment of Transport Effects*.

2.5.1 Kāpiti Coast Airport

The Kāpiti Coast Airport is one of the few privately owned regional airports in New Zealand and is strategically significant as a second airport for the Wellington Region. Located off Kāpiti Road, in Paraparaumu, the airport has about 40,000 aircraft movements each year, predominantly light aircraft. The Airport has recently been upgraded to become a regional airport, with more options for national air travel to other major centres. In conjunction, a recent plan change has provided for significant business development to occur adjoining the airport, which is expected to generate increased business and employment opportunities locally and is likely to result in additional traffic (freight and private vehicles) movements on local roads, particularly Kāpiti Road and the proposed future Ihakara Street extension.

2.5.2 State Highway Network

SH1 connects Wellington to the Kāpiti Coast and further northwards to the central North Island. In the Wellington Region, SH1 is a 'national strategic' State Highway, signifying its high importance in terms of strategic connections for freight traffic and other vehicles to Wellington City, CentrePort, the Interislander ferry, and Wellington International Airport. Through the Project area, SH1 is the primary north-south route, providing the only road crossing of the Waikanae River and accommodating both local and inter-regional traffic movements. Between MacKays Crossing and Peka Peka, the highway is generally located parallel to the North Island Main Trunk, (NIMT), and is typically two laned except for several overtaking sections and for the section south of Poplar Avenue. The various communities of the District are accessed by a combination of the SH1 and/or via secondary local roads.

2.5.3 Local Road Network

There are a number of major local arterial roads that connect to SH1 or that perform a significant function in the local road network. The existing east-west local roads and arterials which will either cross under or over the Expressway, and/or that will provide as connections to the Expressway include (from south to north):

- Poplar Avenue
- Raumati Road
- Kāpiti Road
- Mazengarb Road
- Otaihanga Road
- Te Moana Road
- Ngarara Road
- Smithfield Road
- Peka Peka Road.

Local roads and streets, including those listed above, are typically two-laned. In the vicinity of the proposed Expressway, local roads have a speed limit of 50km/h, except for Otaihanga Road which has a speed limit of 80km/h.

Figure 2.2 Road Hierarchy Plan – source KCDC District Plan/UDLF

2.5.4 Public Transport

The Kāpiti Coast District is well serviced by public transport with rail and bus services. **Figure**[1] **2.3** below shows the bus and rail network services which operate in the project area.

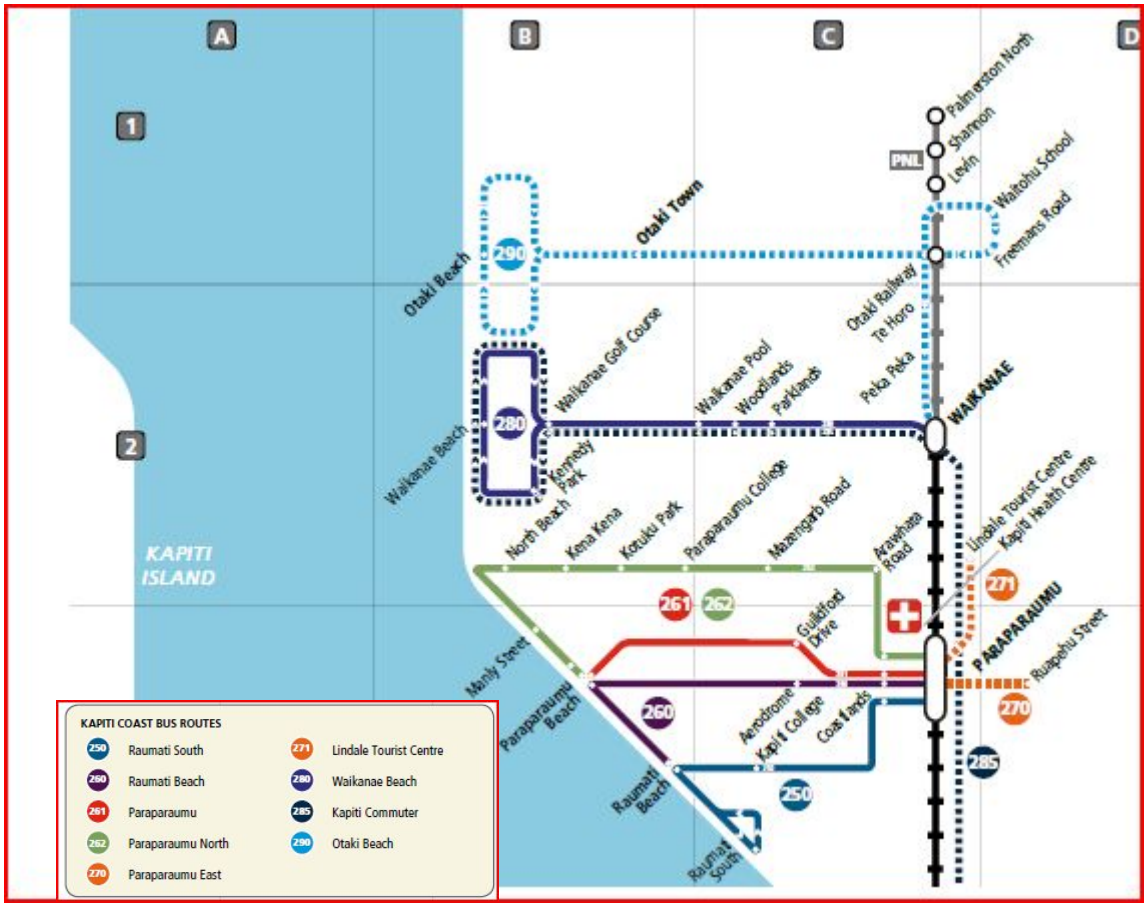

Figure 2.3 – Project Area Public Transport Network Map

The North Island Main Trunk (NIMT) rail line runs north-south through the Kāpiti Coast District. Within the Project area there are rail stations at Paraparaumu and Waikanae. The project area is well serviced by passenger rail services.

There is a network of bus services on the Kāpiti Coast, as illustrated in **Figure 2.3**, including the following routes:

- Routes 250 and 260: Raumati Beach to Paraparaumu Rail Station
- Routes 261 and 262: Paraparaumu Beach to Paraparaumu Rail Station
- Route 270: Paraparaumu East to Paraparaumu Rail Station
- Route 271: Lindale Shuttle to Paraparaumu Rail Station
- Route 280: Waikanae to Waikanae Rail Station

[1] Source: Greater Wellington Regional Council's public transport website: www.metlink.org.nz

- Route 290: Otaki to Waikanae Rail Station.

The bus services are generally scheduled to meet trains at Paraparaumu and Waikanae rail stations. Bus services generally run at 20-25 minute frequencies during the peak periods, and on weekends and off peak the bus routes operate on a one hour frequency.

2.5.5 Walkways, Cycleways and Bridleways

The current provision for walking, cycling and horse riding through the District is by a mix of on-road facilities, footpaths and cycle lanes, as well as paths that traverse open spaces or cut through parks and between streets as lanes. The Wharemauku Trail and Waikanae River Trail are well used areas provided for recreational walking, cycling and horse-riding. Many of these accessways provide for school traffic.

Both SH1 and the Kāpiti Coast Cycle Route are part of the regional cycling network as shown within Figure 4. The 16km Kāpiti Coastal Cycle Route runs from Paekakariki through to Peka Peka beach, generally along residential streets, through Queen Elizabeth Park and along the Waikanae River. There are currently no cycle lanes on the existing SH1 between MacKay's Crossing and Peka Peka. Cyclists ride in the shoulder, where available. The Paraparaumu rail overbridge and the Waikanae River Bridge are very narrow and cyclists are effectively forced to ride in the traffic lane in both of these locations.

Figure 2.4 – Kāpiti Coast District Coastal Cycleway (Source: Kāpiti Coast District Coastal Cycleway Guide, Kāpiti Coast District Council, 2011)

2.6 Cross project linkage issues

There are a number of factors relating to the surrounding community and environment that might influence cross project linkages. The Urban Design and Landscape Framework contains a number of recommendations to address these matters which have informed project design and may influence future mitigation requirements. Some of the important design implications follow in relation to land use and built environment issues, network movement issues, and services.

2.6.1 Design implications for land use and built environment issues

Maintaining wide corridors to provide for options to design separation spaces will be important in areas where residential uses are adjacent.

Regional centre type land uses such as - airport, town centres and schools - will benefit from the design location of connections to the interchange where those connections enable better accessibility.

Freeing up the current SH1 from highway traffic enables the design of the town centres at Paraparaumu and Waikanae to be reconfigured to function more positively and with higher amenity, including better connections between the centres and railway stations.

Options for the Expressway should be designed to avoid effects on schools and to encourage the safety and directness for walking and cycling access.

The people at the beach communities will typically need to pass across the Expressway regularly and this experience of moving from the west to east and east to west needs to visually, functionally and safely provided for in the design. This includes the way interchanges are designed to facilitate local road movements by pedestrians and cyclists.

The opportunity should be taken to set a precedent for the quality of the wider stretch of Kāpiti Road with the design of the Expressway interface with this arterial road.

Design approaches should assist KCDC policy to discourage urban growth at locations on the route where this is contrary to that policy - this is primarily at Otaihanga and Peka Peka.

The future growth and development in residual areas of the Expressway designation (such as at Raumati) and at planned growth areas needs to be considered in the design especially in terms of connections, to, from and within these areas, as well as the protection of recognised features.

2.6.2 Design implications for network movement issues

The Expressway crosses a number of east west oriented local roads linking the beach communities on the coastal side with those inland. These connections need to be maintained to provide for the interaction between these communities. This includes through the construction period.

The Expressway is to provide a consistent highway speed (100kmh) route through the district. The local road crossings will accordingly be grade separated and take the form of a bridge over or road under the Expressway. Walking and cycling movements will be most sensitive to the condition and quality of the crossing - be that having to move under a bridge or on an over-bridge.

The communities at Waikanae and Paraparaumu interact constantly for a range of economic and social reasons. The Expressway can be designed to enhance the function of the district and its economic performance and social condition by providing connectivity to the Expressway at Waikanae and Paraparaumu.

The Waikanae River and Wharemauku Streams provide highly used corridors for recreation and commuting movements. They also have other amenity values. The sensitivity with

which the Expressway crosses these waterways will be important to the continuance of the movements and enjoyment of these places.

SH1 is part of the regional cycle network. Consideration needs to be given to either maintaining this route along its current alignment and/or providing a new commuter cycle route along the Expressway, as well as how this connects at either end to the wide network. In either case, the safety, convenience and amenity of cycling must be a primary consideration to satisfy transport policy and project objectives.

The Expressway enables the former SH1 to take on a new character including revitalised town centres at Waikanae and Paraparaumu. The design for the condition of the former SH1 is of interest to KCDC and the community generally, given that it will pass to KCDC once the Expressway is operational as the new SH1. Of interest will be:

- the ability to enhance connections across the former highway to railway stations and bus interchanges from the town centres
- the potential to reduce the width of asphalt to improve visual amenity for example by the planting of trees
- the potential for a lower speed environment that may encourage a quieter and more comfortable route option for some drivers
- the utilisation of some of the current width for walking and cycling facilities
- the ability to introduce traffic controls at some local road connections to make the turning to and from these to the former highway easier and safer
- the relative extent to which any changes to the former SH1 are to be prioritised as well as funded.

There will be an interaction between the former SH1 and Expressway at the points where interchanges are provided for. The implications for the design of the local roads that connect the two need to be considered in terms of impacts on existing land uses and the quality of the road as a walking and cycling route.

At interchanges the effect on the safety and comfort with which pedestrians and cyclists (as well as horse riders) can cross through the interchange will require careful design.

The location of interchanges and the level of connectivity these provide will influence the land uses around them. Where there is good connectivity to the local network there is likely to be pressure for land development by urban land uses. Although this connectivity can be positive, KCDC has a growth policy which aims to limit urban growth outside of the existing towns and nominated growth areas.

The interaction between the former SH1 and future land uses along its length will need to be considered to ensure that KCDC's urban growth policy is not put at risk by its status changing from the current limited access status.

The need for future connections across the Expressway in the north Waikanae area needs to be recognised and provided for, both in terms of their physical provision in the design as well as in the definition of the funding responsibility of these.

There is the possibility of a future Raumati railway station – the Expressway design should not preclude this possibility.

Raumati Road, Kāpiti Road, Guildford Drive, Mazengarb Road and Te Moana Road form the backbone of the bus network. Good pedestrian access to bus stops on these routes in the vicinity of the Expressway should be provided for.

2.6.3 Design implications for services

A range of major services supporting the urban environment are located within the Project area, and include transmission and distribution lines for gas, electricity, and telecommunications, and reticulated networks for water supply and wastewater disposal. The Alliance will work closely with the Major Service providers within the Project area including KCDC, Vector Gas, Electra, Telstra, Telecom and FX Network to ensure maintenance of supply and future proofing occurs.

3 Overview of Preferred Option

This section of the Scheme Assessment Report gives a brief description of the preferred option for the Expressway project. It is described from south to north along the route. This description is divided into the four sectors as listed in Section 2.0 above.

3.1 Overall Alignment

The Mackays to Peka Peka project consists of approximately 18 km of four lane median divided highway extending from the recently completed MacKays Crossing in the south to just north of Peka Peka Road which is located to the north of Waikanae. The initial 2kms, Raumati Straight, will not be upgraded to Expressway standard but the carriageway will be rehabilitated to improve the rideability and reduce long term maintenance. From just south of the proposed Poplar Avenue interchange to Peka Peka the alignment will be to Expressway standard. It is mostly constructed offline from the existing State Highway 1, which will become a local arterial road.

The proposed alignment for the Expressway is shown in the following Figure 3.1.

Scheme Plans showing the Preferred Option are included in Appendix A.

Figure 3.1 - Proposed Alignment

3.1.1 Connectivity

The overall alignment provides connectivity to local roads at four locations; Poplar Avenue, Kāpiti Road, Te Moana Road and Peka Peka Road.

At Poplar Avenue, connectivity takes the form of a partial interchange, with south facing ramps only. The south facing ramps provide for a northbound off-ramp joining with Poplar Avenue, and for a southbound onramp, allowing traffic from Poplar Avenue and from Paraparaumu to join SH1 and continue south. Two roundabouts are provided on a realigned Poplar Avenue, with the Expressway passing over Poplar Avenue.

At Kāpiti Road a full interchange is provided, with both north facing and south facing on and off-ramps. These allow traffic from the Expressway to exit at Kāpiti Road, and allow traffic on Kāpiti Road to enter the Expressway. The Expressway passes over Kāpiti Road, which is widened to provide two through lanes in each direction and turning lanes at the signalised intersections with the ramps. The widening of Kāpiti Road takes place over a length of approximately 350 metres.

Similarly, a full interchange is provided at Te Moana Road with both north facing and south facing on and off-ramps provided, linking the Expressway with Te Moana Road. Again, the Expressway passes over Te Moana Road. The intersections of the ramps with Te Moana Road are to be traffic signal controlled.

At Peka Peka Road, a partial interchange is provided with north facing ramps, this allows north bound traffic to enter the Expressway, and southbound traffic to exit the Expressway. The Expressway remains close to existing ground level with a local road connection passing over the Expressway from the existing SH 1 in the south to join to the northbound on ramp and Peka Peka Road. A new roundabout is provided at the junction of the southbound off-ramp and the existing SH 1 and the local road connection passing over the Expressway. The existing NIMT railway level crossing at Hadfields Road remains and the south bound off ramp from the Expressway joins the old highway at the intersection of Hadfield Road.

It is proposed that the Expressway and a new local road continue north from this location, this work is being undertaken by the Peka Peka to Otaki Project.

3.1.2 Expressway General Cross Section

The typical cross section of the Expressway along the full length consists of 2 x 3.5m lanes each way, a nearside shoulder of 2.5m width and an offside shoulder of 1.0m width.

The central median remains at 3m from MacKays Crossing to the start of the south facing ramps just south of Polar Avenue. The central median then varies in width from 4.0m (edge line to edge line) to 6.0 m (edge line to edge line). The 4.0m width applies from the southern end of the Expressway, (just south of Poplar Avenue) through to south of Raumati Road and then again from north of Mazengarb Road through to the northern end. In between these places it is 6.0m wide. The narrower median has been selected to help minimise the Expressway footprint where practicable. However a 6.0m median allows

Expressway bridges over local roads to be constructed as two separate structures with an opening between to allow natural light through to the footpaths below, and therefore this has been used in the more urban areas of the Expressway. The only exception to this is at Te Moana Road where a narrow median has been maintained as widening out to a wider median for a single structure compromises geometric alignment. Maintaining single structures for the longer Waikanae River Bridge and Te Moana Road Bridge will also provide significant savings.

3.1.3 Sector 1, Raumati South: from MacKays Crossing to just north of Raumati Road

The Expressway starts north of the MacKays Crossing overbridge, on the four lane length of SH 1 known as Raumati Straight. Rehabilitation of the western side of the carriageway will be undertaken as part of this project to improve the ride particularly on the northbound lanes. The 3m median will be maintained. The existing concrete median barrier will remain. Consideration will be given to the lack of clear zone and whether protection around culverts etc. needs to be provided.

The Expressway will pass over Poplar Avenue, just west of the existing SH 1 location and continue parallel to the existing highway before curving away to the west some 500m north of Poplar Avenue. This part of the Expressway, from Raumati Straight to between Poplar Avenue and Raumati Road differs from the Western Link Road, (WLR) designation which is located further to the west beyond the houses in Leinster Avenue and also west of the Te Ra School in Poplar Avenue. The Expressway joins the WLR designation south of Raumati Road and continues north within this designation, rising up to pass over Raumati Road.

The Expressway severs one end of Leinster Avenue where it joins onto the existing SH 1 where a cul-de-sac will be constructed, for traffic to turn and exit at the Poplar Avenue end of Leinster Avenue. A local road is to be constructed off this cul-de-sac to provide for access to some severed properties to the north of Leinster Avenue.

3.1.4 Sector 2 – Raumati/Paraparaumu: from north of Raumati Road to north of Mazengarb Road

From north of Raumati Road, the Expressway continues on the line of the WLR designation rising several times to pass over the Wharemauku Stream, Kāpiti Road and Mazengarb Road, dropping down to close to existing ground level between each of these crossings.

At the Wharemauku Stream crossing, provision is made for the floodway and a possible future extension of Ihakara Street. The alignment at this location is located slightly east of the WLR designation, to provide some separation from the residential properties to the west.

At Kāpiti Road, a full interchange is provided, with on and off ramps from both the north and south joining onto Kāpiti Road. The Expressway will pass over Kāpiti Road and signalised intersections are provided where the ramps join Kāpiti Road. Retaining walls are provided along the Expressway north and south of Kāpiti Road to reduce the footprint.

North of Kāpiti Road, the Expressway continues within the WLR designation, to pass over Mazengarb Road, which will be lowered locally to help minimise the height of the Expressway underbridge.

3.1.5 Sector 3 – Otaihanga/Waikanae: from north of Mazengarb Road to north of Te Moana Road

After crossing Mazengarb Road, the Expressway alignment grades down to the existing surface before rising to pass over Otaihanga Road. From Otaihanga Road to the Waikanae River the Expressway cuts through the existing dune landscape. The Expressway severs access to a number of properties at this location and a new private accessway will be constructed on the east side of the Expressway to reinstate property access.

The Waikanae River Bridge is 180m in length as it has to span the wider flood way as well as the river channel. At Te Moana Road a full interchange is provided. The on and off ramps at Te Moana Road are controlled by round abouts, specific locations for cyclists and pedestrians to cross will be located where there is good visibility and a narrow lane to cross to a cetral median.

The alignment is largely within the WLR designation through to just south of the Waikanae River, after which it leaves that designation and is located to the east to minimise the foot print on the Wāhi tapu area.

The Expressway also severs access to El Rancho and the urupa and new access roads are provided for these areas. The access to El Rancho is proposed under the Waikanae River Bridge and while this will flood in some storm events, agreement has been reached for this, provided the access is maintained by NZTA and alternative emergency access is approved by KCDC on to Weggery Drive. Alternate access to the urupa is being proposed off Te Moana Road to the west of the interchange. The exact location of this is yet to be agreed with the Takamore Trust.

3.1.6 Sector 4 – Waikanae North: from north of Te Moana Road to Peka Peka

From Te Moana Road, the Expressway varies from the WLR designation through to the new Smithfield Road crossing and then again at the Peka Peka interchange. These areas depart from the WLR to avoid ecologically significant areas, (QEII covenanted areas), and to allow the Expressway to tie into the next stage of the Wellington Northern Corridor just north of Peka Peka Road.

The Expressway alignment severs the existing access to Nga Manu Nature Reserve and the existing Smithfield Road. A new connecting road will be constructed to reinstate the Nga Manu access and access to Smithfield Road properties on the east side of the Expressway. This new road location was selected such that it can form a future road planned by KCDC to link through to the existing SH 1. It also allows for a suitable location should a road be extended west in the future towards the coast. The new road passes over the Expressway with an overbridge then crosses the Karkariki Stream on the east side of the Expressway.

North of Smithfield Road the Expressway is kept relatively low above existing ground level, sufficient to remain above the required flood events and for geotechnical requirements, and stays at grade to rejoin the existing SH1 north of Peka Peka Road. At this point, the Peka Peka to Otaki project starts, with a limit of work being the existing intersection of SH 1 and Te Kowhai Road. The Expressway will have a temporary tie-in to the existing SH 1 should the Peka Peka to Otaki (PP2O) project be delayed.

The partial interchange at Peka Peka (assuming the PP2O project is complete) will provide for north facing ramps which will enable traffic from the existing SH 1, Peka Peka Road and Hadfield Road to access the Expressway to travel north. Southbound traffic from the Expressway will be able to exit and continue south on the existing SH 1, or travel to Peka Peka Road or Hadfield Road. A new two-lane road will also be provided adjacent to the Expressway to link with a new two lane road in the Peka Peka to Otaki project, for access to properties and other local roads on the west side of the Expressway north of Peka Peka, this will initially tie into Te Kowhai Road. The Expressway is kept low with the local road passing over the Expressway.

3.2 Cyclists and Cycleway, Walkway and Bridleway Facility

Cyclists may use the Expressway as a continuous 2.5m minimum width shoulders are provided along the Expressway and these continue over all bridges. Access is by the on and off ramps at interchanges.

However it is preferable that cyclists choose to use the off road route that is being provided the full length of the Expressway. This will have a 3m paved width. In addition to this the existing State Highway revitalisation project currently includes cycling facilities.

The width of 3m has been chosen to provide for two way cycle traffic with allowance for pedestrians to move beside cyclists with minimal conflicts.

An adjacent unformed berm (approx. 1m width) to the cycleway/walkway will be provided where possible to allow for horse riding beside the cycleway/walkway in the north area of the route as well as in the south section in QE Park. Within the Park the cycle and walking path will be provided in accordance with GWRC and KCDC requirements and implemented by the Council.

The cycleway/walkway facility will join to the existing cycle/shared path network in the area to provide for cross corridor connection.

The cycleway/walkway will join to each local road that it crosses. Generally, it will drop down to the local road level rather than crossing local roads on the Expressway bridges, and therefore allow users to cross the local road and continue on the cycleway/walkway or leave the cycleway/walkway to use the local road. Other connections to local roads are provided where a desired line has been determined. Two cycling and walking cross Expressway bridges have also been included. The exact location of these is yet to be determined, however they are currently proposed just north of Leinster Avenue and between Kāpiti and Mazengarb Roads.

At Raumati Road it is proposed to provide a clip on 3m cycleway with access only down to Raumati Road on the northern side. This is due to the steep dune and close proximity to the adjoining property on the south western side of the Expressway at Raumati Road.

At the Waikanae River crossing, the cycleway/walkway will cross the river on the Expressway bridge, separated from the traffic lanes by a barrier. A link will be provided down to the path located along the bank of the river.

On the northern side of the Waikanae River the cycle way/walkway drops down to the access to El Rancho and follows the local road through to Puriri Road to minimise the overall footprint across the Wāhi tapu area.

The cycleway/walkway facility is proposed to be on the west side of the Expressway from Poplar Avenue through to Otaihanga Road, the east side from Otaihanga Road through to Ngarara Road and then back to the west side north of Ngarara Road.

4 Scheme Assessment Design Process

4.1 General

The Scheme Assessment design has focussed on developing the design of the preferred option to a level of detail where a scheme estimate can be prepared and technical specialists can carry out their assessments of the scheme.

This has involved preliminary design and investigation in the following areas:

- Road geometric design for the preferred option to incorporate superelevation, alignment modifications in specific areas following consultation and feedback from other parties and refinement based on outcomes from the Value Improvement Process (refer section 4.2 below)
- Value engineering review input, (refer section 4.8.3 below)
- Earthworks design and quantities based on the above design
- Ground improvement design development including one peat excavation trial and further analysis of options for ground improvements
- Seismic design considerations and route security, particularly at bridge approaches
- Stormwater modelling and design of stormwater collection, conveyance, attenuation and treatment facilities
- Structural design of bridges and retaining walls
- Landscaping
- Architectural concepts developed for bridges
- Urban design considerations, particularly around bridges
- Pavement design and whole of life considerations
- Traffic modelling
- Noise modelling and analysis and preliminary selection of mitigation options
- Cycleway/walkway alignment
- Lighting considerations
- Barriers, signage, markings, ITS and road furniture design.

4.2 Value Improvement Process

A Value Improvement Process (VIP) was adopted through this Scheme Assessment design phase.

The purpose of this VIP was:

- To review design proposals for the preferred alignment, and to provide challenge and feedback on the proposals
- To gain alignment from Alliance members on the scope of work, what is in the project, what is not in the project and what is still undecided

- To identify areas of the current design proposal where alternatives were to be further investigated with a view to improving value and/or reducing cost
- To expedite the design process and meet the programme.

