Prepared for
Waka Kotahi New Zealand Transport Agency
Co No.: N/A

Nelson Future Access DBC

Preliminary Design Philosophy Statement

30-Sep-2021

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Client: Waka Kotahi New Zealand Transport Agency

Co No.: N/A

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Reviewed by Dave Gedney

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	26 August 2021	Draft for WK review	Adam Ashford Project Manager	
2	30-Sep-2021	Final	Graeme Doherty Team Leader	

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1.0 Introduction

1.1 Purpose

The Nelson Future Access Detailed Business Case specifies approximately a programme of 100 individual interventions and activities to implement over a 30 year period. This Preliminary Design Philosophy Statement covers the projects that are identified to be implemented over the near term (0-3 years) and the Rocks Road Walking and Cycling project, which is programmed to be delivered within the next 10 years.

This Preliminary Design Philosophy Statement (PDPS) sets out the key design parameters and assumptions to be used in the development of the preliminary design for the near term and Rocks Road options.

All the projects, interventions and activities are listed in Appendix A by timeframe from 2021, with two large specific projects (Rocks Road Walking & Cycling Facility and the Priority Lanes) and their associated projects are also listed separately:

- Near term (0-3 years);
- Short term (4-10 years);
- Rocks Road Walking and Cycling Facility (0-10 years);
- Medium and long term (10-30 years);
- Priority Lanes (10-15 years).

This is a live document that will be updated throughout the programme and for specific projects closer to when consenting and design phases occur.

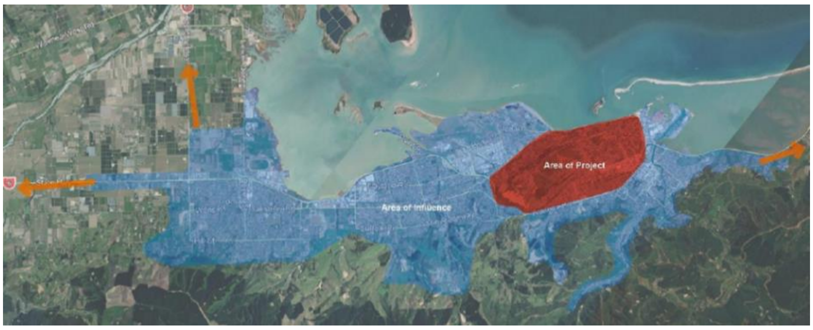
The purpose of this report is to describe the Waka Kotahi New Zealand Transport Agency's (WK's) requirements for the design standards for the near term and Rocks Road projects, taking account of the constraints within the project area.

2.0 Background

Nelson is a medium sized city at the Top of the South Island intimately linked to the surrounding region of Tasman/Marlborough socially and economically. The city is a key area of employment through the presence of the port, agglomeration of businesses in the central city, and the activity that comes through the density of people. People choose to live there because of the environment and work options, with a variety employment.

The area where the business case is focussed is highlighted in Red below, with the area of influence for the project area highlighted in blue.

Figure 1: Project area and area of influence

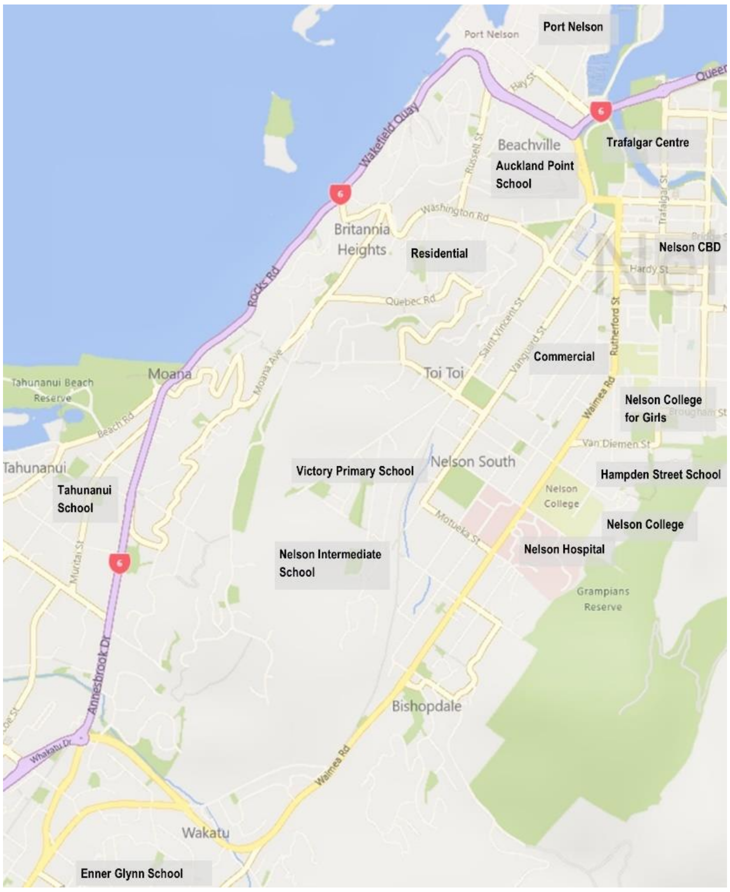


The boundaries of the Red area includes:

- SH6 Rocks Road, Tahunanui Drive and Annesbrook Drive fronting the harbour
- Waimea Road and Whakatu Drive

The project area is shown in more detail in Figure 2. The area includes the Nelson hospital campus, Nelson colleges, primary and intermediate schools, commercial, retail and residential areas.

Figure 2: Project area



The Nelson Future Access Project is being developed in collaboration between Waka Kotahi and Nelson City Council. To understand the key problems and opportunities for investing in changes to the transport network an Investment Logic Mapping (ILM) workshop was undertaken and the following key problems were agreed for this business case:

Problem 1: The inability of Nelsons transport network to support the increasing movement of people and freight between Stoke and Nelson city centre is constraining the economic growth and social well-being of the region.

Problem 2: Conflicting uses and inappropriate use of the network severs neighbourhoods reducing their safety and amenity.

Problem 3: The susceptibility of the arterial network to natural events of increasing severity and a greater number increases the risk of significant economic shock to Nelson and the wider region.

The following key benefits were agreed from resolving these problems:

Benefit 1: Nelson's transport system is more effective in moving people and freight.

Benefit 2: Nelson is more accessible.

Benefit 3: Nelson's transport system contributes to quality urban environments.

Benefit 4: Nelson's transport system feels safer and is safer.

Benefit 5: Nelson's transport system is more resilient.

The project outcomes for this DBC have been revisited to align with the GPS 2018 and GPS 2021, to develop a detailed multi-modal transport system investment programme that supports community aspirations for a thriving CBD, a world-class waterfront, a healthy environment and provides a safe, accessible and resilient transport system, whilst meeting the diverse needs of customers and communities. The project seeks to:

1. Identify and respond to customer needs and growth pressures in the study area.
2. Define the existing and future function of key transport corridors (for all modes) in the study area, to deliver a safe, accessible and resilient network cognisant of Nelson City Council's (NCC) goals, the needs of customers and the wider community.
3. Make best use of existing infrastructure and services as well as new/emerging technologies.
4. Ensure integration of land use and transport systems to reduce the dependency on private single occupancy motor vehicles.
5. Investigate and identify a package of measures that could be progressed on SH6 Rocks Road in the short to medium term which enhances walking and cycling and supports NCC's vision for a world-class waterfront.
6. Investigate and make recommendations in respect of the key journeys between Nelson City's CBD, waterfront, airport, port and Richmond including the need for, and if appropriate the timing and/or triggers for an alternative arterial route to Rocks Road and Waimea Road, to resolve long standing uncertainty about the Nelson Southern Link.

2.1.1 Rocks Road (SH6) – Existing Seawall

Rocks Road Seawall construction dates back to pre-1890, where the first iteration of the wall was constructed with locally sourced granite rock along Wakefield Quay. Since then there have been a number of modifications and improvements installed.

