Technical Report 1

Design Philosophy Statement

NZ TRANSPORT AGENCY
WAKA KOTAHI

1 MacKays to Peka Peka Expressway

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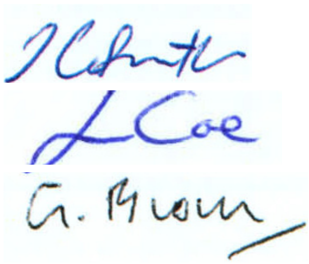
Action	Name	Signed	Date
Prepared by	D Stirrat: Civil/Roads I Smith; Stormwater L Coe; Geotechnical G Brown; Structures M Baily; Urban design B Faulkner; Visual S Bannock, Sustainability B Wood, Noise		 15 Dec 2011 16 Dec 2011 15 Dec 2011
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on behalf of	MacKays to Peka Peka Alliance		

Table of Contents

Appendices

List of Tables

List of Figures

1. Introduction

1.1 General

In 2009, the Government identified 'Roads of National Significance' (RoNS), and set priority for investment in these as New Zealand's most important transport routes. The RoNS are critical to ensuring that users have access to significant markets and areas of employment and economic growth.

The MacKays to Peka Peka Project is a critical part of SH1 Wellington Northern Corridor, which is one of seven Roads of National Significance prioritised by the Government to contribute to New Zealand's economic growth.

The Project consists of approximately 18km of four lane median divided highway through the areas of Paraparaumu and Waikanae, and includes a new bridge over the Waikanae River and a number of interchanges providing connections with local roads.

The MacKays Crossing Project, located to the south of this Project, was completed in April 2007. The delivery of the Peka Peka to Ōtaki Project located immediately north of this Project, is expected to overlap with the delivery of this Project. All three projects must integrate to provide an optimal outcome for the SH1 Wellington Northern Corridor.

1.2 Purpose

This Design Philosophy Statement (DPS) is a live document that outlines the current status of the design process (the Scheme Assessment Design) and will change as the design progresses from Speciman Design during the Target Out turn Cost (TOC), phase to Detailed Design as information is received or opportunities emerge. The relevant design reports, (Civil, Geotechnical & Structural) provide more detail on the design philosophy.

This document identifies the standards, guidelines and key criteria that will be used in the design of the MacKays to Peka Peka Project.

It is to provide guidelines for design but should not be a constraint to innovative design, provided that sufficient redundancy is incorporated into the design in accordance with standard practice to allow for normal variations in ground conditions and construction quality as well as to account for extreme conditions as might be reasonably expected over the design life of the proposed Expressway.

This DPS covers the design philosophy for the proposed Expressway and the local road network that is influenced by the proposed Expressway construction. It does not specifically cover the design philosophy for the existing State Highway 1 following construction of the proposed

Expressway as the scope and nature of the treatment of this road is still being developed and will be reported separately.

2. The philosophy

This section describes the high level relationships between the Design Philosophy, Project Objectives and other strategic matters. It recognises that there are important aspirational goals that the Project team[1] have set for the Project design outcomes which will, within the ambit of the Alliance's influence, be sought to be realised.

This section is intended to describe succinctly what it is that the Project design 'stands for' and sets out the intentions of the Project in terms of the built and functional outcomes.

The Design Philosophy Statement sits within the context of several contributing high level requirements and expectations (refer to Appendix 1.A for a more detailed list):

2.1. Project objectives

The Project objectives, for the purpose of section 171 of the Resource Management Act 1991, are:

1 To:

(a) enhance inter-regional and national economic growth and productivity;

(b) 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;

(c) enhance safety of travel on SH1;

(d) 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 District to be efficiently accessed;

By developing and constructing, as soon as practicable, a cost optimised new State Highway alignment to expressway standards between MacKays Crossing and Peka Peka.

2 To manage the social, cultural, land use and other current and future environmental impacts of the Project on the Kāpiti District and its communities by, as far as practicable, avoiding, remedying or mitigating any such effects through route and alignment selection, expressway design and conditions.

[1] This Technical Report refers to the Project team as carrying out works on behalf of and as contracted by the NZTA. The NZTA is the requiring authority and the consent holder.

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

In advancing these objectives the consenting component of the Project will be guided by the following considerations in seeking to secure the necessary RMA and non-RMA approvals:

That the purpose and relevant principles of the RMA and other applicable legislation are achieved;

That environmental effects are properly scoped, comprehensively assessed and appropriately managed;

That the consenting process is consistent with other RoNS projects, particularly those within the Wellington Northern Corridor;

That delays in obtaining necessary approvals are avoided;

That consent conditions control and manage the effects associated with the construction of the proposed Expressway, and provide for its continued operation and maintenance in a manner that:

- is consistent with NZTA's objectives;
- is practicable to implement; and
- does not unduly constrain contractor flexibility and innovation.

That particular regard is given, as relevant, to the Guiding Objectives for the Alliance on behalf of the NZTA, which are as follows:

1. General
a. "The Project" is defined as the design and construction of the network (i.e. proposed Expressway and local road network) between MacKays Crossing and Peka Peka, as altered by the construction of the proposed Expressway.
b. Where objectives are in conflict with each other, the Project is to provide the best compromise between the objectives whilst still seeking, as far as reasonably practicable, to deliver each objective as a whole.
c. That a Memorandum of Understanding is in place between KCDC and NZTA by the end of the design phase, which ensures the consented operation and maintenance standards, service levels and design standards are maintained, at least at that level, for the life of the proposed Expressway.
2. Tangata Whenua
a. That the Project is designed and constructed in a manner that acknowledges tangata whenua as treaty partners, respects their concerns and exhibits best practice mitigation where tangata whenua values are affected.

3. Levels of service

That:

a. the proposed 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

b. level of Service ‘C” is achieved at the intersections between the proposed Expressway and local network

c. that the overall network operates to significantly improve travel times.

d. an integrated transport network can operate in a manner which reduces congestion in Waikanae town centre and at Elizabeth Street level crossing

e. the Level of Service set out in a. and b. above is not intended to restrict the number or location of connections in the network or pre-determine design solutions the test year for levels of service is 2026.

4. Connectivity

a. All existing and proposed east/west local road, cyclist and pedestrian connections are to be maintained consistent with existing KCDC Community Outcomes, Development Management Strategy, Sustainable Transport Strategy, and Cycle, Walkways and Bridleways Strategy, in particular for access to public transport systems, neighbourhoods, public open space, recreational amenities and local centres and services.

b. The Project will maximise connectivity (including grade separated and left on/left off interchanges) to the local network consistent with the proposed Expressway’s inter-regional function.

c. In determining connectivity solutions, particular consideration is to be given to:

All travel modes

Access to schools and colleges (e.g. Kāpiti and Paraparaumu colleges)

Employment areas

Other community facilities

d. The Council, NZTA and Alliance members will work together to confirm the need for multiple routes for local businesses and residents across the Waikanae River. This will include assessments of the design assumptions against urban design and traffic principles and will show how the design principles link to and are consistent with international best practice.

5. Resilience

a. The Project will improve network resilience in the event of emergencies.

6. Delivery programme

a. The design process is to focus on providing certainty to residents as a priority consistent with appropriate community consultation, particularly at northern and southern connections.

b. The Project will achieve early Project delivery consistent with the Government's infrastructure programme.

c. Opportunities for early physical works that deliver benefits will be identified during the design process.

7. Property impacts

a. The Project is to be designed and constructed in a way that seeks to minimise adverse impacts on adjoining and surrounding properties.

b. The Project delivers mitigation of noise and visual impacts on surrounding properties using best practice 'soft engineering' and landscape practice consistent with enhancement of the surrounding landscape and visual amenity values and specifically seeks to avoid the use of hard engineered surface sound barriers (such as noise walls.)

8. Local planning

That

a. the Project is to be consistent with existing KCDC Community Outcomes, Development Management Strategy, Sustainable Transport Strategy, and Cycle, Walkways and Bridleways Strategy and will include recognition of and respect for the wider urban and rural contexts

b. the pre-eminence and economic viability of the District's existing major town centres as social, employment, retail and passenger transport nodes are maintained. In particular the Project is to include well designed, direct access via the proposed Expressway into and out of Paraparaumu town centre, nearby commercial areas and the airport, consistent with the proposed Expressway's inter-regional function.

9. Safety

a. The design of the proposed Expressway is to meet KiwiRAP 4 star standards.

b. The design of the local network, including the existing state highway, is to exhibit best practice and be consistent with local urban design standards

c. The design and construction of required adjustments to the existing SH1 to deliver an appropriate local function is included in the Project scope, including adequate consideration for the safety of elderly and young residents and the transport disadvantaged.

10. Urban form

That the Project is designed and constructed in a manner that:

a. interchanges are configured to achieve integration with urban form and surrounding land uses

b. community severance is to be avoided, mitigated or minimised as far as reasonably consistent with local planning documents including KCDC Community Outcomes, Development Management

Strategy, Sustainable Transport Strategy, and Cycle, Walkways and Bridleways Strategy

c. the nature and scale of the existing State Highway 1, especially at Waikanae and Paraparaumu town centres, delivers a viable and attractive roading and access system for local needs (i.e. is able to accommodate the impacts of projected passenger transport movement and growth, vehicle, pedestrian and cycle movements and enhances those town centres).

d. avoids, mitigates or minimises any adverse impacts to local schools, community amenities and facilities and the local roading network, in particular the nature and character of residential streets

e. avoids, mitigates or minimises pressures for urban sprawl (including coastal development) and associated inefficient infrastructure systems

f. avoids, mitigates or minimises pressure for retail and other development outside the existing town centre and employment nodes, in particular, at Raumati, Otaihanga and north of Waikanae.

g. achieves consistency with the District's Development Strategy and associated regulatory policies (including the District Plan and Plan Changes 79 and 80.)

11. Stormwater and groundwater

That the Project is designed and constructed in a manner that:

a. Conforms to the Kāpiti Coast District stormwater requirements and associated best practice, in particular the Stormwater Management Strategy and the policy of on-site hydraulic neutrality

b. ensures the hills to coast stormwater flow (both surface and groundwater) is not impeded

c. ensures the natural flows in wetlands are not impeded.

12. Environmental

That the Project is designed and constructed in a manner that:

a. minimises the loss of dunes and wetland landscape through which it passes, including any remnant native vegetation

b. provides a high quality of natural environment where the Project crosses streams, wetlands and the Waikanae River and avoids culverting and closing in of streams

c. ensures that adverse effects on the environment and amenity of the Waikanae River corridor are avoided, mitigated or minimised

d. avoids, mitigates or minimises adverse impacts on local flora and fauna, particularly in areas currently protected or covenanted for their natural systems and ecological values

e. avoids, mitigates or minimises any adverse amenity, environmental, archaeological, waahi tapu and visual impacts in a manner representative of internationally accepted best practice, including but not confined to the NZTA's best practice statements on urban design and planning.

13. Value for money

a. Project solutions are to be value for money and consistent with NZTA funding requirements and mitigation requirements, noting that the Project must integrate the proposed Expressway into the local network and must take account of the impacts of this

b. Evaluation of Project solutions will take into account life-cycle costs (e.g. maintenance costs and design life) as well as initial construction costs.

The Design Philosophy Statement does not take precedence over the above listed high level requirements. It describes the standards and criteria that the design team currently propose to use to develop the design to meet the above objectives. As the design develops and more information becomes available the design criteria and standards may need to be amended, to meet the overriding Project objectives while satisfying site constraints and other information received.

In considering the context set by the above influences the key design related headings are as follows:

2.2. Economic and regional development

To design the proposed Expressway to ensure that it can deliver a balance of interregional transport efficiencies which are required to enable regional and national level economic development in concert with the effective local movement and the amenity this delivers for the residents of the district.

To design the proposed Expressway with interchanges in locations that enable regional, interregional and local transport movements that can support and encourage economic development from urban and business growth, taking into consideration the future development plans for the district.

To design the proposed Expressway and its Alignment such that it optimises the opportunities for future land uses around the proposed Expressway corridor to reconfigure, fill in, or develop in new ways such that the district's urban and business growth can benefit.

2.3. Movement and accessibility

To design the proposed Expressway with retention of all existing east-west local roads and to consider and provide as practicable opportunities for increased accessibility and connectivity for all modes of transport through such means as:

(a) additional parallel local connections within the road corridor;
(b) additional east west connections to service future growth areas; and
(c) improved accessibility to public transport, cycle and walking networks.

To design the proposed Expressway with some strategic consideration of the role of the old highway corridor and the benefits this can provide for local accessibility to and from public transport, cycle and walking networks and the destinations within and external to the district.

To design the proposed Expressway in a form that provides in-built flexibility with respect to changing transport needs of future generations.

2.4. Time, cost and affordability

To design the proposed Expressway with a strategic and long term view that recognises the immediate cost, value for money and consistency of the cost with NZTA's funding requirements, in balance with the future cost of maintenance and the effectiveness of the design in providing for transport needs into the future.

To design the proposed Expressway such that it can be reasonably expected to be achievable by gaining statutory consents and then being constructed within, respectively, the consent requirements that apply and within the timeframes as set by government.

2.5. Safety and security

To design the proposed Expressway to the requisite standards that will provide for the safety of its users.

To design the proposed Expressway and the associated interchange and other network connections to provide a secure route for the movement of people and goods through the district from north to south, which is a route that is resilient in the event of emergencies and resistant to disasters within accepted design standards.

To design the proposed Expressway and its associated infrastructure including local road network, cycle ways, footpaths and open space areas such that these are safe, secure and have a good level of associated amenity.

To design the proposed Expressway and local road connections such that changes in local network traffic safety conditions are maintained or improved.

2.6. Social outcomes

To design the proposed Expressway with reference to the needs and amenity of the district's people including through the sharing of the functional benefits for movement and accessibility this brings as well as addressing sensitivity to the effects from Expressway traffic.

To design and construct the proposed Expressway in a manner that is respectful of the social and cultural issues it generates and the NZTA engages to understand these issues as well as responds to those issues in the most effective manner it reasonably can. In particular, the design is to give due regard to the potential for social severance, community disruption and loss of amenity.

2.7. Environmental outcomes

To design the form of the proposed Expressway including its Alignment, cross section, interchange locations, structures, and height in response to the environment it traverses recognising that it is both rural and urban in its nature.

To design the proposed Expressway in recognition of the particular water (river corridors, flood paths and groundwater) environments and expressing these water related environmental aspects in the design and management of associated water runoff, retention of existing wetlands where practical and the development of additional wetland areas for improving water quality.

To design the form of the proposed Expressway in recognition of the natural dune landform of the coastal area by use of those dune forms for buffering, enabling local road crossings, and reducing visual impacts.

To design the form of the proposed Expressway in recognition of the ground conditions in this environment which includes deep peat in many locations and the effects of this ground on the structural and construction techniques this will demand.

To design the form of the proposed Expressway in such a way that the adverse effects of noise, vibration and poor air quality are mitigated in accordance with relevant standards.

To be cognisant of resource efficiency and sustainability opportunities and innovations in the design of the proposed Expressway, as may afford or effect opportunities in the construction, operation, use and/or maintenance phases of the proposed Expressway.

To design and construct the proposed Expressway to maintain the effectiveness of the current State Highway and minimise all adverse effects on State Highway users.

To design and construct the proposed Expressway to ensure the future maintenance (including compliance with designation and resource consent conditions) represents the best whole of life outcome.

To provide a maintenance management plan that clearly conveys all future expectations and responsibilities and deliver all design and construction records in formats compatible with NZTA systems, complete and accurate.

3. Project overview

As stated above the Project commences just north of MacKays Crossing. The existing section of State Highway 1 immediately north of MacKays Crossing is a four lane divided highway known as the Raumati Straight. This section has a central median barrier finishing just south of Poplar Avenue. The existing Western Link Road (WLR) designation held by the Kāpiti Coast District Council commences at the intersection of Poplar Avenue and SH1 and extends 800 metres west along Poplar Avenue. From this point the existing WLR designation extends in a generally northerly direction along an unformed corridor crossing local roads before tying into the existing state highway just south of the Peka Peka Road intersection. Refer figure 1 below.