The VIP took the form of three workshops. These were attended by a wide audience representing all members of the Alliance. This included members of the design team, estimating team, construction team, approvals team, technical specialists, NZTA and KCDC. It also included "challengers", these being specialists from the wider organisations within the Alliance who were not directly involved in the design, to provide challenge to the design proposals.

The workshops were held on 20 April 2011, 18 May 2011 and 22 June 2011. Presentations were made to the participants by the design leads, challenge was provided and actions for further work or conclusions were recorded and issued to participants. The Alliance Management team, (AMT) met after the workshops to review recommendations and where a decision had not been reached a decision was made to allow the design to progress. The main outcomes of each of these workshops are included in appendix C

4.2.1 VIP 1 20 April 2011

The first VIP workshop introduced the main design concepts to the participants. A number of areas were identified for design consideration by the wider design team and for reporting back at the second workshop.

4.2.2 VIP 2, 18 May 2011

At VIP No 2, design and construction representatives reported back to the participants on design development since VIP 1. Where possible, these reports included cost implications (savings or increases) that options may provide. In other areas, further work was identified before decisions could be made.

Following this VIP workshop, the AMT met to review and confirm measures that were to be included and where further work was required and these are summarised in the table in Appendix C.

4.2.3 VIP 3, 22 June 2011

Following the VIP 3 workshop the Project Alliance Board, (PAB) at the meeting on the 4th July discussed the outcomes from the workshop and approved the following items recognising that the items listed below would need to presented to the VAC in a 'value for money' paper.

- Retaining the median width of 6m from just south of Raumati Road to just north of Mazengarb Road for design freeze as approved at the 31st May PAB meeting, noting that a saving of $1m would have been available if 4m median with was included throughout

- Proceeding to design Freeze with the current preload strategy as approved at the 31st May PAB meeting, (this proposed a reduced amount of excavate and replace of the peat in preference for preloading peat areas)
- Proceeding to design Freeze with the geogrid strategy as approved at the 31st May PAB meeting, (this proposed including geogrids in embankements over 3m high to reduce displacement in a seismic event)
- Proceeding to design freeze with the current bridge spans as approved at the 31st May PAB meeting noting that the cost premium compared to minimum requirements will need to be reviewed during the TOC phase.

4.3 NZTA Meetings

The following meetings have been held with NZTA representatives.

4.3.1 Route Security and ITS meeting with NZTA Operations

This meeting was held on 20 June 2011 at the Traffic Operations centre in Johnsonville. This meeting was held to discuss Route Security criteria for the Expressway and to gain information on NZTA's requirements for ITS to be included in the design.

Route security issues identified related to magnitude of acceptable movements at embankments under seismic loading. These are reported on in more detail in the geotechnical report.

The high seismic loading in this area together with the nature of the ground conditions result in movement at high embankments at relatively short return period seismic events.

Following this meeting it was proposed that measures will be included to limit movements at embankments as follows:

- Target 50% probability of exceedance movement < 300mm under 1/1000 year design earthquake
- Target 10% probability of exceedance movement < 700mm under 1/1000 year design earthquake.

NZTA also outlined their current requirements for inclusion for ITS, summarised as follows:

- Pan/tilt/zoom cameras at each interchange and along the route to show as much of the route as practicable (approx. 14 cameras)
- VMS signs on the Expressway prior to off ramps at interchanges and on local roads leading to the Expressway interchanges
- Six ducts, and associated pits and chambers along the full length of Expressway.

4.3.2 Pavements Meeting

Meetings were held with NZTA on 20 June and 28 June 2011 related to pavements.

These meetings discussed proposed long term settlement criteria, risk profiles to be adopted for pavement design, whole of life costs and advantages/disadvantages with the different pavement options being considered.

The Pavement Design Report, contained in the Civil Design Report gives a description of the settlement criteria adopted, risk profiles, pavement options and proposed pavement construction.

The proposed adopted settlement criteria are over a 10 year period, which matches resurfacing timeframes. The proposed criteria are:

- Transverse Differential: 1% change in crossfall
- Longitudinal Differential: 30mm over 10m.

The proposed Expressway pavement construction is foam bitumen base on a modified sub base construction. (Refer to Civil Design Report, pavement section).

4.4 KCDC Meetings

Regular meetings were held with KCDC during this design phase particularly in relation to design matters around local roads, cycleway/walkway and stormwater issues. These discussions will be on going as design is further developed in these areas.

A specific meeting on bridge pier positions at local roads was held on 28 June, following VIP Workshop 3 which raised a challenge on pier positions and bridge spans.

KCDC relaxed their requirement for bridge piers to remain outside the road corridor in all cases during the value engineering phase, however all central spans are 20m or more but in some cases due to the skew that the Expressway crosses the local road the piers protrude slightly into the road reserve. This still allows for future widening or other upgrading of the local roads, including service provisions, walkway and cycleways.

4.5 Safety in Design

A Safety in Design Workshop was held on 13 June 2011. Safety in Design is a process intended to facilitate and document the management of Health and Safety risks throughout the life cycle of the works, from design, through construction and operation and including eventual decommissioning, and how risks may be managed through the design stages of the project. The workshop involved representatives from the different design disciplines, construction personnel and KCDC.

A register of risks and potential mitigation measures was prepared from this workshop, which will be reviewed and updated at appropriate stages through the rest of the design process.

This register is attached in Appendix F of this Report.

4.6 Noise Mitigation Workshop

A noise mitigation assessment workshop was held on 1 July 2011. This was attended by the noise specialist, design and planning team representatives, construction personnel and KCDC.

Options for noise mitigation at specific locations along the route were presented and assessed in a multi criteria assessment format. Assessments were carried out by the acoustic specialist, design discipline leaders in the areas of roading, structures, stormwater, urban design and landscape, and a construction representative.

For the purposes of Scheme Assessment Design, preferred options for noise mitigation were agreed at the specific locations along the route where properties are affected by noise.

The noise mitigation measures adopted include the use of low noise generating road surface (OGPA), noise bunds where these can be fitted between the road and the properties, noise barriers beside the road and timber boundary noise fences.

It is proposed to earth fill and plant on the outside of the concrete noise barrier, to conceal these when viewed from outside the Expressway. Depending on the height required an 1100mm high edge barrier maybe filled against or where a greater height is required a combination of a road side barrier in front of a gabion wall maybe used.

4.7 Peka Peka Interchange, AMT Meeting 12 July 2011

As a result of further investigations and design around the Peka Peka interchange area, a late decision was made regarding the layout of this interchange. The footprint of the previously preferred design, referred to as a "Dog-bone" arrangement, had become significantly greater in size as a result of design development, and the scope of ground improvements necessary had also increased, resulting in significant cost increases for this scheme and greater extent of elevated road construction.

The AMT met on 12 July and agreed to revert to the alternative arrangement at this location. This layout has the connection from the existing SH1 to the northbound Expressway and Peka Peka Road passing over the Expressway on an embankment and bridge over the Expressway, with a roundabout constructed on the existing SH 1 alignment.

4.8 Value Engineering

4.8.1 General

The preferred option design was completed on the 8th July 2011, (the design freeze). Packages were then handed to the quantity surveyor and then estimators. The scheme estimate developed at this time was $719,741,182, (P50). This was a 30% increase on the previous $550 million business case estimate. At the PAB meeting on the 23 August 2011 it was decided a value engineering phase needed to be undertaken before seeking NZTA Board approval for the Scheme. The value engineering phase was to focus on understanding the scheme estimate and identifying engineering or technical items for challenge before considering scope change. Further, any scope changes to be considered should not compromise satisfying the 'Guiding objectives'.

4.8.2 Value Engineering Workshop

A workshop was held on 30 August 2011 to review the scheme design and identify areas where savings could be made. The participants included a wide range of specialists from the alliance partners including NZTA National office staff. PAB members were also in attendance.

The outcomes from this workshop were discussed by the PAB afterwards and at a meeting on the 6th September 2011 the PAB agreed a focused value engineering phase should be undertaken. The items to be considered were confirmed at an extra ordinary PAB meeting on 12 September 2011, these items are listed below in section 4.8.3.

4.8.3 Value Engineering Outcomes

The table below summarises the outcome of this VE phase along with approximate direct cost savings achieved.

It should be noted this scheme assessment report has included the outcomes from the value engineering phase and this section identifies what changes and savings have been made.

Description	Comment	Cost saving
Revised baseline geometry	Reduction in bridge spans over local roads and a reduction in vertical clearances. Steepen fill batters. This allowed the alignment to be lowered by 500 to 1500mm adjacent to local road under bridges.	$10 million
Abutments and approach embankments	Ground improvement reduced extent to central block, sleeved bored piles replaced with steel H piles.	$17.5 million
Peat Utilisation / Offset Drainage	Options for reducing were investigated but specific options will not be identified until design is progressed. Currently most of the saving is included in the change in the Peka Peka interchange.	

Description	Comment	Cost saving
Pavement depth vs. geotextile improvement	A reduction in the embankment height across the peat flats by use of a granular material did not provide further cost savings.	
Raumati Straight	Options were investigated that did not require work in QE park and maintained the existing 3m median. A staged rip and re make along with further shape correction has been adopted.	$3 million
Open graded porous Asphalt, (OGPA)	A review of the extent of OGPA enabled a reduction over the shoulders, plus agreement was reached with KCDC to delay constructing OGPA between Te Moana interchange and Smithfield Road until further development has taken place.	$1.5 million
Landscaping	A review of the landscaping was undertaken and revised plan prepared and costed.	$4.7 million
Poplar Ave	Taking Poplar Ave over the Expressway was investigated, however it was found that significant cost was incurred in building the raised carriageway on the each side of the Expressway. This option also required more land from QE Park. This option was not adopted.	
Ngarara Road / Smithfield connectivity	Deleting the local road over the Expressway and taking a new local on the eastern side of the Expressway to provide access to Nga Manu and Smithfield Road was investigated. While a saving could be made other issues made this less desirable. These issues included; not providing for KCDC long term plan for an east/west connection and additional land requirements from a new owner. This option was not adopted.	
Bridge form / abutment treatment	The bridge form has been refined to improve the buildability and structural performance of the bridge piers and to suit the changes to the bridge geometry outlined in item 1 above. Changes to the abutment treatments were made through simplifying the gabion basket type that is proposed.	$14 million
Peka Peka Interchange	The change from the 'dog bone' design to the interchange with roundabouts at grade reduced significantly the extent of ground improvements that were required.	Included above in bridge form

5 Stakeholder Management and Consultation

5.1 Community Consultation

Three phases of consultation have been undertaken. Key consultation stages were:

- August–October 2009 Consultation on three alignment options carried out by NZTA
- November 2010 – February 2011 Consultation on Expressway alignment and interchange location carried out by the M2PP Alliance
- May–August 2011 Consultation on Expressway design development (i.e. cycleways, landscaping, stormwater/drainage & noise mitigation) the carried out by M2PP Alliance.

5.1.1 Phase 1 Consultation

NZTA undertook consultation in August 2009 to ascertain residents' current views on two Expressway options, the eastern and western routes. The consultation period was extended to 30 October 2009 as a result of the community's desire for more information and a new option to be considered using the Western Link Road designation.

The consultation process involved letters, brochures, media, project website, 0800 phone line, open days and meetings. The NZTA received a positive response from the community with 4446 submissions on the Expressway options. Of the submissions:

- 1041 (23.4%) preferred the eastern option
- 619 (13.9%) preferred the western option
- 1609 (36.2%) preferred the Western Link Road option
- 1177 (26.5%) referred to alternate transportation options such as the Western Link Road or improved public transport services.

More information can be found in the MacKays to Peka Peka Community Engagement Report 2009.

Input from Kāpiti residents was taken into consideration when the NZTA Board made its decision to proceed with the preferred option. Feedback from the community confirmed the preferred option is the Western Link Road (Sand hills) route. The consultation also identified the need for good local links between communities both sides of the Highway.

5.1.2 Phase 2 Consultation

Following the 2009 consultation, further investigation and design work was been carried out to determine the proposals for the various components of the Expressway. Consultation was undertaken between 28 November 2010 and 4 February 2011, with the purpose being to consult on the preferred route alignment options developed to date for the proposed Expressway. In addition to consultation on the preferred route alignment options, feedback was also sought on the following key issues:

- The route options between north of Waikanae River and Te Moana Road
- The number and location of interchanges
- The Northern connection at Peka Peka Road
- The Southern connection around Poplar Avenue.

The Consultation Report provides an outline of the process undertaken and a summary of the feedback received during the November 2010-February 2011 consultation. 1617 submissions were received. The following graph shows the breakdown of the total number of submissions received by locality of submitter.

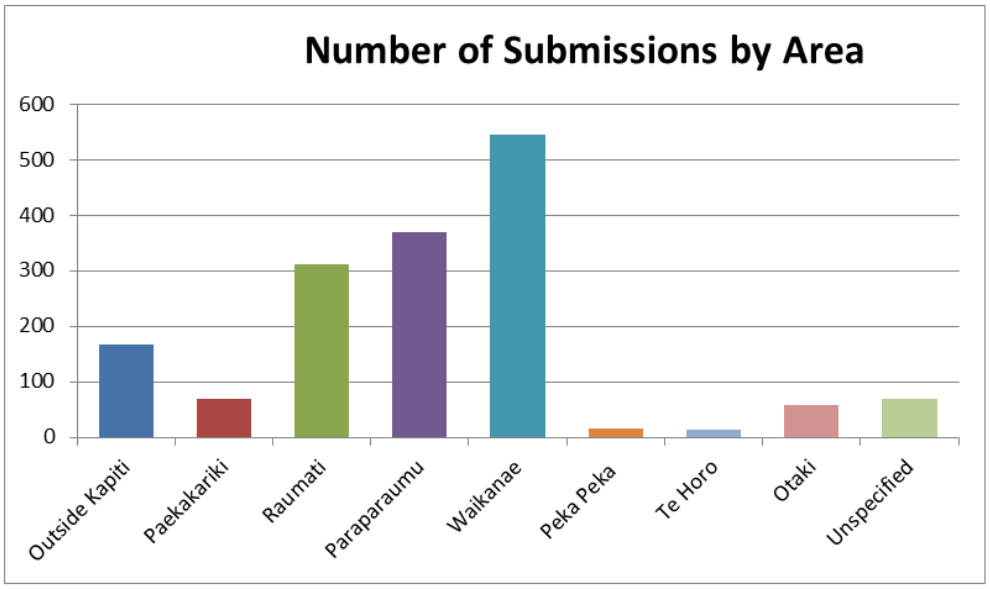

Figure 5.1 - Number of Submissions by area following Expo 1

5.1.3 Phase 3 Consultation

Once the route was decided specific consultation was undertake on the design of the Expressway. This occurred between May-August 2011. A total of 216 submissions were received. The following graph shows the breakdown of the total number of submissions received by locality of submitter.

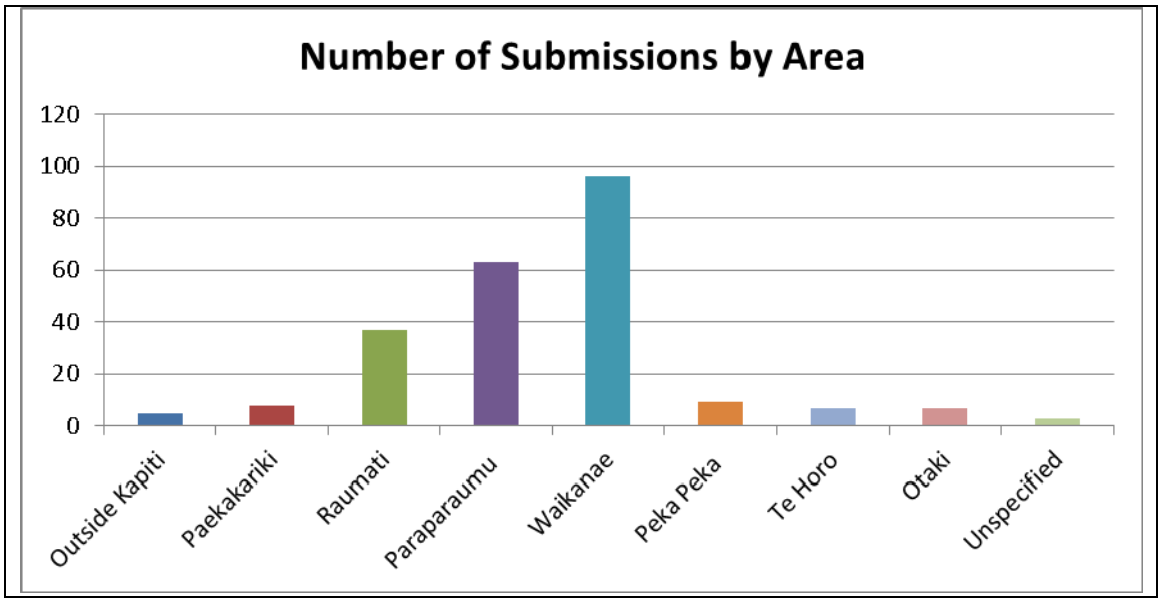

Figure 5.2 – Number of Submissions by area following Expo 2

The Southern end and Waikanae alignment options, as well as the proposed interchanges generated a large amount of interest. At the Southern end the Queen Elizabeth Park alternative was preferred over the Main Road proposal. With respect to Waikanae, Option 1 (that being the option closest to the Urupa) generally was preferred overall.

In May 2011 NZTA announced the following decisions had been made on the Expressway alignment and interchanges:

- Partial interchange at Poplar Avenue
- North of Poplar Avenue, at the southern end, the Expressway would divert away from State Highway 1
- Full interchange at Kāpiti Road
- Bridge over the Waikanae River
- Full interchange at Te Moana Road
- North of Waikanae, the Expressway would follow Option 1 – the western alignment
- Partial interchange at Peka Peka Road.

A newsletter detailing the confirmed Expressway alignment and interchanges was sent to all Kāpiti households.

5.2 Outcomes of the Community Consultation

The objectives for consulting on the preferred route alignment options for the proposed MacKays to Peka Peka Expressway have been achieved:

- The public is informed about investigation work taken place and the conclusions reached.

Information has been provided about the options that NZTA were considering around:

- The route options at Waikanae
- The number and location of interchanges
- The Northern connection at Peka Peka Road
- The Southern connection around Poplar Avenue.

Further information has been provided about the alternatives that NZTA had considered and why these options were not being pursued.

- Information has been obtained and feedback sought from the public and stakeholders on the options being considered
- The community has been further informed about the process for consultation and further opportunity for engagement.

5.3 Local Authority Consultation

Throughout the project the Alliance has consulted closely with KCDC who are members of the Alliance and the Greater Wellington Regional Council in order to meet the requirements of the Resource Management Act 1991, the Land Transport Management Act 2003 and the Local Government Act 2000. This has involved regular meetings and workshops with the KCDC and Greater Wellington Regional Council through this design phase. In particular KCDC staff have attended all the Value Improvement Process workshops and Value Engineering workshops as well as the safety design workshop held on 13 June and noise mitigation assessment workshop held on 1 July 2011.

6 Alternate Route Options assessment

6.1 General

In December 2009, following public consultation, the NZTA announced the preferred route option for the MacKays Crossing to Peka Peka section of the Wellington Northern Corridor. This option (now known as the MacKays to Peka Peka Expressway or M2PP) generally follows the Western Link Road (WLR) corridor (currently designated for a local link road) and will bypass the existing SH1 from Raumati South to Peka Peka.

This section summarises the findings of an assessment undertaken by the Alliance (refer to the full report, 'MacKays Crossing to Peka Peka Alternative Route Options Report Volume 1' dated 10 October 2011) to satisfy the statutory requirements of the Resource Management Act 1991 (RMA) in the preparation of notices of requirement and resource consent applications. In particular, under s171(1)(b) of the RMA, when considering a notice of requirement and any submissions received, decision-makers must, subject to Part 2, consider the effects on the environment of allowing the requirement, having particular regard to, inter alia:-

> *a) whether adequate consideration has been given to alternative sites, routes, or methods of undertaking the work if—*
>
> *(i) the requiring authority does not have an interest in the land sufficient for undertaking the work; or*
>
> *(ii) it is likely that the work will have a significant adverse effect on the environment*

The RMA does not, however, require decision makers to consider the full suite of alternatives available for a public work, or to select the best option in assessing the relative merits of the alternatives identified.

In regard to (i) above, while the NZTA does have an interest in a proportion of the land which is required for the project within the M2PP corridor, the remainder of the land is either held in private ownership or under the ownership of KCDC and GWRC. Thus, there is a statutory obligation to consider alternative sites, routes, or methods of undertaking the Expressway.

In addition, in respect of the resource consent applications to be sought for the project, any Assessment of Effects on the Environment must include, under clause 1(b) of the Fourth Schedule of the RMA, "where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity".

In 2009, the NZTA undertook an assessment of the alternative route corridors for constructing an Expressway between MacKays Crossing and Peka Peka, and selected the WLR (or Sand hills) corridor.[2] This assessment, which was undertaken within the statutory framework of the Land Transport Management Act (LTMA), led to the NZTA Board concluding:

> *That the Sand hills route is the preferred Corridor for the SH1 Expressway through Kāpiti, subject to further alignment development within the corridor including more detailed assessment of effects and further community consultation*[3]

The reasons for the decision were that, compared with the other route options:

- The Western Link corridor had the least impact on properties, least population displacement, and the fewest properties required
- It would be the least cost to construct (an estimated 25-30% lower)
- It could be constructed within the shortest period, with least disruption
- It had the greatest proportion of local community support.

Pursuant to the NZTA Board's decision, and in accordance with the requirements of the RMA in lodging a notice of requirement and the associated resource consent applications, the M2PP Alliance undertook an assessment of the principal alternative route options according to an RMA framework, based on accepted methodologies for evaluating the comparative impacts of the principal options. This section documents the findings of that assessment. This work was carried out in parallel (albeit separate) to the investigations that were carried out by the Alliance on the final alignment and design of the MacKays to Peka Peka Expressway.

6.2 Alternate Routes

The objectives of this work are:

- To review and confirm the principal route options for constructing an Expressway between MacKays Crossing to Peka Peka
- To undertake a design, transportation and environmental evaluation of the non-cost attributes of these route options at a level sufficient to yield robust conclusions
- To undertake a multi-criteria assessment of the comparative non-cost attributes of the route options, including sensitivity testing of the various attributes
- To undertake a cost assessment of the four principal route options to inform the analysis of the comparative cost attributes

[2] NZTA Workshop Briefing Paper 09/12/0300, SH1 Kapiti Expressway: MacKay's Crossing to Peka Peka, 8 December 2009 – refer Appendix H

[3] Minutes of New Zealand Transport Agency Special Board Meeting, 11 December 2009, s1(c) (g).

- To record the outcome of the multi-criteria analysis and cost assessment to satisfy statutory requirements.

The following four Expressway route options were identified, analysed and assessed:

Table 6.1 - Expressway Alternative Route Options

Route	Description
1	Expressway following the Western Link Route
2	Expressway following the Western Route
3	Expressway following the Eastern Route
4	Upgrade of the existing State Highway to Expressway standards

Each of the four Expressway route options considered in this report represents a feasible alternative that would:

- meet the M2PP project objectives
- be consistent with regional and national planning strategy objectives
- provide the Level of Service (LOS) identified by the RoNS strategy.

A rigorous multi-criteria assessment (MCA) was undertaken to assess each of the four Expressway route options against a suite of criteria agreed by a panel of technical experts as being appropriate to fulfil the project objectives and statutory requirements. The criteria factored in both cost and non-cost outcomes, and the four route options were evaluated against these criteria by experts experienced in the relevant areas of knowledge, and with a good understanding of the study area. Sensitivity testing was also undertaken to determine the robustness of the findings. Accordingly, the outcomes of the MCA process are considered to provide an appropriate basis for assessing the Expressway route options as required by the LTMA and the RMA.

The MCA process confirmed Route 1 (Expressway following the WLR) as the preferred route option when assessed against the non-cost outcomes: Route 1 had marked advantages over Route options 2, 3 and 4 in most non-cost categories, and a substantive positive in overall terms. The process also identified Route 1 as the preferred route option when assessed against the combined non-cost and cost outcomes, with Route 1 having a 'significant' positive difference over route options 2, 3 and 4. The MCA scoring and rationale for that scoring is documented in this scheme report (both non-cost and cost).

Sensitivity testing of the MCA results was undertaken and indicated that these results were insensitive to variable weightings being placed on particular assessment criteria. Only when a greater weighting was afforded environmental and cultural/heritage outcomes did Route 1 not emerge as the sole preferred option - ranking first equal with Route 3 (Eastern Route) as the preferred route with respect to the former, and fourth with respect to the latter.

In terms of property impacts, the previous 2009 assessment underestimated the overall amount of property that would be required to construct the route options compared with the WLR route option. The total number of properties affected by the WLR route option was estimated to be 75, with 44 buildings affected. In comparison, the number of affected properties for the other route options ranged between 209 and 368, with between 127 and 241 buildings affected.

The cost assessment of the four Expressway route options[4] confirmed that the construction costs of the WLR route option are significantly less than any of the other three route options: the P95 cost estimates[5] indicate that the other route options would be between 32% and 57% more costly to construct. Furthermore, the property acquisition costs of the other route options would be two to three times that for the WLR route.

[4] MacKays to Peka Peka Options Report Final 15 November 2011

[5] These estimates represent a 95 percentile prediction that the probability of the final outcome cost exceeding the P95 value is 5%

7 Social and Environmental Management

7.1 Introduction

A full social and environmental screen (SES) has been undertaken in accordance with NZTA's *Minimum Standard Z /19 – Social and Environmental Management,* to ensure the project complies with NZTA's social and environmental legal requirements, policies, plans, standards, specifications and guidelines.

The SES has been applied in combination with the *Social and Environmental Assessment (SEA)* during the development of options for the project.