The Rocks Road Seawall presents varied seismic risks due to the configuration of different types of wall, i.e. reinforced concrete, unreinforced masonry, and combinations of these. It also appears to be vulnerable to slope instability from the cliff faces, between the Basin Reserve and Magazine Point.

The condition of the seawall varies along its length essentially due to the age of the structure in each section. In some locations it is exhibiting signs of scouring and undermining, which may become more problematic over time. However, the condition assessment undertaken by Opus[1] provides an indication of the remaining useful life of between 15 and 50 years depending on location.

While closure of Rocks Road does cause significant inconvenience and travel–time delays, it is not currently relied upon as a life-line route due to its history of susceptibility to slope instability, especially those related to storm events.

Should the wall fail, whether due to its condition, or a high impact low probability event, the closure required to facilitate building the seawall has the potential to be in the order of months, therefore access between Nelson and other areas would be totally reliant on Waimea Road for an extended period of time. It is this lack of redundancy in the transport system (i.e. lack of alternative people moving capacity) should an event occur that will impact the region, given the economic link to the port and key commerce in the CBD.

2.1.2 Sea Level Rise and Overtopping

AECOM[2] has completed a wave overtopping assessment for Rocks Road as part of this investigation (noting that with sea level rise there will be parts of the City Centre and Tahunanui that will be susceptible to tidal inundation).

This assessment indicates that flooding of Rocks Road will become more frequent, due to the continuing effects of climate change and sea-level rise. In general, the overtopping rate increases at Rocks Road as time progresses. It is anticipated that Rocks Road could experience more frequent closure during the design extreme condition in the future, which is based on Mean High Water Spring plus extreme wave height. For comparison, Cyclone Fehi was approximately a 1 in 300-year ARI event, whose return period in the future will represent a 1 in 100 year event.

[1] Rocks Road Investigation Report
[2] AECOM Wave Overtopping Assessment

3.0 Near Term projects

The following projects have been identified as those requiring a preliminary design philosophy statement. The Project number is a reference that comes from the main project prioritisation spreadsheet, which can be located as an Appendix in the Detailed Business Case report. The description describes the main elements of the project.

Number	Activity	Location	Description
C001	Cycling Route	Cycling Connection from Waimea/Hampden to Railway Reserve via Broads Fields	3.5m shared path – If space is limited, widen existing footpath on south side of Hampden up to Kawai St to create shared path, utilise verge on west side of Kawai to Franklyn as a shared path. If space permits, create a separated path to same locations. Reduce lane widths on Franklyn and transfer to footpath on south side of Franklyn as a separated cycle path and separated footpath if room provides for this or 3.5m shared path if not. Remove parking on east side of Tipahi and install separated cycle path and separate footpath to AustRoad standards. Install shared path from Tipahi to Railway Reserve (WC048). Install traffic signalised intersection (WC038a) at Motueak/Tipahi.
RR001	Rat Running Interventions	Washington Road Based on safety concerns	speed humps, chicanes, one-way traffic signal channelisation narrower lanes and side friction with planting. Gateway to valley outside playground using humps and buildouts etc. Part of [project C071.
RR009	Rat Running Interventions	Tipahi Street based on mode shift	chicanes, double cul-de sac in conjunction with Project C001.
WC033	Intersection	Waimea Road and Franklyn Street Signalised Intersection	Install new traffic signalled intersection.

WC054	Desired Arterial Crossing Point	Tahunanui/Muritai St Crossing	kerb build outs and central refuge on Muratai Street
WC060	Intersection	Tahunanui/Parkers/Maire Signalised Intersection	Safety access intervention - signalised intersection. Includes active mode crossings (WC061)
WC071	Walking and Cycling Route	Washington Rd Walking and Cycling Route	St Vincent Street to Wolfe Street - create separated cycling facility on south side of Washington to Austroads standards and 2m footpath on other side of road. Beyond Wolfe create shared path 3.5m wide on south side up to Mt Vernon Place. Install raised crossing point near Mt Vernon intersection to access footpath on north side of Washington and act as traffic calming measure. Include rate running interventions (RR001).
WC081	Desired Arterial Crossing Point	Maori Road / Haven Road intersection	Crossing across throat of intersection.
WC082	Desired Arterial Crossing Point	SH6 between Muritai and Rui	kerb build outs and/or central refuge
WC083	Desired Arterial Crossing Point	SH6/Gracefield Intersection	kerb build outs and/or central refuge
MISC28	Intersection	SH6 Tahunanui Drive Bisley Ave signals	Reinstate southbound second lane on approach and merge on downstream side to operate 24/7.

Rocks Road Walking and Cycling Facility

WC020	Corridor Widening for walking and cycling	Along Rocks Road and through Tahunanui Reserve to link to existing facilities	Create 5m shared path by widening into CMA (excluding at ONL) through reclamation using a revetment or a seawall. At ONL, build new seawall to minimise impact on ONL and CMA. Lane configuration to facilitate buses and freight with curve widening of lanes on corners as per Austroad standards. Parking width to match LDM standard for arterial route. Extents of project from intersection of Waikare St / Beach Road across Tahunanui reserve to Rocks Road and finish at Anchor Bldg (approx. 3.5km in length).
WC021	Desired Arterial Crossing Point	SH6/Richardson Intersection Crossing	kerb build outs and/or central refuge; zebra crossing
WC030	Desired Arterial Crossing Point	Rocks Road Crossing at Basin area	kerb build outs and/or central refuge; zebra crossing
WC037	Desired Arterial Crossing Point	Days Track and SH6 Signalised Crossing	Part of priority lanes package but requires building as part of Rocks Road project (WC020).
MISC031	Priority Lanes SH6 S/B	Days Track to the intersection with Bisley or Parkers. NB: Southbound extent of PL in RMA application to be determined in next phase.	Widen existing c/way to create S/B priority lane. Inclusion of N/B priority lane to same extents to be determined. All to be part of Rocks Road project (WC020)
WC008	Desired Arterial Crossing Point	Wakefield Quay Crossing near Anchor Shipping building	kerb build outs and/or central refuge; zebra crossing
WC009	Desired Arterial Crossing Point	Wakefield Quay Crossing outside the Quay building	kerb build outs and/or central refuge; zebra crossing

WC013	Desired Arterial Crossing Point	Nelson Yacht Club Crossing	kerb build outs and/or central refuge; zebra crossing, signalised crossing
WC015	Desired Arterial Crossing Point	Near Rocks Road/Victoria intersection	kerb build outs and/or central refuge; zebra crossing

In summary, the main elements associated with the permanent works of the above projects are:

- Shared paths;
- Separated walking and cycling paths;
- Uncontrolled crossings using build outs and/or central refuges – possibly raised;
- Zebra crossings – possibly raised;
- Signalised intersections;
- Traffic calming measures;
- Seawalls;
- Reclamation into the sea using general fill and rock revetments;
- Carriageway widening, reconstruction, overlay and inlay;
- Associated surface water drainage, traffic services, landscaping and service relocations

This Preliminary Design Philosophy Statement speaks to the design of the permanent works above as a guide to implementing the next phase of design, being implementation for near term projects and pre-implementation for the Rocks Road projects.

4.0 Preliminary Design Development Philosophy

4.1 Approach

This project is about people, enhancing communities and providing effective and efficient transport.

This means prioritising modes of transport and allocation of space that supports moving people and accommodating freight.

Urban Design principles cover all aspects in the delivery of options within places. It provides guidance in achieving and assessing the quality of developed and restored urban areas.

Urban design principles developed for NFAP are provided in Appendices in the NFAP DBC report and should be used when developing the design for each individual project as the principles create a one approach to achieve the desired urban outcomes.

Some of the existing corridors are constrained with limited available width to accommodate the various transport modes and other improvements. There are areas where compromises will be necessary to develop the design. Designers should take into account the feedback gained from the public engagement undertaken for NFAP and any specific engagement on a project that occurs during the pre-implementation phase. This feedback will help inform the trade-offs that may need to occur.