The Project has been divided into four sectors south to north as described below:

- Sector 1 – MacKays Crossing to just north of Raumati Road
- Sector 2 North of Raumati Road to north of Mazengarb Road
- Sector 3 North of Mazengarb Road to north of Te Moana Road
- Sector 4 North of Te Moana Road to Peka Peka

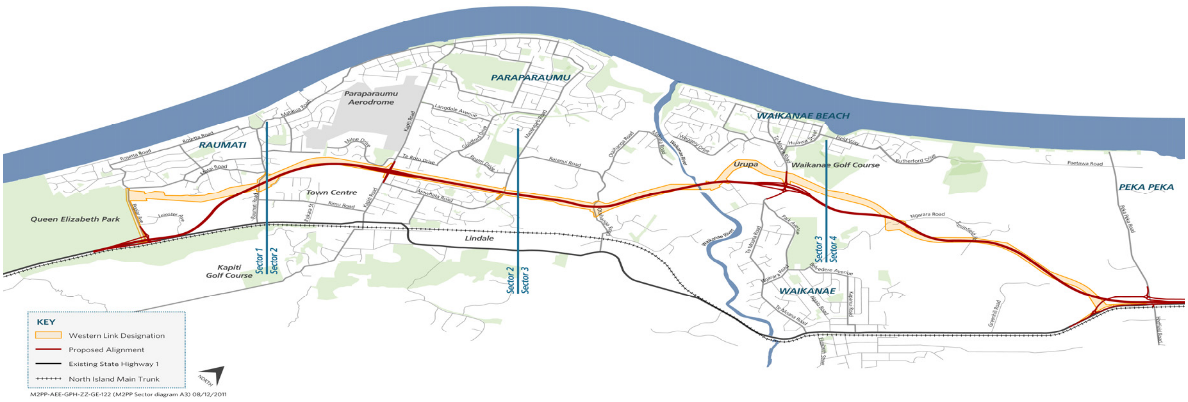

Figure 1: MacKays to Peka Peka Sector Diagram

The key components of the Project comprise:

i. Tie in to the existing highway just south of Poplar Avenue,

ii. A tie into the existing SH1, north of Peka Peka Road, or into the southern end of the Peka Peka to Ōtaki Project if completed first,

iii. Rehabilitation of the existing pavement on the section of highway from MacKays Crossing to the southern tie-in but no additional widening (this section will not conform to the RoNS guidelines due to median width and some shoulder widths),

iv. A four lane median divided Expressway to meet NZTA's RoNS guidelines,

v. A new four lane bridge across the Waikanae River,

vi. Grade separated crossings at existing local road crossings, except for Leinster Avenue,

vii. Four grade separated interchanges, northern and southern are partial interchanges while full interchanges are provided for at Kāpiti Road and Te Moana Road,

viii. Stormwater treatment and attenuation facilities,

ix. Provision of facilities for pedestrians and cyclists.

The completed Project will result in a four lane median divided Expressway that provides primary functionality along the proposed Expressway route while addressing secondary connectivity to the local road network without the use of at grade intersections.

4. Road design

4.1. General

The proposed Expressway traverses a mix of rural and urban environments and as such will need to be designed to ensure that changes in the road and berm width typical section due to the environment e.g. median width and clear zone, are 'readable' to the motorist. The new Austroad Guide for Road Design (AGRD) uses the term 'Driver Domains'. These define the desirable range of values for parameters, given the prevailing topography and conditions. The RoNS guidelines have tabulated some of the specific requirements and are considered in light of the AGRD.

The proposed Expressway has 9 grade separated crossings of local roads, Leinster Avenue in the south being the only east/west connection not being maintained. Four interchanges are proposed, the interface with the local roads being designed in liaison with KCDC. The selection of whether the proposed Expressway passes over or under the local road at each of the crossings has been considered on a case by case basis, taking into account such factors as elevation of the proposed Expressway at the road crossing, development established on the proposed Expressway and/or local road, proposed Expressway and local road geometrics, construction sequence, drainage considerations, appearance, cost and use by all forms of transport.

At the southern end of the Project (Raumati Straight) it is proposed to rehabilitate the existing pavement but not widen it to RoNS standard from MacKays Crossing to the southern interchange at Poplar Avenue.

At the northern end of the Project at Peka Peka, liaison with the designers of the Peka Peka to Ōtaki Project has been undertaken to determine the appropriate temporary or permanent solution depending on the final timing of construction of both projects.

4.2. Levels of service

Level of service is a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and safety.[2]

Table 1: Level of Service Definition

Level of Service	Description
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
B	In the zone of stable flow where drivers still have reasonable freedom to elect their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A.
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.
F	In the zone of forced flow, where the amount of traffic approaching the point

[2] Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, 2009.

	under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

The Guiding Objectives for the Alliance on behalf of the NZTA (refer section 2.1) specify a Level of Service for both the proposed Expressway and intersections with the local network as follows:

the proposed 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] (Objective 3a);

level of Service ‘C’ is achieved at the intersections between the proposed Expressway and local network [in the year 2026] (Objective 3b); and

the test year for levels of service is 2026.

The Guiding Objectives note that the Level of Service objectives above are not intended to restrict the number or location of connections in the network or pre-determine design solutions.

4.3. Secondary local roads

General

All local roads will be designed to meet KCDC’s design guidelines. A preliminary list of standards and requirements for local road cross sections has been prepared by KCDC and this is contained in KCDC Expressway Technical Note T7 Local Road Standards. A copy of this document is attached in Appendix 1.B. These will be used as a guide, and specific arrangements agreed between KCDC and NZTA.

The extent of work undertaken on the local roads will depend on the location and type of interchange proposed, and other local road effects resulting from changes in traffic patterns due to the proposed Expressway.

There will be locations where existing roads/property access will require realignment or other modification. In all such situations options will be developed jointly between NZTA and KCDC and property owners where appropriate, and take network effects and journey patterns into consideration.

The existing State Highway

The section of existing state highway bypassed by the proposed Expressway will need to be ‘modified’ to be suitable for the change of use for local road traffic. Design options will be developed jointly between NZTA and KCDC separate to the proposed Expressway Project.

4.4. Other transport modes

Cycleway/walkway

As part of developing the design for the proposed Expressway consideration has been given for a shared use cycleway/walkway along the route. The type of facility(e.g. surfacing and width) depends on the environment through which the proposed Expressway is located, and gives regard to safety, convenience and finished appearance. The design considers the existing network and ensures connectivity with existing cross corridor routes are maintained.

The objective of the design is to encourage cyclists off the proposed Expressway and onto the safer separate cycling and walking path, and to reflect the interest of the community in walking and cycling for transport and recreation.

The off road cycleway/walkway has a design width is 3m throughout the Project area, to allow for two way cycle traffic and pedestrians, though in certain locations where constraints require a narrower footprint, a 2m minimum width may be adopted in accordance with AUSTROAD standards.

Bridle trail

Existing bridle trail connectivity will be maintained, and where appropriate enhanced for the use of the public. New bridle trails will be considered at the northern and southern ends to recognise areas of local horse movement. These can consist of a grass strip 1m or greater in width adjacent to or separate from the cycleway/walkway path.

Rail corridor

At both tie-ins for the proposed Expressway, SH1 is adjacent to the North Island main trunk, (NIMT) railway. Any impacts on the rail corridor from the proposed Expressway design will be designed in liaison with Kiwi Rail.

Changes at Hadfield Road adjacent to the existing level crossing shall be designed in accordance with appropriate railway standards.

The future dual tracking of the NIMT at Hadfields Road has not been considered as part of the proposed Expressway Project.

4.5. Geometric design roading standards adopted

The following design standards documents have been used for the development of the MacKays to Peka Peka Project:

Table 2: Geometric Design Roading Standards

Design Element	Standards
Alignment	NZTA - Roads of National Significance Design Standards and Guidelines Austroads, Guide to Road design 2006 & 2010 – Parts 1, 2 & 3 NZTA DRAFT State Highway Geometric Design Manual (SHGDM)
At Grade Intersections & Roundabouts	NZTA DRAFT State Highway Geometric Design Manual (SHGDM) NZTA Manual of Traffic Signs and Markings (MOTSAM) Part 2 LTSA RTS 14 – Blind and Vision Impaired Pedestrians LTSA RTS 18 – On Road Tracking Austroads - Guide to Traffic Management – Part 6 Austroads - Guide to Road Design Parts 4, 4A & 4B KCDC Subdivision & Development Principles & Requirements NZS 4404 Land Development & Subdivision infrastructure (local roads)
Grade Separated Intersections	NZTA DRAFT State Highway Geometric Design Manual (SHGDM) Austroads - Guide to Traffic Management – Part 6 Austroads - Guide to Road design Parts 4 & 4C NZTA Traffic Control Devices Manual – Part 10 (MOTSAM Part 3)
Road Cross Section	NZTA DRAFT State Highway Geometric Design Manual (SHGDM) Austroads - Guide to Road design Parts 3, 6 & 6B NZS 4404 2010 Land Development & Subdivision infrastructure (local roads) KCDC Subdivision and Development Principles and Requirements Best Practice Subdivision Guide Best Practice Rural Subdivision Guide Streetscape Strategy and Guidelines
Safety Barriers	NZTA M23 Road Safety Barrier Systems AS/NZS 3845: 1999 Road Safety Barriers Austroads – Guide to Road Design – Part 6
Signs & Line Markings	NZTA Manual of Traffic Signs and Markings (MOTSAM Parts 1, 2 & 3)

Design Element	Standards
Drainage	Refer section 7, Stormwater Management
Bridges	Refer section 8, Structures
Pedestrian & Cyclist	Austroads Guide to Road Design - Part 6A

Where there is ambiguity or uncertainty between design standards discussions have been held with NZTA and KCDC as appropriate to resolve the issue. Where required, these ambiguities will be referred to the Value Assurance Committee, (VAC).

The NZTA Roads of National Significance Design Standards and Guidelines document defines the standards and guidelines that have been applied to the proposed Expressway Project, (except for Raumati Straight). This document provides standards and guidelines on some elements affecting the road geometry such as design speed, minimum curve radii, maximum grades, lane and shoulder widths, median and clear zone widths etc.

Generally the balance of the proposed Expressway geometric design standards have been sourced from the new Austroads design guides, which have recently been adopted by NZTA. The NZTA and LTSA documents such as the DRAFT State Highway Geometric Design Manual (SHGDM) are used for standards that are deemed applicable to New Zealand specific roading requirements.

4.6. Geometrics - Curve radii and superelevation

The curve radii used for the proposed Expressway design is taken from the NZTA RoNS design standards and guidelines

Desirable minimum radius 1100m (110km/hr); 820m (100km/hr)

Desirable superelevation of 4% (based on desirable radii and speeds)

Desirable minimum curve length 500m

Minimum radius 720m (110km/hr); 550m (100km/hr)

Maximum superelevation 6% (based on minimum radii and design speed)

Minimum curve length 300m

The minimum radii used for the scheme design is 720m for a design speed of 110km/hr with a maximum superelevation of 6%. In general, the horizontal curvature adopted has a minimum radii of 820m with a superelevation of 5.3%.

4.7. Longitudinal gradients

The vertical alignment has been developed using the gradient limits detailed in the NZTA RoNS design standards and guidelines.

Gradient limits – Limited to 4% and length <600m

Maximum 8% and lengths <300m

Longer steeper gradients require consideration of crawler lanes for safety and efficiency.

4.8. Operating speed and design speed

Expressway

The RoNS guidelines state that the design speed for the proposed Expressway shall be 100 km/hr increasing to 110 km/hr on long level sections. Given the general nature of the existing terrain (flat to rolling), it is proposed to use a design speed of 110kph throughout the proposed Expressway.

Local arterials/local road connections and crossings

The design speed of local roads will vary depending on the site conditions. This will be agreed with KCDC but it is expected that existing posted speeds will be maintained, unless the speed environment of the local road is altered as a result of the proposed Expressway. Any future speed management regime will be discussed with KCDC and adopted as appropriate.

4.9. Cross section

Expressway

The typical proposed Expressway cross section through Sectors 1 to 4 will consist of 2 x 3.5m traffic lanes in each direction, separated by a median with barrier, a nearside (lefthand) shoulder width of 2.5m, and an offside (right hand) shoulder width of 1.0m, (except for the Raumati Straight).

The current proposed median width along proposed Expressway route varies from 4m to 6 m (edge line to edge line). A narrow median contributes to an overall narrower road footprint and therefore assists in minimising the width and quantity of ground improvements required particularly in the peat. However a slightly wider median allows for the construction of separate (or twin bridges) that pass over local roads with a light shaft between, which is desirable in the urban road locations. Therefore the current proposed median widths are as follows:

Existing 3m median with concrete barrier to remain on Raumati Straight (i.e. staying within the existing WLR designation and minimising intrusion into QE Park to the start of the southern interchange);

4m median just south of south facing ramps at Poplar Avenue through to south of Raumati Road, to minimise footprint width;

6m median from South of Raumati Road through to north of Mazengarb Road, to provide greater width for separate bridges at the urban local road crossings of the proposed Expressway;

4 m median from north of Mazengarb Road through to Peka Peka. This section is generally away from the urban area and therefore a narrower footprint with single bridges is provided. The narrower footprint through Waikanae assists in minimising impacts on the surrounding Waahi Tapu area and reduces the width at the two longer bridges.

To provide visibility at the median barrier a 6m wide median is provided for curves less than 820m radius

The preferred median barrier treatment is a TL-4 wire rope (WRB) median barrier between north and southbound carriageways. Where twin structures pass over local roads rigid concrete barriers are proposed.

At the shoulder edge, barriers may be required where localized reductions in berm width are required, appropriate clear zones cannot be achieved and as protection to bridge structures, sign gantries and other hazards within the clear zone.

Shoulders

The left hand shoulder is 2.5m in width and will have diagonal markings at 100m spacings generally and 50m spacings closer to interchanges. Shoulders will include a 0.5m verge adjacent to edge barriers to provide a 3m shy line off set. The RoNS guidelines state that full shoulders shall be carried over structures. Edge barriers will be placed at the back of the shoulder over structures.

Local roads

Where local road alignments are adjusted for line and/or grade to accommodate the proposed Expressway, the existing local road carriageway cross section widths will be maintained unless required to be changed as a result of construction of the proposed Expressway or advised by, and agreed otherwise with KCDC.

Carriageway widths will be measured from edge of seal to edge of seal. Concrete channels / nibs are not included in any traffic lane, but are to be included as part of the overall shoulder width.

All footpath and berm widths will be provided as per the existing configuration or as advised by, and agreed with KCDC.

All barriers and clear zones shall comply with the requirements of the design standards for local roads. All clear zones shall be matched to the operating speed of the road where achievable.

Edge treatment - clear zones and side protection barriers

The clear zone width for the proposed Expressway is prescribed in the RoNS Standards and Guidelines document as 9.0 m from the edge of the traffic lane.

The preferred maximum berm slope within the clear zone is prescribed in the RoNS Standards and Guidelines as 6H:1V where there are significant numbers of heavy vehicles, but with an overall maximum of 4H:1V. Should surrounding constraints make these slopes unachievable or undesirable, steeper slopes will be used with an appropriate edge barrier system provided.

The design philosophy adopted to date has been to minimise the footprint of the construction of embankments and cuts and thereby minimising the extent of ground treatment to the underlying peat. The current proposed clear zone treatment is as follows:

9 m clearzone with maximum slope of 4H:1V in cut areas and in low embankment areas (less than 2.5 m high) and provide a 3m run off width at the base of slopes that are >6H:1V. The clear zone width may include the swale where it meets the criteria for a traversable ditch.

Provide a barrier within a 1.5m wide verge, with a maximum slope of 3H:1V slope at high embankments, typically >2.5m high to minimise fill material volumes and ground improvement widths.

For local roads the clear zone width requirement is adopted from the appropriate section of the NZTA SHGDM and is based on the operating speed of the road.