Technical assessment reports have been prepared for each of the issues identified, and this was guided by the NZTA's *Social and Environmental Management Form PSF / 13,* as follows:

- Culture, archaeology and built heritage
- Air quality
- Ecological resources
- Erosion and sediment
- Stormwater
- Groundwater
- Hazardous Substances
- Lighting and Glare
- Noise
- Resource Efficiency and Waste
- Ground Settlement
- Social
- Traffic
- Urban Design
- Vibration
- Visual and Landscape
- Contaminated Land
- Climate Change.

A significant aspect of the project is construction. In this regard a variety of measures will be used to manage construction activities and ensure that construction is being undertaken in a way that avoids, minimises or reduces effects on the environment. To assist this process, and ensure that the Alliance meets both the designation and resource consent requirements and the NZTAs requirements, a Construction Environmental Management Plan (CEMP) has been prepared for the Project.

The CEMP is an overarching document which supports the applications for resource consents and designations and, ultimately, provides a blueprint to be used by the construction contractors to manage the environmental effects of the Project. The principles and general approach to managing the environmental effects are set out in the main body of the document. The management of specific effects (e.g. construction air quality, noise, vibration etc.) are detailed more particularly within a suite of environmental management plans (sub-plans) that form the appendices to the CEMP.

The Alliance will undertake all construction activities on site in accordance with the provisions of the relevant management plans as part of their contractual arrangements.

The CEMP will be reviewed after confirmation of the resource consent and designation conditions and will be revised in accordance with these conditions. The CEMP and the sub-plans will be updated, with the necessary approval, throughout the course of the Project to reflect material changes associated with changes to construction techniques or the natural environment.

Figure one below illustrates the relationship of the CEMP to other Project management plans and the Assessment of Environmental Effects.

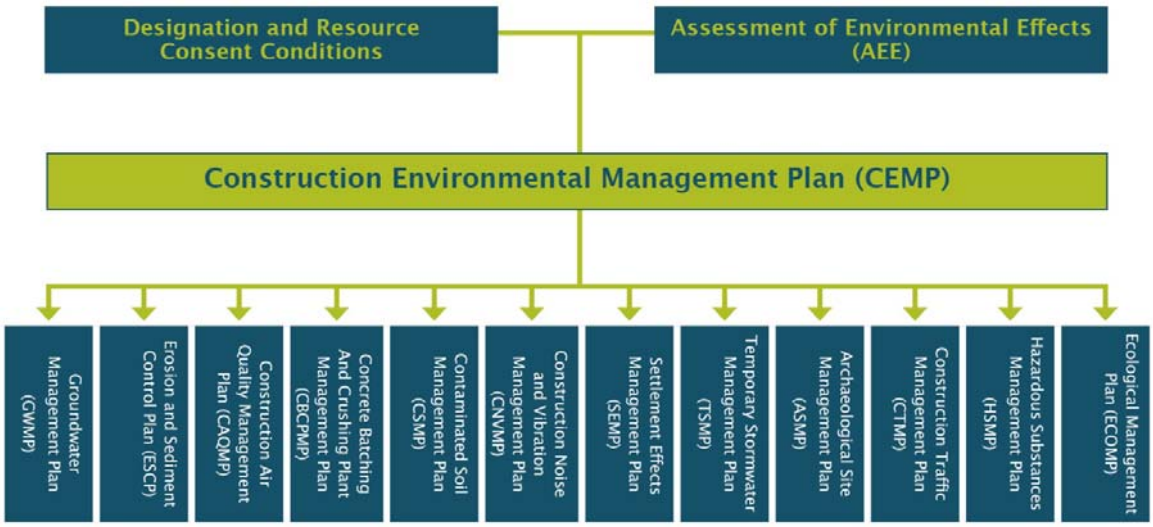

Figure 7.1 - Construction Environmental Management Plan

A summary of the social and environmental impact of the project follows.

7.2 Culture, archaeology and heritage

This covers Wāhi tapu, identified Maori interests, archaeological sites, historic buildings, places, trees and special features.

Based on known findings and predictive modelling the project has the potential to have a large and significant effect on the archaeological resource on the Kāpiti Coast. However, assessment concludes there is no reason on archaeological grounds why the Expressway

should not be built provided there are appropriate mitigation measures in place. Known and probable archaeological sites will be destroyed by the construction; however, this loss is balanced against the potential for retrieval of detailed archaeological data through a series of well-planned high level investigations and through the potential development of roadside or movable interpretation panels about the archaeological history of the area.

Any earthworks or clearing work required for the project will require an authority to modify damage or destroy sites in terms of Part 1 of the *Historic Places Act.*

The authorities, if granted, are likely to contain conditions specifying how the archaeological work is to be undertaken. An Archaeological Management Plan will also accompany the applications, detailing procedures of how the archaeological work is to be carried out, and detailing roles and responsibilities of the various parties involved.

7.3 Air quality

Air quality includes dust and odour (particularly during construction) and air pollution from vehicles using the Expressway.

In terms of construction, due to the close proximity of sensitive receptors (mainly residential premises) to large parts of the proposed construction footprint for the Project, a high standard of emissions control and management will be employed to adequately avoid or mitigate the effects of discharges of construction dust.

A Construction Air Quality Management Plan (CAQMP) will form part of the comprehensive suite of environmental controls within the Construction Environmental Management Plan (CEMP). The CAQMP will:

- Identify the various sources of dust that may be created during the construction project
- Dust mitigation and prevention methods
- Monitoring methods
- Methods for managing complaints regarding discharges into air and keeping records related to compliance.

In terms of on-going operational impacts on ambient air quality of the Expressway, the Alliance has followed the procedures outlined in the Ministry for the Environment's Good Practice Guide for Assessing Discharges to Air from Land Transport (MfE, 2008) (MfE Transport GPG) and the draft NZTA Standard for Producing Air Quality Assessments for State Highway Projects (NZTA, 2010). To assess impacts we have gathered baseline data collected at a project specific monitoring location on Raumati Road, adjacent to the project area.

The key conclusions of this air quality assessment are that there will be a low level of effects and as such neither mitigation nor monitoring of operational air quality effects is required. Further, the reduced level of traffic on the existing SH1, and the consequent reduction in congestion, will result in improvements in air quality in the vicinity of this road.

7.4 Ecological resources

The ecological investigations included terrestrial flora and habitats (including wetlands), herpetofauna, avifauna, freshwater and marine ecology. The Assessment of Ecological Impacts (EcIA) provides the findings of the suite of environmental investigations undertaken into the potential ecological effects.

Ecological involvement has formed an important component of the final Expressway design and location. As a result, the most ecologically significant areas have either been avoided or the potential scale of effects on these areas minimised as far as possible. Most notably, the project has avoided a large number of statutorily recognised or ecologically significant wetlands and areas of indigenous vegetation along its length. There have also been a number of smaller scale modifications to the Expressway design to reduce ecological effects. Overall, the Alliance is satisfied that every practical opportunity to avoid adverse ecological effects through refinement of the Expressway alignment has been undertaken.

Despite consideration of ecological features, the nature of the study area has meant that some areas of indigenous vegetation and wetland and some large lengths of stream will be lost beneath the Expressway and affected by other construction activities. These activities will lead, at least in the short term, to significant and unavoidable impacts on terrestrial and freshwater habitats and their associated fauna.

The EcIA has considered the magnitude and significance of these residual impacts and recommended a number of mitigation measures. In a number of locations, there are anticipated to be some long-term ecological benefits as a result of the mitigation proposed. A number of areas of significant indigenous vegetation will be enhanced and assured permanent protection through the Designation process. Overall, assuming the recommended mitigation is established, most ecological effects are considered to be neutral.

While the construction and operation of the MacKay's to Peka Peka Expressway will result in a range of adverse ecological effects, the scale of the mitigation proposed and the permanent avoidance of a large number of areas of identified ecological importance along the length of the Alignment, overall the indigenous biodiversity and ecological values can be maintained in the long-term.

7.5 Erosion and sediment

During construction, erosion and sediment control measures will be put in place to minimise potential adverse effects by utilising measures which meet industry best practice guidelines such as reflected by Greater Wellington Regional Council's Erosion and Sediment Control Guidelines for the Wellington Region, September 2002 (Wellington Guidelines). The draft NZTA Erosion and Sediment Control Standard for State highway Infrastructure dated August 2010 (NZTA Draft Standard) has also been considered.

The impacts of Expressway construction on freshwater systems associated with culverting and stream diversions have been largely mitigated through stream restoration within and outside of the Designation. Further, as a result of over half the route being in sand, the construction of the Expressway is not expected to generate the large quantities of sediment that are assosicated with construction in silt or clay soils. Best practice erosion and sediment control mechanisms through construction, combined with the slow-moving nature of the water bodies downstream of the alignment, will assist in reducing potential sediment-laden run-off reaching ecologically sensitive downstream receiving environments.

7.6 Hydrology and Stormwater

The assessment of hydrology and stormwater details the issues, design, effects and mitigation measures relating to stormwater from the Expressway. It details the following stormwater topics post construction:

- Hydrology (surface water only) including climate change
- Drainage
- Attenuation (peak flow control)
- Treatment (water quality)
- Watercourse culverts and bridges
- Flooding and floodplain issues.

The Expressway passes through two main land types with distinctly different characteristics. The first is the low lying flatland containing peat areas and is associated with characteristically high groundwater. The other is the sand dune formations which are relatively free draining in comparison to the peat. The location of the peat and sand dunes is a result of historic geomorphological processes such as coastal dune migration and the wind. There are three large peat flat areas along the Expressway: Raumati Straight, around Wharemauku Stream and around the Paetawa Drain. The Expressway crosses many watercourses, both large and small, as well as crossing several floodplains, the largest of these is the Waikanae River Floodplain but the Wharemauku Stream, Kakariki Stream and Paetawa Drain floodplains are also sizable.

The effects of the proposed Expressway on stormwater and surface hydrology will be mitigated by the following:

- Increased peak flow discharge – mitigated by attenuation in swales and wetlands to 80% of pre-Expressway flows
- Partially filled in floodplain areas – mitigated by the creation of off-set storage areas and by attenuation of peak flows in wetlands and swales
- Increased flood levels – mitigated by the attenuation in the swales and wetlands provision of off-set storage areas and designing low head culverts
- Increased scour and erosion of watercourses – mitigated by providing attenuation of flows in swales and Wetlands and rip rap protected culverts and outlets

- Adverse water quality effects – mitigated by the use of swales and wetlands to treat stormwater prior to discharge. New open channel drains are also designed to resemble natural streams with riparian vegetation to provide shade and cover
- Effects on fish passage – mitigated by the inclusion of fish friendly features in the design and designing new open channels drains to resemble natural streams with natural stream beds, riparian planting and refugia.

Given that a number of the water bodies traversed by the Expressway already have elevated nutrient issues as a result of their agricultural and residential location, we consider any potential effects to be negligible. However, this is still being investigated. Overall, the level of stormwater treatment proposed combined with the reduction in traffic from the current SH1 (from which untreated stormwater discharges directly to many of the same water bodies traversed), is anticipated to lead to reduced levels of contaminant loading to the water bodies downstream of the Alignment in the long-term.

7.7 Groundwater

Construction and operation of the Expressway will require construction of embankments (with localised peat treatment), cuts below the groundwater table, construction of stormwater devices for treatment, conveyance and attenuation of run-off, and short term groundwater take for construction water supply. The near surface hydrogeology is dominated by Holocene dune sands, with areas of peat (that support wetlands of high ecological value) having developed in the lower lying areas between dunes. The construction of the Expressway has the greatest potential to affect the shallow groundwater system (i.e. the Holocene sand and peat).

Two and three-dimensional groundwater modelling, based on field work, was undertaken to assess the effects of the short term construction and long term operation of the Expressway on regional and local groundwater flows. Overall the effects of the Project on groundwater are considered to be small. A monitoring programme will be established prior to construction to record natural variations in groundwater levels and surface water flows. This monitoring will allow appropriate responses to be triggered should actual effects differ from those predicted. These could include such measures as limiting extent of excavations, adding more porous material etc.

7.8 Hazardous Substances

A hazardous substances management plan has been prepared: to provide information to the construction team as to acceptable management methodologies during the construction phase, and also to the consenting authorities to demonstrate that the possible risks as a result of storage and use of hazardous substances has been considered and will be appropriately managed by the construction team.

7.9 Lighting and Glare

Lighting effects of the project relate to lighting to be installed on the Expressway, including the on/off ramps, interchanges, pedestrian/cycle ways and construction activities.

It is apparent that the lighting proposed will only have significant effect of the immediate environs of the Expressway given the actual value of illumination predicted onto residential properties.

Although road lighting is exempt from obtrusive light controls set by the Kāpiti Coast District Council the assessment shows that the 10 lux limit can be easily met for residential properties and that the majority of the lighting will be in areas where there are no immediately adjacent residences.

7.10 Noise

This includes construction noise, and traffic and maintenance operations noise. Consideration is given to the presence of sensitive receivers such as houses and rest homes.

Noise from all proposed construction activities has been considered and noise levels have been predicted at surrounding dwellings. Several construction activities are likely to generate noise levels in excess of daytime Project construction noise criterion (70 dB $L_{Aeq\ (T)}$). Construction activities occurring at night are likely to be confined to bridge beam placement and intersection works; these activities will generate noise levels in excess of the night-time Project construction noise criterion (45 dB $L_{Aeq\ (T)}$). As part of developing the CNVMP alternative methods and options will need to be developed to ensure compliance with the standards is achieved.

Noise from construction truck movements on the State Highway and on local roads has been considered. In most cases, because of the existing volumes of heavy traffic, the increase in noise level is unlikely to be perceptible and at most will be just perceptible.

Mitigation measures have been identified in the construction noise vibration management plan (CNVMP).

An extensive and detailed assessment of operational noise effects has been undertaken. Each Project sector (1 to 4) has been assessed separately, and a variety of mitigation options examined.

The mitigation options have been presented to, and assessed with, the wider Project team. The resultant extensive feedback and input provided has resulted in further mitigation options being developed and refined. For all sectors, preferred mitigation options have been selected and presented in the Assessment of Traffic Noise Effects report, together with a description of the processes by which decisions were made.

Noise mitigation proposed for this Project includes various types of measures such as low-noise road surface material, road-side barriers, higher and longer edge safety barriers, and a combination of bunds and barriers where necessary and appropriate. The most effective placement of barriers has been determined for each sector in order to fulfil the requirements of NZS6806 that structural noise mitigation achieves a minimum noise reduction performance to be considered practicable.

7.11 Resource Efficiency and Waste

This Resource Efficiency & Waste Management Plan forms part of a comprehensive suite of environmental management plans within the CEMP for the construction phase of the Project.

The purpose of the Plan is to document decisions made by the Alliance during the design phase of the Project that impact positively on resource efficiency, and to describe how the Alliance will manage waste generated from the construction phase in a sustainable manner.

This will be achieved by:

- Using smarter design and construction methodologies to reduce waste
- Identifying opportunities for avoidance, reuse, recycling or recovery for all major waste streams
- Considering landfill disposal as a final option
- Measuring and tracking waste arising through the Project
- Actively promoting waste awareness through assigning responsibilities, training and staff engagement.

The Plan is intended to be a live document and will be updated quarterly, throughout the course of the Project, to reflect material changes to construction methodologies or management practices to reduce waste. The Plan will be formally reviewed yearly and a revised plan will be forwarded to Greater Wellington Regional Council for comment.

7.12 Ground Settlement

There are four sources of settlements associated with the construction and operation of the Expressway, as follows:

- Consolidation of the ground due to the construction of the embankments
- Consolidation of the ground due to lowering of the groundwater
- Mechanical settlement of the ground due to the movement of retaining walls
- Mechanical settlement of the ground due to vibrations.

The extent of ground settlements resulting from the project has been determined by superimposing, as applicable, settlement caused by the various sources described above.

The predicted settlements are generally less than 25 mm beyond the edge of the earthworks, and lateral extent of settlement is generally within 50 m to 70 m of the earthworks footprint.

Potential settlement effects on dwellings and other buildings in the project area have been assessed using the Limiting Tensile Strain concept described by Burland (1997). As a result the, ground settlement effects on buildings are assessed as being low with hairline cracks being the most significant potential damage.

Settlement effects on services and on transport infrastructure beyond the project footprint are, similarly, assessed as being low. Services that pass beneath the Expressway alignment are being specifically addressed with the respective utility organisation. Some will inevitably need to be realigned, and others will be monitored and repaired or protected as agreed with the owner.

Monitoring is proposed to confirm that ground settlement effects are no worse than predicted. It will include building condition assessments for structures within a conservatively assessed corridor extending beyond the zone where 12.5 mm settlement and/or 0.2m groundwater drawdown is predicted, together with measurement and reporting of ground settlement and groundwater levels.

7.13 Social

The Social Impact Assessment (SIA) has assessed the effects of the Project within two contexts; within the wider Wellington Region and within the local communities between MacKays Crossing and Peka Peka. To carry out the assessment within these contexts, the following were prepared: a profile of the existing social environment, a SIA framework to assess the social effects of the Project regionally and locally; and appropriate measures to avoid, remedy or mitigate the social effects identified in the planning, construction and operation phases of the Project.

The SIA is based on and informed by a number of other technical assessments prepared for the Project, including air quality and noise impacts on local residents. The SIA therefore considers the effects identified by other technical assessment from the perspective of social wellbeing.

The SIA identifies a range of significant benefits arising from the proposed Expressway, particularly economic and transport/accessibility benefits. There will also be adverse social effects associated with the Project, primarily of a temporary nature arising from transitional effects on residential, business and rural environments adjusting to the presence of the proposed Expressway.

Many of the negative social effects would occur during construction. Noise, dust and vibration from construction activities have the potential to disrupt people's patterns of movement, creating a level of disturbance, nuisance and stress. It is therefore important that these effects are monitored and mitigated through effective construction management, communication and community liaison. The Project design has mitigated a

number of potentially negative social effects including reducing the acoustic and visual effects of the proposed Expressway, and maintaining local accessibility in the local communities.

Table 30.1 of Chapter 30 of the Assessment of Environmental Effects Report summarises the principal mitigation measures that are proposed to be undertaken by the NZTA to address the actual or potential social effects identified. With these mitigation and monitoring measures in place, the overall social effects of the Project on the Region are anticipated to range from moderately negative on occasions during construction to significantly positive when the proposed Expressway is in operation.

The Construction Environmental Management Plan (CEMP) and its subsidiary plans for traffic, noise, vibration and air quality have been informed by the social effects assessment and are designed to ensure adverse effects arising from construction will be at acceptable levels. A community liaison group will be established to help identify any adverse social effects that may occur during construction. Once in operation, the scale of the social impacts from the proposed Expressway will diminish as people and communities adjust to the presence of the road.

While the Project is of national and regional significance, the social effects of the Project apply predominantly to the local communities.

In terms of Regional effects overall, it is concluded that the Project, when in operation, will have moderate to significant positive effects for the Region. There will be some minor traffic inconveniences during construction but these will be temporary and for short periods only.

In terms of overall local area effects, it is concluded that the Project, when in operation, will have moderately negative to significantly positive effects on the Local communities. Those directly affected are the most adversely affected. The moderately negative effects are anticipated to be experienced by those who do not want the Project, and / or will experience noise and severance, but these negative effects are anticipated to reduce over time. During construction, effects are anticipated to range from moderately negative to minor positive but these effects are temporary and for limited times only. Mitigation measures in the CEMP will manage these effects.

7.14 Traffic

The traffic impacts during construction will be managed in accordance with the *Construction Traffic Management Plan*, (CTMP), which forms part of the CEMP suite of documents.

There are a number of impacts to SH1 and the arterial road network that require detailed mitigation strategies at the construction planning stage. It is expected that the effects and mitigation strategies identified in this assessment will be used to inform the traffic management methodologies employed for facilitating construction work on the Project. In general the effects outlined in this assessment are expected to be able to be mitigated

acceptably provided the procedures outlined by the CTMP are followed. The effects are not anticipated to be significantly greater or unusual compared with other major road construction projects completed in the Wellington region in the last five to ten years. As such, the NZTA has considerable experience and a strong track record of successfully managing the effects of construction on traffic.

Once operational the Expressway will have on-going implications for pedestrians and cyclists, public transport, traffic flows and volumes, travel times, and property access.

The Project is consistent with the Project Objectives and Guiding Objectives (refer to Appendix B) in that:

- The Project is predicted to enhance efficiency and journey time reliability
- The Project balances inter-regional and local traffic movements. The proposed Expressway provides significant benefits for through traffic and local traffic movements; thereby 'supporting economic development and Improving the movement of freight'
- The proposed Expressway will operate at Level of Service B in 2026
- The overall network operates to significantly improve travel times with the proposed Expressway in place
- The Project significantly reduces the volume of traffic on the existing SH1
- Local road crossings are maintained and a plan for proposed crossings developed by the Project
- The Project improves network resilience by providing a second crossing of the Waikanae River.

Further design work is necessary to develop pedestrian and cycle connections to the local road network, including further design of the dedicated walkway / cycleway.

The proposed Expressway affects existing bus stops on Kāpiti Road and at Peka Peka. Further design work is necessary to develop suitable alternative locations for these bus stops.

Traffic calming measures are being considered for Park Avenue to mitigate any adverse effects generated by the increase in traffic volumes as a result of the Project.

7.15 Urban Design

The Urban and Landscape Design Framework (ULDF) is a Technical Report prepared to fulfil the NZTA Urban Design policy requirements. The ULDF purpose is to ensure that the urban and landscape design concepts of the project are appropriately defined, developed and implemented for the Project. Because the project is still to progress to a detailed design phase, the UDLF also provides direction to matters that need to be considered in the future. The project will have a sufficient level of design development to support applications to the Environmental Protection Authority for the designation of the route.

Many of the potential adverse effects in urban planning and design terms have been addressed through the design process. However, there remain two types of mitigation that could be applied by way of conditions on the designation. These are:

- Challenging elements in the Expressway design that have yet to be fully resolved: in these situations, enough design work has been done to satisfy the project team that there is an ability to resolve design issues in the further stage of detailed design
- Known adverse effects that will need some other form of mitigation because they cannot be avoided by further design or remedied by other means.

The Assessment of Urban Planning and Design Effects set out the elements of the project urban planning and design which will require conditions to address adverse effects, for example:

- The design of noise barrier forms and the detailed way in which the landforms behind these provide for their integration to the landscape and associated planting
- The need for safe and convenient pedestrian crossing at the Kapiti Rd and Te Moana Rd interchange.

In addition, the Assessment of Urban Planning and Design Effects suggest the following actions that would most appropriately be undertaken by KCDC:

- The potential development opportunities for the Waikanae North Area should be revisited to confirm the likely yield and the need for additional land areas to be identified for future urban growth (noting this is most appropriately undertaken by KCDC as part of its District Plan review process)
- The need for any additional bridges across the Expressway can be identified in the District Plan. With these crossing points identified the Alliance can ensure that the construction of the Expressway does not preclude them being built in the future
- The urban development opportunities associated with the residual areas between Leinster Avenue and Raumati South should be explored by KCDC in conjunction with NZTA and any other larger land owners and any development which is proposed managed by a structure plan that may require new east west connections, the protection of wetland areas and the larger dune forms.

7.16 Vibration

7.16.1 General

Monitoring of ambient vibration in the vicinity of the Expressway has been carried out. The results showed that ambient vibration levels in the vicinity of the proposed Expressway are generally below the threshold of perception. Most residents did not perceive any traffic-induced vibrations in their home, and those who said they had were not disturbed by them.

7.16.2 Construction Vibration

It is anticipated that the Project's most significant vibration effects are likely to come from the use of vibrating rollers in Sector 2 between Kāpiti and Mazengarb Roads, because of the close proximity to a large number of residences.

Predictions of construction vibration levels indicate that the risk assessment[6] may be exceeded in every Sector of the Project. The development of a Construction Noise and Vibration Management Plan (CNVMP) will help to ameliorate this risk, and will outline the methodology for implementing the full Project criteria and assessing, managing and mitigating the Project construction effects. These assessments lead to the following recommendations:

- A Construction Noise and Vibration Management Plan (CNVMP) should be developed
- The Project construction must be measured and assessed in accordance with the standards contained in the Project Design Philosophy.

7.16.3 Operational Vibration

The assessment of human response to vibration, which is most relevant to operation effects once the Project is complete, is based on measurements in accordance with the Norwegian Standard NS 8176.E:2005. The operational vibration effects are predicted to be negligible, provided the road surface of the new Expressway is maintained in accordance with NZTA current mainatenance practices, in order to avoid vibration issues from heavy traffic.

7.17 Visual and Landscape

The Assessment of Landscape and Visual Effects highlights that the Expressway will be an unavoidably visible component in the landscape. The large scale of the Expressway, with elevated structures, makes it difficult to screen from view. The dynamic aspect of traffic movement visible on the Expressway accentuates the visual impact. However, for large sections of the Expressway the proposed earth bunds, noise walls and planting will screen views of the moving traffic.

The effects on the visual amenity of the Waikanae River corridor will be very high. The River corridor's high natural and recreational values and its status as an Outstanding Natural Landscape make this area sensitive to change. While the visual effects would be severe from close proximities of the bridge (i.e. within about 200m), they diminish with distance.

Similarly, the bridge and embankments crossing Wharemaku Stream introduce large elevated features into a relatively flat and undeveloped landscape, reducing the openness

[6] The risk assessment involved identifying buildings that were in proximity to the Expressway that would be effected from construction vibration

of the area and restricting views to Kāpiti Island from some locations. The proposed interchanges at Kāpiti Road and Te Moana Road include large elevated structures, crossing busy local roads and in residential areas, therefore impacting on a large viewing audience.