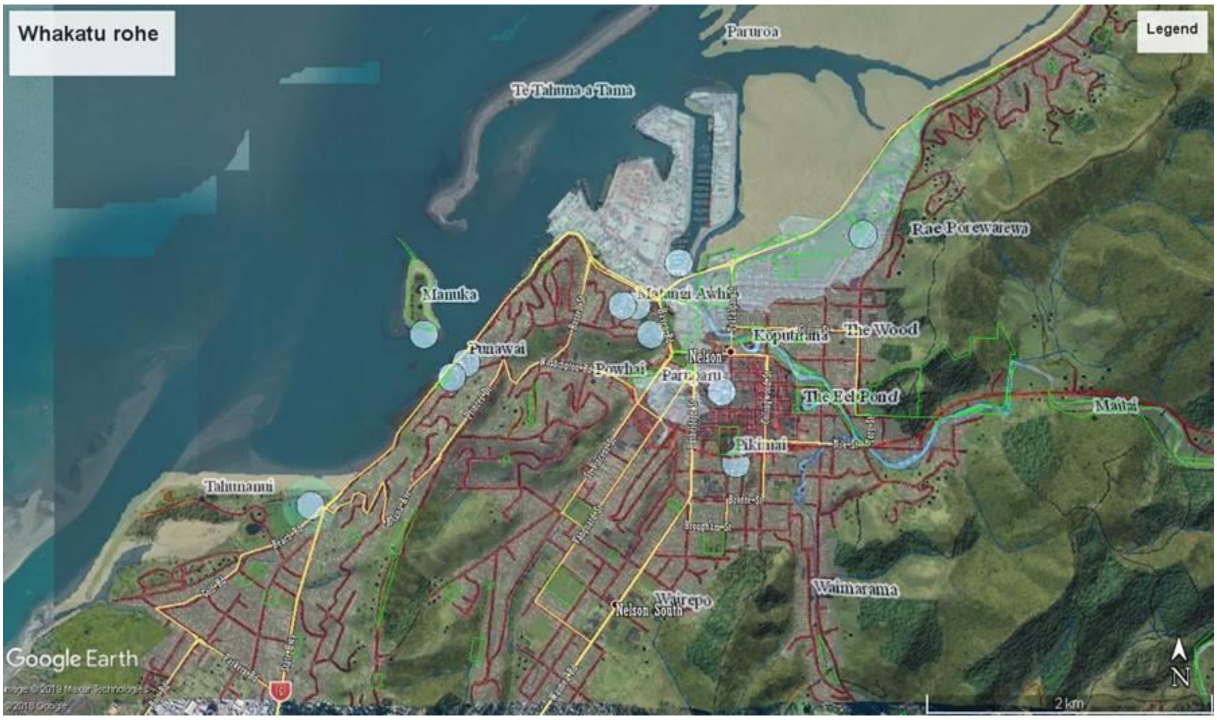
A strong safety focus must be adopted during the development of the design phases for each project, acknowledging the desired outcomes from the Governments Road to Zero strategy.

4.2 Mana Whenua Values

The following are the Mana Whenua values adopted during the Multi-Criteria Analyses undertaken. These values are to be used to guide the development of the design.

Sub criteria	Matters to Consider	Quantitative measures, information or data to assist assessment	Key assumptions
Te Ao Tūroa (Natural World)	Domain of Papatūānuku and Ranginui and their offspring Tangaroa - Wai Ora Fresh Water quality and Quantity Moana Coastal Marine Quality Tawhirimatea - Air Quality Whenua quality Haumiatiketike – uncultivated foods and fern roots - Indigenous biodiversity Rongomaraeroa – cultivated foods Tutewehiwehi – reptiles and amphibians	Te Mana o te Wai framework Historical indigenous footprint Cultural Health Indicators data/information Cultural Impact Assessment reports Mātauranga Māori reports Wāhi tapu areas and taonga sites. public and private information	Focus on use of the transport network and the resulting impacts from its use
Whānau and hapū	Whānau Hauora The integrity / sustainable management of cultural sites / areas / locations	Including cultural practices and uses (access, customary harvest, mahinga kai and rahui (restrictions and controls) Support for all cultural, social, environmental, property and commercial endeavour	Focus on the impact to cultural sites from the construction/implementation, noting that the sites are clustered around the costal marine area (Rocks Road and the cliffs above) and the historic pre European/reclamation shoreline as per image below. Also includes package impact on communities with significant proportion of Māori
Ki Uta ki Tai	Managed in accordance with Kaitiakitanga and Tino Rangatiratanga	All factors evaluated against kaitiakitanga framework to achieve ‘net enduring restorative outcomes	How can the net outcome be most contributory to the Māori world. How can Mana and Leadership shape the net enhancement? The Crown has proivides a range of solutions and given it to Te Tau Ihu to judge which makes the least impact and on the other hand the Māori world is the parallel world to the crown and in that world Māori lead the application of Ki Uta ki Tai in a way that Mauri is enhanced as a consequence of intervention. Rather than looking at the least impact the cultual responsibility is to be restorative?

Rohe are shown below.



4.3 Community Values

The following are the Community values to be adopted during the development of the design.

Criteria	Description
Community Connectivity and Cohesion	How does it impact community cohesion and Nelson's diverse range of cultures, ages and backgrounds? How well does the design facilitate good connections (minimising severance) to jobs, schools, shops, key community services and recreational facilities from residential areas? Will access to and enjoyment of key community areas and liveability be enhanced or reduced?

Criteria	Description
Active and Equitable Transport Modes	How well does the design facilitate and encourage active, healthy and diverse transport modes (walking, biking, micro-mobility)? How effective is the design in providing public transport to the right areas and at convenient times, particularly for younger and older residents and for those who do not have access to a car? How does the design increase perceptions of safety so that they choose active and healthy, diverse transport.
Sustainability and Environment	How does the design contribute to the overall sustainable management of natural and physical resources – see RMA Part 1 Section 2 and 5 for Definition

4.4 Heritage – Rocks Road

The design will retain heritage values to the highest degree, even as it is combined with the utility and amenity of Rocks Road as one of two future access roads and will require careful integration. A conservation architect will be essential in advising the design process, whichever way the road is changed.

With careful consideration and design attention, the least damage to fabric and the heritage values could be achieved. From a heritage perspective, noting the trade-offs that will need to occur, the aim should be:

- A sea wall rather than a revetment
- Reinstated chains and stanchions, enhancing the coastal edge
- A current or similar wall alignment, with similar appearance
- The full retention of the Outstanding Natural Landscape
- Retention of the integrity of all heritage structures

4.5 Typical Cross Sections and Lane Widths

Cross sectional elements for the different modes shall be designed to achieve, where possible, the Nelson Tasman Land Development Manual for local roads and Austroads and Waka Kotahi standards for the state highway.

These shall be correlated to the hierarchy of the specific mode being designed, which are also correlated the anticipated volumes and desired widths through the Functional Level of Service. These documents are contained in the appendices of the NFAP Detailed Business Case.

4.6 Geometrics

4.6.1 Width of Shared Paths

The width of the path required to cater for future cyclist and pedestrian demand was established during the DBC phase against the Austroads guidance as set out in the tables below. A width of 5.0m was assessed for Rocks Road using:

- Highest demand is predicted at the weekends for tourist and recreational trips;
- Looking at the projected cyclist numbers over the first 25 years, the likely weekday peak hour numbers are approx. 450-500 cyclists and up to 200-220 pedestrians. This puts the forecast demand into the 4.5m shared path width;
- Between 25 to 40 years, the likely numbers averaged over a year is up to 500-550 cyclists and up to 250 pedestrians per peak hour. This puts it into the 4.5m path width category. Combined with a 0.5m shoulder on the seaward side, this creates a 5m width overall.