Structural Lateral Clearances

Where a structure (bridge pier / retaining wall face panel) cannot practically be located outside the required clear zone width, a TL-4 barrier will be provided. The face of the structure will be located 900mm (min) behind the face of a rigid barrier, or outside the deflection of a flexible barrier system.

4.10. Sight distance

As the Alignment is generally flat the key sight distance criteria is based on a reaction time of 2.5 seconds. A deceleration rate of 0.26 gravity will be used.

Main carriageway

All traffic lanes on the main carriageway have been designed to comply with the two following stopping sight distance (SSD) criteria for cars, which are taken from the Austroads Guide to Road Design Part 3 and the NZTA SHGDM.

1 x SSD from an eye height of 1.10m to an object height of 0.2m

1.4 x SSD from an eye height of 1.10m to an object height of 1.25m

Off-ramps

All off-ramps will be designed to comply with the following sight distance criteria, which are taken from Austroads Guide to Road Design Part 4c: Interchanges, NZTA SHGDM and Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.

310m from an eye height of 1.10m to the start of the diverge taper (object height 0.0m), or 215m with an exit auxiliary lane;

310m from eye height of 1.10m to the pavement adjacent to the ramp nose (object height 0.0m), or 215m with an exit auxiliary lane;

310m from an eye height of 1.10m to the pavement (zero) through the diverge to 60m past the nose where achievable, or 215m with an exit auxiliary lane;

Approach sight distance (ASD) and safe intersection sight distance (SISD) will be provided at ramp terminal intersections. (ASD eye height=1.10m to 0.0m object height, SISD eye height = 1.10, object = 1.25m)

Minimum gap sight distance (MGSD) will be provided at unsignalised ramp terminal intersections. (MGSD eye height=1.10m, object height=0.65m)

Note that tabulated values for different design speeds and correction factors for grades are given in the reference documents.

On-ramps

On-ramps will be designed to comply with the following sight distance criteria, which are taken from the design guides as listed in 4.8.2 above.

Approach to: 6 seconds of travel time at respective operating speeds on each carriageway prior to the nose (1.10m eye height to 0.1m object height)

Mutual visibility between carriageway: 4 seconds of travel time at respective operating speeds for each carriageway prior to point where merging lanes are separated by 2m (1.10m eye height to 1.10m eye height)

Terminal visibility: 6 seconds of travel time at operating speed to any point on merge taper (1.10m eye height to 0.0m object height)

Approach sight distance (ASD) and safe intersection sight distance (SISD) will be provided at ramp terminal intersections. (ASD eye height=1.10m to 0.0m object height, SISD eye height = 1.10, object = 1.25m)

Minimum gap sight distance (MGSD) will be provided at unsignalised ramp terminal intersections. (MGSD eye height=1.10m, object height=0.65m)

Local road intersections

Local road intersections will be designed to comply with the following criteria, which are taken from Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.

Approach sight distance (ASD) safe intersection sight distance (SISD) will be provided at local road intersections(ASD eye height = 1.10m, object = 0.0m, SISD eye height = 1.10m, object height = 1.25m)

Minimum gap sight distance (MGSD) will be provided at local road unsignalised intersections (MGSD eye height = 1.10m, object height = 0.65m)

4.11. Vertical clearance

Bridges and sign gantries over the proposed Expressway will be designed for a minimum vertical clearance of 6m, and provide for minimum vertical clearance for over dimension loads.

Footbridges over the proposed Expressway will be designed for a minimum vertical clearance of 6.2 m.

Bridges over local roads will be designed for a minimum clearance of 4.9 metres. The Raumati Road underbridge has a clearance of 6.0m to provide for over dimension loads south of the Waikanae River. North of the Waikanae River over dimension vehicles can use the Peka Peka interchange over bridge.

4.12. Design vehicles

The primary design vehicle used for all proposed Expressway ramp and local road intersections is a 19m quad axle semi-trailer (vehicle configuration A124). All turning movements are undertaken using the 15m general minimum turning radius as opposed to the absolute minimum radius.

High Productivity Motor Vehicles (HPMV's) will also be considered in the final design of the proposed Expressway ramps and local road intersections. The 19m quad axle semi-trailer design is expected to cater for many HMPV configurations however final choice of design vehicle and performance at intersections will need to confirmed.

All multi-lane turns shall be designed so that the primary design vehicle can use any lane in conjunction with a 90th percentile car.

4.13. Services

Existing services that are affected by the construction works have been identified and extent/scope of relocation is being agreed in discussions with the relevant services authorities.

Space for new or future services will be provided adjacent to the proposed Expressway. It is expected that these may be accommodated under the shared cycleway/walkway which will also provide future maintenance access to the services. Where these are services proposed are not to be owned by NZTA appropriate agreements will need to be negotiated.

4.14. Customer information services

Customer information services such as ATMS, CCTV and VMS will be incorporated into the design. The current requirements are as follows:

Ducts and pits

6 x 100mm diameter ducts and associated pits, along the full length of the proposed Expressway.

Variable message signs (VMS)

I. VMS signs on the proposed Expressway, located prior to off-ramps. Signs to be 3-line, 300 mm high characters, 18 characters per line. Current proposed locations are as follows:

Northbound: south of Poplar Avenue (existing sign on Raumati Straight), south of Kāpiti Road interchange and south of Te Moana Road interchange.

Southbound: north of Peka Peka interchange, north of Te Moana Road interchange, north of Kāpiti Road interchange and near MacKays Crossing (existing sign).

II. VMS signs on local roads at approaches to interchanges. Signs to be 3-line, 200 mm high characters. Current proposed locations are Poplar Avenue (one sign), Kāpiti Road (two signs, one each on east and west approaches to interchange) and Te Moana Road (two signs, one each on east and west approaches to interchange).

CCTV cameras

Pan tilt zoom (PTZ) cameras are to be provided at each interchange and at locations along the proposed Expressway route selected to give coverage of as much of the route as practicable. Approximately 14 locations are currently proposed.

4.15. Construction considerations

Potential construction effects will be reviewed during the design process, with a view to considering how these temporary effects may be avoided or mitigated as part of the design.

Safety of pedestrians, cyclists and motorists, minimising impacts on traffic movements during construction are factors which have been considered in evaluating options and in developing the design of the proposed Expressway. These factors apply particularly at interchanges and grade separated road crossings, as most of the proposed Expressway is being constructed off line of existing roads and areas where the public will access.

This DPS does not cover detailed construction methodologies. Construction management plans will be prepared demonstrating how other effects of construction will be managed including noise, dust, erosion and sediment control and runoff and other discharges.

A construction methodology has been developed which takes into account constraints including ground improvements (preload durations, excavation and replacement etc.), material sources, minimising vehicle movements on public roads and possible early opening of parts of the proposed Expressway. At this time it is expected that a main component of the construction methodology will involve using the proposed Expressway corridor to transport materials along rather than utilising existing local roads for this purpose, with bridges constructed early to allow this transport to occur.

5. Pavement design

5.1. General

Pavement design will generally fall into 3 categories:

- Expressway pavements;
- Existing State Highway pavement rehabilitation; and
- Local road pavement rehabilitation and widening.

It is anticipated that the local road pavements will consist of a granular base with asphaltic concrete surfacing and the proposed Expressway pavements will consist of a granular base, including modified materials with a combination of asphaltic concrete, open grade porous asphalt and chipseal, depending on the location along the proposed Expressway. The rehabilitation of the existing State Highway, (Raumati Straight) maybe undertaken with an asphaltic concrete overlay/ foamed bitumen, or similar to address the failures that have occurred.

5.2. Design standards and references

All pavement designs at this stage will be designed in accordance with Austroads (2004) Pavement Design Guide and the TNZ supplement (2007). The NZTA are aware that there is a 2009 Austroads Guide with a 2010/2011 supplement due out in the next 12 months which will be used during the detailed design phase. A design life of 25 years will be adopted.

Whole of life cycle costs/benefits have been considered in the evaluation of pavement and surfacing design options including the option of a full depth structural asphalt.

5.3. Assumptions

The pavement design will be based on the following supplied data and assumptions:

- 25 year design life. The 25 year design life does include some pavement rehabilitation due to the long-term settlement as part of the design philosophy adopted.
- 95% Project reliability.
- An Expressway design speed of 110km/h.
- Subgrade CBR data obtained from ground investigations.
- Calculations of predicted traffic flows and percent heavy vehicles will be determined once interchange options have been confirmed.

5.4. Traffic loading

Traffic volumes and heavy vehicle percentages will be extracted from the traffic model for the years 2016, 2026 and 2031. Data will also be obtained from heavy vehicle operators in the region. HCV growth rates from the modelled years will be used to extrapolate HCV growth to 2041. If the growth rate of High Mass HPMV Vehicles is considered to be significant an appropriate allowance will be made in the traffic loading calculations to account for this.

6. Geotechnical

6.1. General

The MacKays to Peka Peka Project traverses through sand dunes and low lying inter-dunal deposits along the proposed Alignment.

The earthworks comprises new embankments typically 2 to 3m high across low lying areas, cut slopes typically 10m and up to 25m high through sand dunes and new approach embankments for structures. Embankments in the order of 7m high are required at local road crossings to provide sufficient height clearance.

There are four grade separated interchanges along the route; these are located at Poplar Avenue, Kāpiti Road, Te Moana Road and Peka Peka Road. There are a number of local road and river/ stream/watercourse crossings along the proposed Alignment. For each bridge structure, piled foundations are required. Road and river/stream crossings are listed in Section 8.2.

The Waikanae River crossing is a major river crossing, and the structure is expected to be approximately 180m in length to bridge across the flood plain.

Peat deposits present in the low lying inter-dunal depressions are typically very soft with high organic contents and high compressibility. The presence of peat deposits across the site, and the associated embankment settlements are a key geotechnical aspect for the Project.

The site is located in a highly seismic area. Known active faults are nearby and potentially cross the northern end of the Alignment. Loose to medium dense sands are present across the site. These have the potential to liquefy as a result of a moderate or larger seismic event.

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 for those greater than 3m high.

Retaining walls are used at Kāpiti Interchange to limit the embankment footprint, for the lowering of the existing Mazengarb Road, and for the new access to Nga Manu Nature Reserve. As the geometric design is refined, the footprint of the earthworks may be reduced due to Designation or neighbouring property constraints. Retaining walls are to be constructed at these locations; however the locations are yet to be determined.

The location and extent of the geotechnical works has been developed as the part of the Scheme Assessment Stage design, and will be refined during subsequent design phases.

6.2. Scope

This section provides the design philosophy that has been adopted for the geotechnical aspects outlined below:

- Peat Treatment. New embankments constructed over peat deposits, including:
  - Assessment of construction settlements;
  - Assessment of the long-term performance of the proposed Expressway (considering post construction settlements).
- Earthworks (Static). New cuttings, new embankments and new earthworks. It also covers existing slopes, where their stability has the potential to impact on new structures. It does not extend to existing geotechnical features which remain unmodified. Assessment of slope stability during construction and under long-term static conditions have been considered.
- Earthworks (Seismic). New cuttings, new embankments and new earthworks. It also covers existing slopes, where the stability of these slopes has the potential to impact on new structures. It does not extend to existing geotechnical features which remain unmodified. Aspects that have been considered are listed below:
  - Assessment of liquefaction potential under the design earthquake events (serviceability and ultimate events);
  - Assessment of slope seismic stability, including the effects of liquefied soil strengths;
  - Assessment of seismic induced displacements, including lateral spreading and liquefaction settlements.

- Seismic Ground Improvements. Ground improvements required for seismic performance of the general embankments and bridge approach embankments.
- Bridges. New bridge foundations and abutments, including the Waikanae River crossing, stream crossings and local road crossings.
- Retaining Walls. New retaining structures, including temporary and permanent structures.
- Groundwater. The assessment of the influence of the proposed Expressway development on the groundwater regime and associated effects.

6.3. Design standards and references

The design is generally in accordance with the relevant NZTA design standards where available. Designs also comply with the relevant sections of the New Zealand Building Code where appropriate. Geological descriptions and materials assessments are in general accordance with the New Zealand Geotechnical Society Guidelines.

Significant portions of the geotechnical scope are not covered by specific New Zealand Standards. Where this is the case a relevant international standard or guideline has been referenced. Relevant geotechnical standards include:

- Transit New Zealand Bridge Manual June 2003, 2nd Edition & June 2004, September 04, December 04 & July 05 Amendments
- NZ Building Code, Verification Method B1/VM4, Foundations, December 2008
- NZS 1170.5: 2004, “Structural Design Actions, Part 5, Earthquake Actions, New Zealand”
- New Zealand Geotechnical Society “Geotechnical Earthquake Engineering Practice – Module 1: Guidelines for the identification, assessment and mitigation of liquefaction hazards”, July 2010.
- NZS 4402: 1986, “Methods of Soil Testing for Civil Engineering Purposes” & Supplement 1: 1998
- AS 2159: 2009, “Piling – Design and Installation”
- AS 4678: 2002, “Earth Retaining Structures” & Amendment 1 & 2.
- BS/EN 1537: 2000, “Execution of Special Geotechnical Work – Ground Anchorages” (partly replaces BS 8081)
- BS 8002: 1994, “Code of Practice for Earth Retaining Structures” & Amendments 12062, 13386 & 8851.
- BS 8006: 1995, “Code of Practice for Strengthened /Reinforced Soils and Other Fills” (partially replaced by BS EN 14475:2006)
- BS 8081, “Code of Practice for Ground Anchorages” & Amendment 7268 (partially replaced by BS 1537)

- FHWA - Mechanically Stabilised Earth Walls and Reinforced Earth Slopes, Design and Construction Guidelines, March 2001, Publication No. FHWA-NHI-00-043
- FHWA - Geotechnical Engineering Circular No. 3, Design Guidance: Geotechnical Earthquake Engineering for Highways, Vol. I & II, May 1997, Publication No. FHWA-SA-97-076 & 077
- CIRIA C580, Embedded Retaining Walls – Guidance for Economic Design, 2003
- TNZ F/1: 1997, Earthwork Construction
- TNZ F/2: 2000, Pipe Subsoil Drain Construction
- TNZ F/5: 2000, Corrugated Plastic Pipe Subsoil Drain Construction
- TNZ F/7: 2003, Geotextiles.

6.4. Design constraints and assumptions

Geotechnical considerations

The key geotechnical considerations that have been identified for the proposed 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; and
- Founding conditions for bridge structures comprising alluvial deposits to depth, predominately interbedded dense sands and gravels.

The presence of peat deposits, seismic aspects and groundwater considerations 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 0.5 m to 4 m thick, and up to 6 m thick in some locations.

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

- Post construction settlements and potential differential settlements which will impact on the performance of the proposed 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 cases; and
- Potential settlement of services beneath the embankment and adjacent structures and property.

Ground improvements are also required to limit post-construction settlement of the proposed Expressway where peat deposits are present below the new road embankments. A paper describing the proposed evaluation methodology for ground improvements was prepared for the NZTA (refer MacKays to Peka Peka Expressway: Long-term Settlement and Pavement Performance, (refer Appendix 1.C). The treatment approaches proposed vary along the proposed 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.

I. Excavate and Replace

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

- The Alignment traverses across both sand dunes and peat deposits, between Kāpiti Road and Smithfield Road. The peat deposits are generally less than 3 m deep in these locations; and
- 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.

II. 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. Some ongoing secondary and creep settlements are expected.

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 proposed Expressway where:

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

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; and
- 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 proposed 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 m in height. The ground improvements are described below in Section 6.5.4.

Groundwater

The site is underlain by a series of shallow unconfined aquifers, with high connectivity. The groundwater level is close to the existing ground level in the low lying areas and wetlands. The shallow aquifers feed the wetland areas, which are considered to have high ecological value. Shallow residential bores target this aquifer for drinking and irrigation purposes. Constraints associated with groundwater include:

- Changes in permeability and groundwater flow resulting from the proposed Expressway construction have been considered and effects assessed (refer Assessment of Groundwater Effects, Technical Report 21, Volume 3). Potential permeability changes include consolidation of peat, or removal of peat and replacement with another more permeable material;
- The choice of construction techniques adopted for excavation (earthworks and piling) have considered potential dewatering and impacts on water quality; and
- Changes in ground water level resulting from the proposed Expressway construction have been considered and assessed (Technical Report 21, Volume 3), including potential settlements below the embankment and on surrounding properties, effects on water quantity/ quality extracted from residential groundwater bores and effects on wetlands/ springs.