In places, the changes the Expressway will produce in relation to altered landforms or mitigation planting will not necessarily adversely affect visual amenity but will simply be different (e.g. along Makarini Street). For a large section of the Expressway between Kāpiti and Mazengarb Roads, the residents on the east currently have views of the remnant dunes in the WLR designation. Some of these dunes will be reduced in height and in places earth bunds will be constructed so traffic on the Expressway will not be visible. Planting proposed on these new landforms will, in time, replace the scrub with a treed backdrop.

At some locations, the effects on visual amenity for residents immediately adjacent to the Expressway will be severe and adverse, particularly for residents who lose views of open space and traffic becomes a prominent element of the foreground view (e.g. Chilton Drive). However, it appears that there will not be a large number of residents affected in this way, although assessments have not been carried out from individual private properties.

The landscape character varies along the proposed 18km route; there are areas with distinct rural, rural lifestyle, residential, urban, industrial, and highway characters. As a large piece of infrastructure, the Expressway will introduce a new type of activity and character through most of these areas.

The linear nature of the Expressway will bisect the landscape, interrupting the natural topography and water bodies as well as man-made patterns such as settlements, plantations, shelterbelts, roads and accessways.

The degree of change to the existing landscape relates to the scale of the Expressway footprint and the size of the various structures. The change to landscape character will generally be greatest in the immediate vicinity of the footprint; however, with increasing distance from the Expressway these effects will mostly diminish.

The least effect on the existing landscape character occurs where the Expressway is close to the existing SH1/rail corridor, which already is a busy highway environment. While the Expressway will contribute to this character in these areas, in other places it will be an unfamiliar element, despite that much of the route lies in a corridor that has long been identified for a major road.

For most of the route the changes to landscape character are rated high. For three character areas the changes will be very high – Wharemauku Basin, Waikanae River and Te Moana. In these locations, the scale of the Expressway structures and the activity the Expressway will significantly change the existing landscape character.

The issues identified above will be addressed as part of the Urban Design and Landscape Framework (UDLF). The UDLF purpose is to ensure that the urban and landscape design

concepts of the project are appropriately defined, developed and implemented for the Project. Because the project is still to progress to a detailed design phase, the UDLF also provides direction to matters that need to be considered in the future. The project will have sufficient level of design development progress to support applications to the Environmental Protection Authority for the designation of the route.

7.18 Contaminated Land

There is the potential of uncovering contaminated land during the construction of the project. There are three sites where contamination levels trigger resource consents to mitigate the effects:

- 55 Rata Road
- Kāpiti Road Intersection
- 124-154 Te Moana Road.

Health guidelines for construction workers and the general public will be exceeded at one site - 55 Rata Road. Specific management procedures for the protection of construction workers and the general public are outlined in the Contaminated Soils and Groundwater Management Plan. Notwithstanding the exceedance of human health guideline values, the human health risks from contaminated soils can be mitigated by adherence to the Contaminated Soils and Groundwater Management Plan and Contractor Health and Safety Plan. This will control the off-site migration of identified and any, as yet, unidentified contaminants and minimise the exposure of construction workers and the general public to actually or potentially contaminated soils.

7.19 Climate Change

Any effects arising from climate change such as sea level rise, and increased rainfall and runoff will be incorporated into the design to ensure culverts and bridges can adequately accommodate increased water flows.

7.20 Summary

The above has traversed the social and environmental issues against which each option for the Expressway has been screened.

Minimum Standard Z/19 - Social and Environment Management (SEM), identifies the potential social and environmental effects including the opportunities to improve outcomes, and the degree of potential effect (before mitigation) in the most affected area(s) of the proposed Expressway.

The Multi Criteria Assessment (MCA) process undertaken by the Mackays to Peka Peka Expressway Alliance is considered satisfactory to conform with the NZTA social and environmental decision process requirements (such as prescribed in the *Social and Environmental Management Form PSF/13*).

The MCA Descriptors and Scores for the proposal are included in the 'Mackays to Peka Peka Options Report' dated 13 June 2011).

8 Overview of Technical Design Considerations

The technical design considerations including standards, issues and options are described in the individual design reports. This section briefly summarises the nature of the main technical design considerations that have been taken into account in the design to date.

8.1 Road Design

8.1.1 General

The project is 18km in length however only approximately 16kms is being constructed to Expressway standard. The Raumati Straight is being rehabilitated to address the poor ride quality and pavement failures. The existing 3m median with a concrete barrier will remain. While this reduction in standard for Raumati Straight has been signed off by the Project Alliance Board a paper will need to be submitted to the VAC to formally close out the issue.

The Expressway design has been carried out in accordance with the RoNS Standards and Guidelines. It is a two lane each way, median divided Expressway with a central wire rope barrier, with a design speed of 110 km/hr, with a posted speed of 100 km/hr.

Design considerations have been made around median width and edge treatment to minimise the overall earthworks footprint and therefore minimise earthworks volumes and ground improvement extent required in the peat and sand ground conditions that prevail along the route.

Edge treatment for the Expressway consists either of a 9 m clear zone with a maximum traversable slope of 4H:1V, or where embankment heights are greater than 2.5 m, a TL4 barrier is provided with embankments steepened up to 3H:1V to minimise the extent of the fill slopes and requirements for ground improvements and fill material.

Arrangements for whether the Expressway passes over or under local roads at interchanges and at locations away from interchanges have been evaluated and reviewed at workshops throughout the design, taking into account earthworks extent, road geometry, property access and purchase, visual effects and noise. In most cases the Expressway has been selected to pass over the local road, with the local road passing over the Expressway only at the three northern crossings at Ngarara Road, Smithfield Road and Peka Peka.

Road bridges over the Expressway are designed to provide a minimum of 6 m clearance to the Expressway. Pedestrian bridges over the Expressway will have a minimum of 6.2 m clearance.

When the Expressway passes over local roads, the alignment has been based on providing a minimum of 4.9 m clearance, except that at Raumati Road a 6 m clearance is provided for over dimension loads south of the Waikanae River. North of the Waikanae River, the

Peka Peka interchange bridge will allow for over dimension loads to pass over the Expressway.

Designs for each of the interchanges have been developed and reviewed by the wider team. Traffic signals are proposed at the Kapiti Road interchange while at the other locations the current proposal is to use roundabout controlled intersections at the termination of each ramp. While the current design for Te Moana Road is shown as roundabout controlled intersections, signal controlled intersections have been developed as well. It is proposed to review this design further in the TOC phase along with the implications it will have on Stormwater flows and road footprint to confirm the best solution for the local road and interchange.

8.1.2 Local Roads

As described above the Expressway will interface with a number of the local roads at interchange and local road crossing locations. Works proposed on these roads is generally restricted to a relatively short distance either side of the Expressway as discussed below:

i. Poplar Avenue – Poplar Avenue will be realigned slightly to the north of the current intersection location back as far as the Leinster Avenue intersection. This is to reduce the area required from QE Park.

ii. Leinster Avenue – The Expressway crosses the eastern end of Leinster Avenue, severing the connection with the existing state highway. Vehicle access will be via the western end to Poplar Avenue. It is proposed to have a pedestrian cycle bridge over the Expressway near the eastern end of Leinster Avenue. A cul-du-sac will be formed at this location and a 6m wide public access road to the severed properties to the north of Leinster Avenue for approximately 450m will be formed. While a separate cycleway is shown in this location it may be preferable to use this access road as the cycleway. Further discussion will be required to confirm this.

iii. Kāpiti Road – Significant widening works are proposed for Kāpiti Road, these works extend 160m to the east and 200m to the west. This is required for the development of two through lanes, a right turn lane and cycle lane in each direction. The Expressway crossing over Kāpiti Road will have a centre pier located in the median island. The current kerb line position on the northern side of Kāpiti Road will be maintained requiring all widening to take place in the vacant land to the south. A number of commercial property accesses will be affected. It is necessary to reform them further from the intersections. Further design is required to finalise these and consultation with affected property owners will be required.

iv. Mazengarb Road – To reduce the height of the Expressway adjacent to Mazengarb Road the design allows for Mazengarb Road to be lowered by a maximum of 2m over a distance of 250m. One property access will require regarding and retaining walls on

the eastern side of the Expressway will be required to prevent earthworks extending into private property.

v. Otaihanga Road – The Expressway crosses over Otaihanga road having minimal impact on the road. Sight stopping distances around the proposed bridge columns will need to be checked in the next phase. Currently a number of properties south of the Waikanae River, but north of Otaihanga Road gain access via a long private right of way (ROW) that joins Otaihanga Road to the west of the proposed Expressway. The Expressway will sever this ROW. A new ROW is to be constructed, at the eastern edge of the proposed designation connecting the existing ROW 730m from Otaihanga Road. Utility services which currently are located on the existing ROW will be to disconnected and new services provided on the proposed ROW.

vi. Kauri Road – The Expressway crosses to the west of the western end of Kauri Road. It does sever the access to El Rancho beyond the end of the public road. It is proposed to relocate the access around in front of the northern abutment of the Waikanae River Bridge. In this location the access will be within the Waikanae river floodway, 300m in length. To address this issue the Alliance will facilitate the consenting for use of an alternate access on to Weggery Drive in emergencies. The Accessway pavement would need to be designed to be low maintenance even though it will be subject to flood waters occasionally. It is currently proposed to use a concrete pavement, however this will be investigated further in later stages. Discussions have been held with the management team and trustees for El Rancho and a final agreement has not yet been reached. However what has currently been proposed is seen as a possible solution.

vii. Puriri Road – The Expressway crosses to the west of the western end of Puriri Road. It does sever the access to one property and the Takamore Urupa beyond the end of the public road. Five properties at the western end are required to enable a cul-du-sac and noise bund to be constructed.

viii. Te Moana Road – Significant widening works are proposed for Te Moana Road with the construction of the roundabouts. These works extend 150m to the east and 150m to the west.

ix. Urupa Access – A new public road is proposed 150m west of the Expressway providing access to the severed properties and the Urupa, 550m in length. The exact location and whether a parking area near the urupa will be provided are still to be determined in consultation with the Takamore Trust.

x. Ngarara Road – The Expressway will pass under the relocated Ngarara Road. This allows the Expressway to sit better in the landscape and also assists with the cut fill balance. The new section of Ngarara Road is 400m in length. At this location the off road cycleway joins Ngarara Road on the eastern side of the Expressway and then crosses over the Expressway on the Ngarara Road Bridge and on to the western side

of the Expressway. Further design will be required to detail the safe transition on to and off the local road.

xi. Smithfield Road – The Expressway severs Smithfield Road 400m from the intersection with Ngarara Road. There are currently 3 properties that gain access off the severed section of Smithfield Road. Also the Nga Manu Nature Reserve is just south of the intersection of Smithfield Road and Ngarara Road and has a long 650m private access that the Expressways severs. After significant design of options and evaluation it has been decided to construct a new road approximately in the location of the Nga Manu driveway, this also provides for KCDC's long term plans to have an east west road between the existing state highway and Ngarara Road and then on further to the coast. The road terminates 50m after crossing over the Kaikariki Streams until at some future date when it is extended to the existing highway. The access to Nga Manu nature reserve is just prior to the bridge over the Kaikariki Stream. A 'T' intersection is designed to connect the road to provide access to the properties currently at the end of Smithfield Road. This road passes close to the registered Pohutukawa tree.

xii. Peka Peka Road – A new roundabout is proposed 120m west of the current intersection with SH1. This roundabout has four connecting roads. The two to the north provide access for north bound local traffic to join the Expressway or travel north using the new local road. The road to the south of the roundabout allows for local traffic to and from Waikanae or Hadfield's Road. This road passes over the Expressway and connects to the existing highway with a roundabout.

8.2 Transportation

There are a number of transportation technical reports which support and inform the Assessment of Environmental Effects (AEE). These reports will be provided separately as part of the AEE. The transport reports include:

- The *Assessment of Transport Effects*
- The *Traffic Modelling Report*
- The *Assessment of Temporary Traffic Effects*
- The *Construction Traffic Management Plan*.

The transportation section of this Scheme Assessment Report draws upon and summarises information in the above reports, which further discuss:

- The Existing transportation environment
- Traffic model development and forecasting method
- Assessment matter and detailed assessment of transportation effects.

The transportation sections which follow are a summary of the transportation network assessment including the predicted users of the Expressway, SH1, and local roads.

8.2.1 Traffic Flows and Travel Times

Existing and Future Flows

The following section provides a summary of the modelled traffic flows across the Project area as obtained from the project assignment model (detailed in the *Traffic Modelling Report)*. This provides a comparison of the baseline 2010 traffic flows with the forecast "Do-Minimum" traffic flows (without the project) in 2016 and 2026.

The daily two-way directional traffic flows on SH1 for 2010 and the 2016 and 2026 forecast future years are shown in **Table 8.1** below. A percentage change is shown to compare the traffic growth from 2010 to the future 2016 and 2026 years based on the Do-Minimum.

Table 8.1 - Comparison of 2010 with 2016 and 2026 Daily Flows on SH1 (Vehicles per Day)

Location	2010	2016 DM	2010-2016 DM Change	2026 DM	2010-2026 DM Change
South of Poplar Ave	22,700	22,900	1%	26,400	16%
South Kāpiti Road	26,900	29,000	8%	31,800	18%
South of Otaihanga Road	22,400	22,600	1%	25,500	14%
South of Te Moana Road	26,900	27,500	2%	31,900	19%
North of Peka Peka Road	15,900	16,700	5%	19,500	23%

As summarised above, there is a limited amount of growth (less than 10%) predicted to occur between 2010 and 2016, with a greater amount of growth (14 – 23%) predicted to occur to the year 2026. This is discussed further in the *Traffic Modelling Report*.

The wider network effects of the growth from 2010 to 2016 and 2026 respectively are shown in Table 8.2. This allows the comparison of the impacts of growth over this period and provides the Do-Minimum scenario to assess the impact of the Project during operation. **Table 8.2** shows the changes in daily flow on selected arterial routes.

Table 8.2 – Comparison of 2010 with 2016 and 2026 Daily Flows on Selected Local Roads (Vehicles per Day)

Location	2010	2016 DM	2010–2016 DM Change	2026 DM	2010–2026 DM Change
Poplar Ave, East of Matai Rd	2,600	3,000	15%	3,200	23%
Matai Rd, South of Raumati Rd	4,300	4,400	2%	5,500	28%
Raumati Rd, West of Rimu Rd	12,900	15,100	17%	17,700	37%
Rimu Rd, South of Kāpiti Rd	19,600	19,400	-1%	15,500	-21%
Kāpiti Rd, West of SH1	16,000	16,100	1%	18,100	13%
Kāpiti Rd, West of Arawhata Rd	24,900	27,200	9%	28,100	13%
Kāpiti Rd, West of Te Roto Dr	15,700	17,300	10%	20,100	28%
Arawhata Rd, North of Kāpiti Rd	7,800	7,800	0%	6,100	-22%
Te Roto Dr, North of Kāpiti Rd	10,300	11,600	13%	12,400	20%
Realm Dr, North of Guildford Dr	2,900	3,100	7%	4,300	48%
Mazengarb Rd, East of Guildford Dr	5,300	6,000	13%	6,400	21%
Ratanui Rd, North of Mazengarb Rd	7,200	7,700	7%	8,200	14%
Otaihanga Rd, West of SH1	6,500	7,300	12%	9,400	45%
Te Moana Rd, West of SH1	10,700	10,200	-5%	12,200	14%
Te Moana Rd, West of Walton Ave	5,200	5,200	0%	6,300	21%
Park Ave, North of Te Moana Rd	1,800	2,400	33%	2,900	61%
Paetawa Rd, South of Peka Peka Rd	900	900	0%	1,100	22%
Peka Peka Rd, West of SH1	1,100	1,200	9%	1,500	36%

The following can be observed from the above table:

- Traffic volumes on Kāpiti Road are predicted to increase by 13% west of SH1 and west of Arawhata Road, and by 28% west of Te Roto Drive, between 2010 and 2026

- Traffic volumes on Te Moana Road are predicted to stay relatively constant from 2010 to 2016 and then increase by 14 to 21% (2010 to 2026). This is primarily due to significant growth planned in the Waikanae North and Ngarara development areas
- Traffic volumes on Rimu Road are predicted to stay approximately constant to 2016 and then reduce in 2026. The reduction in traffic flow on Rimu Road is due to the inclusion of new local road links in Paraparaumu town centre and also the Ihakara Street Extension in the 2026 model
- Traffic volumes on Arawhata Road are predicted to stay approximately constant to 2016 and then reduce in 2026, as a result of some vehicles choosing alternative routes to avoid the traffic signals at the Kāpiti Road / Arawhata Road intersection which are in the 2026 traffic model
- Traffic volumes on Park Avenue are predicted to increase by 33% by 2016 and by 61% by 2026.

Existing and Future Travel Times

The Kāpiti Traffic Model (KTM2), the project assignment model, was used to derive travel times along three selected routes in the Project area:

- SH1 from MacKays Crossing to Peka Peka Road
- Kāpiti Road from Ocean Road to Hinemoa Street
- Te Moana Road / SH1 / Elizabeth Street from Ruaparaha Street to Winara Avenue.

The travel times for the Do-Minimum scenario will later be used to compare with the travel times which result from the completion of the Project. The travel times along these three routes for 2010, 2016 Do-Minimum, and 2026 Do-Minimum are summarised below.

Table 8.3 - AM Peak Hour Modelled Travel Times on Selected Routes (min:sec)

Location	Direction	2010	2016 DM	2026 DM	2010-2026 DM Change
SH1: MacKays Crossing to Peka Peka	NB	14:34	14:42	15:27	6.1%
	SB	15:21	15:17	18:14	18.7%
Kāpiti Road: Ocean to Hinemoa	WB	05:00	05:30	05:38	12.4%
	EB	04:49	05:01	05:28	13.5%
Te Moana Rd / Elizabeth St: Ruaparaha to Winara	WB	06:29	07:17	07:23	13.9%
	EB	05:52	06:28	06:38	13.0%

Table 8.4 – PM Peak Hour Modelled Travel Times on Selected Routes (min:sec)

Location	Direction	2010	2016 DM	2026 DM	2010–2026 DM Change
SH1: MacKays Crossing to Peka Peka	NB	16:57	16:26	21:01	24.0%
	SB	13:51	13:55	14:16	3.0%
Kāpiti Road: Ocean to Hinemoa	WB	05:05	05:30	05:41	11.7%
	EB	05:11	05:13	05:58	15.1%
Te Moana Rd / Elizabeth St: Ruaparaha to Winara	WB	06:58	07:00	07:01	0.7%
	EB	06:44	06:46	07:06	5.6%

The modelling is predicting significant travel time increases on SH1 in the peak directions (southbound in the am and northbound in the pm) between 2010 and the 2026 Do-Minimum. Travel times east-west on Kāpiti Road is also expected to increase by approximately 12-15%. The Te Moana Road to Elizabeth Street route is predicted to experience a small increase in travel time in the eastbound direction.

8.2.2 Project and Surrounding Area Assessments

Users of the Expressway

The predicted daily and peak hour volume of traffic using the Expressway is summarised in **Tables 8.5 and 8.6**.

Table 8.5 – Daily Users of Expressway

Location	Direction	2016	2026	Increase 2016-2026
Expressway South of Poplar Ave	NB	11,800	13,900	18%
	SB	11,200	13,000	16%
Expressway Between Poplar Ave and Kāpiti Rd	NB	6,000	7,100	18%
	SB	6,000	6,800	13%
Expressway Between Kāpiti Rd and Te Moana Rd	NB	8,100	10,000	23%
	SB	8,000	10,100	26%
Expressway Between Te Moana Rd and Peka Peka Rd.	NB	5,400	6,300	17%
	SB	5,000	6,100	22%
Expressway North of Peka Peka Rd.	NB	6,900	8,100	17%
	SB	6,600	7,800	18%

Location	Direction	2016	2026	Increase 2016-2026
Poplar Ave South-Facing Ramps	NB (Off)	5,800	6,800	17%
	SB (On)	5,200	6,200	19%
Kāpiti Rd South Facing Ramps	NB (Off)	2,000	2,400	20%
	SB (On)	1,700	1,900	12%
Kāpiti Rd North Facing Ramps	NB (On)	4,100	5,300	29%
	SB (Off)	3,800	5,300	39%
Te Moana Rd South Facing Ramps	NB (Off)	3,200	4,300	34%
	SB (On)	3,400	4,500	32%
Te Moana Rd North Facing Ramps	NB (On)	480	550	15%
	SB (Off)	380	440	16%
Peka Peka Rd North Facing Ramps	NB (On)	1,500	1,800	20%
	SB (Off)	1,600	1,700	6%

Table 8.6 - AM and PM Peak Hour Users of Expressway

Location	Direction	2016 AM	2016 PM	2026 AM	2026 PM
Expressway South of Poplar Ave	NB	910	1,590	1,100	1,830
	SB	1,200	820	1,440	970
Expressway Between Poplar Ave and Kāpiti Rd	NB	480	780	580	930
	SB	640	420	770	510
Expressway Between Kāpiti Rd and Te Moana Rd	NB	570	790	690	1,030
	SB	810	570	1,160	670
Expressway Between Te Moana Rd and Peka Peka Rd	NB	450	480	540	560
	SB	450	410	620	470
Expressway North of Peka Peka Rd	NB	570	640	690	740
	SB	620	520	820	590
Poplar Ave South-Facing Ramps	NB (Off)	420	810	520	900
	SB (On)	550	400	660	460

Location	Direction	2016 AM	2016 PM	2026 AM	2026 PM
Kāpiti Rd South Facing Ramps	NB (Off)	140	350	170	410
	SB (On)	290	100	310	140
Kāpiti Rd North Facing Ramps	NB (On)	230	370	290	520
	SB (Off)	460	240	700	310
Te Moana Rd South Facing Ramps	NB (Off)	170	350	210	510
	SB (On)	400	180	600	230
Te Moana Rd North Facing Ramps	NB (On)	40	30	50	40
	SB (Off)	50	30	60	30
Peka Peka Rd North Facing Ramps	NB (On)	120	160	160	180
	SB (Off)	170	110	200	120

From **Table 8.5** and **Table 8.6** the following points can be made:

- The highest daily flow on the Expressway in 2026 (nearly 20,000 vpd) occurs between Kāpiti Road and Te Moana Road intersections
- The Kāpiti Road north facing ramps are the busiest during the day, followed by the Te Moana south facing ramps.

Further analysis on the predicted users of the Expressway is contained in the *Traffic Modelling Report*. In summary:

- Over 75% of trips have either or both the origin / destination end of their journey north of Peka Peka or south of Mackays Crossing
- Around 25% of daily users travel between Waikanae and Paraparaumu
- Around 60% of journeys join / leave at Kāpiti Intersection
- Approximately 40% of journeys join / leave at Te Moana intersection.

Impacts on Existing SH1

The Project is expected to significantly reduce the volume of traffic using the existing SH1, as summarised in the table below.

Table 8.7 - Comparison of 2010, 2016 DM and 2026 DM with 2016 OPT and 2026 OPT Daily Flows on SH1 (Vehicles per Day)

Location	2010	2016 DM	2016 OPT	2016 DM–2016 OPT Change	2026 DM	2026 OPT	2026 DM–2026 OPT Change
South of Poplar Ave	22,700	23,000	23,100	0%	26,400	26,900	2%
South Kāpiti Rd	26,900	29,100	19,500	-33%	31,900	21,100	-34%
South of Otaihanga Rd	22,400	22,700	10,500	-54%	25,800	11,700	-55%
South of Te Moana Rd	26,900	27,600	13,100	-53%	31,800	14,700	-54%
North of Peka Peka Rd	15,900	16,800	1,600	-90%	19,100	1,900	-90%

With the Project in place, the traffic flows on the existing SH1 are expected to reduce approximately 35% (south of Kāpiti Road) to 55% (south of Otaihanga Road). This is likely to be a function of through traffic transferring to the Expressway and also some local traffic transferring to the Expressway. The significant reduction in traffic on SH1 provides an opportunity to make changes to the existing SH1 as discussed in the *SH1 Revitalisation Study Report*.

The *Traffic Modelling Report* documents further analysis undertaken at existing key intersections along SH1, including the signalised intersections at Elizabeth Street, Te Moana Road, and Kāpiti Road as well as the priority-controlled intersections at Poplar Avenue, Raumati Road, Ihakara Street, and Otaihanga Road.

The analysis indicated that delays at the Elizabeth Street, Te Moana Road, and Kāpiti Road intersections reduce slightly with limited optimisation of the signals with the KTM2. With the significant reduction in traffic on the existing SH1, it is expected that the intersections could be optimised to provide greater reduction in delay.

The analysis also indicated that the delays at the four priority-controlled intersections reduce significantly with the Expressway in place. This is due to the significant reduction in traffic on SH1, making it easier find gaps in the traffic flow to turn into and out of these intersections.

Impacts on Local Roads

Table 8.8 summarises 2010, 2016 DM and 2026 DM traffic volumes as well as 2016 OPT and 2026 OPT traffic volumes on selected local roads with the Expressway in place.