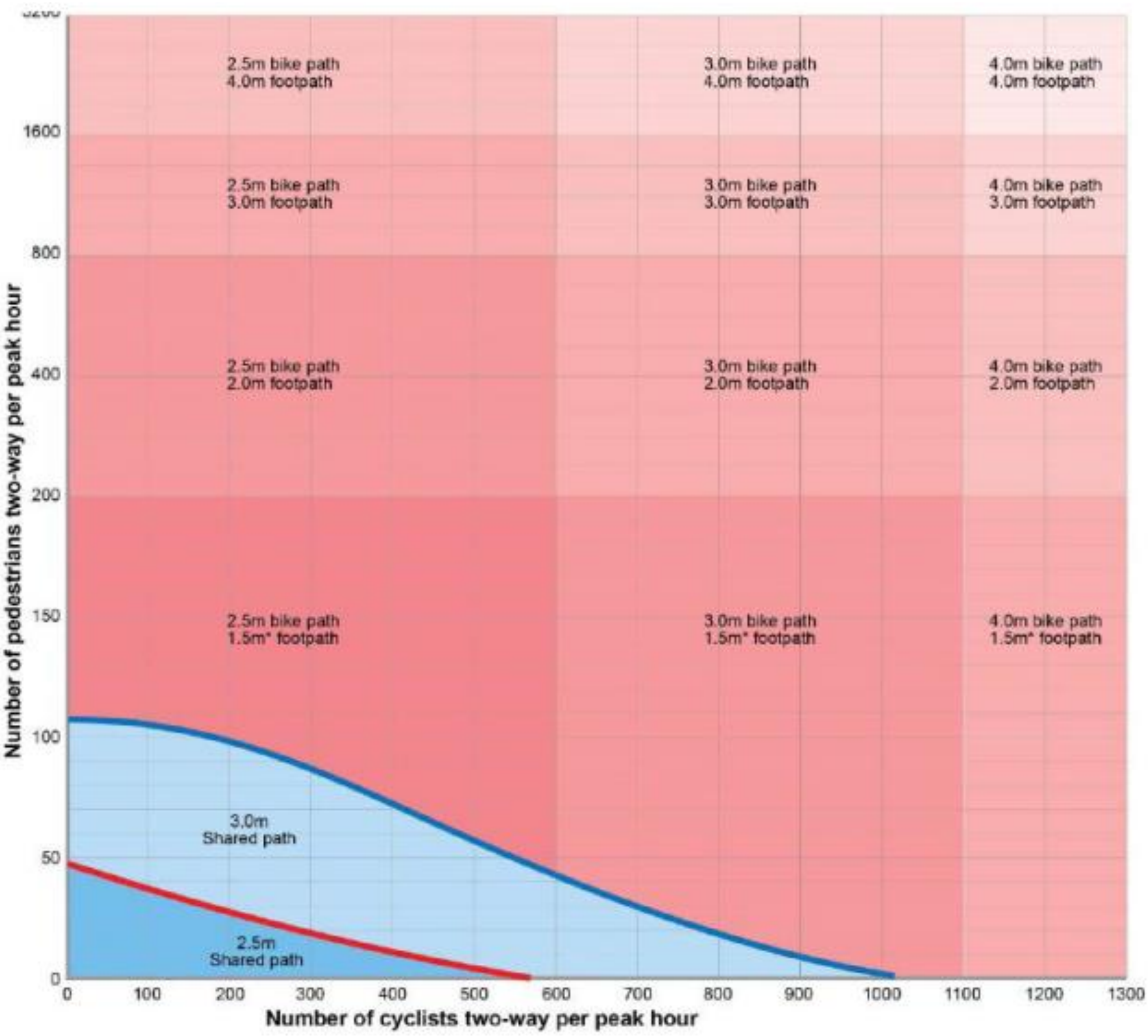


Figure 1 Recommended shared path widths for 50/50 directional split (Austroads AGRD 6A, Figure 5.4)

Table 5.4: Separated two-way path widths

	Suggested path width (m)		
	Bicycle path	**Pedestrian path**	**Total**
Desirable minimum width	2.5	2.0	4.5
Minimum width – typical maximum	2.0– 3.0	≥ 1.5	≥ 4.5

Figure 2 Recommended separated widths for 50/50 directional split (Austroads AGRD 6A, Figure 5.4)

Footpath widths are to be in accordance with the Nelson Tasman Land Development Manual and the Functional Level of Service determined during the NFAP DBC and is contained within the report's appendices.

4.6.2 Other Design Considerations

The following table summarises other aspects that have been taken into consideration for the geometric design.

Aspect	Preferred Outcome
Line of sight	A continuous sightline throughout the alignment
Ride quality	Reducing sudden conflict movements between cyclists and pedestrians
Finish Quality	To improve overall experience, continuously meet LoS standards over the design life and discourage vandalism
Connection to existing shared path network	Smooth and easy transition between each link of the greater corridor

4.7 Design Speed

Within the near term (0-3 years), Nelson City Council will adopt different speed restrictions on different parts of their road network. When considering the design speed for any particular project, thought must be given to whether to adopt a particular speed restriction for the design elements or to use a standard 50 km/hr design speed. Geometric and cross sectional elements at different speed environments can be used to mitigate locations where the overall corridor width is constrained or below standard, rather than undertake significant works such as eg retaining walls or significant earthworks. Design speed is a tool that should be given consideration to help mitigate constraints in width or budgetary constraints.

4.8 Traffic Signals

The Traffic Signal design is to be based on the following standards:

- Austroads Guide to Road Design – Part 4a: Unsignalised and Signalised Intersections
- Austroads Guide to Traffic Management – Part 9: Traffic Operations
- RTS 14 Guidelines for Installing Pedestrian Facilities for People with Visual Impairment
- Signals New Zealand User Group (SNUG) National Traffic Signal Specification
- NZ Transport Agency Standard Signal Layout Draughting Guide Drawing 1/ 1061/ 140/
- 8104/ Sheet 1/ Rev 0

4.9 Accessways and Driveways

The potential conflict between cyclists on the cycleway and vehicles entering/leaving properties is a key issue that needs to be considered during the preliminary design phase. This includes ensuring adequate visibility of all users of all modes is provided correlated to the anticipated user speed, rather than the designed speed.

4.10 Signage and Road Markings

All signage will be to NZTA MOTSAM standards.

4.11 Parking Facilities

The project will involve loss of and changes to on street parking. Changes are the removal of the existing angle parking and the replacement with parallel parking. At key locations (where for instance additional visibility is required) it may be necessary to remove some parallel parking.

4.12 Preliminary Urban and Landscape Design

4.12.1 Overview

The project is framed within maximum widths of the existing road corridors. Sound urban design principles are essential and will help guide solutions to meet the project's intent and vision. The urban design principles are contained in the Appendices within the NFAP DBC report.

The project looks to:

- Shape streets to work with neighbourhoods and street users;
- Define nodes that help characterise place and identity
- Encourage safe and accessible mixed mode transport
- Measure and evaluate through:
  - Shift in physical and operational changes / improvements
  - Changes in its use and function and its resulting impacts
  - Determining if investments delivered desired outcomes (safety, quality of life, sustainability, economic, improved mobility etc)

Both quantitative and qualitative metrics are important. There are different methodologies in how to measure the above; these include before and after photos, survey and consultation with local patronage and communities and traffic count recorders.

Landscaping, urban design and aesthetic considerations will be developed with cost effective landscaping and urban design solutions in the detailed design.

Consultation has taken place with the partners, stakeholders and the public to develop concepts that could be incorporated into future improvements particularly the integration between existing and proposed walkways and cycle-paths.

4.12.2 Urban Design Principles

Complementing the NFAP, NCC have their own objectives related to community's urban design principles for the region's success - these provide guidance in achieving and assessing the quality of developed and restored urban areas. This project is about people, enhancing communities and providing effective and efficient multi-modal transport. This means prioritising modes of transport and allocation of space that supports moving people and accommodating freight.

Natural Identity

The streets within NCC offer social and economic benefits for Nelson. The topographical layout of Nelson and in particular the connection of land to sea is an important context to consider - the Rocks Road project, in particular, has an opportunity to celebrate this natural identity.