Design assumptions

The Scheme Assessment Stage geotechnical design has been based on the following assumptions:

Seismic design criteria have been developed based on the site specific seismic hazard assessment undertaken for the Project area (refer M2PP-SAR-RPT-ST-GE-278: MacKays to Peka Peka Expressway Site Specific Seismic Hazard Assessment). The seismic design events for the bridge approach embankments, the bridge structure foundations and the retaining walls have been based on the return periods outlined in Table A4 of the NZTA Bridge Manual December 2004 Amendment. The general embankments design has been based on a ULS seismic design event with a 1/1000 year return period.

Seismic induced displacements for new embankments and existing sand dunes are acceptable under the ultimate seismic design event, where these slopes are not associated with structures. In this case, the magnitudes of displacements have been assessed. Measures have been included within the Project scope to prevent “flow” type failures and limit seismic movements of general embankment where considered economically feasible (refer seismic ground improvements).

6.5. Principal elements

Peat treatment

Where the proposed Expressway will be constructed over peat deposits, some ongoing secondary and creep settlements are expected. The post construction performance of the proposed Expressway, and an acceptable level of risk, has been assessed. 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 proposed Expressway performance and reputation. The criteria adopted for design is outlined below:

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

The pavement will require resurfacing approximately 8 to 10 years following construction. Some shape correction of the pavement is likely to be required within the 10 years following construction.

The magnitude and timing of the construction and post construction settlements have been assessed where Preload and Excavate peat treatment is proposed.

Earthworks: static stability

Engineered fill embankments, cut slopes and existing slopes affected by the proposed Expressway are designed to achieve the following static slope stability requirements.

I. Methods of Analysis

Where applicable, stability analyses have been undertaken using the computer program Slope/W at critical cross sections along the Alignment. The lowest factor of safety have generally been located by searching through a range of circular and translational failure surfaces.

II. Analysis Cases

The following cases have been analysed:

- Long Term Static Case – analysis used most credible/moderately conservative effective stress parameters and anticipated long-term groundwater profiles.
- Short Term End of Construction Case (for fill embankments) – analysis used initial undrained strength parameters, not allowing for any increase in strength due to consolidation.
- Staged Construction Case (for fill embankments) – analysis used undrained strengths derived from applied loading, assuming 50% consolidation. Field conformation will be required during construction.

III. Factors of Safety

For general design of cut and fill slopes, the following loadings and target factors of safety against instability have been adopted:

Table 3: Cut and Fill Slope Loads and Target Factors of Safety

Load Case	Loading	Factor of Safety
Long Term Static Case (embankments and cuts)	Traffic surcharge as per NZTA	≥ 1.5
Short Term - End of Construction Case (embankments)	Initial undrained strength parameters and construction traffic surcharge, strength gain from staged construction	≥ 1.3

IV. Erosion Control

Sand dunes are particularly prone to wind and water erosion. All cuts and embankments will be stabilised by revegetation.

Earthworks: seismic design

I. Liquefaction Assessment

Potentially liquefiable material has been identified along the Alignment. A liquefaction assessment has been undertaken generally based on the New Zealand Geotechnical Society Geotechnical Earthquake Engineering Practice (July 2010).

The liquefied shear strength of the soils assessed to liquefy have been determined based on empirical relationships proposed in a paper by Idriss and Boulanger (2007). These liquefied shear strengths have been adopted to assess the seismic performance of the embankments and expected permanent displacements.

II. Seismic Stability of General Embankments

The Transit NZ Bridge Manual does not specifically cover embankments and slopes away from structures. The seismic design cases have been based on industry practice and other large NZTA projects. The following design cases have been considered for a ULS seismic event with a 1/1000 year return period:

- Where liquefaction is anticipated, the design seismic acceleration is modelled concurrently with liquefied soil strength and permanent displacements assessed;;
- Where liquefaction is anticipated, a post-earthquake event is modelled with residual liquefied soil strength. For this case a target Factor of Safety greater than 1.0 has been adopted to avoid potential flow failures; and
- Where liquefaction is not anticipated, the design seismic acceleration is modelled. For this case the assessed permanent displacements are less than 150 mm.

Ground improvements have been included into the scheme to limit the seismic embankment movements of new embankments greater than 3 m high (refer Section 6.5.4: Seismic Ground Improvements).

III. Seismic Stability of Bridge Approach Embankments

The seismic design cases for bridge approach embankments are based on the Transit NZ Bridge Manual requirements. The ULS design seismic event varies based on the Importance Level of the structure, as presented in Table 4.

Table 4: Bridge structure seismic design events

Structure Importance Level [1]	Return Period of ULS Event
2	1:1000 year
3	1:2500 year
(1) The Importance Level is defined in the Transit NZ Bridge Manual	

For slope stability affecting structures:

- Where liquefaction is not anticipated, a target Factor of Safety greater than 1.0 has been adopted;
- Where liquefaction is anticipated, the slope has been analysed adopting liquefied strength parameters and 100 % of the design peak ground acceleration concurrently. The permanent displacements have been assessed and considered during the structural analyses of the bridge. Ground improvements have been adopted to limit these displacements to values that the structures can tolerate; and
- Where liquefaction is anticipated, the slope has been analysed adopting liquefied strength parameters post-earthquake event. For this case a target Factor of Safety greater than 1.0 has been adopted to avoid potential flow failures.

IV. Predicted Seismic Movements

The movement of the bridge approach embankments have been estimated using the empirical method outlined in a paper by Ambraseys and Menu (1988). These movements have been assessed considering liquefied strength parameters and 100 % of the design peak ground acceleration concurrently. Target movements have been developed for both the general and bridge approach embankments(refer 6.5.4). Movements for the bridge approach embankments have been limited to be consistent with the bridge structure foundation design.

Seismic ground improvements

I. General Embankments

The expected performance of slopes following a significant earthquake event has been assessed. The proposed 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 for new embankments greater than 3 m high. These have been design based on the following target movements for the 1:1000 year earthquake event.

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

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

As the design is developed, there may be situations on the Project where these general guidelines are considered uneconomic or unwarranted. In such cases site specific criteria may be developed (with the approval of NZTA) using a risk based approach.

II. Bridge Approach Embankments and Abutments

The design of the bridge abutments, abutment piles and associated ground improvements, are governed by the seismic loading and potential liquefaction. The proposed extent of ground improvements is based on limiting movement of the bridge abutments and approach embankments in close proximity to the bridge structures. Table 5 outlines the target movement limits that have generally been adopted for preliminary design of the ground improvement. These target movements have been selected based on compatibility with the adopted structural form and to limit the loading imposed on the structure.

Table 5: Proposed ULS abutment movement limits

Movement Direction	50% POE Movement (mm) (2)	10% POE Movement (mm) (2)
Longitudinal	100	300
Transverse	100	300

(1) Movements have been estimated using Ambraseys and Menu (1988).

(2) (x)% is the probability the predicted movement is exceeded.

(3) The predicted movements are based on the full design acceleration occurring in the movement direction.

Bridge structures and foundations

This section should be read in conjunction with Section 8. The piles are to be designed in accordance with Transit New Zealand Bridge Manual and AS2159, considering:

- Scour depths;
- Negative Skin Friction (NSF) resulting from both consolidation and liquefaction settlements; and
- Seismically induced embankment displacements.

Retaining walls

All retaining walls will be designed in accordance with the Transit New Zealand Bridge Manual. The extent and location of the retaining walls are yet to be defined.

Groundwater

The influence of the proposed Expressway development on the groundwater regime and associated effects have been assessed.

The KCDC Guiding Objectives require this proposed Expressway to be designed and constructed in a manner that:

- Ensures the hills to coast stormwater flow (both surface and groundwater) is not impeded.
- Ensures the natural flows in wetlands are not impeded.

The potential changes in groundwater and associated effects are presented in the Assessment of Groundwater Effects Report (Technical Report 21, Volume 3).

7. Stormwater management

7.1. General

NZTA's approach to stormwater management sets the context and framework for stormwater management on this Project. This approach, noted in NZTA's Stormwater Treatment Standard for State Highway Infrastructure, is:

> *"To provide best practice for both stormwater quantity and quality control that, in the absence of local requirements or where local requirements are limited, NZTA will undertake to demonstrate environmental responsibility"*

Because this proposed Expressway will be within the Kāpiti Coast District Council area, and they have a formal stormwater strategy and preferred approaches for stormwater and flood risk management, the proposed Expressway Project has taken these into account in selecting design options.

On M2PP stormwater management addresses issues that can be divided into five general areas:

- Expressway stormwater management (quantity and quality);
- Pavement surface drainage;
- Subsurface drainage;
- Wider catchment stormwater management; and
- Erosion and sediment control.

The route generally traverses a mix of rural and urban catchments both upstream and downstream. Many wetlands have formed in the low lying inter-dunal areas and many of these are culturally and/or environmentally significant.

The proposed Expressway Project will interact with the following stormwater and related environmental features along the route, progressing south to north:

- Queen Elizabeth Park Drain (Whareroa Stream tributary);
- Wharemauku Stream and tributary drains;
- Mazengarb Drain;
- Wastewater Treatment Plant Drain;
- Landfill Drain;
- Otaihanga Drain;
- Muaupoko Stream;
- Waikanae River;
- Waimeha Stream;
- Ngarara Creek;
- Kakariki Stream (adjacent Ngamanu Wildlife Reserve);
- Paetawa Drain;
- Ngarara Stream tributaries;
- Hadfield / Te Kowhai Stream;
- Wetland areas (of varying sizes and environmental significance);
- Land drains & other smaller watercourses;
- Local KCDC drainage networks; and
- Floodplains and other flood storage areas and flow paths (including associated infrastructure such as stopbanks) associated with the above.

7.2. Design standards and references

The design is to NZTA requirements for highway serviceability and the RoNS standards, but will also need to be consistent with the conditions of regional consents for stormwater discharge and works in watercourses and with KCDC requirements.

The design will be prepared according to the following standards and guidelines as appropriate:

- Roads of National Significance Design Standards and Guidelines;
- Stormwater Treatment Standard for State Highway Infrastructure, 2010, NZTA;
- Bridge Manual, Second Addition, June 2003 (with July 2005 Amendment), NZTA;
- TNZ F3 Pipe Culvert Construction;
- TNZ F5 Corrugated Plastic Pipe Subsoil Drain Construction;
- TNZ Highway Surface Drainage: A Design Guide for Highways with a Positive Collection, 1977;
- Austroads Waterway Design, 1994;

- Waikanae River Floodplain Management Plan: The Community's Plan for the Waikanae River and its Environment, 1997;
- Waikanae Floodplain Management Plan – 10 year Review Summary Report for Consultation, May 2010, GWRC;
- Waikanae River Environmental Strategy, KCDC and GWRC, Mar 1999;
- Draft Erosion and Sediment Control Standard for State Highway Infrastructure. Aug 2010, NZTA;
- Erosion and Sediment Control Guidelines for the Wellington Region, 2002, GWRC;
- NZS 4404, Land Development and Subdivision Engineering;
- Verification Method E1/VM1, New Zealand Building Code;
- Tools for Estimating the Effects of Climate Change on Flood Flow: A Guidance Manual for Local Government in New Zealand, 2010, Ministry for the Environment;
- Tools for Estimating the effects of climate change on flood flow, 2010, Ministry for the Environment;
- Bridge Scour, Melville & Coleman;
- Regional Freshwater Plan, 1999, GWRC;
- Fish Friendly Culverts and Rock Ramps in Small Streams, GWRC;
- Mind the Stream Guide, GWRC;
- Landscape and Ecology Values Within Stormwater Management, Aug 2010, ARC;
- AS/NZS 2566 Buried Flexible Pipelines, 1998;
- AS/NZS 3500.3, Plumbing and Drainage Part 3: Stormwater, 2003;
- AS/NZS 3725, Design for Installation of Buried Concrete Pipes, 2007;
- Auckland City Council, Soakage Design Manual, 2003;
- ARC, TP10 Stormwater Management Devices: Design Guidelines Manual;
- ARC, TP108 Guidelines for Stormwater Runoff Modelling in the Auckland Region;
- ARC, TP131, Fish Passage Guidelines for the Auckland Region;
- Waterways Wetlands and Drainage Guide – Part B: Design, CCC;
- KCDC District Plan;
- KCDC Subdivision and Development Principles and Requirements, 2005; and,
- KCDC Stormwater Management Strategy.

The following additional documents and information sources will also be used as an input into the design:

- KCDC Western Link Road Stormwater and Hydrological Assessment, 2007;
- Investigating the Sustainable Use of Shallow Groundwater on the Kāpiti Coast, 2005, GWRC;
- KCDC Update of Kāpiti Coast Hydrometric Analysis, SKM, 2008;

- Western Link Road Resource Consents;
- Wharemauku Stream Floodplain Management, Rev C, 2009, KCDC;
- Mazengarb Floodplain Management Plan (when released in 2011), KCDC;
- Waikanae Flood Hazard Mapping, Rev A, Mar 2010, KCDC;
- Poplar Avenue Flood Hazard Plan, Jun 2005, KCDC;
- Ngarara – Assessment of Environmental Effects – Stormwater, Rev D, Mar 2008, Maypole Environmental Ltd;
- Waikanae Hydraulic Model Update 2009, GWRC;
- Waikanae Hydraulic Model Update 2010, GWRC;
- HIRDs V3 Rainfall database, NIWA;
- Water Resource Explorer (WRENZ), NIWA, 2011;
- Long Term Town Centre Flood Storage Options Assessment, Rev B, Jul 2010, KCDC;
- Flood Analysis of the Zoned Paraparaumu Town Centre Expansion Area, Draft, Jul 2010, KCDC;
- Design Guidelines for the Calculation of Stormwater Peakflows for Kāpiti Coast District Council, 2003;
- Plan Change 80 - Ngarara Settlement;
- Plan Change 79 – Waikanae North Urban Edge and Eco-hamlets;
- Plan Change 83 – Meadow Life Trust; and
- Other plan changes as identified as the Project progresses.

7.3. Design constraints and assumptions

Constraints

The following are identified as stormwater design constraints:

- Not increasing flooding to land upstream or downstream, nor increasing peak flow rate leaving the site;
- Flood levels, flow paths, storage areas and floodplains as shown on KCDC flood maps;
- Existing wetlands;
- Groundwater levels;
- Spatial constraints for locating new wetlands/ponds;
- KCDC District Plan that details existing and future land development;
- Bridge piers/abutments clear of the primary watercourse channel; and
- Further key constraints to be added as identified.

Assumptions

The key assumptions for the design are:

- KCDC/GWRC catchment/river models have been used to provide water level and flow information:
- Treatment and attenuation (80% of pre-Expressway flows) is required and will be designed in accordance to NZTA's Stormwater Treatment Standard for State Highway Infrastructure;
- Climate change will be considered out to 2090 in accordance with KCDC parameters. These were confirmed to be at 2090, with a 0.8m sea level rise and a 16% rainfall increase. Long term groundwater rise from climate change is not expected to effect the functioning of swales and wetlands as these will include a gravity outlet that sets and maintains water levels during dry periods;
- Seek to minimise stormwater effects on the environment by utilising a low impact design approaches;
- Overall, the design will meet KCDC's hydraulic neutrality criteria whilst keeping open the opportunity of achieving this outside the footprint of the proposed Expressway (e.g. integration with KCDC's town centre development works etc);
- Simulations of future catchment development scenarios is not required due to KCDC's requirement that new developments achieve "hydraulically neutrality" means that future peak flows will be no greater than current levels;
- Downstream boundary conditions/tail water levels to be confirmed in the first instance from KCDC/GWRC models or for areas not covered by models then further investigation and design will be carried out; and,
- Road geometry allows for aquaplaning requirements to be achieved. In specific situations where this cannot be achieved the risk and consequences will be reviewed on a case by case basis and exemption sought.