Table 8.8 – Comparison of 2010, 2016 and 2026 DM with 2016 and 2026 Option Daily Flows on Selected Local Roads (Vehicles per Day)

Location	2010	2016 DM	2016 OPT	2016 DM–2016 OPT Change	2026 DM	2026 OPT	2026 DM–2026 OPT Change
Poplar Ave, East of Matai Rd	2,600	3,000	3,400	13%	3,300	3,800	15%
Matai Rd, South of Raumati Rd	4,300	4,400	4,000	-9%	5,800	5,300	-9%
Raumati Rd, West of Rimu Rd	12,900	15,100	14,300	-5%	17,800	16,300	-8%
Rimu Rd, South of Kāpiti Rd	19,600	19,400	18,800	-3%	16,100	15,500	-4%
Kāpiti Rd, West of SH1	16,000	16,100	13,500	-16%	18,700	13,600	-27%
Kāpiti Rd, West of Arawhata Rd	24,900	27,200	27,600	1%	29,400	29,400	0%
Kāpiti Rd, West of Te Roto Dr	15,700	17,300	19,100	10%	20,700	22,000	6%
Arawhata Rd, North of Kāpiti Rd	7,800	7,800	7,400	-5%	6,400	6,300	-2%
Te Roto Dr, North of Kāpiti Rd	10,300	11,600	11,200	-3%	12,400	12,200	-2%
Realm Dr, North of Guildford Dr	2,900	3,100	2,600	-16%	4,100	3,400	-17%
Mazengarb Rd, East of Guildford Dr	5,300	6,000	5,900	-2%	6,200	5,800	-6%
Ratanui Rd, North of Mazengarb Rd	7,200	7,700	5,400	-30%	7,800	4,900	-37%
Otaihanga Rd, West of SH1	6,500	7,300	4,900	-33%	8,600	5,600	-35%
Te Moana Rd, West of SH1	10,700	10,200	5,400	-47%	12,100	5,800	-52%
Te Moana Rd, West of Walton Ave	5,200	5,200	3,700	-29%	6,100	4,200	-31%
Park Ave, North of Te Moana Rd	1,800	2,400	3,800	58%	2,900	5,000	72%
Paetawa Rd, South of Peka Peka Rd	900	900	900	0%	1,000	1,000	0%
Peka Peka Rd, West of SH1	1,100	1,200	600	-50%	1,400	800	-43%

The Project is predicted to change traffic flows on local roads in a number of ways:

- In many cases traffic volumes on local roads are predicted to decrease as a result of the Project. Kāpiti Road west of SH1, Otaihanga Road, Realm Drive, Ratanui Road, Te Moana Road, and Peka Peka Road west of SH1 are all predicted to significantly decrease in traffic volume as a result of the Project
- Traffic volumes on Matai Road, Raumati Road, Mazengarb Road, and Paetawa Road are also expected to decrease as a result of the project
- Traffic volumes are expected to increase by around 6-10% on Kāpiti Road in the vicinity of the Kāpiti Road Interchange however the increase in traffic volume is not expected to significantly adversely impact on the operation of Kāpiti Road
- Poplar Avenue, east of Matai Road is expected to experience an increase in traffic of 13-15%. While significant in percentage terms, this results in an increase of only 400-500 vehicles per day, comparing the DM and OPT scenarios, due to the relatively low volume of traffic on Poplar Avenue and will not alter the current nature and character of the road environment, nor cause any significant increase in delay or queuing. The Poplar Avenue intersections with the Expressway ramps will operate with an excellent Level of Service and minimal delays and queuing
- Traffic volumes on Park Avenue, north of Te Moana Road are predicted to increase by 72% (2,100 vehicles per day) by 2026. This is due to Park Avenue being a direct route to the Te Moana Interchange from the Ngarara and Waikanae North development areas. Park Avenue is classified as a Secondary Arterial in the KCDC District Plan. At a daily volume of 5,000 in 2026, Park Avenue will still carry a reasonable volume of traffic expected of a secondary arterial[7]. While the volume of traffic may be reasonable for a secondary arterial, the road environment is primarily residential in character with regular property access. The change in traffic volume could be expected to change the nature and character of the road environment. It is recommended that speed control measures are considered for Park Avenue by the Alliance and KCDC[8].

Travel Time Savings

Predicted travel time along a number of selected routes was calculated for the Do-Minimum and Option in 2026. The selected routes are:

- Poplar Avenue
- Kāpiti Road
- Rimu Road / Mazengarb Road
- Te Moana Road
- SH1 – MacKays Crossing to Peka Peka

[7] 1 Needs to be reference to a standardCTSY1

[8] May require updating following model updates. Increase on Park Ave could be less.

- Expressway – MacKays Crossing to Peka Peka.

The selected routes are illustrated in **Figure 8.1** below.

Figure 8.1- Travel Time Routes

Table 8.9 summarises the AM and PM peak travel times along each of the selected routes in 2026 for both the DM and OPT.

Table 8.9 – Travel Times on Selected Routes (mins)

Origin	Direction	Length (km)	DM AM	OPT AM	Change	DM PM	OPT PM	Change
Expressway	SB	16		09:20			09:20	
	NB	16		09:20			09:20	
SH1	SB	15	16:30	13:00	-22%	12:30	12:30	0%
	NB	15	14:40	13:10	-10%	20:20	13:30	-33%
Te Moana Rd	WB	5	07:10	07:00	-2%	07:40	07:20	-4%
	EB	5	08:00	07:50	-1%	07:30	07:40	1%
Rimu Rd – Mazengarb Rd	EB	6.5	16:30	10:30	-36%	16:40	11:10	-34%
	WB	6.5	09:10	08:40	-6%	10:00	09:20	-6%
Kāpiti Rd	EB	3.7	06:20	07:00	11%	06:50	06:50	2%
	WB	3.7	06:30	07:20	11%	06:40	07:10	10%
Raumati Avenue	EB	5	12:40	06:30	-48%	10:50	06:40	-39%
	WB	5	06:20	06:14	-2%	06:50	06:20	-7%
Poplar Avenue	EB	3	12:30	03:20	-73%	06:31	03:30	-47%
	WB	3	03:10	03:20	5%	05:23	03:30	-36%

From the table above, it can be seen that in the am peak the Expressway provides a route that is predicted to be seven minutes faster between Peka Peka and Mackays Crossing compared with the equivalent SH1 route in the Do Minimum in the peak direction. In the pm peak the Expressway provides a route that is over ten minutes faster in the peak direction than the equivalent SH1 corridor, due to congestion within Paraparaumu and Waikanae town centres in the PM peak Do Minimum networks.

The travel time data shows that in the year 2026:

- AM peak journey times along SH1 (southbound) are 20% quicker in the Option than the Do-Minimum
- In the PM peak, the northbound SH1 journey time is seven minutes faster in the Option than the northbound journey time in the Do-Minimum
- Journey times for the through movement along Kāpiti Road increase slightly in the Option, as a result of traffic signals at the Kāpiti Road Interchange
- Raumati Road, Poplar Avenue and Rimu Road/ Mazengarb Road have improved journey times in the Option compared with the Do Minimum, most noticeably so in the PM peak.

Further detailed analysis was undertaken to understand the travel time benefits for through traffic and local traffic. The introduction of the Project has an impact on travel times across the network. The effect on travel times between a number of origin and destination sectors were calculated. The travel times for both the Do Minimum and Option can be found in Section 6.7 of the *Traffic Modelling Report*.

The conclusion that can be drawn from the travel time analysis contained in the *Traffic Modelling Report* is that the Project provides significant travel time savings for both through traffic on the Expressway and local traffic movements.

Heavy Commercial Vehicles

Once completed, it is expected that a significant volume of heavy commercial vehicles (HCV's) will transfer to the Expressway. The expected volume (and per cent) HCV's on the Expressway in 2016 and 2016 is summarised in the table below.

Table 8.10 – Volume and Per cent Heavy Vehicles on the Expressway in 2016 and 2026 (Vehicles per Day)

Location on Expressway	2016 HCV Volume	2016 Total Traffic Volume	HCV % 2016	2026 HCV Volume	2026 Total Traffic Volume	HCV % 2026
South of Poplar Ave	3,170	23,100	14%	4,640	26,900	17%
Between Poplar and Kāpiti	1,640	12,100	14%	2,190	13,900	16%
Between Kāpiti & Te Moana	1,880	16,200	12%	2,720	20,200	13%
Betweeen Te Moana and Peka Peka	1,680	10,400	16%	2,510	12,400	20%
North of Peka Peka	2,060	13,500	15%	2,930	15,900	18%

As summarised above, of the total traffic the Expressway is predicted to carry, between 12 and 20% will be HCV's. This is consistent with the character of an Expressway and well within its capacity.

The impact of the Project on HCV's on the existing SH1 both in the DM and OPT scenarios in 2016 and 2026 is summarised below.

Table 8.11 – Change in Heavy Vehicles on SH1 in 2016 and 2026 (Vehicles per Day)

Location on Existing SH1	2016 DM	2016 OPT	2016 DM–OPT Change	2026 DM	2026 OPT	2026 DM–OPT Change
South of Poplar Ave	3,180	3,170	0%	4,650	4,640	0%
South Kāpiti Road	3,230	1,650	-49%	4,340	1,840	-58%
South of Otaihanga Road	2,930	1,280	-56%	3,610	1,340	-63%
South of Te Moana Road	3,050	1,170	-62%	4,160	1,240	-70%
North of Peka Peka Road	2,480	880	-65%	3,570	950	-73%

The Project is expected to significantly reduce the volume of heavy vehicles on SH1.

The impact of the Project on HCV's on other selected local roads is summarised below.

Table 8.12 – Change in Heavy Vehicles on Selected Local Roads in 2016 and 2026 (Vehicles per Day)

Location	2016 DM	2016 OPT	2016 DM–OPT Change	2026 DM	2026 OPT	2026 DM–OPT Change
Poplar Ave, East of Matai Rd	210	220	5%	250	250	0%
Matai Rd, South of Raumati Rd	140	130	-7%	200	170	-15%
Raumati Rd, West of Rimu Rd	780	710	-9%	1,390	1,130	-19%
Rimu Rd, South of Kāpiti Rd	910	860	-5%	700	590	-16%
Kāpiti Rd, West of SH1	1,130	780	-31%	1,790	820	-54%
Kāpiti Rd, West of Arawhata Rd	1,530	1,620	6%	2,010	1,850	-8%
Kāpiti Rd, West of Te Roto Dr	990	1,190	20%	1,490	1,870	26%
Arawhata Rd, North of Kāpiti Rd	280	330	18%	280	240	-14%
Te Roto Dr, North of Kāpiti Rd	990	1,020	3%	1,220	1,100	-10%
Realm Dr, North of Guildford Dr	310	240	-23%	510	280	-45%
Mazengarb Rd, East of Guildford Dr	580	490	-16%	860	500	-42%
Ratanui Rd, North of Mazengarb Rd	570	330	-42%	990	290	-71%
Otaihanga Rd, West of SH1	640	400	-38%	1,180	450	-62%
Te Moana Rd, West of SH1	490	270	-45%	570	300	-47%
Te Moana Rd, West of Walton Ave	370	310	-16%	410	350	-15%
Park Ave, North of Te Moana Rd	140	190	36%	180	210	17%
Paetawa Rd, South of Peka Peka Rd	90	110	22%	110	120	9%
Peka Peka Rd, West of SH1	110	50	-55%	130	60	-54%

The results of the modelling indicate that with the Expressway in place, heavy vehicle volumes on most these local roads will reduce, many of them significantly. Heavy vehicle volumes are predicted to increase on Kāpiti Road west of Te Roto Drive by around 20-26%. The volume of heavy vehicles is predicted to increase on Park Avenue and Paetawa Road

by 30 and 10 vehicles respectively in 2026. This small predicted increase on Park Avenue and Pawtawa Road is not expected to adversely impact on the function of these roads.

As discussed earlier, the Wellington Regional Freight Strategy expects freight volumes to double by 2031 and includes projects such as the Levin to Wellington Airport Road of National Significance (of which the Project is part) to help cater for the increased freight demand.

Expressway Level of Service

The *Guiding Objectives* contain a Level of Service target for the Expressway:

> *"3(a) the Expressway achieves Level of Service 'B' between MacKays Crossing rail over-bridge and the location of the current intersection of Peka Peka Road and the existing SH1 [in the year 2026]."*

The Austroads *Guide to Traffic Management Part 3: Traffic Studies and Analysis* (Austroads Guide) was used to calculate the Level of Service for the Expressway based on the "basic freeway segments". According to the Austroads Guide, Level of Service B will be achieved if the maximum flow (passenger cars per hour per lane) is less than 1,100 for a facility with a free flow speed of 100kph.

The highest peak hour volume on the Expressway between Poplar Avenue and Peka Peka Road in the 2026 occurs during the am peak, southbound between Kāpiti Road and Te Moana Road, at 1,240 passenger car units (pcu's) per hour. This volume is accommodated in two traffic lanes. At 50% of the volume per lane, this would result in 620 pcu's per lane, which would be within the criteria for Level of Service B.

The section of the proposed Expressway between MacKays Crossing and Poplar Avenue (which is already four lanes wide) is predicted to carry 1,934 pcu's northbound in the pm peak. At 50% of the volume per lane, this would result in 967 pcu's per lane, which would be well within the criteria for Level of Service B.

Based on this assessment, it can be readily concluded that the Expressway between MacKays Crossing and Peka Peka will meet the objective of achieving Level of Service B in 2026.

Operational Model Assessments

Operational models have been developed to provide an assessment of the future year traffic effects along the Kāpiti Road corridor between the intersections of Kāpiti Road with Te Roto Drive and Arawhata Road. The performance of the road corridor has been assessed using VISSIM, an industry standard micro-simulation package.

SIDRA models have been developed to model the performance of the Poplar Avenue, Te Moana Road, and Peka Peka Road Interchanges.

The following form the overall summary to the micro-simulation modelling undertaken for the Kāpiti Road study corridor:

- The option scenario generally operates significantly better than the DM scenario
- An additional lane on Kāpiti Road in the section between the proposed interchange and Te Roto Drive / Kāpiti Road and Milne Drive / Kāpiti Road intersection is recommended to help increase the capacity of the road and operation of these intersections
- Overall, the proposed interchanges meet the Guiding Objective (to operate at LoS C or better) although it is noted that some movements at the ramps have a LoS E. However, the queues at the ramps do not exceed the ramp length
- The delays at Te Roto Drive and Milne Drive generally improve significantly in the option scenarios, due to platooning of vehicles created by the signals at the interchange. It is noted however, that in the AM 2026 Option scenario, the delays at Te Roto Drive increase slightly at Te Roto Drive approach when compared to the 2026 Do-Minimum. However, this increase in delay is considered to be minor
- Overall, the average speed along Kāpiti Road is slightly worse in the option scenario due to the signals at the interchange and Arawhata Road / Kāpiti Road intersection. However, it is considered that increase in traffic volumes on Kāpiti Road (when compared to the Do-Minimum) also contributes to the reduction in speeds along this corridor.

The results of the SIDRA analysis indicated that the Expressway interchanges with Poplar Avenue, Te Moana Road, and Peka Peka Road all operate at LoS B or better in 2026. The VISSIM analysis indicated that the Expressway interchange with Kāpiti Road will operate at LoS C in 2026. Therefore, Guiding Objective 3(b) which requires achievement of LoS C in 2026 at the intersections between the Expressway and local network will be met.

8.2.3 Summary

The following is a brief summary of the *Assessment of Transport Effects*.

Pedestrians and Cyclists

The Project will provide a dedicated walkway / cycleway along the Expressway corridor which is seen to be consistent with KCDC's CWB Strategy, the Project Objectives, and the Guiding Objectives, and will enhance connectivity between local communities. Pedestrian and cycle facilities will be provided at each of the Expressway interchanges to facilitate movement through these key movement nodes.

Further design work of pedestrian and cycle connections, including the dedicated walkway / cycleway, will be undertaken during the design phase of the Project.

Public Transport

The provision of the Expressway will result in travel time improvements across the road network which will also be experienced by buses. The Expressway provides an opportunity to establish a Waikanae Beach to Paraparaumu bus route along the Expressway which is seen to be consistent with KCDC's *Sustainable Transport Strategy*.

The location of existing bus stops on Kāpiti Road and at Peka Peka will be affected. Further design work will be undertaken to develop new, suitable locations for these bus stops.

Traffic

In summary, the key points discussed in the traffic assessment for the project and surrounding area are:

- The highest daily flow on the Expressway in 2026 is South of Poplar Avenue at 26,900 and next highest at over 20,000 vehicles per day between Kāpiti Road and Te Moana Road intersections
- With the Project in place, the traffic flows on the existing SH1 are expected to reduce approximately 35% to 55%. The delays experienced at priority-controlled intersections such as Poplar Avenue, Raumati Road, Ihakara Street, and Otaihanga Road are predicted to reduce significantly
- In many cases traffic volumes on local roads are predicted to decrease as a result of the Project
- Traffic volumes are expected to increase by around 6-10% on Kāpiti Road in the vicinity of the Kāpiti Road Interchange. However the increase in traffic volume is not expected to significantly adversely impact on the operation of Kāpiti Road
- Poplar Avenue, east of Matai Road is expected to experience an increase in traffic of 13-15%. While significant in percentage terms, this results in an increase of only 400-500 vehicles per day, comparing the DM and OPT scenarios, due to the relatively low volume of traffic on Poplar Avenue and will not alter the current nature and character of the road environment, nor cause any significant increase in delay or queuing. The Poplar Avenue intersections with the Expressway ramps will operate with an excellent Level of Service and minimal delays and queuing
- Traffic volumes on Park Avenue, north of Te Moana Road are predicted to increase by 72% (2,100 vehicles per day) by 2026. At a daily volume of 5,000 in 2026, Park Road will still carry a reasonable volume of traffic expected of a secondary arterial. While the volume of traffic may be reasonable for a secondary arterial, the road environment is primarily residential in character with regular property access. The change in traffic volume could be expected to change the nature and character of the road environment. It is recommended that traffic calming measures are considered for Park Avenue by the Alliance and KCDC
- In the AM peak the Expressway is predicted to reduce the travel time for through traffic in the peak (southbound) direction by seven minutes. In the PM peak the Expressway is predicted to reduce the travel time for through traffic in the peak (northbound) direction by over ten minutes
- The travel time analysis contained in the Traffic Modelling Report indicates that the Project provides significant travel time savings for both through traffic on the Expressway and local traffic movements

- 12-20% of the predicted traffic on the Expressway will be HCV's, which is consistent with the character of an Expressway and is well within its capacity, and is expected to significantly reduce the volume of HCV's on SH1
- HCV volumes are predicted to reduce on many local roads including Te Moana Road. The volume of heavy vehicles is predicted to increase on Park Avenue and Paetawa Road by 30 and 10 vehicles per day respectively in 2026. This small predicted increase on Park Avenue and Pawtawa Road is not expected to adversely impact on the function of these local roads
- The Expressway between MacKays Crossing and Peka Peka will meet the objective of achieving Level of Service B in 2026
- The results of the SIDRA analysis indicated that the Expressway interchanges with Poplar Avenue, Te Moana Road, and Peka Peka Road all operate at LoS B or better in 2026. The VISSIM analysis indicated that the Expressway interchange with Kāpiti Road will operate at LoS C in 2026. Therefore, Guiding Objective 3(b) which requires achievement of LoS C in 2026 at the intersections between the Expressway and local network will be met.

Property Access

The Expressway will affect existing access to a number of properties. The Expressway has been designed to minimise adverse effects on adjoining properties, consistent with Guiding Objective 7(a). Appropriate alternative access is proposed as mitigation and will be further developed during the design phase of the Project.

Summary of Findings

The MacKays to Peka Peka Expressway Project will provide significant transport infrastructure that forms an integral part of the Wellington Northern Corridor Road of National Significance. The Expressway is predicted to significantly improve travel times for through traffic between MacKays Crossing and Peka Peka, reducing the travel time in 2026 by seven minutes in the weekday morning peak and over ten minutes in the weekday evening peak. The provision of the Expressway will also generally provide travel time savings to local traffic. The overall network will operate with significantly improved travel times, relieving congestion and facilitating planned growth within the Kāpiti District.

This transportation assessment has found that the Expressway Project will be consistent with the Project Objectives and the *Guiding Objectives* in that:

- The Project is predicted to enhance efficiency and journey time reliability
- The Project balances inter-regional and local traffic movements. The proposed Expressway provides significant benefits for through traffic and local traffic movements
- The proposed Expressway will operate at Level of Service B in 2026
- The overall network operates to significantly improve travel times with the proposed Expressway in place

- The Project significantly reduces the volume of traffic on SH1. In Waikanae town centre this enables a reduction in congestion
- Most existing local road crossings are maintained by the Project. The eastern end of Leinster Avenue will be closed by the Project, however alternative access is provided to Leinster Avenue via Poplar Avenue
- The Project improves network resilience by providing a second crossing of the Waikanae River
- Intersections between the Expressway and the local road network will operate at Level of Service C or better in 2026
- The Project has been designed to minimise adverse effects on adjoining properties.

8.3 Geotechnical

8.3.1 General

The Geotechnical Interpretive Report (MacKays to Peka Peka Expressway Geotechnical Interpretive Report) presents the geological model for the site, the geotechnical considerations and the derivation of the material properties used for the Scheme Assessment design stage. The site interpretation in this report develops and refines that presented in the preliminary geotechnical appraisal, which was prepared as part of the scoping phase (refer MacKays to Peka Peka Expressway Preliminary Geotechnical Appraisal Report).

The Geotechnical Design Report (MacKays to Peka Peka Expressway Geotechnical Design Report, Appendix H) outlines the preliminary geotechnical design for the Scheme Assessment stage. The design is based on the recommendations presented in the Geotechnical Interpretive Report.

This section provides a summary of the ground conditions and key geotechnical considerations for the Expressway site, along with the geotechnical design elements of the Scheme Assessment.

The geotechnical considerations and design impacts on the following features of the Expressway:

- Earthworks, including cuts typically 10m high and up to 25m high and embankments typically 2 to 3m and up to 7m high at bridge crossings
- Pavements
- Bridge structures, including foundations and ground improvements
- Retaining wall structures.

8.3.2 Geotechnical Conditions

The Expressway corridor traverses the dune sands and swamp deposits of the Kāpiti coastal lowlands. The dunes rise to around 20m elevation, with intervening low lying areas and depressions, typically containing peat. Recent river and fan alluvial deposits form low

level terraces adjacent to the Waikanae River, including the present floodplain. Underlying all of these deposits is a thick sequence of older alluvial sand and gravel deposits, with greywacke bedrock at 70-120m depth, though rock occurs at much shallower depths at the north end of the route.

Peat deposits present in the low lying inter-dunal depressions are typically very soft with high organic contents and high compressibility. The groundwater level within the peat deposits is relatively shallow, typically between 0 and 1m below the ground level. The presence of peat deposits across the site, and associated embankment settlements is a key geotechnical aspect for the Project. The distribution of these peat deposits has been mapped along the Expressway using the available geotechnical investigation data and interpretation of the landforms (refer Geotechnical Interpretive Report).

The Expressway alignment is located in an area with a high seismic hazard compared to many other parts of New Zealand. There are NE-SW oriented active faults located north, south, and east of the Expressway. The active faults in the area and distance from the Expressway are presented in the Geotechnical Interpretive Report. A site specific hazard study has been undertaken to refine the seismic hazard for the Expressway and provide recommended design loadings, refer MacKays to Peka Peka Site Specific Seismic Hazard Assessment Report. The high seismic accelerations and potential liquefaction of saturated sand deposits are key geotechnical considerations for the design of the bridge structures and embankments.

8.3.3 Geotechnical Considerations

The key geotechnical considerations that have been identified for the Expressway are:

- The presence of peat deposits across the site, and associated embankment settlements and stability
- The high seismic hazard and known active faults
- The presence of relatively loose to medium dense saturated sand deposits with the potential to liquefy during the moderate to significant design seismic events
- Liquefaction induced slope instability and settlements
- Founding conditions for bridge structures comprising alluvial deposits to depth, predominately interbedded dense sands and gravels
- The presence of peat deposits and seismic aspects are described further below.

Peat Deposits and Settlements

Peat deposits have been encountered along the route in the low lying inter-dunal depressions. The peat is very soft, with a high water content. It varies in nature from fibrous to amorphous. These deposits are typically 0.5m to 4.0m thick, and up to 6m thick in some locations.

The Expressway design addresses the challenges associated with construction of a road embankment over these weak peat deposits, including:

- Settlement of these underlying deposits. Post construction settlements and potential differential settlements will impact on the performance of the Expressway, resulting in poor rideability, altered surface drainage patterns and increased maintenance
- Instability of embankments constructed on weak foundations, in particular the temporary (construction stage) and seismic stability case
- Potential settlement of services beneath the embankment and adjacent structures and property.

Seismic Design

The site is located in a highly seismic area, with known active faults. Loose to medium dense sand deposits are present within the sand dunes, and underlying marine and alluvial deposits. A moderate or significant seismic event, somewhat less than the ultimate design event, is expected to result in:

- Liquefaction of these sand deposits, where saturated
- Settlement of these sand deposits, as a result of densification in the dry sands and liquefaction induced settlements in the saturated sands
- Seismically induced slope instability and horizontal movements of existing sand dunes and new embankments constructed over these deposits
- Potentially lateral spreading or flow failure of existing sand dunes, new embankments, and the new approach embankments for the bridge structures, including the Waikanae River Crossing;

The performance of the Expressway, during and post seismic design events is a key design aspect. Ground improvements are proposed at each bridge structure to mitigate liquefaction and limit the movement of the approach embankments towards the structure. Ground improvement measures have also been included to limit the movement of general road embankments typically greater than 3.0m in height. The ground improvements are described below.

The acceptable level of damage, emergency access and post-earthquake repair requirements under design events has been considered by the alliance including NZTA Asset staff, and balanced against the economics and risk profile.

8.3.4 Peat Treatment Design

Ground improvements are also required to limit post-construction settlement of the Expressway where peat deposits are present below the new road embankments. The treatment approaches proposed vary along the Expressway depending on the depth and extent of the peat expected to be encountered and the sensitivity of adjacent areas. Two treatment methods are proposed; a) Excavate and Replace and b) Preload and Surcharge. The treatment approaches selected along the Expressway are shown on Drawings M2PP-SAR-CV-EW-100-111, with typical details for each approach shown on Drawings M2PP-SAR-CV-EW-120 to 123. The treatment methods are described below.