People, Place + Transport

Pedestrians and a mix of diverse modes of transport aid in developing a sense of place for communities and neighbourhoods. Success is achieved when delivering transport which can also provide public space and 'pause' moments for people to share experiences, interact and socialise. The project is framed within maximum widths of the existing road corridors. Sound urban design principles are essential and will help guide the right solutions to meet the project's intent and vision.

Included in appendices of the NFAP DBC report are the urban design principles developed for NFAP that begin with focusing on a city-wide extent and describes precincts within the project and surrounding areas. These nodes are developed based on the existing concentration of activities and intensity. The focus is on people, place and transport as interconnected components. A completed site analysis around these nodes describes the current constraints and opportunities for development during the design.

Standards and References

The urban design should be developed in accordance with the NZTA requirements and include:

- NZTA Urban Design Professional Services Guide – PSG/12;
- NZTA Bridging the gap: Urban Design Guidelines (2013);
- NZTA Urban Design Objectives and Methods (2013);
- NZTA Environmental and Social Responsibility Policy (2011);
- NZTA Landscape Guidelines – Final Draft September 2014;
- NZTA Safe System;
- NZTA Environmental Planning Manual;
- NZTA P39 Standard Specification for Highway Landscape Treatments (2013).

4.13 Preliminary Pavement Treatments

The Pavement and Surfacing design is to be based on the following standards:

- Austroads Pavement Design – A guide to the Structural Design of Road Pavements;
- 2004 NZ Supplement to the Document, Pavement Design – A Guide to the Structural Design of Road Pavements (Austroads 2004), 2007;
- NZ Transport Agency specifications (B, M, P and T series).

4.14 Stormwater

The stormwater design approach is to retain the existing stormwater network, flow paths and inlets as much as is practicable.

Generally projects does not increase the impervious area, with existing sealed areas (parking lanes, footpaths, carriageway) being converted to sealed shared and separated cycleways, meaning that post development runoff will not increase. The exception to this is along Rocks Road where the new shared path with extend towards the adjacent sea.

4.14.1 Key Design Assumptions:

- Where possible, the existing catchments, flow paths, inlets and pipe system should be retained;
- The existing pipe system is assumed to have sufficient capacity. Capacity assessments of the existing system is to be considered on a project by project basis;
- Improvement to the condition of the existing stormwater system network is also to be undertaken on a case by case basis correlated to asset management condition databases;
- Stormwater quality treatment will be required.

4.14.2 Stormwater design criteria

The following design criteria are proposed, based on Austroads 6A, Nelson Tasman Land Development Manual and NZTA 2016: Rainfall intensities will be as per the Nelson Tasman land Development Manual with 20% allowance for climate change

Primary system (kerb and channel, sumps and pipes) are to be sized to match the Average Recurrence Interval specified in the Nelson Tasman Land Development Manual so the rainfall event does not encroach on traffic lanes, but can encroach onto the shoulder / parking area by up to 1 m width

Secondary system (overland flow) sized to match the Average Recurrence Interval specified in the Nelson Tasman Land Development Manual flood water depth does not exceed 0.1 m depth and 2 m/s velocity on trafficable lanes with a minimum of one traffic lane free from flooding, with no limits on flooding over separated cycleways and shared paths. (In a ARI event for secondary flow calculations it is not anticipated that cyclists and pedestrians would be using the cycleways and footpaths due to the high rainfall.

4.14.3 General Stormwater Philosophy

Stormwater system standards and specifications will be in accordance with the following organisations requirements, in order of precedence Nelson City Council and Waka Kotahi.

Raised pedestrian crossings on roads and in cycleways would cut off overland flow paths, affecting both the primary and secondary systems. Raised crossings to be assessed and solutions developed on a case-by-case basis:

Existing sumps to be retained where possible, or replaced as close as possible to the existing location, and connected to the existing stormwater system.

Stormwater treatment to align with Nelson Tasman Land Development Manual.

4.15 Street Lighting

4.15.1 Overview

With the road and shared path corridor width remaining similar to existing but changing in configuration the existing lighting will need to be assessed against the revised layouts. As the kerb lines are being revised there will be a need to relocate columns.

The project intersection(s) will need to be lit with appropriate highway lighting designed to the Nelson Tasman Land Development Manual and Waka Kotahi standards. The requirement for and proposed arrangement of any street lighting shall be confirmed with the appropriate client organisation.

4.15.2 Design Standards

The Street Lighting design is to be based on the following standards:

- NZ Transport Agency M/30 Specification and Guidelines for Road Lighting Design
- AS/NZS 1158 Lighting for Roads and Public Spaces
- “RightLight” Roading Lighting Guideline ;
- Nelson Tasman Land Development Manual

4.16 Utility and Public Services

Impacts on utilities or services are to be identified as part of the project development.

Utility databases should be explored and early in the design phase conflict points identified. Based on experiences with other recent projects, it is recommended that potholing, trenching and general hydro vacuuming be undertaken to accurately locate underground services to either alter the design to avoid or accept the relocation cost. Knowing actual costs related to services prior to procuring a physical works Contractor will provide significant benefits in terms of confidence around time and cost against adopting a philosophy of dealing with service conflicts as and when they occur during construction.

4.17 Proposed Construction Methodology

With the exception of the Rocks Road project, the nature of the other near term projects is primarily relocation of kerb lines, some carriageway changes to suit the new alignments, installation of shared and/or separated paths and then resurfacing and new lining. As such it should be relatively easy to split the works into linear sections for phasing along the length of each project.

For Rocks Road a separate proposed construction methodology is provided below.

Noting the effects of Covid-19 on the supply chains for materials and resources, consideration should be given to providing for the provision of materials to be secured at the start of the physical works project as a mitigation measure against supply chain disruptions that might occur.

4.17.1 Potential Phasing – Near Term Projects

The key constructability issues will be to accommodate and manage the traffic volumes, cyclists and pedestrians during construction. Where possible, the project should be broken up into construction areas between intersections with the associated intersection upgrade being undertaken independently. This could also be facilitated through road closures and diversions.

Where new traffic signals are to be installed as part of a project, installing TTM as a de-facto roundabout during non-work periods could be an effective method of controlling traffic through the works as opposed to maintaining 3-way or 4-way temporary traffic signals 24/7. This should be considered within the contracted working days, noting that there will likely be significant periods of non-working time due to noise limits essentially ruling out night works.

Temporary traffic signals, if used during non-working periods, should be connected to a mains electricity supply rather than operating diesel generators overnight.

Each project will have its own set of bespoke constraints and will require specific construction methodologies. Engaging a Contractor (as an advisor) at some point during the design process, can help inform the design to match likely construction methodologies.

The outcomes that can be achieved through undertaking the potholing for services and a design that has already been tested for construction methodology will minimise and mitigate time and cost risks associated with unforeseen circumstances.

4.17.2 Potential Phasing – Rocks Road Shared Path Project

The Rocks Road Walking and Cycling project is a complex project which runs the length of the state highway from the Tahunanui Reserve area to near the intersection with Hay street – a length of approximately 3km. Many trade-offs, not only between the effects of the project on the environment, but also there will likely be trade-offs in design standards to meet statutory requirements and consent conditions that will be imposed on the project.

Additionally, the project is constrained by high traffic volumes together being the primary freight route to and from the Port of Nelson with a steep hillside (with residential housing) on the eastern side of the state highway and the sea to the western side of the state highway.

Whilst the construction methodology will be determined by a specialist contractor at the time of design development, the following will need to be considered in the overall construction philosophy based on a rock revetment reclamation in some areas and a seawall in other areas. A suggested construction methodology is also provided:

A. An area of Outstanding Natural Landscape (ONL) runs adjacent to part of the project – refer to the drawings for extent.

B. The expected sea level rise in the next 100 years is 1.4m;

C. The proposed seawall / revetment should be designed to a 1% AEP with the user being exposed to a light spray during that event.