Further key assumptions to be added as identified.

1.7.4 Principal elements

Hydrologic design criteria

Rainfall

KCDC hydrology has been used for determining the flows for waterway crossings (culverts and bridges) as these will be tested in KCDC's models. However, for design within the Expressway HIRDS V3 is used because it provides data at a level of detail and in a form that is more appropriate for proposed Expressway design and is slightly more conservative than KCDC's rainfalls.

The potential effects of climate change have been allowed for to 2090 the HIRDS V3.0 generated rainfalls are consistent with KCDC's climate change parameters. A comparison of rainfall depths to 2090 climate change at the Waikanae River are set in the table below. KCDC rainfalls for durations shorter than 24hrs have been determined in accordance with KCDC's guidelines:

Table 6: Comparison of Rainfall Depths to 2090 Climate Change at the Waikanae River

Storm	Duration	KCDC Rainfall (mm)	HIRDS V3 Rainfall (mm)
1% AEP	10mins	165.6	172.0
	1hr	43.1	52.3
	24hrs	18.2	21.8
10% AEP	10mins	12.1	13.4
	1hr	28.7	31.6
	24hrs	110.2	113.8
50% AEP	10mins	8.4	9.1
	1hr	20.0	21.0
	24hrs	76.0	80.7

KCDC and GWRC's models already include design storms / hyetographs that will be used for investigating the wider floodplain effects and also for design of waterway crossings. However, it is noted that they may not have sufficient resolution for the short times of concentrations that will be involved with the proposed Expressway carriageway drainage design and will be subject to review.

In accordance with KCDC standards, an abstraction of 5mm will be used for pervious areas and 0mm for impervious areas.

Runoff

Information on runoff from catchments outside the proposed Expressway has been sourced from KCDC and GWRC models, in the first instance. Where models are not available runoff has been investigated using several different methods, including the U.S. Natural Resources Conservation Service "Curve Number" (CN) method, the regional flood estimation method[3], and the KCDC method[4]. The last of these gave the most appropriate results, and closely align with those used by KCDC / GWRC in their models.

For the purposes of carriageway attenuation design the runoff from the proposed Expressway has been determined by volumetric methods. Previous KCDC reports have used the following typical Curve Numbers for which the following volumetric parameters are matched. It is noted that these will vary with storm intensity, and for storms of greater than 2% AEP these would be increased for 5 points as recommended in KCDC's guidelines:

Table 7: Typical Curve Numbers and Runoff Coefficients for Rainfall at Wharemauku of 114mm (10% AEP) and 169 mm (1% AEP)

	Soil Type	Base Curve Number (KCDC)	Equivalent Volumetric Runoff Coefficient	
			10% AEP	1% AEP
1.0	**Loose Dune Sands**	45	0.25	0.34
2.0	**Gravel/Silt/Loams**			
	Pasture	69	0.47	0.57
	Urban Gardens	61	0.38	0.49
	Bush	48	0.27	0.36
3.0	**Residential Inland Dune Sands**	61	0.38	0.49
4.0	**Steepland Hill Soils**			
	Pasture	79	0.59	0.69
	Urban	74	0.53	0.63
	Bush	65	0.42	0.53

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3 *Flood Frequency in New Zealand*, McKercher A.I., Pearson C.P., DSIR Division of Water Sciences, 1989.

4 *Isohyet Based Calculation of Design Peakflows*, KCDC, 2003.

5.0	Peat[5] [1]	89	0.74	0.81

Consideration of the effect of future catchment development on CN values is not necessary due to KCDC's requirement for hydraulic neutrality on all new developments.

Expressway stormwater management design criteria

Quantity

Where attenuation is required, the peak stormwater flows will be attenuated to pre-Expressway levels for the 50%, 10% and 1% AEP storms. Where known flooding is an issue downstream, or there is a potential for cumulative effects due to other developments in the same catchment, then attenuation will be to 80% of pre-Expressway flows. It has been agreed with KCDC that this will meet KCDC's hydraulic neutrality requirement.

The design is in accordance with the methodology set out in NZTA's Stormwater Treatment Standard for State Highway Infrastructure.

Attenuation will primarily be provided by swales (both planted and grassed) that run along the edge of the proposed Expressway. More conventional shaped wetlands or flood storage areas will be used where it is more topographically or ecologically appropriate to do so, or where it is not practicable to provide sufficient swale capacity.

Attenuation and offset storage (refer section 7.4.5) areas can be above existing wetlands if it is practical to do so. However, existing wetlands will not be used for treatment of Expressway runoff. Attenuation will be considered on a case by case basis in agreement with KCDC/GWRC including the storage areas with new storage elsewhere in the catchment.

At the Waikanae River it may be appropriate to not attenuate runoff in order to pass the Expressway peak runoff away before the much larger but slower to arrive peak flow arrives from the upstream river catchment.

Runoff from carriageway catchments has been modelled in InfoWorks software and was determined by volumetric methods. A range of pond, wetland and swale options were modelled in InfoWorks using the hydrological parameters outlined above to determine the required storage volumes. At this stage the modelling was simplified and relatively high level, including the attenuation systems and the basic conveyance system. Mainline pipes and swales were modelled, but individual sumps/catchpits and leads were not.

[5] As advised by SKM, their KCDC SW modelling reports do not specifically list a CN for peat areas. A value of 89 has been assumed.

The pre-Expressway runoff was also modelled for each sub catchment draining to an attenuation system. These peak pre-Expressway runoff rates were used to set the discharge limits of the attenuation systems, but formal outlet structures such as orifices and weirs were not be modelled at this stage.

All stormwater attenuation and treatment systems include safe access for maintenance, typically a 5m maintenance and excavator access ramps will be provided. Traffic safety during maintenance will also be considered in the design.

Quality

Stormwater quality management measures that remove contaminants, or provide treatment, will be designed in accordance to NZTA's Stormwater Treatment Standard for State Highway Infrastructure. Treatment devices address the removal of gross debris, suspended sediment, heavy metals, and hydrocarbons.

A typical approach will be using a combination of swales or wetlands with a controlled and stabilised discharge point into existing watercourses as appropriate. However, other mechanisms including proprietary devices will be considered on a site specific basis (although unlikely to be used due to KCDC's requirement to use natural systems over such devices).

Swales will be designed to treat runoff by "through flow" and achieve an average 9 minute residence time. The use of a minimum average residence time acknowledges at that the downstream end it will be less and at the upstream end more.

The swales and wetlands will be designed for:

- stormwater treatment including sediment capture;
- peak flow attenuation;
- flow conveyance (swales);
- minimisation of erosion; and
- ease of maintenance.

Surface runoff from bridge decks up to the 1% AEP storm event shall be conveyed to the abutment/s, and treated prior to discharge.

Runoff from the cycleway/walkway may discharge directly to a watercourse untreated.

Pavement Surface Drainage

Aquaplaning

Aquaplaning will be investigated in accordance with the methodology set out in TNZ Highway Surface Drainage: A Design Guide for Highways with a Positive Collection, 1977.

Aquaplaning will consider a 4mm maximum water depth above the top of the proposed Expressway surface (assuming that if Open Graded Porous Asphalt is provided it is fully clogged), in a 10 minute duration 50% AEP storm.

Carriageway Collection

Runoff will be collected by roadside swales draining to existing watercourses along the route. Shallow swales and standard kerb and sump drainage networks will be used where spatial constraints prevent the use of the much wider attenuation swales. These networks would drain to attenuation and treatment wetlands discharging to watercourses as appropriate.

On the proposed Expressway, collection will be designed so flow does not encroach beyond the lane edge during a ten minute, 10% AEP rainfall event. During a 1% AEP storm one lane in any multi-lane section may be covered in water that is no more than 100mm deep and with a velocity not exceeding 2.0m/s.

For any link road or ramp, during a 1% AEP storm there shall be at least 2.0m of carriageway free of stormwater.

Where needed, KCDC standard WCC siphon type sumps will be used.

Local road drainage will be in accordance with KCDC standards.

Swales

Swales will generally be grassed in sandy soils and where longitudinal grade permits. The design will be to provide treatment and conveyance. Swale outlets will be typically be formed from sump and pipe outlet with an overflow arrangement.

Where longitudinal gradient of the swale is less than 1% a subsoil drain will be provided.

Where the swale is in low-lying, poorly drained soils, wetland or wet tolerant planted swales will be used, and the gradient may be flat, with no subsoil drain provided.

The following table summarises the types of swales and channels expected to be used in the design.

Table 8: Swale and Channel Type Summary

Type	Description	Approx Dims (width x depth)(m)	Side Slopes	Location	Primary Purpose
1	Planted trapezoidal	11x1	1:4	Along edge of carriageway in	Attenuation, conveyance &

				peat areas	treatment
2	Planted trapezoidal	11x1	1:4	Along edge of carriageway in sand areas	Attenuation, conveyance & treatment
3	Planted/Grassed trapezoidal	6x0.5	1:4	Toe of cuts along edge of carriageway	Conveyance
4a	Planted/Grassed trapezoidal	4x0.2	1:10	Central median where super-elevation (6m median)	Conveyance
4b	Pavement/sealed trapezoidal	2x0.1	1:10	Central median where super-elevation (4m median)	Conveyance
5	Concrete vee drain	0.6x0.05	1:6	Toe of barriers/walls etc	Conveyance

Kerb and Channel

Where kerb and channel is used, grated inlets to piped stormwater systems will have either a bypass that enables the inlet to remain effective should the grate become clogged with debris, or a secondary flow path that prevents ponding from encroaching on the running lanes in the event of a blockage of the inlet. Minimum sump lead diameter will be 300mm.

High capacity sumps will be required at low points on the main carriageway Alignment and at low points on the access on off ramps. These will be designed to capture flow assuming the next sump upstream are expected to is 50% blocked.

KCDC standard WCC siphon type sumps will be used.

Conveyance System

Swales/kerb & channel will be typically drained by pipes. While the intent is to minimise the length of the conveyance network, it is recognised that land will not always be readily available along the route. The use of open channel conveyance will be examined on a case by case basis however space, maintenance, safety and sediment issues suggest a piped conveyance system may be preferred.

The conveyance system will be designed to achieve 10% AEP capacity without surcharging. Where no secondary flow route is also available then the capacity will be designed to a 1% AEP standard. Pipework will be designed to achieve self-cleaning velocities of at least 0.75 m/s.

The design will account for the effect of tail water conditions on the conveyance system. Outlet/discharge points will be armoured to protect against scour.

On the proposed Expressway and ramps any manholes will be placed outside of the traffic lanes and where practical outside any sealed area. This may not be possible on the existing network of local roads in which case heavy duty bolted down lids will be specified

Surface drainage piping shall be designed with a minimum life expectancy of 100 years.

Subsurface drainage

Soakage Disposal

Soakage disposal is not being proposed as a primary source of disposal.

However, if the opportunity arises and where existing ground conditions are found to be favourable, soakage disposal devices will be investigated and designed in accordance with New Zealand Building Code and the ACC Soakage Design Guide, (except in regard to the design storm event duration, with the most critical storm duration used).

Soakage designs will be based on appropriate soakage rates (based on site testing), including allowance for any reduction in soakage rate due to error margins in testing methods, saturation in longer duration storms, long term clogging of the underlying soils and considering fluctuating groundwater levels. As a general rule design soakage rate will be no more than 1/3 of the rate measured on site. Provision will be made to convey excess flows arising from larger storms to a suitable surface discharge point.

Subsoil Drainage

Subsoil drainage to new pavements will be provided where required, to control moisture levels. Subsoil drains shall be designed in accordance to NZTA Standards.

Where swales are provided as drainage and the swale invert is below the adjacent pavement subgrade level then the need for subsoil drainage will be reviewed.

Wider catchment stormwater management design criteria

Floodplains and Flood Storage

The effect on existing flood plains and flood storage areas will be identified and tested in existing KCDC/GWRC hydraulic models.

The proposed Expressway will be built such that there is at least 0.5m freeboard from the adjacent 1% AEP flood level to the edge of seal.

The model simulations that will be run in KCDC/GWRC models to assess the floodplain effects and also for designing the waterway crossings are listed in Appendix 1.D. These are summarised as the:

- 10% AEP storm;
- 1% AEP storm;
- 1.5x1%AEP storm (KCDC overdesign event); and
- 0.04% AEP storm (1 in 2500yr storm for bridge loading design).

Any significant effects will be minimised or mitigated to the approval of KCDC/GWRC. This may include options such as constructing additional flood storage elsewhere in the catchment to offset the effect at the proposed Expressway.

GWRC advise that they consider 100mm to be a significant increase for the Waikanae River and floodplain and KCDC advise 10mm in other urban areas.

In general existing secondary flow routes will be maintained to discharge to the same area.

South of Te Moana Road the existing flood overflow route from the Waikanae River (designated in the District Plan) crosses the proposed Alignment and will require diversion (to an extended Te Moana overbridge) or additional structures designed to pass the flow across the proposed Expressway. This accounts for stopbank overflow or a breach situation.

Cross Expressway Culverts

Existing watercourses will be either culverted or bridged under the proposed Expressway. As most of the waterways that the proposed Expressway crosses are relatively small they are most appropriately dealt with by culverts. It is noted that the NZTA Bridge Manual specifies that a culvert of cross sectional area greater than $3.4m^2$ is to be considered in the same manner as a bridge under the Bridge Manual, (i.e. the larger box sections). This achieves the same waterway outcome as a traditional bridge, but simply has a different structural form. These larger culverts will have the stream bed continuing through them, including a formed low flow channel within the bed.

Typically the more significant and larger watercourses will be bridged (refer section 8.4.1 for this list). Larger box section culverts are listed below with the remaining smaller watercourses being standard piped culverts:

- Drain 7 north (downstream of Rata St);
- Mazengarb Drain;
- Ngarara Creek;
- Upper Paetawa Drain branches at Peka Peka Road; and
- Hadfield/Te Kowhai Stream.

Culverts will be designed to:

- Not create or increase flood risks on upstream or downstream properties without mitigation, and be in accordance with KCDC flows and flood levels (where available). It is noted that while it is generally not feasible to have “no increase in flood risk” (if that is defined as a zero increase in water level upstream), as the presence of a structure over a waterway will always have some local effect, it is proposed that there will be no increase without mitigation. As such each crossing will be examined on a site specific basis for both the effects and flood risk consequences as assessed using the KCDC models. Any effect will be addressed in order that there is no increase in risk to other property.
- Accommodate the 10% AEP storm flow without heading up above the pipe soffit level and the 1% AEP storm flow without heading up more than 2m above the culvert soffit, or within 0.5m of the level at the edge of seal.
- Design of culverts for local road crossings will be in accordance with KCDC’s standards.
- Provide fish passage through all culverts using methods acceptable to KCDC & GWRC. Typically this will include setting culvert inverts below adjacent drain invert level, continuing the watercourse substrate through the culvert, or artificial features in the culvert invert to facilitate passage (where required).
- Mitigate erosion and scour at the interface between natural streams and the culvert inlet/outlet, including erosion control and energy dissipation measures as appropriate.
- Orientate the culvert, where practicable, to match the orientation of the upstream and downstream drain.
- Locate the culvert to minimise disturbance to the existing watercourse where practical (i.e. construct off line etc).
- Provide Surface water links each side of a wetland wherever the proposed Expressway bisects one.

- HN-HO-72 Loadings and in accordance with NZS/AS 3725 and TNZ F/3. Temporary construction loads will also be taken into account as required. The minimum target cover will be 600mm from road surface to top of pipe.
- Have a minimum design life expectancy of 100 years.
- Include consideration of Safety by Design.
- Consider minimising maintenance requirements throughout the design life.

Bridge Waterways

The waterways of all bridges have been designed in accordance with the Bridge Manual.

The GWRC/KCDC models have been used to determine flow and flood water levels, and to assess the effects of proposed Expressway structures on flood level. Bridge piers will be set clear of the principal waterway. Where waterways are not covered by KCDC/GWRC models water levels will be determined using methods set out in the Austroads Waterway Design Guide.