8.3.5 Excavate and Replace

This treatment option involves removing the peat deposits from below the Expressway footprint. The peat deposits are excavated and replaced with compacted sand. In general, peat deposits are to be excavated along the Expressway alignment:

- Where the alignment traverses across both sand dunes and peat deposits, between Kāpiti Rd and Smithfield Rd. The peat deposits are generally less than 3.0m deep in these locations
- At bridge abutments to improve the stability and differential performance at the approach embankment/ structure interface. The peat excavation allows seismic ground improvement (i.e. stone columns) to be installed.

In removing the peat, the risk of poor long-term performance resulting from settlement is eliminated. This is considered a high cost treatment option and it has not been adopted in areas where significant thicknesses/ volumes of peat have been encountered.

A trial excavation in peat has been undertaken to replicate the proposed Excavate and Replace treatment approach. The results of this trial have been used to inform the scheme design and cost estimate.

8.3.6 Preload and Surcharge

This treatment option involves constructing the road embankment over the peat deposits and allowing the majority of settlement to occur prior to pavement construction. Preload and surcharge fill is to be placed above final design level during the settlement period to reduce the long-term settlements. The preload is equivalent to the expected settlement depth and the surcharge is the additional fill placed and removed at the end of the settlement period. Generally, Preload and Surcharge is considered a lower cost, higher risk treatment option compared to Excavate and Replace.

Some on-going secondary and creep settlements are expected. The performance of the Expressway will be impacted by on-going post construction settlements. The risks to the Expressway performance associated with changes in the pavement surface include reduced operating speed, altered drainage paths and reduced rideability.

The post construction performance of the Expressway, and an acceptable level of risk, has been discussed with NZTA. The Preload and Surcharge design aims to limit the settlement over the 10 years following construction to an acceptable operational level. The 10 year design criteria adopted is considered to balance capital costs with the pavement life cycle and the Expressway performance and reputation. The criteria adopted for design are outlined below:

- Transverse Differential: <1% change in crossfall
- Longitudinal Differential: <30mm over 10m.

The pavement will require resurfacing approximately 8 to 10 years following construction. It is expected that a shape correction will be undertaken as part of these works to adjust

for settlement that has occurred. Some shape correction of the pavement is likely to be required within the 10 years following construction, although the areas requiring this are expected to be relatively small.

Preload and surcharge treatment has been adopted over a significant proportion of the route to reduce costs and environmental effects associated with excavation of the peat. In general, peat deposits are to be preloaded and surcharged along the Expressway:

- Where the Expressway traverses low-lying peat areas. The depth and extent of the peat is such that removal is not considered feasible
- Where the Expressway traverses across both sand dunes and peat deposits, between Raumati Rd and Kāpiti Rd
- Adjacent to the Otaihanga Landfill. The peat is to remain in place to reduce the risks associated with removal of the potentially contaminated peat.

8.3.7 Earthworks Design

The earthworks for the Expressway involve:

- Cuts through sand dunes, typically up to 20m high
- Fill embankments across low lying areas, up to approximately 7m high.

The earthwork footprint has been modelled based on the following recommended slope profiles:

- For cut slopes in dune sands, a cut slope profile of 3H:1V has been adopted. Drainage measures may be required for stability of large cut slopes
- For the sand embankment fills constructed over peat (i.e. Preload and Surcharge treatment), an embankment profile of 3H:1V has been adopted
- For the sand embankment fills constructed over sand foundations, a steepened embankment profile of 2.25H:1V has been adopted.

These recommended slope profiles have been based on the static stability requirements. The seismic stability performance has been considered, and seismic ground improvements for general embankments are proposed at some locations (refer Seismic Ground Improvement Design).

The material cut from the sand dunes is considered suitable for use as cut to fill. The majority of the embankments will be constructed using this cut to fill material. Where there is a shortfall of material, material will be imported from local sources. Additional sand fill is available from the Otaihanga Sand Quarry. Greywacke rock fill is available from Kāpiti Quarry in Paraparaumu and Otaki Quarry. Imported rock fill is targeted for areas with the largest design benefits i.e. placed in the base of the embankments constructed over peat and at the bridge abutments.

The dune sands are prone to erosion, both by wind and water. Erosion control measures, such as re-vegetation of cut and embankment slopes, will need to be implemented

immediately after construction. Water will be required during summer construction to control dust.

8.3.8 Seismic Ground Improvement Design (Road Embankments)

The Expressway is located in a highly seismically active area, with widespread liquefaction expected under a moderate seismic event. Ground shaking is expected to result in lateral movements of the embankments and cut slopes. If liquefaction occurs, significant lateral spreading of the existing sand dunes and new embankments is likely to occur. These movements will be in the order of 0.5m to in excess of 1.0m for the 1:1000 year return period event unless measures are included to mitigate these effects. Some movement is also expected under lower return period events, with minor pavement repairs likely to be required.

For earthworks (cuts and embankments) it is not considered economically feasible to prevent seismic induced instability and lateral displacements where foundation soils liquefy. Ground improvements to prevent wide spread liquefaction across the route are not proposed for the scheme design. This approach is in line with current practise, and has been adopted for other recent large highway projects (RoNS projects such as Christchurch Southern Motorway and Tauranga Eastern Link).

The expected performance of slopes following a significant earthquake event has been discussed with the NZTA. The Expressway is considered to be a NZTA strategic route and is required to provide emergency access into Wellington following a significant earthquake event. Ground improvements have been included into the scheme to limit the seismic embankment movements. These ground improvements comprise of high strength geotextile placed at the base of the embankments greater than 3m high. These have been designed based on the following target movements for the 1:1000 year earthquake event.

- Target 50% probability of exceedance movement < 300mm under 1/1000 year design earthquake
- Target 10% probability of exceedance movement < 700mm under 1/1000 year design earthquake.

Minor earthworks will be required to provide emergency access post earthquake based on these movements.

No ground improvements are proposed in areas of cut. Seismic movements are expected to occur, with clearance of the Expressway required for emergency access following a moderate to significant seismic event.

8.3.9 Bridge Structure Foundation Design

For each bridge structure, piled foundations and approach embankments are required. The recommended design approach for the foundation design is summarised below:

- The piles are to be founded in the Dense/ Very Dense SAND/ GRAVEL underlying the site at depth. Driven steel H piles are envisaged at the abutments and bored concrete piles at the piers, and are to be embedded into this layer
- The vertical load capacity is provided by the end bearing capacity of the Dense/ Very Dense SAND/ GRAVEL layer, no positive skin friction is to be considered.

Ground improvements are required below the bridge abutments and approach embankments based on high seismicity and liquefaction potential, refer below.

8.3.10 Seismic Ground Improvement Design (Bridge Structures)

The design of the bridge abutments, abutment piles and associated ground improvements, are governed by the seismic loading. Liquefaction of the underlying saturated sand deposits is expected to occur under a moderate or significant earthquake event.

Without ground improvements to mitigate liquefaction under the abutment, the approach embankment is expected to 'flow' towards the bridge (several metres horizontal movement). The approach embankment with no reinforcement would also be expected to move under the high seismic acceleration without liquefaction (hundreds of millimetres horizontal movement). The movement of the approach embankment towards the bridge would result in significant loads being imposed on the bridge structure (both abutment and pier piles).

The bridge structures along this NZTA strategic route need to provide emergency access following a significant earthquake event and be repairable. Ground improvements at the bridge approaches are required to achieve this level of performance and to meet the Transit New Zealand Bridge Manual requirements.

The approach embankment and ground improvement design is based on limiting the movement of the embankment within the immediate vicinity of the bridge to protect the bridge structure, and reduce the imposed soil loading. The ground improvements proposed comprise:

- Stone columns (and associated drainage blanket) below the abutments. These mitigate the liquefaction potential at the abutments and limit global movements along the liquefied soil layers. The stone columns are to extend a minimum length equivalent to the liquefaction depth in front of the structural abutment
- Geogrid reinforced soil block (MSE with imported granular fill) to limit movements of the approach embankments. The core of the embankment, directly beneath the road pavement behind the abutment, is to be reinforced with near vertical faces. The fill

outside of the MSE embankment will be unreinforced and will displace under the design earthquake, but will be repairable.

Typical ground improvement details are shown on Drawings M2PP-SAR-ST-GE-155 and 156. Specific ground improvement details for each bridge structure are provided on the bridge general arrangement drawings (refer Drawings M2PP-SAR-ST-BR-150 to 980).

The combination of both the stone columns and reinforced block reduce the bridge abutment movements. The movements have been limited to be in the order of 100 to 300mm for the ULS seismic event. These target movements have been selected based on compatibility with the adopted structural form and to limit the loading imposed on the structure.

The ground improvement zone is expected to move as a block during the earthquake. The movement is expected to occur at depth, along the liquefied soil layer. The ground improved block is expected to be stable following the earthquake, based on liquefied soil strength outside the ground improved block and no earthquake acceleration.

The abutment piles will be installed within the ground improved mass and are expected to displace with the global seismic slope movements. Steel H piles have been adopted as they are more flexible than concrete bored piles and therefore the movements of these piles will be compatible with the global ground movements.

Generally, no ground improvements are proposed at the pier foundations. The bridge span arrangements have been configured to provide at least 5m clearance between the ground improvement block and the piers. The liquefied soil is expected to effectively flow around the piles and is not expected to transfer the global ground movements to these piles.

Retaining Wall Design

There are several permanent retaining walls required for the Expressway. These are required to either: a) retain near vertical cuts in the sand dunes or b) limit the earthworks footprint in areas of fill. There are also a number of temporary retaining walls required to limit cuts adjacent to private property, in particular at bridge abutments.

The walls required to retain cuts are typically cantilever post and panel walls, with concrete bored piles. These walls will generally be constructed using a top down methodology, where the wall is installed first, followed by excavation of the in situ material in front of the wall. These walls include:

- Mazengarb Walls (refer Drawing M2PP-SAR-ST-GE-120). Mazengarb Wall 1and 2 run adjacent to the existing Mazengarb Road along the residential boundaries
- Nga Manu Wall (refer Drawing M2PP-SAR-ST-GE-130). Nga Manu Wall runs adjacent to the new Nga Manu Access Road.

The walls required to limit the fill footprint are typically reinforced earth walls (RE or MSE). These walls are located at Kāpiti Interchange (refer Drawings M2PP-SAR-ST-GE-110 to 111), and retain the proposed on and off ramps.

There is a risk that additional retaining walls are required as the geometrics and property accesses are refined through the design development process.

8.4 Structures

8.4.1 Introduction

This section describes the bridge structures to be provided for the Expressway, including a summary of the key design standards to be adopted, the earthquake performance of the bridges and a description of the bridges by type. Reference should be made to the following documents for further detail:

- Design Philosophy Statement
- Structures Design Report
- Structures Preferred Options Report, (which discusses in more detail bridge options considered).

The 18 bridge structures required for the Expressway comprise:

- Underbridges that carry the Expressway over local roads
- Overbridges that carry local roads over the Expressway
- Waikanae River Bridge that carries the Expressway over the Waikanae River
- Stream bridges that carry the Expressway and local roads over stream
- Pedestrian/cyclist bridges that carry pedestrian/cyclists over the Expressway.

This section excludes culverts which cross over minor streams and drains, retaining walls and noise wall structures.

8.4.2 Design Standards

Bridges will be designed to the Transit Bridge Manual except where specific design standards have been adopted for this project. The key design criteria are:

Design Criteria	Standard proposed
Vertical clearance at bridges over local roads (underbridges)	4.9m except 6.0m at Raumati Road
Vertical clearance at bridges over Expressway (overbridges)	6.0m for road bridges 6.2m for pedestrian bridges
Shoulder widths for bridges that carry the Expressway (underbridges)	2.5m outer shoulders 1.0m inner shoulders
Horizontal clearances for bridges over local roads (underbridges)	17.0m clear span to suit local road, footways and cyclists except 30.0m at Kāpiti Road including the central pier

Design Criteria	Standard proposed
Footway/shoulder widths on overbridges	2.5m/0.6m except 2.0m/1.5m at Peka Peka Road
Edge barriers	TL 4 except TL 5 at Otaihanga. 1.1m high concrete except 1.1m high concrete including steel top rail at overbridges 1.4m high for pedestrian bridges
Earthquake design	2500 year APE for underbridges 1000 year APE for overbridges

8.4.3 Earthquake Design

The Expressway is located in an area of very high seismicity and close to a major fault, requiring particular attention to the seismic performance of bridges in developing the structural form to be adopted.

Bridges will be designed to meet the earthquake performance requirements of the Transit Bridge Manual and AS1170, with bridges that carry the Expressway designed for a 2500 year APE and bridges that carry local roads for a 1000 year APE. Integral bridges with full connection between superstructure and supporting piers and abutments are proposed with seismic loads being resisted by a combination of ductile frame action and passive soil resistance behind abutments and piles.

All bridges will be designed to achieve the requirements of the Transit Bridge Manual with respect to the use of bridges as lifelines post-earthquake and any damage being economically repairable.

Under transverse seismic actions the lateral loads are shared between the piers and the abutments via the deck slab acting as a rigid diaphragm. The piers behave as portal frames with the crosshead beams. The loads are distributed between the piers and the abutments in proportion to their stiffness. Under longitudinal seismic actions the lateral loads are resisted by the piers and the abutments with passive earth resistance and pile bending at the leading abutment and pile bending at the trailing abutment and piers.

The ground below the abutment and approach embankment at each bridge will be improved by the installation of stone columns to prevent liquefaction of the underlying sands and silts and to reduce the lateral movement of the embankment under seismic actions. The abutment piles are designed to be sufficiently ductile to deflect to the shape of the embankment and sub-soil movement under seismic loads. In some locations, side spans to underbridges and overbridges are extended slightly to prevent high lateral soil pressures onto pier piles due to the improved ground under the abutments (refer Section 7.3).

Approach embankments at bridges will be reinforced by geogrid to strengthen the fill to give stability under earthquake design loading. The face of the MSE embankment will be located behind the steel H-piles and will have a vertical face, with unreinforced fill provided in front of the MSE embankment to form the sloping face of the spill through abutment.

8.4.4 Principal Bridges

The principal bridges on the Expressway are described in the table below:

Bridge Name	Bridge Type	Length	Width	No of Spans	Obstacle Crossed
Poplar Avenue	Underbridge	57m	25m	3	Local road
Pedestrian Leinster Ave	Pedestrian bridge	58m	4m	3	Expressway
Raumati Road	Underbridge	58m	12m + 15m	3	Expressway
Ihakara Street & Wharemauku Stream	Underbridge	62m	2 x 12m	3	Local road and waterway
Kāpiti Road	Underbridge	52m	2 x 12m	2	Local road
Ped bridge between Kāpiti & Mazengarb Rd's	Pedestrian bridge	58m	4m	3	Expressway
Mazengarb Road	Underbridge	27m	2 x 12m	1	Local road
Otaihanga Road	Underbridge	27m	25m	1	Local road
Waikanae River	River crossing	182m	28m	5	River
Te Moana Road	Underbridge	142m	25m	6	Local road, waterway & floodway
Te Moana North On-ramp	Stream bridge	32m	12m	2	Waterway
Te Moana South On-ramp	Stream bridge	32m	12m	2	Waterway
Ngarara Road	Overbridge	73m	15m	3	Expressway
Smithfield Road	Overbridge	70m	16m	3	Expressway
Peka Peka Road	Overbridge	87m	17m	3	Expressway
Kakariki Stream	Stream bridge	20m	26m	1	Waterway
Paetawa Stream	Stream bridge	14m	26m	1	Waterway
Smithfield Road over Kakariki Stream	Stream bridge	12m	14m	1	Waterway

8.4.5 Description of Bridge Types

The key features for each bridge type are described below.

i. Underbridges

Underbridges are provided to carry the Expressway over local roads, waterways and floodway channels. They will have between one and six spans with spill through abutments generally provided to suit urban design requirements, although vertical MSE wall abutments are provided at some bridges where appropriate.

The local roads to be crossed are either secondary arterials or rural roads depending on location. A clear minimum width between piers of 17m is proposed at all locations except Kāpiti Road to allow for two 3.5m traffic lanes, 1.5m shoulders/cycleways, 2m footways and a 1.5m verge on each side. At Kāpiti Road, a two span structure is proposed with a central pier located within the median allowing two traffic lanes, a right turning bay, shoulders/cycleways, footways and verges on each side, with a width of 30.0m including the central pier.

Underbridges vary in length between 27m and 142m to suit the local road, waterway or floodway to be crossed, the skew angle of the crossing and the type of abutments. Typical main spans are between 20m and 25m for local road crossings which are suitable for 900mm deep Double Hollow Core beams. These will provide an economic and elegant solution which will minimise construction depth and allow earthwork volumes on approaches to be optimised.

Pier shapes have been developed to suit the urban design framework with shaped concrete piers provided in line with the folded edge barriers to hide the pier crosshead and provide a smooth transition between super structure and supports. Edge barriers are folded to reduce their apparent depth and will be precast. TL4 barriers are provided at all underbridges except Otaihanga Road where a TL5 barrier is required due to the curvature of the Expressway. Edge barriers will be 1100mm high concrete barriers for all underbridges to suit noise requirements.

Underbridges will be fully integral structures with full structural connection between Double Hollow Core beams and pier and abutment crossheads, with minimal use of bearings or expansion joints. This will reduce long term maintenance. Bearings and expansion joints are proposed at the abutments for longer structures such as Te Moana Underbridge to suit thermal movements. Where skew angles are high, voids will be provided behind abutments to prevent passive earth pressures causing rotation effects.

Underbridge widths will accommodate two 3.5m wide traffic lanes, 2.5m wide shoulders and a 6m or 4m median, depending on location which includes 1.0m inner shoulders. Where a 6m median is provided, two separate bridge structures are provided with a 3m gap between to allow daylight to the road below. Where the median is 4m wide, a single width bridge is provided as the gap between structures would be too narrow and un-economical.

The vertical clearance provided at underbridges is 4.9m, except where increased vertical clearance of 6m is provided at Raumati Road to allow over dimension vehicles to cross the Expressway corridor.

Piled foundations and ground improvement measures to prevent liquefaction are proposed. Peat will be removed from below bridge foundations and the immediate approaches to the bridge to minimise settlement and down-drag effects on piles. Piles will be large diameter bored cast in situ reinforced concrete located below each pier column founded in the underlying very dense sands and gravels with lengths up to 25m. Abutment piles will be steel H-piles that are driven into the underlying very dense sands and gravels, and designed to accommodate the movement of the approach embankments under earthquake loads. The ground below underbridge abutments will be improved by installing stone columns on a grid pattern to prevent liquefaction and the approach embankments will be reinforced by geogrid for stability under earthquake design loading.

Overbridges

Overbridges are provided to carry local roads over the Expressway. They will have three spans with spill through abutments provided to suit urban design requirements. Alternative forms of overbridge with either two or five spans utilising piers located within the Expressway median will also be considered in detailed design, but will have similar appearance to the above.

Overbridge piers will be located behind the Expressway shoulders and will have main spans of 28m and 35m depending on skew angle. Piers will be protected from impact by guardrails. Overbridges vary in length between 70m and 87m to suit the skew angle of the crossing and side span requirements. Superstructures will comprise 1225mm and 1525mm deep Super Tee beams with 180mm deck slab which will provide an economic and elegant solution.

Pier shapes have been developed to suit the urban design framework with shaped concrete piers provided in line with the folded edge barriers to hide the pier crosshead and provide a smooth transition between super structure and supports. Edge barriers are folded to reduce their apparent depth and will be precast. TL4 barriers are provided at all overbridges. Edge barriers will be 1100mm high concrete barriers including a steel handrail.

Overbridges will be fully integral structures with full structural connection between the Super Tee beams and pier and abutment crossheads without bearings or expansion joints. Where skew angles are high, voids will be provided behind abutments to prevent passive earth pressures causing rotation effects.

Overbridge widths will accommodate two 3.5m wide traffic lanes, 0.6m/1.5m wide shoulders and a 2.0m/2.5m footway depending on their location. The vertical clearance provided at overbridges is 6.0m.

Piled foundations and ground improvement measures to prevent liquefaction are proposed. Peat will be removed from below bridge foundations and the immediate approaches to the bridge to minimise settlement and down-drag effects on piles. Piles will be large diameter bored cast in situ reinforced concrete located below each pier column founded in the underlying very dense sands and gravels with lengths up to 30m. Abutment piles will be steel H-piles that are driven into the underlying sands and gravels, and designed to accommodate the movement of the approach embankments under earthquake loads. The ground below overbridge abutments will be improved by installing stone columns on a grid pattern to prevent liquefaction.

The approach embankments will be reinforced by geogrids to strengthen the fill and provide stability under earthquake design loading.

Waikanae River Bridge

The Waikanae River Bridge will carry the Expressway over the Waikanae River and flood plain between stop banks, as well as providing for an access road to the El Rancho property.

The overall bridge length will be 182m with five spans of between 33m and 38m, with a 38m span over the Waikanae River channel. The superstructure will comprise 1525mm deep Super-Tee beams with a 180mm deck slab. 1825mm deep Super Tee beams will also be considered at detailed design stage.

The Waikanae River Bridge will comprise a single width bridge 28m wide to cater for the four traffic lanes, 2.5m wide outer shoulders, 4m wide median and 3m wide pedestrian footway/cycleway required on one side of the bridge.

Pier shapes have been developed to suit the urban design framework with shaped concrete piers and folded precast edge barriers to hide the pier crosshead and to reduce their apparent depth. TL4 barriers are provided which will be 1100mm high concrete for noise reasons. Pedestrian barriers 1400mm high will be provided to the outside of the pedestrian footway/cycleway and between the traffic lanes and pedestrian footway/cycleway.

The Waikanae River Bridge will be an integral structure with full structural connection between Super-Tee beams and pier crossheads with bearings and expansion joints only provided at the abutments to suit thermal effects and seismic design requirements.

Piled foundations and ground improvement measures to prevent liquefaction are proposed. Piles will be large diameter bored cast in situ reinforced concrete below each pier column founded in the underlying very dense sands and gravels with lengths up to 25m. Abutment piles will be steel H-piles that are driven into the underlying sands and gravels, and designed to accommodate the movement of the approach embankments under earthquake loads. The ground below the abutments and the approach embankment will be improved by installing stone columns on a grid pattern to prevent liquefaction.

The approach embankments will be MSE walls with concrete facing to maximise the waterway area for flood conditions.

8.4.6 Stream Bridges

Stream bridges are provided to carry the Expressway over waterways and to carry the re-aligned Smithfield Road over a local stream.

The stream crossings vary in length between 12m and 32m to suit the waterway requirements and comprise one or two spans. The superstructures will be 650mm deep Double Hollow Core beams with spans of between 10m and 15m.

The stream crossings will be single width structures with widths that vary between 12m and 26m to cater for on and off ramps, the Expressway or Smithfield Road.

Piers will be simple circular columns with crosshead beams, supported on bored concrete piles founded in the underlying gravels. Abutments will be founded on steel H-piles driven into the underlying gravels. Ground improvement in the form of stone columns will be provided at all stream crossings to prevent liquefaction. This will extend across the waterway.

Edge barriers will be steel Thrie beam TL4 barriers with a top rail for the safety of occasional pedestrians/cyclists using the outer shoulder.

8.4.7 Pedestrian/Cyclist Bridges

Two pedestrian and cyclist bridges are proposed to cross over the Expressway to provide additional connectivity in the east-west direction for pedestrians and cyclists to that to be provided by the existing arterials and local roads. The two bridges are located at Leinster Avenue and between Kāpiti Road and Mazengarb Road, where existing pedestrian routes across the Expressway corridor have been identified.

The pedestrian/cyclist bridges will be 3m wide between handrails and 3.5m overall and will have a main span over the Expressway of 28m and side spans with spill through abutments. The overall bridge length will be 58m. A vertical clearance of 6.2m will be provided.

The superstructure will be a 1525mm deep Super Tee beam with 180mm deck slab supported on shaped concrete piers and end abutments. A single bored concrete pile will be provided at each pier founded in the underlying sands and gravels. Steel H piles will support the end abutments.

Approach ramps may also be required which will be constructed of either filled embankments or reinforced concrete structures with precast spans supported on piers, with spans in the range of 5m to 10m.

Edge barriers will be 1400mm high precast concrete barriers which will be of similar form to other bridge structures.

8.4.8 Utilities on Bridges

Utilities on Bridges can be provided for under and between the Super Tee sections or within the double hollow section or within the edge barrier arrangement.

It is proposed that services to be carried by the various overbridge structures can be accommodated both within the void of the Super-Tee girders and within the raised footways on overbridges.

Where the Expressway crosses over a secondary arterial or local road, services within the road may need to be relocated to suit the proposed ground improvement measures and pile locations.

For services to be carried along the Expressway, it is envisaged that they will be located within the voids of the Double Hollow Core beams or possibly within the concrete edge barrier.

Any large diameter services, such as water mains or gas mains to be carried over the Waikanae River can be suspended from the underside of the superstructure and located between Super Tee beams, subject to NZTA approval.

8.5 Stormwater and Flood Risk Management

The Expressway project has included detailed investigation and design in relation to stormwater and flood risk management to ensure any adverse effects are addressed. This involved identifying the major drainage and aquatic features in the existing environment, developing a methodology for approaching the design and applying this methodology to achieve the appropriate standard of service for the Expressway and to manage potential effects, in consultation with key stakeholders.

A more comprehensive report, covering both the design and the environmental implications, is provided in the *Assessment of Hydrology and Stormwater Effects*, Report M2PP-AEE-RPT-CV-SW-078, Beca, November 2011. For locations of existing wetlands refer to Techncal Report 26 Ecological Impact Assessment, pages 82 to 85 for figures 8a to 8d.

8.5.1 Existing Environment

The Expressway crosses the low-lying coastal plains and dune areas of the western Kāpiti District. The general fall of the land, and of the cross drains and streams, is from the hills in the east, across the alignment of the proposed Expressway, through to the coast in the west. This topography results in the proposed Expressway crossing a number of low-gradient drains and streams, many of which have moderate to high ecological value.