D. Austroads standards for a 50 km/hr urban arterial road should be adopted, with NCC parking width adopted;

E. The inside lane needs to accommodate buses and possibly freight with the offside lane needing to accommodate freight and general traffic. Curve widening in accordance with Austroads is applied to corners correlated to their radius;

F. For the option of building a seawall, a minimum of 2m of width beyond the existing seawall is required for construction of a new seawall (including working room). The existing seawall is to be incorporated into the widening but can be broken down to 500mm below footpath level;

G. For the option of building a revetment, the revetment starts at the edge of the existing seawall, which is broken down to approximately 500mm below footpath level and the whole wall incorporated into the backfill of the proposed revetment.

H. Any bench provided in the revetment should be situated at MHWS which provides the means to adapt to sea level rise by increasing the height of the bench correlated to actual sea level rise over time;

I. The existing stanchion chain fence will need to be retained either on top of the new seawall or at the edge of the shared path.

J. There are no on road cycle lanes.

K. Right turn lanes and flush median locations have been provided to locations where these currently exist.

L. The extent of Priority Lanes needs to be reassessed nearer the time of design development;

M. A reduced width of the proposed walking and cycling facility is accepted rather than widening into the cliffside;

N. A utility trench providing for service providers new apparatus and also fibre ducts (for CCTV and ITS) should be provided under the new path;

O. Monitored CCTV should be provided;

P. The existing fishing platform may require relocation

Q. No widening into the cliffside is envisaged;

R. Construction could occur by firstly creating the revetment/seawall in 200m sections utilising the permanent closure of the northbound lane over that distance, using temporary traffic signals over a 24 hr, 7 day per week timeframe.

   1. Working hours should be daylight hours, 7 days per week, whilst complying with current noise limits.
   2. A speed restriction of 30 km/hr should be in place.
   3. A footpath will need to be provided as part of the temporary traffic management.
   4. Cyclists could continue to use the carriageway but at times cyclists will be in-lane adjacent to the works.
   5. Large laydown areas will be required for primary rock armouring, whilst secondary armouring and general fill and pavement materials could be tipped and installed in one operation at the required location.
   6. Primary rock armouring can firstly be used to provide an overfilled toe of revetment to provide protection against waves.
   7. Once revetment fill material has been deposited, secondary rock armouring will be installed with the overfilled toe armouring relocated on top of the secondary armouring.
   8. For the seawall option, over each 200m length, the seawall will be constructed using mass block reinforced concrete followed by rock revetment to prevent scouring at the toe. The 1m loose material assumed to be above the bedrock is hydro-vac prior to placing first precast blocks. Rock anchors will be installed at 15 degrees at approx. 2.5m from top of wall for seismic strength and to be below services.
   9. Once the seawall/revetment is constructed along the full length, the traffic management can be altered to construct the eastern half of the project in 200m sections and when complete, the traffic management altered to enable construction of the western half of the project in 200m sections.
   10. Access to driveways and side roads will be maintained but there may be limited short term closures at side road intersections with diversions in place.
   11. An 18 month construction timeframe is envisaged.

4.18 Property

Apart from the Rocks Road project, the other near term projects are all within the existing road boundaries and property purchased is not envisaged.

Property impacts for Rocks Road and any associated accommodation works will be determined as the overall design progresses. Indicative land requirement plans for Rocks Road are provided in Appendix J.

Any property purchase should be consistent with the Property and Consenting Strategies contained within the appendices of the NFAP DBC report.

4.19 Environmental and Social Responsibility Issues

Minimum standard Z/19 – Social and environmental Management will guide the design to incorporate the desired environmental and social responsibility outcomes detailed in the Urban and Landscape Design Framework, which is located in the appendices of the NFAP DBC report.

The ULDF also contains the ESR screens and provides commentary against each category for specific consideration in developing the design.

4.20 Asset management Considerations

In developing the design of projects, consideration must be given to the use of materials that align to the standard materials used within the Nelson Tasman region on the road networks. Whilst bespoke materials and/or specific assets (eg bespoke street lighting columns/luminaires) may be desirable from an urban design perspective, the use of bespoke assets needs to be balanced against the long term maintenance needs and the availability of spares and replacements.

Within the appendices of the NFAP DBC report there is an Asset management Plan that will need to be referred to when developing the design and considering asset management principles and practicalities.

4.21 Geometrics

The primary standards used and proposed are listed below in order of precedence:

- Austroads Guide to Road Design (AGRD) Parts 1 to 8;
- Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings;
- Austroads Guide to Traffic Management Part 9: Traffic Operations.

Other design and general documentation also to be considered in the design phase:

- Safety in Design Minimum Standard for Road Project (Oct 2014, Version 1)
- AS1428 Design for access and mobility;
- AS5100 Bridge Design Code;
- AS/NZS 3845-1999 (Roadside Barriers);
- AS/NZS 1158.3.1 (Road Lighting – Pedestrian Area (Category P) Lighting
- NZTA M/23 (Roadside Barriers)
- NZTA M30 – Specification and Guidelines for Road Lighting
- Manual of traffic signs and markings (MOTSAM) Part 1: traffic signs
- Manual of traffic signs and markings (MOTSAM)
- NZS 1170:5 (2004) - Structural Design Actions – Earthquake Actions – NZ.
- NZ Transport Agency (NZTA) Bridge Manual 3rd Edition (2013)
- NZS 3101 (2006) – Concrete Structures Standard
- NZS 3404 Part 1 (2009) – Steel Structures
- NZ Building Code / Act 2004
- NZS 3114:1987 – Specification for Concrete
- AS/NZS 2315 (2002) – Guide to the Protection of Structural steel against atmospheric corrosion by use of protective coatings
- Transit New Zealand Draft State Highway Geometric Design Manual

5.0 Structural Design Philosophy

The need for structures within the NFAP near term projects is primarily for the Rocks Road project, although there are likely to be short length, low height, retaining walls required for shared path connection from Tipahi Street to the Railway Reserve and a medium height retaining wall required on a section of the Washington Road shared path.

The next phase for the Rocks Road project is to undertake the consenting design as part of the pre-implementation phase. This will require mostly understanding the likely physical and statutory constraints that will influence the choice of structure(s) required to achieve a widened walking and cycling facility, whose widening is into the Coastal marine Area (CMA).

This draft design philosophy is therefore focused on the inputs that are required to choose the most appropriate structure and also to provide some options for consideration into the next phase. Geotechnical investigations will be needed to help inform this consideration.

5.1 Coastal Effects on Users

- During adverse storm/storm-tide/wave events throughout the life cycle of the Project, there will be an unavoidable effect of some discomfort for pedestrians and cyclists on the shared path from wind driven spray, which is distinctly different to wave overtopping discharges.
- Wind-driven spray and debris will continue to cause some nuisance impacts during storms (and are unavoidable), and temporary closure of the shared path may still be required during extreme storms.
- There will be a requirement to provide access to the foreshore in the short and medium term. How, depending on the amount of sea level rise, the low tide beach area that is currently accessible may no longer exist under a higher sea level rise.
- In the revetment area, due to the extent of the reclamation footprint access may not be required as at low tide there may not be a beach in front of the reclamation toe.
- The substantial reduction in wave overtopping will reduce the number of closures to either the shared path and/or carriageway, maintenance and clean-up costs providing a positive social and economic benefit (NZCPS policies (3, 10)).
- To accommodate the effect of coastal effects on users a threshold design condition needs to be set. The most recent similar reclamation project is the Te Ara Tupua project in Wellington who set the threshold design condition at 63% AEP (1-year ARI) event for pedestrians and 1% AEP for structural damage. As this is one of the main inputs into the structural design, early confirmation of the thresholds and return events will be required.
- Sea level rise is another critical component in determining the wave overtopping likely to occur under specific storm events. The MfE RCP value will also need to be agreed to estimate the anticipated sea level rise over the next 100 years as the structure will need to be design to achieve a 100 year design life.
- The table below sets out the parameters from which a usability threshold should be determined. This threshold also has a significant influence on the structure that is required to achieve a particular performance outcome as well as visual and cost impacts.