Waterway capacity will be to 1% AEP and the bridge level set considering relevant freeboard requirements of:

- 1.2m minimum above 1% AEP flood level on main channels of large waterways that may carry significant debris; and
- 0.6m minimum above 1% AEP flood level for slower flowing floodplain areas and for smaller urban streams with low risk of debris.

For the Waikanae River bridge the freeboard has been set at 2.2m for consistency with GWRC policies.

Scour at abutments and piers is calculated in accordance with Melville & Coleman, using data from the river hydraulic models. Abutments and piers are expected to be armoured for scour protection.

Watercourse Diversions

The relocation and combination of farm drains has been avoided where practicable, although some minor drain realignments may be required. It may also be necessary to carry out temporary drain diversions to facilitate culvert construction. Should any permanent drain diversion become necessary the following requirements will apply:

- Drain geometry shall be sufficient to convey future design discharges;
- The diversion drain will be formed to mimic an equivalent drain by taking account of local drain conveyance;
- Drain gradient will be managed to ensure there is no increase in drain erosion; and

Cross-section will be developed with input from ecologist and landscape designers in order to determine an environmentally appropriate diversion (e.g. riparian requirements, fish passage and refugia, meanders, form and function etc).

Existing Wetlands

Should wetlands be required in order to offset those filled in by the proposed Expressway theses are designed to replicate the hydrological function/regime of the wetland cleared. This will be carried in close coordination with geotechnical engineers and ecologists, KCDC and GWRC.

Erosion and sediment control

Erosion and sediment control during construction will be planned and implemented in accordance with the following document:

Draft Erosion and Sediment Control Standard for State Highway Infrastructure, New Zealand Transport Agency, August 2010.

The design of erosion and sediment control works, and preparation of erosion and sediment control plans, are addressed in separate Project reports.

8. Structures

8.1. General

The MacKays to Peka Peka Expressway Project will have a significant number of structures over its 18 km length. These will include overbridges, underbridges, pedestrian and cyclist bridges, stream crossings, retaining walls, noise walls, culverts, lighting structures and a major bridge across the Waikanae River.

The design philosophy statement sets out the design standards, constraints and assumptions and outlines the major structural elements within the Project at Scheme Assessment stage.

8.2. Design standards and references

Bridge design standards

The Transit New Zealand Bridge Manual (TNZBM) Second edition 2003 and the material design standards specified therein define the general design criteria to be adopted for the structures. This includes the June and September 2004 amendments and the Provisional Amendment dated December 2004.

Where the Transit Bridge Manual does not address the specific requirements the appropriate Australian or UK bridge design standards are referenced.

The RoNS Design Standards and Guidelines include a number of bridge related requirements. These are:

- Use of Texas HT edge barriers on bridges
- Full width 3.0m outer shoulders to be taken over full bridge length

Refer to sections below for actual standards to be adopted for edge barriers and shoulders.

Vertical clearances

The minimum vertical clearances for structures will be:

- Road underbridges where the local road goes under the proposed Expressway – 4.9m except at Raumati Road where 6.0m clearance will be provided to suit overheight vehicles crossing the proposed Expressway south of the Waikanae River (refer also to section 4.11).
- Road overbridges where the local road goes over the proposed Expressway – 6.0m
- Pedestrian/cyclist Bridges – 6.2m
- Waikanae River Bridge – 1.6m free board above 100 years flood level and 4.9m to El Rancho access road

Horizontal clearances

A clear width of 17.0m square to the local road will be provided for underbridges where the proposed Expressway crosses over local roads to allow for a two 3.5m traffic lanes, 2.0m shoulders/cycleways, 2.5m footways and 0.5m verges, except at Kāpiti Road.

At Kāpiti Road a 30.0m width will be provided to allow for four traffic lanes in future, two right turning lanes, shoulders/cycleways and footways on each side, plus a median in which a central pier will be located.

Shoulder widths of 2.5m for the outside shoulder and 1.0m for the inside shoulder will be provided for underbridges that carry the proposed Expressway with two 3.5m traffic lanes in each direction. The median width varies with 4.0m to be provided in rural areas and 6.0m in urban areas of the route.

For overbridges that carry local roads over the proposed Expressway, two 3.5m traffic lanes plus 0.6m shoulders and 2.5m footways will be provided except for Peka Peka Road where shoulders will be 1.5m and footways 2.0m.

A 3.0m width cycleway/walkway will be provided over the full length of Waikanae River Bridge and on Raumati Road Underbridge.

Pedestrian/cyclist bridges will be 3.0m wide between handrails.

Edge barriers and protection

Vehicle bridges will be provided with rigid barriers meeting the required performance levels selected in accordance with Appendix 1.B of the Transit Bridge Manual.

The RoNS guidelines recommend the use of a Texas HT barrier (TL5).

The proposed barrier types in accordance with the Transit Bridge Manual will be:

- For underbridges that carry the proposed Expressway over local roads – TL4 rigid concrete barrier 1.1m high for noise mitigation, except at Otaihanga Road where a TL5 barrier 1.1m high will be provided.
- For overbridges that carry local road bridges over the proposed Expressway – TL4 rigid concrete barrier 1.1m high including a steel top rail for pedestrians.

Cycleway/walkway bridges will have handrails 1.4m high complying with TNZBM.

Cycleway/walkways on Waikanae River Bridge and Raumati Road Underbridge will have handrails 1.4m high in accordance with Transit Bridge Manual.

Vehicle and train impact loads

All support columns and structure placed within the width of the proposed Expressway will be protected from vehicle impact using barriers in accordance with the Transit Bridge Manual.

Materials and finishes

The choice of materials and finishes for bridges and retaining walls has been developed in conjunction with the urban design team and takes account of whole of life costs. Concrete is proposed for all bridges including superstructure, piers, abutments and piles as this provides an economic solution with good durability for the range of spans required. Steel H-piles will be proposed at bridge abutments as they will provide ductility to cater for the deformation of filled approach embankments and sub-soil that will occur under seismic loads.

Appropriate measures will be considered and incorporated in the design to prevent or discourage graffiti on surfaces which are accessible by members of the public.

Drainage

Stormwater will be collected from the bridge roadways and Pedestrian footbridges and discharged into the road drainage system. For all bridges except Waikanae River Bridge and Te Moana Road Underbridge, stormwater will run-off the ends of the bridge and will be collected by the adjacent road drainage system.

For the longer Waikanae River Bridge and Te Moana Road Underbridge stormwater will be collected on the bridge by a system of sumps and pipes and discharged into the road drainage system. Stormwater will not be discharged directly into watercourses.

Lighting

Provision will be made in the design of vehicle and pedestrian/cyclist bridges for the support and integration of lighting requirements.

Sign gantries

Provision will be made in the design of all vehicle and pedestrian bridges for required signage.

Scour

Appropriate allowance will be made for scour effects in the design and detailing of the river, floodway and stream bridges. The scour assessment will be determined on the basis of the geotechnical conditions and the hydraulic conditions in the river or stream.

Scour depths will be determined using the methods outlined in the Transit Bridge Manual.

Hydraulic capacity

The hydraulic capacity of river, stream and floodway crossings has been determined from hydraulic modelling taking account of the proposed arrangement of bridge piers and overall bridge length. In particular, modelling has been undertaken for the Ihakara Street and Wharemauku Underbridge, Waikanae River Bridge and Te Moana Road Underbridge for the design flood event as described in the stormwater section.

River bank protection works will be provided for the Waikanae River Bridge and stream bridges as described in the stormwater section.

Retaining walls

Retaining walls will generally be mechanically stabililised earth walls as described in the geotechnical section. Walls will be designed in accordance with the Transit Bridge Manual.

Provision for services

Provision will be made on structures to accommodate existing services with an agreed allowance for future services where appropriate. Requirements are to be determined in consultation with utility companies and Kāpiti Coast District Council.

Services to be carried by the various overbridge structures will be accommodated both within the void of the Super-Tee girders and within the raised footways on overbridges.

Where the proposed 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.

Services to be carried along the proposed Expressway will be located at bridges 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 will be suspended from the underside of the superstructure and located between Super Tee beams, subject to NZTA approval.

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

Seismic design of structures has been undertaken to the requirements of the Transit Bridge Manual 2003 including the June and September 2004 amendments and the Provisional Amendment dated December 2004. The seismic design limit state criteria to be adopted are as follows:

Table 9: Seismic design limit state criteria

Limit state	Seismic Event Annual Probability of Exceedance (APE)
Serviceability Limit State (SLS)	25 years
Ultimate Limit State (ULS)	2500 years(importance level 3) 1000 years (importance level 2)

A site specific seismic study has been undertaken for the proposed Expressway corridor. The ground accelerations which will be used for the design of bridges for the proposed Expressway have been reduced slightly from the Transit Bridge Manual/AS1170 values on the basis of this study.

Bridge approach embankments has been designed to be stable under static and seismic loads and ground improvement will be provided below approaches and bridge abutments where required to prevent liquefaction of underlying soils. Where required, bridge abutment piles will be designed to be sufficiently ductile to cater for movements that may occur to the filled embankment or sub-soil under seismic loads.

Approach embankments will also be strengthened using geogrid materials where required to achieve stability under seismic loads.

Expansion joints and bearings

Structures are designed to minimise the use of expansion joints and bearings in order to reduce long term maintenance requirements. Integral bridges will be adopted where possible, but where joints or bearings are required they will be selected to minimise future maintenance requirements.

Where bridges are highly skewed, voids will be provided behind abutments to prevent earth pressures on the back of the abutment from causing bridge rotation due to the skew under thermal and seismic load effects.

Bridge foundations

Bridge foundations will be designed in accordance with the Transit Bridge Manual to provide stability and control settlements. Piled foundations will be provided for all bridge abutments and piers with piles founded in the underlying dense sands and gravels with SPTN value = +35.

Peat that occurs below bridge abutments and approach embankments will be removed and replaced by granular material to mitigate differential settlement between the bridge and the approach.

8.3. Design constraints and assumptions

Design constraints

The design constraints that have been identified for the design of structures on this Project are:

- Poor ground conditions to support bridge loads requiring deep piled foundations to the underlying marine gravels.
- Peat that will require excavation below bridge abutments and approaches.
- Liquefaction of the underlying marine sands and lateral spreading requiring approach embankments and the area below reinforced earth walls to be subject to ground improvement works.
- Structures will be located in close vicinity of the sea (within 2 km) and in the direction of the prevailing wind with potential for wind-blown salts requiring appropriate precautions to achieve the required durability.
- High seismicity and close proximity to the Wellington Fault which runs inland of the proposed Expressway.

- High pressure gas mains that cross the proposed Expressway Alignment diagonally in the vicinity of the proposed Waikanae River Bridge which are to be relocated.
- Urban design requirements which will influence the form, materials and finishes of bridge structures given the urban environment over much of the proposed Expressway route.
- The need for noise barriers on bridges requiring 1.1m high concrete traffic barriers for underbridges that carry the proposed Expressway over local roads.
- Construction of bridges and structures in close vicinity of residential areas that will place restrictions on construction noise and vibration limits.
- Construction of bridges over busy existing local highways requiring construction methods that minimise/avoid road closures.
- Presence of existing utilities within the existing local road corridors that will require to be diverted.
- Utilities that are required to be carried on bridges including possible large diameter water or gas mains across the Waikanae River.
- Construction loading on underbridges that may exceed the normal design loading to suit earthworks operations during construction.

Design assumptions

The following assumptions have been made as a basis for developing the preliminary design of structures for this Project:

- HPMV loads are covered by normal HN loading and require no special provision as confirmed by a recent study, (Vehicle Dimension and Mass Rule Change – Development of Bridge Design Loading for HPMV's, prepared by Opus International Consultants for New Zealand Transport Agency, May 2011).
- Seismic design criteria will be developed on the basis of the site specific seismic hazard assessment that has been carried out for this Project.
- Where the proposed Expressway crosses existing streams provision has been provided for fish passage that may require bridges to be provided than smaller culverts.

8.4. Principal elements

Bridges

The bridges on this Project will include underbridges, overbridges, stream bridges, pedestrian/cyclist bridges and a major bridge across the Waikanae River.

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

Table 10: Principal bridges

Bridge Name	Bridge Type	Length	Width	No of Spans	Obstacle Crossed
Poplar Avenue	Underbridge	57m	25m	3	Local road
Pedestrian Bridge at Leinster Avenue	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
Pedestrian bridge between Kāpiti Road and Mazengarb Road	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
Kakariki Stream	Stream bridge	20m	26m	1	Waterway
Smithfield Road	Overbridge	70m	16m	3	Expressway
Smithfield Road over Kakariki Stream	Stream bridge	12m	14m	1	Waterway
Peka Peka Road	Overbridge	87m	17m	3	Expressway
Paetawa Drain	Stream bridge	14m	26m	1	Waterway

Other structures

Other structures required for the proposed Expressway include pedestrian and cyclist bridges for the cycleway/walkway, retaining walls, culverts over small streams, noise walls and lighting structures.

These structures will be designed in accordance with the Transit Bridge Manual and other appropriate national standards depending on the structure type and design life.

9. Landscape and visual

9.1. General

It is important that the final Alignment and design provides for the integration of the proposed Expressway in the landscape rather than sitting on it. An important way to help achieve this integration is the way the design of the road and the associated responds to the different landscape contexts through which it passes (i.e. rural, rural residential, suburban, urban, river corridor, dunelands). Each of these areas has a distinctive character that should be acknowledged and responded to accordingly in terms of Alignment, design and details.

Another key principle is that the consideration and addressing the landscape and visual effects on the communities through which the road passes should take precedence over road user or driver experience considerations.

9.2. Design standards and references

Compatibility with national policy and standards:

- Land Transport Management Amendment Act [2008]
- NZ Transport Strategy [2008]
- NZTA Standards – e.g. Z/19 and others
- RONS Guidelines
- NZ Energy Efficiency and Conservation Strategy [2007]
- NZ Urban Design Protocol

Compatibility with Sustainable Transport Plan, Walking & Cycle Plan and other relevant local and regional transport documents for the area

- Sustainable Transport Strategy
- Wellington Regional Land Transport Strategy [2007-2016]
- GWRC Parks Management Plan
- Proposed WRPS

- Cycleways, Walkways and Bridleways Strategy
- Kāpiti Coast District Plan
- Paraparaumu Town Centre Plan
- Coastal Management Strategy
- Development Management Strategy
- Kāpiti Coast State of the Environment Report
- Sustainable Subdivision and Development on the Kāpiti Coast

9.3. Design considerations

Landscape context

The design provides for the integration of roading infrastructure within the landscape which includes areas of rural and urban landscapes and communities, the Waikanae River corridor, and modified dunelands.

The following points will be considered:

1.9.3.2 Visual integration

- visibility from residential areas
- visibility from recreation/open space areas
- associated structures – noise walls, under/overpasses, signage, lighting scale of proposed interchange and associated structures

1.9.3.3 Land shaping and vegetation

- new landform from filling and cuts and batter slopes
- retention of existing vegetation
- retention of dominant and natural landforms
- new vegetation
- contextual enhancement (areas outside road corridor)

Local relevance

The design of the road and associated infrastructure responds to the local character of the area through which it passes (rural, semi-rural, suburban) and reflects a form and character appropriate for this location.

The following points will be considered:

- Scale, bulk and elevation of new structures especially in relation to adjoining residential areas

- Character of local roads at connections and over/under points
- Scale, bulk and shape of earthworks
- Scale and nature of planting
- Width of road corridor
- Traces of history and patterns of use and development – cultural landscape

Community amenity

Addressing the amenity effects on the receiving communities' takes precedence over road user experience.

The following points will be considered:

- Minimise the physical presence of the road, in relation to elevation, location and design
- Maximise width of external buffers rather than have wide median strips
- Retain and utilise existing landforms, such as dunes, for buffering
- Retain existing mature and semi mature vegetation adjacent to the footprint, to provide a framework for additional planting.