The Waikanae River is the largest watercourse that will be crossed by the Expressway. The river is managed by the Catchment Management (CM) division of the Greater Wellington Regional Council (GWRC) which has a flood protection scheme for the Waikanae River and

actively manages the river corridor in accordance with this. There are another five crossings along the route which require bridges rather than culverts.

There are many natural or modified wetlands along the route, some in peat areas, and some in low points in the sand dune areas of the coastal plain. The Expressway also passes through the headwaters of the regionally significant Te Harakeke/Kawakahia Wetland complex located near the coast between Waikanae Beach and Peka Peka Beach settlements.

The proposed Expressway alignment crosses a number of areas that are flood prone, with significant flood storage within the footprint of the proposed designation. Of particular note are areas around Wharemauku Stream and its tributaries, the Waikanae River and flood plain areas to the south, the Waimeha Stream, the Kakariki Stream and the Paetawa Drain in the north. Further, there is an identified flood overflow path north from the Waikanae River to the Waimeha Stream, which would flow in the event of a Waikanae River stop bank failure, or a flood exceeding the river's stop bank capacity.

8.5.2 Design Approach

The design approach is based on detailed criteria set out in the Project's Design Philosophy Statement. The key principles that this methodology aims to achieve are:

- To attenuate peak flows from the Expressway to avoid increasing flooding to adjacent land i.e. part of achieving hydraulic neutrality
- To treat stormwater from the Expressway to best practicable option (BPO) standard for contaminant removal before discharge to existing drainage systems
- To provide offset to lost floodplain storage taken up by the Expressway in order to avoid flooding effects on adjacent land (an aspect of hydraulic neutrality)
- The stormwater treatment, attenuation and offset storage areas are integral with the operation of the Expressway and as such these areas will be within the final Expressway designation
- To keep the Expressway carriageway 0.5m above the 1% AEP[9] flood level
- Bridges to pass a 1% AEP design flood with appropriate freeboard in accordance with the Bridge Manual and GWRC requirements, with a sensitivity check for performance in 1.5 times the 1% AEP flow
- Culverts to pass a 10% AEP flow with the head water not being above the pipe soffit (note, in some low-lying areas with very flat gradients this criterion may be relaxed to suit site conditions)
- Culverts to pass a 1% AEP flow with heading up limited to no more than 2m depth above the pipe soffit and at least 0.5m below road level (whichever level is lower)

[9] Annual Exceedance Probability is the probability that a flood of this magnitude would be equalled or exceeded in any one year.

- Culverts to accommodate fish passage by either setting the culvert below the existing watercourse bed level and/or placing gravel or equivalent bed forms through the invert of the culvert to create a low flow channel
- Allowance for the effects of climate change out to 2090.

8.5.3 Standards and Guidelines

The key design standards and guidelines are:

- *Stormwater Treatment Standard for State Highway Infrastructure*, 2010, NZTA
- *Bridge Manual*, 2003, Transit NZ
- Alliance/KCDC Guiding Objectives, 2010
- *Kāpiti Stormwater Management Strategy*, KCDC
- Austroads *Guidelines for the Collection and Discharge of Stormwater from Road Infrastructure*, 1994, ARRB.

8.5.4 Design Features

Refer to the Drainage Layout drawings CV-SW-100 through 132 and the schedule of watercourse crossings included in Appendix H.

The design approach has resulted in four principal stormwater management features:

- Swales for the conveyance, treatment and (where space and grade allow) attenuation of runoff from the Expressway
- Kerb and channel and piped systems where there is not sufficient space for swales
- Wetlands for treatment of runoff where swales are not present or are not adequate
- Flood storage areas to attenuate Expressway runoff peak flows and offset flood storage lost to the Expressway footprint.

8.5.5 Design Methodology

Stormwater assessment and design for the Expressway falls into three broad components:

- Hydrology – rainfall, catchments and runoff
- Hydraulics – flow, velocity, water levels and pipe sizes
- Water Quality – treatment of runoff.

The key methodologies applied to each facet of the design are:

Where available, use existing KCDC and GWRC hydrological and hydraulic models to:

- determine design flows
- determine pre and post Expressway flood levels (in both floodplains and watercourses)
- confirm culvert/bridge waterway sizing
- determine the effects of Expressway discharges and the efficacy of Expressway peak flow attenuation

- determine the effects of in-fill of floodplains and size any subsequent offset storage
- confirm the adequacy of proposed mitigation measures.

Both KCDC and GWRC have prepared and maintain hydrological and hydraulic stormwater models for their own management purposes. GWRC manages the Waikanae River, while KCDC manages the other watercourses along the Expressway route.

The key design storms that have been modelled (including climate change as set out later) are:

- 10% AEP
- 1% AEP
- 1.5 x 1% AEP
- 0.04% AEP (Waikanae River only).

The 1.5x1% AEP storm is KCDC's standard method for testing overdesign events, while the 0.04% AEP storm (2500 year ARI) is used in the structural design of bridges in accordance with the Bridge Manual. For the Waikanae River, 1.5x1% AEP equates to approximately a 0.03% AEP (3200 year ARI) flood.

Both of KCDC's and GWRC's incumbent modelling consultants, SKM and River Edge Consulting (REC), have been engaged by the Alliance to modify these models to include the Expressway and then test the stormwater designs. This means that the majority of the stormwater catchments and associated hydrology, including climate change, have already been investigated and the models calibrated by KCDC and/or GWRC. This is considered to be the most efficient method of investigating the effects of the Expressway on stormwater and flood risk for areas both upstream and downstream of the Expressway.

SKM are responsible for the Wharemauku Stream / Drain 7 and the Waimeha Stream models and REC for the Mazengarb and Waikanae River models. SKM's and REC's modelling reports are included in Appendix E, F and G of the Assessment of Hydrology and Stormwater Effects, and the results of these reports are summarised and discussed further in Sections 3.3 to 3.6 of that report. In some cases the modelling has been completed and the design has then needed to include additional works as a response to the modelling.

While KCDC and GWRC have primarily used these models to set building floor levels and quantify flood risk, the Alliance's use for the models has been slightly different in that the Alliance is primarily interested in understanding the effect of the Expressway on existing flood levels, determining the extent of any consequences and developing mitigation as required. In this respect, it is the relative difference between the pre-Expressway (existing) and post-Expressway (after) that the Alliance needs to understand rather than absolute flood levels. This is why modelled water surface levels rather than with freeboard added (as per KCDC and GWRC practice) is the appropriate method. Appropriate freeboard is then added on a site-specific basis to meet NZTA's standard at culverts and bridges.

The area around of Poplar Avenue and north of Peka Peka Road are not covered by existing KCDC models and the hydrology and hydraulic designs have been carried out by applying KCDC's standard design methods. The catchment hydrology has been compared against similar adjacent catchments that are covered by a model.

All design storms include mid-range climate change effects estimates out to 2090.

This is in accordance with the recommendations of the MfE guidelines.[10] In addition, sea level rise has been set in accordance with KCDC guidelines, rather than the slightly lower value recommended by MfE.

These parameters are to mid-estimate range of:

- 16% increase in rainfall intensity
- 0.8m rise in sea level.

Long-term groundwater rise from climate change is not expected to affect the functionality of swales and wetlands as these will have gravity outlets that set and maintain water levels during dry and wet periods, including taking account of any increased groundwater levels.

Mitigate for increased runoff from the Expressway by providing attenuation – i.e. part of being hydraulically neutral.

This is generally provided by swales, wetlands or flood storage areas to suit local topography. In some areas, both swales and wetlands are needed to achieve the required attenuation, but swales are preferred over wetlands due to simplicity and ease of maintenance and reduced space required. During later design stages the swales will be optimised further with a view to reducing the number of wetlands and their footprint, while still achieving the required performance.

The Expressway catchments were modelled using InfoWorks CS software. The models were set up in accordance with NZTA's standard for attenuation for the 50% AEP, 10% AEP and 1% AEP events. The 10% and 1% AEP discharge hydrographs from the swales and wetlands were then used as an input to SKM/REC's models to test effects on the flooding in the receiving watercourses.

Where flooding is a known issue in downstream areas then attenuation was set in accordance with the NZTA standard to 80% of pre-Expressway peak flows. It has been agreed with KCDC that this, along with offset storage, would achieve their requirement for hydraulic neutrality.

[10] *Climate Change Effects and Impacts Assessment. A Guidance Manual for Local Government in New Zealand*. 2nd Edition. Ministry for the Environment, May 2008.

KCDC's requirement for new developments to be hydraulically neutral means that future catchment development scenarios do not need to be tested, as hydraulic neutrality will mean increased catchment development (outside of the Expressway but from which the Expressway needs to pass flows) will not generate future "up catchment" flows that are greater than existing.

The attenuation modelling carried out to date has focused on achieving or bettering the 80% target during the 1% AEP storm, because if attenuation can be achieved for this event then achieving it for the 10% and 50% AEP storms is just a matter of fine tuning the swale outlet design which will be carried out during later stages of the Project design.

Refer to the report Expressway Stormwater Attenuation Modelling, Beca, 2011 included in Appendix D of the Assessment of Hydrology and Stormwater Effects for further detail and results of the Expressway runoff modelling.

Mitigate for the Expressway partially filling in existing floodplain storage – i.e. the other part of being hydraulically neutral.

As the proposed Expressway passes through several low lying floodplain areas, it will take up existing flood storage volume, resulting in slightly increased flood levels on adjacent land. In the majority of areas the simplest way to mitigate this is to provide additional flood storage to offset that taken up. This can be achieved by one of more of:

- removing areas of higher ground, such as sand dunes and allowing these areas to flood
- lowering the existing ground surface in areas that currently flood
- restricting drainage outlets so that floodwater backs up more in an attenuation device
- where the affected area is small and localised, designate it as flood storage area for the Expressway
- oversizing the Expressway attenuation wetlands.

These options all have their own limitations and effects, which need to be taken into account. Thus site-specific solutions are needed to determine the most appropriate approach, and to identify the footprint and functionality of these storage areas. For example:

- natural groundwater level influences the lower level limit of the storage area
- groundwater level influences the form of storage area i.e. creating wetlands is better suited to areas of high groundwater
- surrounding infrastructure e.g. proximity of railway, buildings etc. that could be affected by changes in groundwater level (buoyancy/settlement/flooding)
- property boundaries
- flood levels influence the top water level, which along the groundwater level (which sets the lower level) determines the area needed for the required storage volume
- surrounding topography influences cost-effectiveness
- land use affects appropriateness of using any particular site.

The topography and land use of the adjacent land influences what is appropriate for mitigation, so for example in urban developed areas full offset mitigation is usually required. However, in some areas that are currently rural or already wetlands then a relatively minor increase in occasional flooding may not be considered significant and so mitigation solutions may vary for these areas.

Expressway stormwater will be treated prior to discharge.

Treatment will be to the Best Practicable Option (BPO) as specified in NZTA's Stormwater Treatment Standard for State Highway Infrastructure. NZTA's Standard reflects internationally accepted best practice for road stormwater treatment.

As the topography is generally low lying, it is difficult to use piped drainage to convey flows to an end-of-pipe treatment device, be it a wetland or a proprietary device. To address this, swales are being used to treat, attenuate and convey stormwater all in one.

In areas of peat or high groundwater, the swales will act and look more like long narrow wetlands than traditional grass swales. They will be in the order of 1m deep and have wetland tolerant plants in the bed. They are intentionally set as flat as possible in order to minimise flow velocity and attenuate flows. This adds as to their wetland appearance.

However, in areas of sand and/or relatively low groundwater, then it is appropriate to use the more traditional grassed swales than to plant them with wetland vegetation.

The majority of road stormwater contaminants are flushed off roads in a pulse in the first stages of a rainstorm (subject to various factors including event size and the length of the inter-event period during which the contaminants build up). This initial runoff is called the "first flush" or the "water quality storm".

The design method in NZTA's Standard determines what is called a Water Quality Volume (WQV) for ponds, but uses an area ratio for wetlands (wetland area to be 2% of the catchment area) and a water quality peak flow rate for swales. The water quality volume is the volume that is needed in order to treat the "first flush" of stormwater runoff. This is defined by the NZTA Standard as being the volume that is generated from the 90th percentile storm: i.e. a storm that 90% of all storms are less than on an annual basis. NZTA has produced nationwide 90th percentile rainfall maps and the 90th percentile Kāpiti is 23mm.

In order to treat the first flush effectively, it is necessary to prevent the runoff from the water quality storm from discharging immediately into the receiving watercourse. In accordance with NZTA's Standards, for swales a water residence time (how long the water flows through the swale) of 9 minutes has been applied to provide approximately an 80% removal of total suspended solids.

Flows from the Expressway near the downstream end of swales cannot meet the 9 minute residence time requirement. On this issue the Standard notes that "the normal approach is to accept that the average flow through the swale does take 9 minutes. There will be areas

in the upper part of the swale that will exceed the required residence time so the average is considered appropriate in light of the benefits that swales provide[11]."

The residence time is achieved with the long lengths of swale (over 100m) and the low gradients (<2%) in the majority of the swales. These two factors have also meant that flow velocity within the swales are such that they are lower than the 0.8m/s in a water quality storm (to promote deposition) and less than 1.5m/s in a 10% AEP event (to avoid erosion and re-suspension) as required by the Standard.

Wetlands will also be used where either the topography better suits them or where the swales cannot provide all the required attenuation and treatment.

NZTA's Standard notes that, for wetlands to be feasible in the long term, they either need catchments greater than 4ha in area or be set low enough for existing groundwater levels to maintain permanent water level within the wetland. Most of the selected wetland locations along the Expressway are in naturally low lying land that has relatively high groundwater, making this requirement easier to meet, as most of the proposed wetland catchments are less than 4ha. In a small number of areas the wetlands may need to retain water during dry periods and low groundwater levels.

The Standard also recommends using a bathymetric wetland layout with areas of varying depths up to 1m to promote proper wetland treatment functions and establish viable habitats.

The depth distributions provided in the Standards:

- 60% of the total wetland area 0-0.5m deep (below permanent water level)
- 40% of the total wetland area 0.5m to 1.0m deep (below permanent water level)
- Sediment forebay a maximum of 2.0m deep (below permanent water level) and 15% of the WQV.

Associated with the above requirements is the wetland planting guide adopted of 60% of the wetland will be planted and 40% open water. Refer Drawing CV-SW-212 for a typical wetland arrangement.

The above will assist in preventing nuisance stagnation, algal blooms and the odour issues that are more common with open pond systems. The depth ranges also provide for effective habitat establishment for animals that feed on mosquitoes so minimising the potential for nuisance mosquitoes. On-going landscaping and maintenance is very important to the proper establishment and on-going performance of wetlands.

Natural treatment mechanisms have been used in preference to proprietary end-of-pipe systems as wetlands and swales can also provide attenuation whereas proprietary treatment systems generally cannot. This means that attenuation ponds would still be

[11] Section 8.5.1.1, Stormwater Treatment Standard for State Highway Infrastructure, 2010, NZTA

needed. KCDC's guidelines[12] also require *"stormwater treatment systems based on created natural systems (e.g. wetlands, lakes and detention ponds) able to function as entire ecosystems".*

Where the receiving watercourse is considered to be particularly sensitive, then an additional level of treatment has been provided by locating wetlands at the end of a run of swales prior to discharge into that watercourse.

The effects of groundwater interaction from wetlands and storage areas are covered separately in the Assessment of Groundwater Effects report and so are not addressed in this report.

Culverts will be designed to "fish friendly" guidelines.

In general, open channel drains have been used where practicable. However, where the proposed Expressway crosses a watercourse and culverts are used, the design will allow for fish passage as appropriate using principles outlined in GWRC's "fish friendly" design guidance pamphlet.[13]

Almost all of the watercourses that the Expressway will cross are relatively flat. The culverts are therefore also nearly flat. This factor alone means the culverts need to be quite large to accommodate flood flows. Large, flat culverts make it easier to accommodate appropriate fish passage, as the inverts can be set below stream bed level resulting in fully flood culvert inverts with low velocity.

The larger pipe culverts will be designed to reflect what GWRC terms as a "low slope" culvert. Generally, this involves:

- minimising the culvert length
- keeping the culvert as wide as the average natural watercourse bed
- aligning the culvert with the natural channel (where practical, refer below for further commentary)
- keeping sufficient water in the invert of the culvert by setting the culvert invert lower than the watercourse invert (the design uses an inset of 0.2 x the pipe diameter)
- allowing bed material to settle into the culvert overtime by setting the culvert lower than the stream invert
- protecting the inlets and outlets with scour and erosion protection either through rip rap rock and planting or other similar methods that incorporate riparian planting.

[12] *Subdivision and Development Principles and Requirements*, KCDC, 2005.

[13] *Fish Friendly Culverts and Rock Ramps in Small Streams*, GWRC, 2003.

The box culverts will be designed to reflect what GWRC terms as a "natural stream bed" culvert. Generally, this involves:

- Minimising the culvert length
- Placing gravels, stones, rocks into the floor of the culvert to continue a low flow channel similar to a natural channel. The design mixes finer materials in with the gravel to better represent each type of stream bed and also so that water flows on top of the gravel rather than through it
- Sizing gravels to stay in place under flood flow conditions. Given the near flat gradient and large size of the culverts, flow velocity in the culverts is relatively low
- Keeping the culverts as wide as the average natural watercourse bed
- Aligning the culverts with the natural channel (where practical, refer below)
- Setting the base of the box culverts lower than the watercourse invert to achieve a smooth transition into and out of the culvert
- Allowing bed material to settle into the culvert over time by setting the culvert lower than the stream invert
- Protecting the inlets and outlets with scour and erosion protection either through rip rap rock and planting or other similar methods that incorporate riparian planting.

It is noted that to minimise the length of culvert crossings, it is not always practicable to keep the culvert on the same alignment as the overall watercourse. However, gentle transitions into the culvert will help mitigate for this modification.

The drawings generally show the longest culvert route for a crossing as this will have the most adverse effect on flood levels. However, the final design may employ shorter culverts, which will be a slight improvement in this respect. For some culverts that would most obviously benefit from this, an alternative alignment has been shown on the drawings. This allows the culvert length to be minimised and makes it easier to construct them offline from the watercourse rather than within the bed, thereby helping to avoid the environmental effects that these works would otherwise have. A list of culverts is included in Appendix H

Effects are shown on the drawings are not sequentially numbered. This is a result of changes during the design so that several culverts have been added in, moved or removed resulting in a non-sequential numeric reference.

Culvert alignment and structural form to reduce the extent of culverts and disturbance of watercourses.

As noted above, there are some culverts where alternative routes will be considered during later design stages. The alignments shown at present reflect the worst case with respect to effects on flood levels and culvert sizing. Shorter culverts on a slightly different alignment are expected to have effects that are slightly more favourable than the longer culverts.

These alternative alignments for the culverts where this would most clearly provide a benefit have been shown on the drawings in order to identify the extent of the flexibility required to select an appropriate culvert alignment and thereby optimise these structures in terms of their performance and environmental effects. As such, it is important to have flexibility during future detailed design stages to revise the angle (or skew) that culverts cross the proposed Expressway.

Similarly, the structural form of the large box culverts is yet to be finalised for all of the culverts. The culvert sections shown on the drawings are typical, and flexibility for later design changes and construction methodology input is needed to optimise their performance. For example, concrete box culverts constructed on-line on a watercourse would need to have the stream temporarily diverted during construction. However, if a sheet pile walled culvert were determined to be cost effective then this may result in less disturbance of the watercourse during construction. Alternatively, the culverts could be positioned so that they are constructed off-line with the existing watercourse maintained until such a time as the culvert is ready to have flow diverted into it.

The form and alignment of the crossings are expected to be confirmed in the detailed design stages of the Project which is expected to be carried out after the consents have been granted.

Where watercourses and open channel drains will need to be diverted a "natural" stream channel cross section will be used wherever practicable.

Wherever practicable, new open channels or diverted watercourses will have a slight meander to them and their banks will be planted with riparian vegetation. They will be formed with a main channel for everyday low flow and with flood berms of varying slope for higher flood flows. They will be reinstated with a substrate to match existing and where appropriate fish refuge will also be included, so they will look more like natural watercourses in appearance than straight engineered drains or farm ditches.

However, the drains will need to fit within the specific spatial constraints of each site that will affect the cross-section of each drain e.g. proximity of the NIMT railway, property boundaries, roads etc. They will also be designed to accommodate maintenance requirements.

Drawing CV-SW-231 shows a typical arrangement of a similar watercourse located near Smithfield Road. The other open channel drains in the Project will be similar to this detail but most on a much smaller scale.

A schedule of the locations of the significant diverted watercourses in the Project is included in Appendix H. It is noted that this schedule may change if the alignments of the culverts and hence watercourses change during later design stages.

8.5.6 Operation and maintenance

On completion, the Expressway will become part of the State highway system. It will be managed as part of NZTA's Maintenance Contract 497N which currently is in the form of a single hybrid performance contract involving both contractor and engineering responsibilities. This section of State highway comes under the Wellington Regional Office of NZTA.

Prior to handover, it will be important that the vegetation associated with the stormwater works is fully established. For wetlands, this will require at least two years of intensive maintenance.

Maintenance activities for stormwater devices such as swales and wetlands are well established. They are set out in the NZTA stormwater treatment standard, and specifications have also been developed for other projects, particularly the Auckland Motorway Alliance.

Principal features of the operation and maintenance of the stormwater systems are:

- A regular programme of inspection and reporting for all devices, including swales, wetlands, pipe systems and culverts, to confirm they are fully functional, and identify any maintenance required
- In wetland swales and treatment wetlands, intensive maintenance for the establishment period
- Regular mowing of grass swales, to maintain the grass typically in the 50mm to 150mm height range
- As a general rule grassed flood storage areas will be leased for grazing, where not planted with native vegetation and where suitable on a site-by-site basis
- When sediment and contaminant build-up in wetlands or swales is such that it reduces the effective capacity beyond that required by the design, the accumulated sediment will need to be excavated, and the topsoil and vegetation re-established.

Works in the Waikanae River outside the main Expressway corridor are expected to be handed over to GWRC for on going maintenance, once vegetation is well established. The Alliance will take responsibility for maintenance of the protection works up to handover after the 2 years defects liability period, and will continue to maintain the works associated directly with protection of the bridge structure.

8.5.7 Summary

In summary, the proposed Expressway contains the following features to manage stormwater and flood risk:

i. The use of swales and wetlands as the primary stormwater management device, including conveyance, treatment and attenuation.

ii. Use of two type of swale: flat grade wetland-planted swales in low-lying peat areas with poor natural drainage; and the use of grassed swales in higher sand dune areas.

iii. The use of kerb and channel and piped systems in limited areas where space constraints preclude the use of swales.

iv. Treatment of stormwater prior to discharge for water quality purposes, using BPO practices.

v. Attenuation of peak outflow from the Expressway to no more than 80% of pre-Expressway peak flows, in some instances bettering this target by large margins.

vi. The creation of offset storage areas to compensate for lost flood plain and supplement the attenuation of peak flows in wetlands and swales.

vii. The use of high capacity / low headloss fish-friendly culverts to convey cross-drainage past the Expressway.

viii. The use of rock rip-rap and riparian planting as appropriate along stream banks, and energy dissipation at stormwater outlets, to avoid scour and erosion of watercourses.

ix. For stream diversions and upgrades, new open channel drains are also designed to resemble natural streams with riparian vegetation to provide shade and cover.

x. Effects on fish passage – mitigated by the inclusion of fish friendly features in the design and designing new open channels drains to resemble natural streams with natural stream beds, riparian planting and refuges.

Overall, our conclusion is that the potential effects of the Expressway on flood risk are able to be addressed in a satisfactory manner, and the use of best practice stormwater treatment will address potential water quality effects.

8.6 Services

The Expressway project will affect numerous existing services along the proposed alignment. Some major services such as Vector's high pressure gas require significant works as the existing mains are located under the Expressway alignment for approximately 2kms. There is also the possibility of relocation of Transpower's power pylons north of Te Moana Road. Numerous other electrical, KCDC, and coms services are affected at road crossing points.

Relocation will be designed either by, or in conjunction with, service owners. Services include the following:

i. Vector: transmission gas lines; delivery point station and distribution lines

ii. Transpower 220 kV lines

iii. Water and wastewater services

iv. Electra, electrical services

v. Telecommunication services.

8.7 Intelligent Transportation System

Intelligent Transportation Systems (ITS) are proposed to be included in the project, to enhance the efficiency and safety of the Expressway for all users. The equipment that is installed will comply with the relevant NZTA ITS specifications. The scope of ITS that is currently proposed to be included in the Expressway has been obtained from discussions with NZTA Traffic Operations staff in Wellington.

8.8 Lighting

Lighting for the Expressway is proposed at all the interchanges, sections of the cycleway and on the existing roads where proposed changes are required.

a) Low spill lighting is proposed at Poplar Avenue, Te Moana Road and Peka Peka. At the Kāpiti Road interchange, standard lighting is proposed as there is already significant light in the area. The decision to use low spill lighting in areas where there is currently little street lighting was made by the wider team at the value improvement workshops. As the light spacing is reduced there is a slight cost increase.

b) The current proposal is to light the section of the cycleway between Raumati Road and Mazengarb Road. This section is likely to be heavily used. Further work is required to determine the most suitable solution for the community. This will be undertaken in the next phases. Current lighting is proposed in accordance with appropriate lighting standards, using 7m high poles. Flag lights are also proposed where the cycleway intersects with the local road.

c) At each of the interchanges lighting will be provided to meet current standards. Lighting may also be required under the bridges where the Expressway passes over the existing local road. Flag lighting will be provided at the new intersection of Smithfield Road and Ngarara Road and just past the Kaikariki Stream Bridge where the road ends and the side road is located.