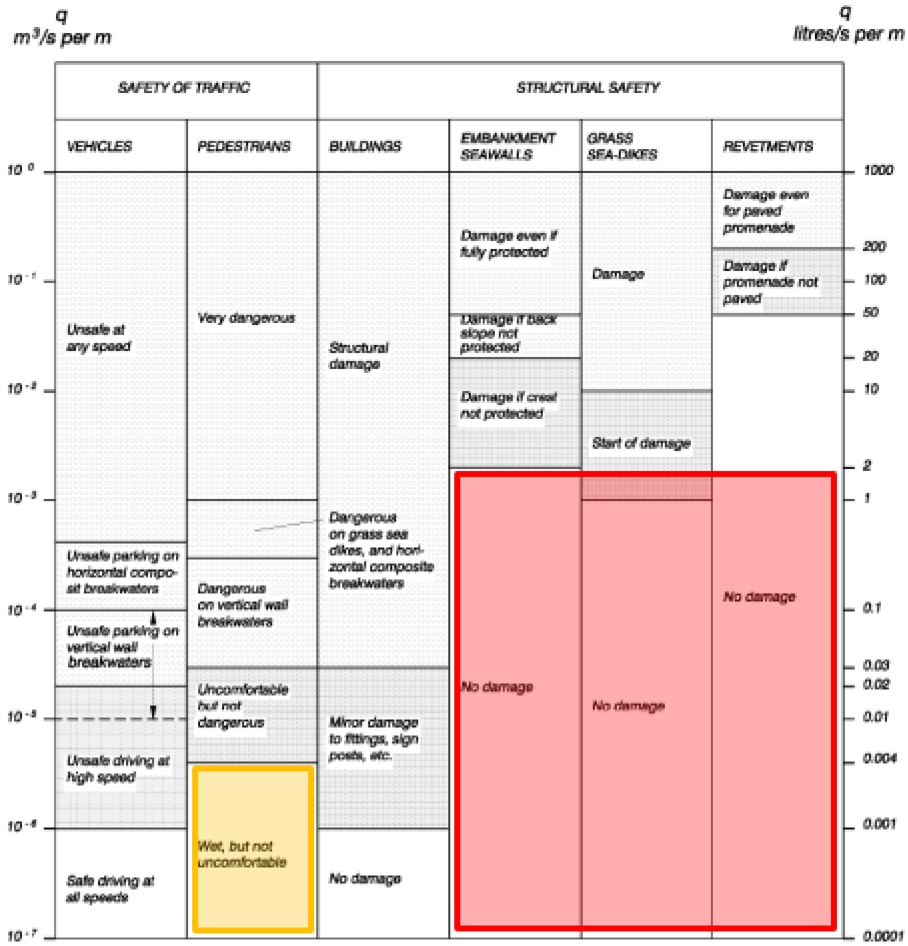


Figure 2-3: **Critical values of average overtopping discharge showing design conditions for the Project for pedestrians (orange shading) and coastal defences (red shading).** [Source: CEM (USACE 2006) Table VI-5-6].

5.2 Resilience

- Sea defence structures are to be designed for a minimum design life of 50 years for the revetment and 100yrs for the retaining walls.
- The seismic design event needs to be determined. The concept design within the NFAP DBC adopted a IL2 event in terms of cost estimation and through referencing Table 2.2 of the bridge Manual.
- The geometry of the sea defences is based on a 100year design in terms of sea level rise (SLR) taking account of the regional and national importance of the infrastructure protected. This will require future modifications to the profile(s) utilising the following or similar options:
    - Increasing the elevation of the berm/bench on the front face of the revetment.
    - Construction of a crest wall alongside the path or on the revetment crest.
    - Upgrading the rock size at key locations (crest, berm), noting this may require partial deconstruction of the revetment.
    - Increasing the height of the capping beam to the retaining walls.

5.3 Environment

- There may be a need to provide offshore habitat areas for various bird species to mitigate the effects on existing roosting areas.
- There may be a need to create mussel beds along areas of the harbour or extend and maintain the existing stormwater discharge connections to the harbour (only if required).
- There will be a need to implement improvements to the existing stormwater systems along the adjacent state highway (SH6) to reduce the levels of contaminants within the stormwater discharge.
- In designated areas structural designs (retaining walls) to minimise the project and construction footprint in highly sensitive ecological areas, and to assist with protection and retention of high value beach environments.
- Revetment design to utilise materials compatible with character of the area and the environmental setting.

5.4 Safety

- Provision to reduce/prevent fall from height
- Sight lines and visibility for Crime Prevention Through Engineering Design (CPTED)
- Path, revetment and structure design elements to protect users from wave action and storm surge
- Provision of Lighting to P3 level and possible CCTV coverage.

5.5 Cultural

- Structure and path design to include provision for placement and use of interpretational signage and design elements related to the sites environmental, cultural setting and Mana Whenua values.

5.6 Land Reclamation

Approximately 1.2km of the path length length is required to be formed through reclamation of the seabed directly adjoining the western edge of SH6 along Rocks Road. Approximately 1.0km is required to be formed through a seawall also directly adjoining the western edge of SH6 along Rocks Road.

Where high value ecological areas are identified this revetment is to be replaced by a vertical seawall immediately adjacent to the path.

5.6.1 Reclamation and Coastal Occupation Footprint Area

The path will require a 15-30m wide reclamation and coastal occupation footprint. This covers the occupation area required to be disturbed between current MHWS and the western most extent of the project area required to form and maintain the reclamation.

5.6.2 Reclamation Form

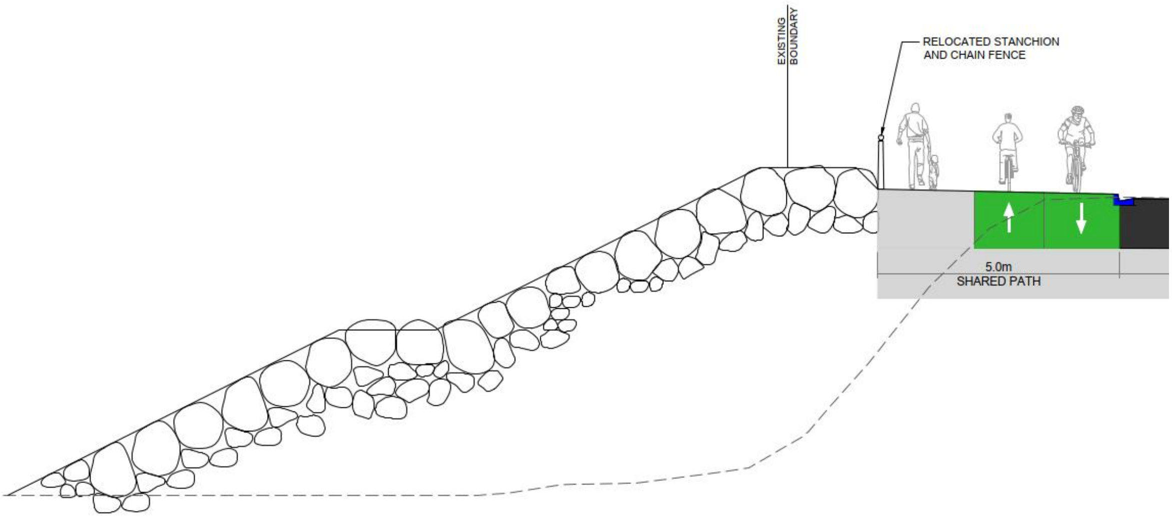
The reclamation and its protective rock revetment will be made up of several profiles as described below.