Quality design

The design provides for good quality outcomes from detailing to large scale forms, sustainable design, and demonstrates collaboration between the design team including engineers, landscape architects, and urban designers.

The following points will be considered:

1.9.4 Physical

- structural elements – shapes, forms, design, and materials
- detailed elements – finishes, lights, barriers and rails, pipes etc.

1.9.5 Sustainability

- recycling of existing construction materials
- low impact stormwater design
- operational energy efficiency (e.g. in lighting)
- Expressway user fuel efficiency (e.g. as affected by traffic congestion, surface roughness, Alignment gradient and curvature, maintenance activities)
- maintenance requirements (including resources and energy)
- resource efficiency considerations in the selection, volume and providence of construction materials

- facilitates alternative non-motorised and public transport modes.

10. Urban design

10.1. General

The route traverses several urban communities as well as more open and semi-rural areas. The success of the proposed Expressway in urban design terms will require an integrated approach that recognises the interrelationships between structures design, landscape, ecology, stormwater management, social and cultural values, landuse planning, transportation planning and geotechnical constraints.

Specifically good urban design performance will require the proposed Expressway to both function in an interregional sense, but also continue to provide and enhance where possible local area movements. The proposed Expressway design provision of interchanges will be a key to effective movement as well as the economic growth of the district in tune with the regional and local area growth policies. The east-west connections across the proposed Expressway and their positioning and design will be fundamental to maintaining the local area connectivity. The old highway route also presents opportunities for enhancing the development of the district and its town centres, movement and amenity. In terms of the physical road itself there are opportunities by the Alignment as well as the placement and form of structures to contribute to a positive identity for the district through referencing and enhancing the environment through which it passes. In urban areas the structures will have an important role to play given the relatively low scale of the existing built environment and the constrained nature of the corridor. This will require consideration to the vertical height of the road itself, addressing the width of the corridor and the associated form such as walls, barriers and interchanges. The natural landforms of the dunes provide the main vertical relief within the proposed Expressway area and these need to be considered as to potential for retention as well as use of these forms for buffering, mitigation and to guide the alignments.

10.2. Design standards and references

Compatibility with national policy and standards:

- Land Transport Management Amendment Act [2008]
- NZTA Urban Design Policy [2007]
- NZ Transport Strategy [2008]
- NZTA Standards – e.g. Z/19 and others
- RONS Urban Design Principles and Objectives [in progress]
- NZ Energy Efficiency and Conservation Strategy [2007]

- NZ Urban Design Protocol.

Compatibility with Sustainable Transport Plan, Walking & Cycle Plan and other relevant local and regional transport documents for the area:

- Sustainable Transport Strategy
- Wellington Regional Land Transport Strategy [2007-2016]
- GWRC Parks Management Plan
- Cycleways, Walkways and Bridleways Strategy
- Kāpiti Coast District Plan
- Paraparaumu Town Centre Plan
- Coastal Management Strategy
- Development Management Strategy
- Kāpiti Coast State of the Environment Report
- KCDC Streetscape Strategy
- KCDC Subdivision and Development Principles and Requirements.

10.3. Design considerations

Modal options

- Enabling local private vehicle movements within the local area and vehicle access to and from the route for inter-regional trips.
- Provision for freight and other non-personal vehicle movements within the local area and inter regionally.
- Promoting operation and/or future improvement of local and interregional public transport network.
- Promoting walking and cycling both along and across the corridor and to link with local network.
- Allowing for horse riding and other recreational movements in the rural sections.
- Enabling access to and from Paraparaumu airport for both local and regional heavy and other traffic, including PT.
- Promoting convenient local access by all modes to Paraparaumu District centre and other local centres.

Land use and transport integration

- Consistency with the provision of the District Plan (currently being revised).
- Influence and pressure for future land use around interchange locations and due to quicker access to parts of the region.
- Compatibility between the route and its effects and the existing land uses of adjoining areas.

- Future land use options associated with existing SH1 corridor and existing town centres.

Urban form

- New road structures to respond to their location in terms of scale and fit and local values including heritage, landscape and ecology.
- Function of route and interchanges to recognise effect on current and future urban form in terms of density of development and mix of uses.
- Consideration of the way in which design of route interfaces with rest of RONS route – experience of arrival to urban part of Wellington region.
- Use of route to define urban edges.

Connectivity

- Maintenance of a sense of community cohesion across and along the route (where it exists).
- Consideration of access to community facilities including schools, shops, civic functions, parks, tourism destinations etc.
- Coordination with the range of physical connections for transport and recreation and including walking, cycling, riding, vehicle, bus, train and plane modes.
- Access to private properties affected by the proposed Expressway.

Amenity

- Visual amenity for surrounding community and for route users in terms of visual experience.
- Quality of user experiences of adjacent or under/over public spaces and streets – e.g. CPTED.
- Intrusion of additional traffic into adjacent residential areas by placement of interchanges/bridges influence on local traffic movements.
- Noise, light and other changes to the local environment from the route.

Structures and sustainability

- Design consistency along the route and with other RoNS.
- Aesthetic considerations for visible structures – both road structures and mitigation measures.
- Minimising impact of design on local physical environment (runoff, groundwater, surface water, erosion etc.).
- Resource efficiency – recycling, energy efficiency, waste reduction, local material use.
- Design of facilities for pedestrian, cycle and PT use.

Traffic management

- Design of traffic control structures – potential visual impact.
- Lighting design – minimise light spill to adjoining residential areas and other sensitive uses.

11. Street lighting

11.1. General

Lighting will be provided at the interchange locations but generally the proposed Expressway will be unlit between interchanges.

11.2. Design standards and references

All the lighting, whether for the proposed Expressway or the construction sites, is designed in accordance to the current road lighting Standard AS/NZS 1158 (all parts) and Kāpiti Coast District Council by laws.

Both the proposed Expressway and other classified interconnecting roads designed primarily for vehicular traffic, cycleway, pedestrian areas, together with appropriate luminaire selection, will be incorporated into the current road lighting site wide Project lighting design.

The proposed Expressway and ramp sections for this Project at interchanges will be designed to AS/NZS 1158 Lighting Category V3, which is the usual designation for New Zealand Expressways.

On/off ramps and local roads at interchanges will be designed to the lower of V3 or the adjacent local road lighting category.

The current NZTA specification M19: Specification for Steel Tubular Lighting Columns deals mostly with the structural aspects of lighting columns. This specification is expected to be withdrawn and replaced with Specification M26 Road Lighting Columns during 2011.

The following published design standards are used to form the basis of the road lighting performance design specification.

Table 11: Design Standards

Design element	Standard	Description
Main carriageway	AS/NZS 1158.1.1:2005	Lighting for roads and public spaces – Vehicular Traffic (Category V) Performance and design requirements
	AS/NZS 1158.1.3:1997	Road Lighting – Vehicular Traffic (Category V) Guide to design, installation, operation and maintenance
Tie in roads, minor connector roads	AS/NZS 1158.3.2:2005	Lighting for roads and public Spaces – Pedestrian areas (Category P) Performance and design requirements

Pedestrian crossing	AS/NZS 1158.4:2009	
	Lighting for Public Spaces – Lighting of Pedestrian Crossings	
Bridge underpass	AS/NZS 1158.5	2007 Lighting for Roads and Public Spaces – Tunnels and Underpasses
Electrical	AS/NZS 3000	Electrical Installations – Wiring Rules
HV overhead lines	NZECP 34:2001	Electrical Safe Distances from Overhead HV Lines
Local Council Bylaws	KCDC CPTED	Kāpiti District Council Crime Prevention through Environmental Design
Traffic signals	AS/NZS 2276	Cables for signal installations

The lighting design will consider the use of standard light fittings, flat screen low spill light fittings and low energy use lighting such as LED fittings.

12. Noise

12.1. General

The proposed Expressway Alignment is close to a number of houses that are currently in a relatively low ambient noise environment. The construction of the proposed Expressway will result in the closest houses experiencing, in many cases, higher noise levels than is currently the case. This is to some extent balanced by the fact that for many of these houses the proposed route is within the existing WLR designation, and there would be some awareness of the potential for a road to be constructed in the future.

The guiding approach for the acoustic design is to address the adverse effects of road-traffic noise on people. The overarching principle is therefore Section 16 of the Resource Management Act 1991. This requires every occupier of land to adopt the best practicable option to ensure that the emission of noise does not exceed a reasonable level.

The acoustic design for this Project is conducted in an approach integrated with other associated disciplines in order to arrive at solutions best suited to avoid, remedy or mitigate adverse effects on the community.

12.2. Design standards and references

The design will be based on the following standards and references as appropriate:

- NZS 6806:2010 Acoustics – Road Traffic Noise – New and Altered Roads
- Resource Management Act 1991 including amendments of September 2009

12.3. Design Considerations

The proposed Expressway is designed and will be constructed so that noise effects are mitigated to a reasonable level in accordance with NZS 6806:2010. Noise mitigation measures are included as part of the integral design. The design is based on external road traffic noise being kept to a reasonable level at noise sensitive receivers through mitigation options that are consistent with the adoption of the best practicable option.

The preferred mitigation method is structural mitigation measures within the road corridor. This includes the use of low-noise generating road surfacing with the addition of noise barriers where required. Where possible, noise barriers will take the form of bunds to recognise the objective of avoiding hard engineered sound barriers, although this will require further consideration at particularly critical areas with tight space constraints.

Other options are for hard noise barriers within the road corridor adjacent to the proposed Expressway and/or on/off ramps, or boundary fences for properties adjacent to the proposed Alignment.

The least preferred option is acoustic insulation of habitable spaces of noise sensitive receivers, which would result in suitable internal noise levels but not provide mitigation of outdoor areas.

13. Resource efficiency/sustainability

13.1. General

Sustainability principles have been considered and will continue to be integrated in the deployment of Project tasks to facilitate design of the proposed Expressway with appreciation of its demand upon natural resources and energy during the construction, maintenance and use phases.

13.2. Design Standards and References

Compatibility with national policy and standards:

NZ Transport Strategy [2008]

Wellington Regional Land Transport Strategy 2007 – 2016 (WRLTS)

NZTA Environmental Plan [2008]

NZTA Procurement Manual [2009]

NZ Energy Efficiency and Conservation Strategy [2007]

NZ Waste Strategy

NZ Urban Design Protocol

13.3. Design considerations

Sustainability in design

- Adoption of strategies and designs to avoid unnecessary resource consumption (i.e. energy (e.g. fuel, electricity) and materials (e.g. aggregate)).
- In the context of whole-of-life value for money, the selection of designs, goods and services that have lower environmental impacts across their life-cycle compared with competing designs, goods and services, and in consideration of subsequent Project phases (i.e. construction, operation, use and maintenance). Environmental impacts considerations include the standard/traditional impact categories (i.e. air, water and soil) and also includes non-renewable resource use (e.g. fossil fuels, aggregate) and greenhouse gas emissions.

Appendix 1.A

Related Project Objectives

NZTA's objectives for the Project

(As set out in the Request for Proposal)

a) Achieve an early start and early delivery as part of the Government's infrastructure package;

b) Develop an integrated solution that achieves an appropriate balance between the functional performance requirements of regional and inter-regional traffic;

c) Secure statutory approvals as early as possible in the Project on conditions that are acceptable to NZTA and that minimise construction constraints;

d) Address the social, land use and environmental impacts of the Project in the context of the aspirations of territorial authorities;

e) Identify and progress opportunities for early physical works that deliver benefits; and

f) Advance the Alliance model into early Project development phases to optimise construction considerations.

The RFP also identified the following objectives/do minimum requirements for the Alliance to be considered a success:

- Functionality The Alliance is expected to obtain statutory approvals with sufficient flexibility to allow it to develop an efficient design and deliver a solution that effectively balances the functional performance requirements of regional and inter-regional traffic.
- Cost The capital budget for the delivery of the Project is tight. Opportunities exist (and should be sought by the Alliance) to manage the Project within budget whilst maintaining full functionality and quality. One of the key challenges for the Alliance will be to deliver a solution within the available budget that will achieve efficient and viable whole-of-life performance.
- Quality The Alliance shall ensure that quality requirements are not compromised.
- Time The Interim Project Alliance Agreement (IPAA) services must commence immediately after signing of the IPAA. Construction is to be completed on or before the target completion date agreed in the Project Alliance Agreement (PAA).
- Environment The Alliance shall ensure that environmental requirements are not compromised and all required consent and approvals are obtained and that all consent conditions are strictly complied with. Through best practice systems and procedures the Alliance is expected to demonstrate genuine sensitivity to the environment.
- Community Work under the Alliance is to be delivered in such a way that the reasonable expectations of those members of the community affected by the Project are satisfied or exceeded. Through best practice systems and procedures the Alliance is expected to demonstrate an ability to integrate with NZTA's communication objectives.

- Traffic Work under the Alliance is to be carried out without undue disruption to traffic through and across the site or the adjacent local roads.
- Interface The Alliance must conduct its operations in such a way that provides consistency with the existing state highway and local roads, including potential improvement projects, and enables the respective objectives of such projects to be met.
- Safety The Alliance is expected to create a culture where the safety of the workforce and the public is paramount. Safety management systems and outcomes are expected to be equal to or better than current best practice in the industry.
- Defects Work under the Alliance shall be delivered with minimal defects. Any defects will be minor in nature and will not affect the functionality of the Project throughout its design life.
- Maintenance The Alliance is expected to minimise whole of life maintenance costs through good design and construction.

At a National and Regional level the following are representative strategic direction for the Design Philosophy

NZ Transport Strategy 2008 (NZTS)

1. Ensuring environmental sustainability – associated outcomes:

- the transport system is actively moving towards reducing the use of non-renewable resources and their replacement with renewable resources
- negative impacts of transport are reducing in terms of human and natural environments

2. Assisting economic development – associated outcomes:

- growth and development are increasingly integrated with transport
- transport users increasingly understand and meet the costs they create
- New Zealand's transport system is improving its international and domestic linkages including inter-modal transfers
- the effectiveness of the transport system is being maintained or improved
- the efficiency of the transport system is continuing to improve
- the negative impacts of land-use developments on the transport system are reducing;
- improve reliability of journey times for identified critical routes
- reduce average journey times for identified critical routes

3. Assisting safety and personal security – associated outcomes:

- New Zealand's transport system is increasingly safe and secure

- the transport system is improving its ability to recover quickly and effectively from adverse events

4. Improving access and mobility – associated outcomes:

- the transport system is increasingly providing affordable and reliable community access

5. Protecting and promoting public health – associated outcomes:

- negative impacts of transport are reducing in terms of fatalities, injuries and harm to health

Wellington Regional Land Transport Strategy 2007 – 2016 (WRLTS)

1. Assist economic and regional development – associated outcomes:

- Aid national and regional economic transformation; and foster the business, housing, employment, education, health and recreation aspirations of the regional community (in line with the WRS).

2. Assist safety and personal security – associated outcomes:

- Achieve a safer community by developing the region's land transport system in a way that leads to a continually declining regional road casualty toll and contributes to a sense of individual and community security when using the transport system.

3. Improve access, mobility and reliability – associated outcomes:

- Provide for the access and mobility needs of our regional community and recognise the wider access needs of adjoining regions. (Improving access and mobility is the primary purpose of a Regional Land Transport Strategy. Improving access enables social participation, inclusion and independence for all, including the transport disadvantaged. Improving mobility ensures the availability of realistic transport choices for the individual or community, including affordability and equity of cost considerations.)
- Improve reliability to improve travel times and reduce trip time variability for strategic networks (both road and rail) in the event of common incidents such as slips or crashes.

4. Protect and promote public health – associated outcomes:

- Provide a transport system that allows for: social participation and interaction; healthy communities via reduced transport impacts on natural resources and communities; and increased uptake of active modes, particularly for short trips.

5. Ensure environmental sustainability – associated outcomes:

- Improve the environmental performance of the transport network, and avoid to the extent reasonable in the circumstances, adverse effects of transport on the environment (in line with the

RPS) and communities. This includes, but is not limited to: increased use of passenger transport, cycling and walking; reduced use of private and company cars; increased energy efficiency of the vehicle fleet; reduced greenhouse gas emissions; and a high standard of environmental design of transport infrastructure.