8.9 Pavements

8.9.1 General

Pavement designs have considered the following:

i. Subgrade differential settlement issues

ii. Design life for surfacing and pavements

iii. Rehabilitation of existing pavements

iv. Noise mitigation from road surfacing

v. Risk profiles for pavements and whole of life cost/value for money

vi. Local road pavements.

Four different pavement types have been analysed, each one split into five different lengths along the Expressway to represent the variation in subgrade conditions.

Following pavement design, a whole of life cost analysis was completed, including analysis with and without risk probabilities of early, planned and late failure.

The conclusion from the pavement analysis, whole of life costing and consideration of factors such as settlements, ease of repair, ability to support open graded porous asphalt (OGPA), and resistance to flood inundation is that a foamed bitumen stabilised pavement is the recommended option for pavement for the Expressway.

It is proposed to surface the Expressway with OGPA between Poplar Avenue and just north of Te Moana interchange. Two sections of approximately 1km in length near End Farm Road and at Peka Peka will also have OGPA surfacing. The OGPA will be laid on a 2 coat chip seal. The OGPA will extend 600mm beyond the road edge line. OGPA surfacing will help mitigate noise from the Expressway.

8.9.2 Raumati Straight

As noted earlier in the report it has been agreed to minimise works on the Raumati Straight. These works from the start chainage just north of MacKays Crossing to chainage 1900 will include pavement rehabilitation and leaving the existing concrete median barrier in place. It is proposed to rip and remake the existing north bound lanes applying make up aggregate to provide a crossfall of a maximum of 4%. After allowing for some settlement over approximately 12 months the north bound lanes will be releveled as required. Further design will be required to ensure that the outer shoulder drop off is acceptable. Minor releveling of the south lanes may be required and then a chipseal surface applied to both sides.

8.10 Noise

Noise assessment and consideration of potential mitigation measures has been carried out. This assessment has been carried out in accordance with NZS 6806:2010 which recommends noise criteria to be applied to road-traffic noise from new or altered roads received at the assessment position(s) of protected premises and facilities (PPF's).

Options for noise mitigation were assessed by a multi-criteria assessment which looked at a number of factors which are taken into account in assessing the best practicable option,

including acoustic performance (getting as many PPF's into Category A[14] as practicable), safety, constructability, form, appearance and cost.

Noise mitigation measures adopted for this project include the following. These are listed in order of preference for inclusion in the design.

i. Low noise generating road surfacing: a low noise generating noise surface is the preferred noise mitigation option.

ii. Noise barriers between the road and PPF's, in the form of bunds.

iii. Noise barriers in the form of boundary fences, it is assumed that these will be timber however this may change depending on whole of life costs etc.

iv. Noise barriers adjacent to the Expressway and/or on/off ramps. The form of these will be further developed. However from the Expressway they will likely appear like continuation of bridge edge barriers and from outside the Expressway, landscaping and planting will conceal these barriers.

v. Treatment of habitable spaces of houses, including ventilation, insulation and double glazing.

8.11 Urban Design

The route traverses several urban communities as well as more open and semi-rural areas. The urban design recognises the interrelationships between structures design, landscape, ecology, stormwater management, social and cultural values, land use planning, transportation planning and geotechnical constraints. For a comprehensive assessment and recommendation of the project area refer to the assessment of Urban Planning and Landscape Design Effects.

Some urban design considerations are listed below.

8.11.1 Interchanges

Interchanges at Te Moana Road and Kāpiti Road are substantial in scale and will require careful design to allow them to function as part of the Expressway, but also as places that people will need to pass on local roads both on foot, cycles, mobility scooters and in some instances by horse riders.

[14] i.e. primary noise criterion in NZS 6806

8.11.2 Local Road Crossings

In the southern sectors of the route the local roads go under the Expressway at grade. This assists with the function of local roads for people on foot or cyclists and maintains the existing local pattern of the roads. The design should be as attractive and comfortable as practicable by providing:

i. openness (by spill through abutments)

ii. lightness (by split bridges and feature lighting at night)

iii. Visual quality (by sculptural bridge and pier shapes)

iv. safety (by application of CPTED best practice in pier positions, clear sight lines, visibility to passing traffic)

v. encouragement (by leading people along the local roads and through under the bridge with low wall structures)

vi. local identity by reference in the landforms and planting to existing conditions.

The design proposes abutment treatment using gabion baskets that extend out into the landscape to integrate with slopes and embankments.

In the northern section of the route the bridges over the Expressway should be safe for pedestrians and cyclists as well as for horse riders to cross – a path of at least 2m width on both sides is proposed.

8.11.3 Land Uses

The need for access to existing land use has been considered in the position of interchanges and east/west connections.

In addition to what is discussed above consideration has been given to future infrastructure requirements in terms of Urban design. To this end additional local crossings of the Expressway have been considered as part of the design.

8.12 Landscaping

The MacKays to Peka Peka Expressway for most of its length, apart from Raumati Straight, is a 'greenfields' project. A new four lane road through rural and residential areas will inevitably have adverse effects on the existing landscape character and amenity of the areas close to the Expressway.

A Sandhills Motorway (or road of varying scales) has been proposed along the approximate line of the WLR designation since the 1950s. Development of residential and rural land since then has occurred immediately adjacent to the proposed road corridor in the knowledge of the intended activity that could occur. Notwithstanding, the landscape and visual effects assessment focuses on the area closest to the Expressway route or the

'zone of highest sensitivity' within which the landscape and visual effects would be the greatest.

The primary study area identified as the 'zone of highest sensitivity' includes land within 100m and 200m from the edge of the Expressway. However, it is recognised that effects will be experienced beyond 200m on a continuum, generally diminishing with greater distances from the Expressway.

The potential landscape and visual effects have been considered and assessed in relation to three interrelated effects:

- Biophysical effects – extent and nature of the physical change to landforms, rivers, streams and wetlands, and vegetation.
- Visual amenity effects – the extent and nature of the visual change, to the outlook and views for the viewing audience. Visual amenity particularly considers the contribution that the visual component of the local environment, make to the overall amenity of an area (i.e. in relation to views, outlook, and local scenery).
- Landscape character effects – extent that the proposal would affect the existing landscape character of the locality, including changes to existing land uses and activities, ambient noise, and overall amenity of an area.

While avoiding landscape and visual effects was a focus in the Expressway design process mitigation measures are addressed. These include ensuring final shaping of landforms – the cut faces and batter slopes, are well integrated with the surrounding area, form and design of earth bunds for noise and/or visual mitigation, and retention of significant areas of existing native and exotic vegetation and planting. The mitigation planting proposed is divided into seven different vegetation types – from massed tree and shrub planting using local native species, amenity tree and shrub planting in areas where the environment is modified such as the Kāpiti Road and Te Moana Road Interchanges, and planting associated with both ecological and stormwater treatment wetlands.

The three effects categories were assessed for each of the 12 character areas on a seven point scale of magnitude and the results are summarised below.

Table 8.13 – Summary of Landscape and Visual Effects by Character Area (1.12.2011)

Character Area	Biophysical	Visual Amenity	Landscape Character
QE Park	low	low	low
Raumati South	moderate	high	high
Raumati Road	high	high	high
Wharemauku Basin	high	very high	high*
			very high**
Kapiti Mazengarb	high	high	high
Otaihanga South	very high	low	high
Otaihanga North	high	moderate	high
Waikanae River (Pending final planting/GWRC	moderate	extreme***	very high
		very High****	
Te Moana	high	very high	very high
Ngarara	high	moderate	high
Peka Peka South	moderate	moderate	high
Peka Peka North	moderate	high	high

Magnitude of Effects – Seven Point Scale

Extreme	1
Very High	2
High	3
Moderate	4
Low	5
Very low	6
Negligible	7

8.13 Otaihanga Road/SH 1 intersection

8.13.1 Background

This intersection is included in the M2PP project as the roundabout will be required to be constructed prior to the Expressway construction commencing to provide safe access for the public and both the workforce and the heavy haulage vehicles to the M2PP project office and precast yard which will be established in the landfill area approximately 1 km from the SH1/Otaihanga intersection.

8.13.2 Existing Intersection

The existing intersection between Otaihanga Road and State Highway 1 (SH1) is controlled by a priority intersection with a stop sign on Otaihanga Road. The major road is SH1, which is on a reasonably tight curve in an area with a posted of speed 80 kph. At peak times SH1 carries a large volume of traffic (22,400 vpd), which makes turning into and out of Otiahanga Road difficult due to the high speeds. A right turn lane from SH1 into

Otaihanga Road and a short merge lane for traffic joining SH1 provides some limited refuge for turning vehicles.

The existing curve radius on SH1 at the location of the intersection measures 250m. Assuming the superelevation in this location is between 5 – 6% the existing road has a design speed of approximately 80 kph. However, traffic travelling southbound on SH1 approaches the intersection from a 100 kph posted speed zone and at this speed visibility of the intersection is restricted by the existing geometry and edge constraints.

Otaihanga Road is a two lane road (one lane in each direction) beginning at SH 1 in the east and ending at Waikanae River in the Otaihanga settlement. It has a posted speed limit of 80 kph from SH 1 to Ratanui Road where it reduces down to 50 kph. Between SH1 and Ratanui Road, Otaihanga Road has no footpath and a number of sharp bends are signposted with advisory speed signs. This section of Otaihanga Road provides access to a number of rural residential properties along with the Kāpiti Landfill (Proposed location for the project site office) and Southwards Car Museum. In 2010, Otaihanga Road had a recorded traffic volume of nearly 6,500 vehicles per day east of Ratanui Road.

8.13.3 Proposed Intersection Arrangement

A three leg roundabout is proposed at this location to assist traffic movements and allow vehicles to turn in a safer environment. This will cater for existing vehicle numbers and construction traffic for the M2PP Expressway.

The position of the roundabout has been chosen to minimise land take with the roundabout being constructed mainly in the land to the northwest of the intersection. The level of the roundabout will be similar to the existing road level but will require a significant amount of pavement reconstruction to achieve suitable crossfall where the existing road is superelevated. There will also be a large cutting through a sand dune on the land to the northwest. With some design refinement it is expected that property purchase maybe limited to one parcel of land which is currently used for grazing.

The proposed approach from the north to the roundabout will be are much straighter than the existing, which allows it to be more visible and will make for a safer junction.

The roundabout size and its geometric elements have been designed to provide capacity for the predicated traffic volumes with the greatest volumes, in particular turning volumes, being during the Expressway construction as the project office will generate at its peak an additional 400 car,190 truck and trailer and 40 concrete truck movements per day. Once the Expressway is commissioned the traffic volume on both SH1 (which will serve an arterial function) and Otaihanga Road are expected to reduce to 11,000 and 5,700 vpd respectively. With the more balanced flow from the 3 legs the roundabout is expected to operate at a LOS B in both AM and PM peaks post Expressway construction. This indicates that a roundabout at this intersection will perform to a high standard with minimal delays and queuing.

The design of the roundabout has been carried out in accordance with the principles in Austroads Guide to Road Design, Part 4B: Roundabouts (2009).

The centre island radius has been determined assuming the desired driver speed on the fastest leg prior to the roundabout is 80 kph. A central island radius of 20m in accordance with Table 4.1 in Austroads is taken as the absolute minimum radius for a two lane roundabout. A two lane roundabout is required to accommodate traffic movements and it is appropriate to keep the footprint as small as possible so as not to dominate the rural surroundings and minimise land take.

All approaches to the roundabout are widened from one lane to provide two lane entries for straight through and turning manoeuvres. On SH1 two lane exits are provided from the roundabout reducing to one lane with the appropriate merge. The roundabout has a single lane exit to Otaihanga Road to cater for the smaller number of vehicles and tie-in with the exiting road at this location. Allowance has been made for on-road cycle lanes and off-road shared path on the western side. These have been incorporated into the proposed roundabout design.

The inside kerb radius is generally equal to the central island radius to promote similar entry and circulating traffic speeds. The exit radius is larger than the entry radius to allow vehicles to start accelerating up to major road traffic speeds.

The circulating carriageway width is 2 x 5.0m traffic lanes in accordance with Table 4.4 in Austroads, which will accommodate a 19m semi-trailer.

The entry path radius is generally equal to the desirable radius of 55m. This is one of the main elements in the design of a roundabout and will generally produce lower overall crash rates than those produced by the absolute values.

8.13.4 Safety

The geometric design of the roundabout has been carried out to provide a safe junction. Where the higher values have been used for elements of the design it is hoped that this will reduce the overall crash rate to less than the national average for a typical roundabout.

The approach signage and warning signs will be carefully designed to promote a safe environment. Early warning signs and clear direction signage shall be designed to reduce the element of surprise and allow motorists sufficient opportunity to make a decision to travel through the roundabout to the desired exit.

Street lighting will be installed to ensure the junction is highly visible during the hours of darkness so that the roundabout is no less safe at night.

8.13.5 Services

The services plans included in the appendices) obtained from the network operators indicate 150mm asbestos concrete and PVC water pipes running along both shoulder of SH1 and Otaihanga Road and one line crossing SH1 through the middle of the proposed roundabout. A 600mm concrete lined steel water main runs in the western shoulder of SH1. It is expected some of these lines will need to be removed and replaced.

Telcom & Telstra Clear have services in the shoulder along SH1 and Otaihanga Road and some of these are likely to require protection, lowering or replacing.

Electra have a 33kV overhead line on the eastern side of SH1 and it is likely one pole may have to be relocated.

9 Road Safety Audit

9.1 General

A Road Safety Review team was appointed in late 2010 consisting of Jos Vroegop (TPC Auckland), Steve Reddish (TPC, Hawkes Bay) and Fergus Tate (MWH NZ Ltd).

The team has undertaken 3 safety audits during this phase:

- An initial safety review was carried out in the Options Stage before a preferred option was selected. Drawings were provided showing the proposed overall alignment and options at six locations along the route which were being evaluated during the Options stage. The Road Safety Review Team considered that the proposed Expressway will significantly improve road safety in this area. No fatal flaws were identified at that time. A list of safety related matters were raised, with most being considered minor but some significant issues noted. These have been considered and taken into account in the further design development.
- An addendum to the above Road Safety Review was carried out in April 2011 on two options for the widening of Kāpiti Road at the interchange area. At that time two options were being considered, the larger one involving widening from Arko Place in the west through to Larch Grove to the east, and with additional signalised intersections at Te Roto Drive/Kāpiti Road/realigned Milne Drive and at Arawhata Road/Kāpiti Road, a length of approximately 800 m. The smaller scale widening was only between Te Roto Drive and Arawhata Road, with no realigning of Milne Drive and no additional signalised intersections, a length of approximately 400 m. At the time of this assessment, the traffic analysis had not been completed in order to determine whether or not the larger upgrade was required from a traffic point of view. The Road Safety Review Team considered that the larger scale option offered significantly improved road safety over the smaller option. Some significant concerns were identified for the smaller option. The design of this interchange has been based on the smaller extent of widening of Kāpiti Road. In carrying out this design, the significant concerns have been considered and where practicable these have been addressed.

The stage 2 safety audit is described below:

9.2 Stage 2 Safety Audit July 2011

A Stage 2 Safety Audit was held on 25 and 26 July 2011 based in the Preferred Option. The significant change from the previously review designs was the revised Peka Peka interchange. The Road Safety Audit team consisted of two of the same members (Jos Vroegop (TPC Auckland) and Steve Reddish (TPC, Hawkes Bay) but Fergus Tate was replaced with Jon England, (MWH Wellington).

The audit report was received on the 6th August 2011. The alliance has reviewed the audit, completed the designer comments column and met with NZTA's safety engineer to

discuss and close out the audit. The audit contains 1 serious, 19 significant, 18 minor and 2 comment issues.

The serious issue related to cyclists being able to use the 2.5m shoulder of the Expressway. This is not an issue the Alliance has any control over as the project scope specifically requires an Expressway be designed and constructed, not a motorway. Of the 19 significant issues 17 of them will be addressed in either the TOC design or detailed design. The other 2 relate to issues that have already been addressed. A copy of the closed out safety audit is included in Appendix. G, this includes comments from the NZTA project manager and safety manager.

10 Cost Estimate and Risk Assessment

10.1 Cost Estimate for the Preferred Options

The costs have been defined by estimating the value of individual elements of work (as defined in NZTA Cost Estimating Manual Form C – Scheme Estimate) for the physical works with the addition of percentage on-costs for Limb2 costs and design fees, the current estimate for the investigation, reporting and property costs with the addition of risks from an @Risk assessment.

For each element a preliminary design package including assumptions and risks was prepared using the information currently available. Quantities for each element were defined in line with the detail provided for each design package and these are reflected the level of risk in each element.

Rates for all elements have been calculated from the baseline of the recently submitted Tauranga Eastern Link (TEL) tender submission from Fletcher Construction as used for the Scoping Report with the addition of rates provided by local contractors and suppliers. The cost estimates have been prepared at August 2011 prices and do not include any allowance for cost escalation.

Property cost for the total length of Expressway has been provided by NZTA Wellington Region from drawings detailing the properties required. The Net Cost for the property has been used in the cost estimate.

The following percentage values have been added to Phase 3 (detailed Design and Construction):

- Detailed Design and Monitoring 7.0%
- PAA LIMB 2/3 of 16.6%.

The extent and appropriate level of risk for each element has been determined at a Risk Workshop. The risks associated with each estimating element have been assessed and used to determine the expected estimate. Section 10 of this Report details the outcome of the Risk Workshop.

An initial cost estimate for the preferred option was prepared on 31 July 2011. This estimate (P50) was $723 million. As this was too high a value engineering phase was undertaken as described in section 4.8 above. The revised scheme estimate was prepared on 27 October 2011. The Project Expected Estimate (P50) for this scheme as defined in this scheme assessment report is $637 million.

The Scheme Estimate for the preferred option is shown below:

Table 10.1 – Scheme Estimate

Project Estimate - Form C

Project Name: MacKays to Peka Peka
27-Oct-11 Remodelled

SE
Revised Scheme Estimate

General Scope: 18km of 4 lane expressway from MacKays Crossing to Peka Peka including 12 bridges and 4 interchanges.

Item	Description	Base Estimate	Contingency		Funding Risk	
			%	$	%	$
A	Nett Project Property Cost	$ 59,669,365	10.0%	$ 5,966,937		
B	*Phase 1 Investigation, Reporting, Board of Enquiry*					
	Phase 1A (Alliance)	$ 20,800,000				
	BOI					
	LIMB 3	$ 500,000				
	NZTA Managed Costs	$ 2,760,000				
	Total I&R	$ 24,060,000	6.2%	$ 1,500,000		
C	*Phase 2 Outline Design & TOC*					
	Phase 1B (Alliance)	$ 4,580,000				
	Phase 2 (Alliance)	$ 6,680,000				
	EPA Costs	$ 2,670,000				
	NZTA Managed Costs	$ 2,670,000				
	Total D&PD	$ 16,600,000	0.0%	$ -		
D	*Phase 3 Costs Detailed Design and Construction*					
	Non Alliance Costs					
	Emerald Glen Costs	$ 5,030,000				
	Alliance Professional Services					
	1 Detailed Design & Monitoring	$ 28,000,000				
	Alliance Physical Works					
	1 Environmental Compliance	$ 3,700,000				
	2 Earthworks	$ 48,596,766				
	3 Ground Improvements	$ 41,191,365				
	4 Drainage	$ 33,207,631				
	5 Pavement & Surfacing	$ 44,373,345				
	6 Bridges	$ 53,163,179				
	7 Retaining Walls	$ 3,323,273				
	8 Traffic Services	$ 10,724,795				
	9 Service Relocations	$ 23,696,999				
	10 Landscaping	$ 20,323,692				
	11 Traffic Management & Temporary Works	$ 17,810,535				
	12 Preliminary and General	$ 73,000,000				
	13 Extraordinary construction costs					
	Accommodation Works					
	Temporary Works					
	SH1 Maintenance					
	PAA LIMB					
	1 Alliance PAA LIMB2/LIMB3	$ 66,824,163				
	Incl Limb 2 for Designer					
	Incl Limb 2 on Balance + Risk					
	Total Alliance Costs	$ 467,935,743				
	Total Construction	$ 472,965,743	12.0%	$ 56,700,000		
E	**Project Base Estimate (A+B+C+D)**	**$ 573,295,108**				
F	*Contingency (Assessed / Analysed)*		*11.2%*	*$ 64,166,937*		
G	**Project Expected Estimate (E + F) P50**			**$ 637,462,044**		
H	*Funding Risk (Assessed / Analysed)*				*15.5%*	*$ 99,034,000*
I	**95th Percentile Project Estimate (G + H) P95**					**$ 736,496,044**

Note the project base estimate cost in line 'E' above is $10m higher than the figure shown in the detailed estimate in appendix C. To line up the figures, $56.7m risk on the detailed spread sheet is subtracted and the $66.8m limb2/3 cost is added. The total risk of $64.2m is then added back to give the P50 estimate of $637.5m.

An external review of the cost estimate was carried out by Ian Bond.

10.2 Risk Assessment

A risk assessment workshop was carried out with a wide cross section of the Alliance Team on the 28 July 2011. The workshop identified 5 risks in the extreme threat category which are listed below. These were around consenting risks, scope change, ground conditions and architectural treatment to structures.

- Design change/ Scope change
- Delayed approval because strong opposition in Wāhi Tapu area
- Delay in receiving HPT approvals to carry out further investigation
- Unforeseen ground conditions due to limited geotechnical investigations
- Increased requirements for architectural treatment to bridges.

The outcomes of this workshop including the proposed mitigation measures are set out in the risk register in Appendix E.

11 Economic Assessment

An economic evaluation has been carried out in accordance with the NZTA Economic Evaluation Manual Full Procedures (EEM). The economic evaluation was undertaken in order to generate a BCR comparison of the four Expressway route options. This work was undertaken as part of the wider assessment of the alternate routes and is contained in the MacKays to Peka Peka Options Report Volume 1 Final 15 November 2011. The estimated cost used in this economic assessment for the preferred option is the cost developed for the earlier scoping report issued in October 2010. This was to provide consistency in comparing the estimated cost for each option.

12 Summary and Recommendations

This report describes the development of the preliminary design of the preferred option for the MacKays to Peka Peka Expressway. This design development has been to Scheme Assessment stage level of detail and also for issue to the technical specialists for preparing assessments of effects and then applications for Resource Consents and Notice of Requirement.

The full detail of the technical aspects of this design development is covered in the various design reports and drawings that have been prepared, and reference should be made to these documents for more detail.

The preferred option was selected in March 2011 following a MCA carried out on one connectivity option and alternative options at six locations along the route. This preferred option has now been developed to a Scheme Assessment level of design.

The design process has involved refinement of the geometric alignment, further geotechnical analysis, stormwater modelling and design, traffic modelling and analysis, structural and architectural design of bridges, noise mitigation assessment, urban and landscaping design.

The design has been challenged by means of a series of Value Improvement Workshops. Meetings have also been held with NZTA specialist staff to gain more understanding and/or agreement on design standards and requirements for route security and lifelines, settlement and pavement performance and ITS provisions. This process has resulted in refinements to the geometry to reduce overall footprint and bridge widths, development of proposed ground improvement measures, decisions on likely pavement construction, review of bridge spans and configurations and reduction in extent of landscaping. A further value engineering phase has been undertaken to reduce the cost of the project.

A stage 2 Safety Audit has been undertaken and a close out meeting held with NZTA's Safety Engineer. The only serious issue identified was the issue of cyclists being able to ride on the sealed shoulder of the Expressway.

The preferred option is therefore summarised as follows:

- A 16 km, two lanes each way median divided Expressway. The median varies in width from 4 to 6 m and has a wire rope barrier; (2kms of Raumati Straight is now being treated as a pavement rehabilitation and will not meet the RoNS guidelines for median width) . While this reduction in standard for Raumati Straight has been signed off by the Project Alliance Board a paper will need to be submitted to the VAC to formally close out the issue
- Connectivity is provided to local roads at four locations, Poplar Avenue, Kāpiti Road, Te Moana Road and Peka Peka

- At Poplar Avenue, connectivity takes the form of a partial interchange, with south facing ramps. Two roundabouts are provided on a realigned Poplar Avenue, with the Expressway passing over Poplar Avenue
- The Expressway continues parallel to the existing highway north of Poplar Avenue, severing Leinster Avenue, before curving away to the west. It rejoins the WLR designation south of Raumati Road and continues north within this designation, rising up to pass over Raumati Road
- From north of Raumati Road, the Expressway rises to pass over the Wharemauku Stream, and allows space for the future Ihakara Street extension
- At Kāpiti Road a full interchange is provided, with both north facing and south facing on and off-ramps. The Expressway passes over Kāpiti Road, which is widened locally
- North of Kāpiti Road, the Expressway continues on within the WLR designation, to pass over Mazengarb Road, which will be lowered locally
- The Expressway rises again to pass over Otaihanga Road and then again to pass over the Waikanae River and then Te Moana Road
- A full interchange is provided at Te Moana Road with both north facing and south facing on and off-ramps. The Expressway passes over Te Moana Road. The intersections of the ramps with Te Moana Road are provided with roundabouts
- From Te Moana Road, the Expressway varies from the WLR designation through to near the new Smithfield Road crossing and then again at the Peka Peka interchange
- The Expressway alignment severs the existing access to Nga Manu Nature Reserve and three properties at the eastern end of Smithfield Road. A new connecting road reinstates those accesses, commencing at Ngarara Road approximately in the location of the current Nga Manu access
- North of Smithfield Road the Expressway is kept relatively low above existing ground level, sufficient for flooding and geotechnical requirements, and stays at grade to rejoin the existing SH1 north of Peka Peka Road
- At Peka Peka, a partial interchange is provided with north facing ramps
- A full length off road cycleway/walkway facility is provided
- The P50 scheme estimate is $637 million.

It is recommended that:

i. This preferred option is adopted as the basis for the Scheme Estimate and preparation of Notice of Requirement and Resource Consents.

ii. The next stage of design (Target Outturn Cost) proceeds based on this preferred option.