6. Ensure that the Regional Transport Programme is affordable for the regional community – associated outcomes:

- Take account of funding likely to be available, economic efficiency, and the impact of funding options on regional communities when considering transport packages.
- Consider the affordability of transport options for all members of the community, including low income groups.

Appendix 1.B

Kāpiti Coast District Council Expressway

Technical Note T7 Local Road Standards (draft)

Expressway Technical Note T7

Local Road Standards

1.0 Introduction

1.1 This note has been prepared in draft for the purpose of working level discussions with the Mackays to Peka Peka Alliance design team and does not represent formal KCDC policy.

1.2 The scope of the note covers the identification of relevant standards and requirements at local road crossings of the expressway.

2.0 Standards

2.1 Required standard of all existing local road corridors 'crossed by or being connected to' the expressway:

- For local roads crossing under the expressway, the existing road corridor width, character and associated facilities/services, need to be fully preserved, including verges, footways and carriageways.
- Where a road is relocated, say to be put over the expressway, then this should be undertaken to the relevant specification for new subdivision roads to allow for long term improvement of the corridor (subject to safety/consistency and other considerations) specific review of these proposals on a case by case basis by KCDC will be required.
- NZS4404:2004 serves as the basis for technical compliance for the subdivision and development of land where these activities are subject to the Resource Management Act. Currently Council's Subdivision and Development Principles and Requirements uses NZS4404:2004 as the base document for meeting minimum engineering requirements, with schedules providing specific design information and any Council requirements that may differ from those in NZS4404:2004. NZS4404:2010 has recently been released and it is Council intention to adopt the revised standard as the base document.
- When proposing any development within the District, Council's Subdivision and Development Principles and Requirements, should be read in conjunction with its suite of supporting documents, i.e. Best Practice Subdivision Guide, Best Practice Rural Subdivision Guide, and the Streetscape Strategy and Guidelines.
- Implementation of integrated storm water management through the use of a range of Low impact urban design devices and best management practices to reduce the quantity and improve the quality of urban storm water run-off before it is discharged into the environment.
- Where there are KCDC plans / identified potential for future corridor treatments, then additional local road corridor width may be required.
- The minimum clearance height above local road corridors should be taken to be 5.5 metres unless otherwise advised by KCDC.
- Changes in the vertical or horizontal alignment of local roads, or to their character, should be avoided. Specific consideration by KCDC will be given to any proposed changes to existing alignments of local roads.

2.2 Required standard of existing local road junctions and links that require treatment as a result of expressway implementation: including Poplar Road, Kapiti Road, Te Moana Road and Peka Peka Road.

- Check any proposals in terms of KCDC aspirations, strategies and designs for the area and corridor concerned.
- Suitable provision for all modes is required, including safe and convenient movement by slow modes and local traffic.
- The design of any changes to the road corridor needs to be attractive, environmentally sensitive and fully integrated with (current and future) land uses, activities and residential frontages.
- Any additional traffic capacity proposed needs to be considered within these constraints.

2.3 Standard and requirements for any future roads affected by the implementation of the expressway, including: a link to replace Leinster Avenue between Poplar Avenue and Raumati Road to SH1 and the Ihakara Street extension.

- The allowance for future local road corridors needs to be to full subdivision standards, including space for integrated storm water management.

2.4 Standard and requirements for other (non-road) network reasons, including: walking, cycling, horse riding, bus routes, rail corridors/facilities, water courses and services.

- Full preservation of other current local network corridors/facilities needs to be made. This includes maintaining appropriate width, height and attractive design for local movements.
- Where there are KCDC plans or identified potential for other local network corridor/facilities then allowance for these in the expressway design will be needed to full subdivision standards.
- Where water courses are crossed by the expressway or other associated road works, bridges (rather than culverts) should normally be provided.

References

Subdivision and Development Principles and Requirements, 2005

NZS4404:2010 Land Development and Subdivision Infrastructure

NZS6896:2010 Acoustics: Road Traffic Noise – New and Altered Roads

Annex: Specific Cross-Sections

1 Standard Dimensions

Introduction

A number of considerations apply to the specification of crossing dimensions for local networks, including:

- Road carriageway seal width for vehicles
- Cycle facilities on the shoulder of the road.
- Footpath facilities or shared walk/cycle facilities adjacent to the road.
- Separate cycle/walk/bridleway facilities along the corridor.
- Verge widths retained for drainage, services and landscaping purposes.
- Safety clearances from structures / furniture.

In addition to these aspects, additional width may be required to allow for: bridge alignment 'skew', visual aesthetics, personal security (CPTED[1]) or watercourse allowances at particular locations. These four aspects are not specifically addressed in this technical note.

Width – local road crossings <u>under</u> expressway

In the absence of any specific advice the following minimum 25 metre cross section should be assumed for local road crossings under the expressway:

- 7 metres road carriageway (either for 2x3.5m lanes, or for narrow lanes and median)
- 8 metres for walking and cycling (2x4 metres either side for either: 2 metres footway and 2.0 metres cycleway, or for footway and parking)
- 8 metres for verges (2x4metre verges for services, landscaping, drainage , banking)
- 2 metre allowance for kerbing, clearances, fencing or additional road width (if required).

It is suggested that the width of the local road crossing should be consistent with the approach width of the existing road corridor on either side of the expressway, unless there are future plans to alter these corridor widths. Provision for any new links should also be based on planned corridors. Widths should be clear of any structures associated with the expressway, for example bridge supports.

At one location to the south (probably Kapiti Road) and north of the Waikanae River (probably Te Moana Road) at least one wider crossing is required to allow west to east movements of over-width loads (to an 11.0 metre clearance).

Width – local road crossings <u>over</u> expressway

- 7 metres road carriageway (either for 2x3.5m lanes – or for narrow lanes and median)
- 3.0 metres for shoulder cycle lane (2x1.5 metres either side)

[1] Crime Prevention Through Environmental Design

Width – CWB crossings

The width requirement for cycling, walking and bridlepath, stock or other access requirements needs to be reviewed as a separate exercise, however, the working assumption is that a minimum of 3.0 metres will be required.

Height

Generally, a minimum height clearance for all local road crossings 5.5 metres should be assumed for all local road crossings passing under the expressway. It is assumed that there will be no height restriction for local roads crossing over the expressway.

At one location to the south (probably at Kapiti Road but alternatively at Raumati Road) and one location north (probably Te Moana) of the Waikanae River and at least one higher crossing to allow west to east movements of over height loads is required.

The height clearances for walking/cycling, bridlepath, stock or other access requirements need to be reviewed as a separate exercise. However, as a general rule a 3.0 metres height clearance for CWB movements will be required.

Weight

It is assumed that current standards will make adequate allowance for future weight loadings on structures.

Special considerations would clearly apply if the local road over expressway bridges were part of any overweight load or special construction routes.

2 Possible exceptions

In some cases the following may need to be considered:

- Shared pedestrian/cyclist provision (say, if on a leisure corridor) if so, facilities should be provided on both sides of the road and a minimum shared facility width for walking and cycling of 2.5 metres is required.
- Shared road/cyclist provision (say, if in a 30km environment and traffic volumes are low).
- Verges may not be required to full standards (say, if there is expected to be low demand for services) or if planting treatments would not be appropriate (say, because of urban/landscape design considerations).
- Carriageway width may vary, up or down, depending on the nature of the road concerned.
- At intersections, specific requirements may apply to accommodate visibility/turning requirements.
- On bends other requirements may apply to maintain visibility or to accommodate vehicle swept paths.

3 Locations

Requirements for selected local road crossing locations are given below:

Location	Current width	Notes *Typical features / character aspects.*	Future Crossing - Minimum Clear Width Requirement.
Poplar Avenue	16m site est. GIS est. 20m	Local Road Under: Semi-rural character, current footway on north side, mainly 50k speed environment, narrow carriageway, with wide verges. Increased future importance as a connector road for local movements and for expressway access.	**20m** (7m/r+3m/s +4m/f + 6m/v)
Leinster Avenue Replacement	N/A	Local Road Over: Probable location crossing the expressway near 200 Main Road. Important local connection to reduce severance effects.	**12m** (7m/r+5m w/c)
Raumati Road	12-17m site GIS est. 21m	Local Road Under: Eastern part of road has sealed shoulders, wide (between 8m and 10m depending on location) carriageway- busy road, 50km suburban environment and bus route. Very important east-west mixed use road.	**20m** (7m/r+3m/s +4m/f + 6m/v)
Ihakara Road	23m site est *(18m +3m +2m)* GIS est. 21m	Local Road Under: Currently a wide service road for commercial /industrial premises, with footway, parking plus sealed shoulder on either side plus a central median, 10 metre carriageway, in a 50k urban speed environment and a bus route. Important leisure use corridor and very important future connector road through to Kapiti Road.	**20m** (7m/r+3m/s +4m/f + 6m/v) +3m + 2m allows for separate leisure tracks either side of stream
Kapiti Road	18msite est. GIS est. 21m	Local Road Under: A heavily trafficked urban arterial road for the most part, predominantly 50km/hr limit (70km/hr past the airport). Typically with footpath, sealed shoulder on either side plus a central median. Approx 10 metre carriageway but width is variable due to flaring at frequent intersections, also an important bus corridor. Very important east-west mixed use road for local movements, town centre, development and expressway access.	**30m** (17m/r+3m/s +4m/f + 6m/v) potential 4 lanes and landscaping treatment
Mazengarb Road	18m site est. GIS est. 20m	Local Road Under: Footways and sealed shoulders on both sides, typically a 10m carriageway and also a bus route.	**20m** (7m/r+3m/s +4m/f + 6m/v)
Otaihanga Road	20m site est. GIS est. 20m	Local Road Under: Footway on south side, 6m carriageway. Semi rural in nature wide verges – bus route.	**20m** (7m/r+3m/s +4m/f + 6m/v)
Te Moana Road	23m site est. GIS est. 26m	Local Road Under: 10 metre carriageway with sealed shoulders on both sides , footpath on north side, gravel track on south side and bus route. Very important east-west mixed use road for local movements, expressway and development access.	**25m** (12m/r+3m/s +4m/f + 6m/v)
Ferndale Road	18m site est. GIS est. 18m	Local Road Over: New suburban development, 10 metre carriageway. Important local link to the Ngarara development zone and precinct.	**12m** (7m/r+5m w/c)
Ngarara Road	23m site est. GIS est. 21m	Local Road Over 5 metre carriageway with wide verges partly used for drainage, rural nature 70km/hr environment. Important connector road.	**12m** (7m/r+5m w/c)
Smithfield Road	18m site est. GIS est. 18m	Local Road Over: 5 metre carriageway with wide verges. Important future connector road between the Waikanae North development, the Ngarara development and the coast.	**12m** (7m/r+5m w/c)
Ngarara paper Road	20m	Local Road Over: Future connector between rural areas and the coast.	**12m** (7m/r+5m w/c)
Peka Peka Rd	18m site est. GIS est. 20m	Local Road Over: 6 metre carriageway in a rural 80k environment and bus route. Important east-west road for local movements and expressway access	**14m** (7m/r+3m/s +4m/f)

ote: The local roads over expressway widths quoted above assumes services can be accommodated within this width – otherwise additional width will be required.

V3.2 28-06-2011

Appendix 1.C

MacKays to Peka Peka Expressway –

Long-term Settlement and Pavement Performance Paper

MacKays to Peka Peka Expressway - Long-term Pavement Performance Criteria

Vertical Displacement Criteria Over following Pavement Construction

Proposed Criteria	Criteria Measurement	Christchurch Southern Motorway - **Criteria over 25 years**	Waikato Expressway Ngaruawahia Stg 2 **Criteria over 5 years**	Tauranga Eastern Link
Total Vertical Displacement		100mm	150mm	Expected post construction settlements shall be allowed for. Ground mitigation measures are required where the pavement surface geometry is expected to deviate significantly over 25 year life.
Transverse Vertical Displacement i.e. Crossfall	Measured over the formation width either side of the median	No greater than 1%	No greater than 1% with minimum crossfalls maintained.	
Longitudinal Differential Vertical Displacement	Measured over successive intervals	No greater than 0.3% over 50m (or 150mm)	No greater than 0.2% over 10m (or 20mm)	
Change in Equivalent Design Speed		Less than 10% change	Less than 10% change	
Longitudinal Differential Vertical Displacement Adjacent to Structures	Measured over 10m approach to structures	No greater than 0.15% (or 15mm)		Smooth transition to the structures. Ground mitigation measures over 25m approach to structures.
Roughness	Measured at end of deflects liability period. IRIQC for each 100m section of lane surfaced with OGPA or SMA	Refer TNZ TM 7009, version 1. No value to exceed a maximum of NAASRA count 60, with the target count of 50.	Not exceed 1.94m/km (NAASRA count 50) as a 95th percentile. Measuerd at the end of the deflects liability period.	TNZ TM 7009, version 1. Measured at opening and at end of deflects liability period.
	Measured at end of deflects liability period. IRIQC for each 100m section of lane surfaced with Chipseal	Refer TNZ TM 7009, version 1. No value to exceed a maximum of NAASRA count 70, with the target count of 60.	Not exceed 2.69m/km (NAASRA count 70) as a 95th percentile. Measuerd at the end of the deflects liability period.	

Appendix 1.D

Stormwater Modelling Simulations

Memorandum

SCHEDULE 4

M2PP Expressway 3320901

Model scenarios - Waikanae / Waimeha 7-Feb-11

Scen.	Description	Purpose		Sensitivity			Storm event			Flood interaction		Model used		Comparisons
		Waikanae	Waimeha	Bridge debris loading	Stopbanks	Waikanae flood plain	Return period	Climate change flow	Climate change sea	Waikanae overflow	Waimeha floodway	Waikanae	Waimeha	
1	Smaller storm - stormwater peak attenuation	-	mitigation design	-	-	-	10% AEP	16%	0.8m	-	-	no	yes	Existing and mitigated
2	Base design case	upstream water level	mitigation design	-	-	-	1% AEP	16%	0.8m	-	-	yes	yes	Existing and mitigated
3	GWRC overflow case	-	mitigation design	-	-	-	1% AEP	16%	0.8m	-	50m3/s	no	yes	Existing and mitigated
4	Bridge design, debris	upstream water level	mitigation design ??	bridge manual	-	-	1% AEP	16%	0.8m	allow	if <50, don't model	yes	??	Existing and mitigated
5	Design - sensitivity case	upstream water level	mitigation design ??	bridge manual	-	floodplain +0.5m	1% AEP	16%	0.8m	allow	if <50, don't model	yes	??	Mitigated only
6	Extreme case	upstream water level	Understand consequences, not fully mitigated	bridge manual	-	-	1% AEP	50%	0.8m	allow	from Waikanae model	yes	yes	Mitigated only
7	2500 year flood	bridge structural design	Understand consequences, not fully mitigated	bridge manual	-	-	0.04% AEP	16%	0.8m	allow	from Waikanae model	yes	yes	Mitigated only
8	Worst case for bridge	bridge structural design	-	bridge manual	raised stopbanks	floodplain +0.5m roughness	0.04% AEP	16%	0.8m	none	-	yes	no	Mitigated only
9	Bankfull discharge	rip-rap design	-	-	-	-	about 20% AEP ?		0.8m	-	-	yes	no	Mitigated only

NOTES

Climate change to 2090, medium emissions, is 16% rainfall

Climate change "extreme" for KCDC is 50%, for MfE high emissions is 41.6%. Use 50%

Existing is current situation prior to implementation of Expressway.

Mitigated is with Expressway in place, including any proposed mitigation required to address potential hydrological / hydraulic effects.

Design case for bridge waterway and flood protection, 1%AEP plus mid-range climate change plus debris loading

Design case for bridge structure, 2500 year event with stopbanks raised as below, and with increased flood plain roughness and level

Design case for raised stopbanks is to ??? [note 2500 year level may be unrealistic, possibly max would be 1% plus climate change]