5.6.2.1 Standard Revetment and Reclamation Profile

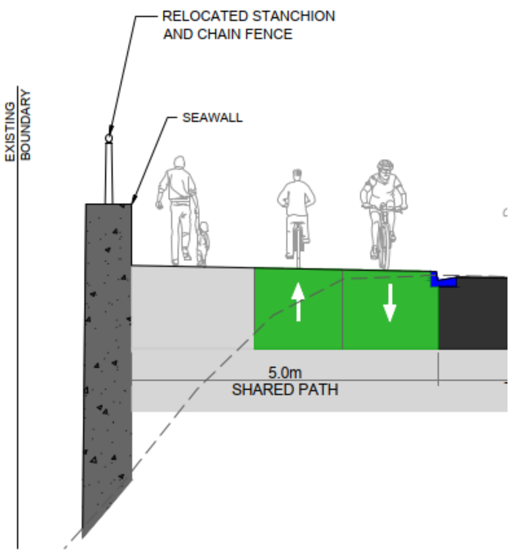
The majority of the path form will be the standard revetment and reclamation profile.

The function of the typical path reclamation form is to provide a rock armoured and backfilled platform that will support the formation of a 5-metre wide shared path and will occupy a coastal footprint of between 15-30m width.

It will also incorporate a horizontal bench in the revetment profile which allows for the addition of further rocks to build up the height thereby future proofing the revetment for sea level rise.



Typical revetement profile



Typical seawall profile

Other features currently envisaged to meet the performance criteria from Fig 2-3 above and the revetment design profile will include the following key features:

- Revetment fore-slope of 1:2 to facilitate construction, pedestrian access and visual aesthetics.
- Constructed from general fill with primarily rock armour (1 or 2 layers of rock armour with permeable core).
- A raised crest alongside the cycleway with total width of 2.9m comprising a berm of 0.45m height at internal slope of 1:2 and a berm crest-width of 2m. The new crest elevation is the point where wave overtopping discharge is calculated.
- A 2m wide horizontal (or near horizontal) berm positioned at an elevation of MHWS and continuing along the revetment for the length of the shared path.

The design criteria were based on tolerable wave overtopping discharges over the design lifetime. There remain uncertainties within the overtopping discharges which will require further development at the design's next stage.

5.7 Drainage

5.7.1 Path Drainage

The path will have a minimum cross fall of 2%. The direction of crossfall is towards the carriageway.

5.7.2 Existing SW Outlets

Existing stormwater outlets through the existing seawall will need to be extended along the length of the reclamation and through the proposed seawall.

5.7.3 Treatment Proposal for Stormwater Discharge to CMA

Policy 11 of the NZCPS require that the project mitigate (off-set) the impacts on the CMA. As no stormwater quality treatment is currently in place on SH6 along Rocks, improvements to the quality of stormwater run-off from the state highway and shared path will help to compensate some of the impacts on the coastal marine environment.

Any solution proposed should have a maintenance frequency not less than 12 months which is in line with the Transport Agency's standard practice and reduce runoff off of Total Suspended Solids (TSS) by 75% from the road surfaces.

Due to the existing SW network configuration, it is recommended for the TSS removal system to be retrofitted to the existing SW network to avoid additional SW network upgrade costs.

The proposed high-level design will have to be developed further at a later stage where environmental and economic assessments will be updated to confirm the most cost-effective mitigation measure.

6.0 Seawall and Revetment Examples

When considering the increase of width to Rocks Road, consideration is required as to the protection needed to the widened transport corridor. There are multiple criteria to consider when balancing out the effects of the different approaches.

The current design has assumed a rock embankment (revetment) as the preferred method of increasing width and this is based on the recently consented Te Ara Tupua pathway, which balanced out the different effects and where the environmental effects on the seafloor in some locations were considered unacceptable, seawalls will be constructed. This same philosophy applies for the Rocks Road project and a rock embankment (revetment), north and south of the Outstanding Natural Landscape (ONL) is the currently assumed design.

The ONL is shown below and the design philosophy adopted is that a 2m area in front of the existing seawall face is required to build a new seawall in front of the existing and provide protection to the transport corridor for a 100 year design life, noting the remaining life of the existing seawall varies between 15 and 50 years.

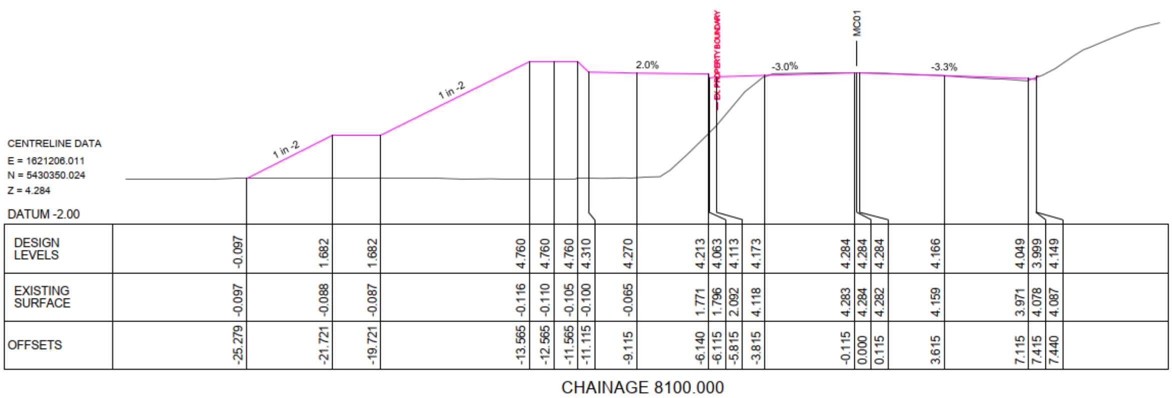
These two approaches, either a rock protected reclamation or a concrete seawall, for Rocks Road are discussed below, with discussion about different seawalls in sub-sections below. In the next phase of the project, the design philosophy will need to be expanded and correlated to the evidence obtained through the significant number of studies that need to occur to meet the requirements of the RMA.

	Rock Embankment (Revetment)	**Vertical Concrete Seawall**
Brief Description	Sea defence and the reclamation is built up using rock and aggregates to a basic 1 vertical to 2 horizontal slope to dissipate wave forces.	Concrete seawall with the front face shaped to dissipate wave forces.
Recreation	Revetment enables greater access for able bodied people anywhere along the revetment length to the foreshore.	Fishing direct from the seawall, a favourite past time by many in Nelson is maintained.
Views	A lower overall height is required due to the revetment slope dissipating wave forces	A higher overall height is required to prevent wave overtopping which in turn may block views
Construction	Construction will require placing rock onto the existing beach and seabed. Disturbance of cretaceous, birdlife and sealife will occur. Probability of some plume effects in the water Minor adverse construction effects achieved by sequenced construction and containing fine-sediments behind silt curtains and "locking" within reclamation body.	Most components would be precast offsite with minor insitu concreting required. Concrete construction has a high carbon footprint. Moderate adverse construction effect assuming land-based construction with piling activities and insitu concreting in the coastal marine area (CMA) only.
Coastal Physical Processes	Moderate encroachment into Coastal Marine Area (CMA). Minor adverse effect on coastal processes (currents and waves around widest reclaimed areas).	Small CMA occupation. Moderate adverse effects from seawall (scour at toe of wall, increased wave reflections, with downdrift erosion of adjacent pocket beaches). Moderate adverse effects from coastal hazards with overtopping due to near-vertical

	Rock Embankment (Revetment)	**Vertical Concrete Seawall**
Brief Description	Sea defence and the reclamation is built up using rock and aggregates to a basic 1 vertical to 2 horizontal slope to dissipate wave forces.	Concrete seawall with the front face shaped to dissipate wave forces.
	Significant positive effect on improved performance against wave overtopping and storm effects.	wall that exacerbates overtopping and wind-affected waves spraying onto path.
Coastal Resilience and Maintenance & Operations (considering whole-of-life and disposal)	Significant positive effect on coastal resilience as the revetment can be adapted over time by modifying the slope and/or height (reusable rock) to accommodate changes in sea-level rise or climate change effects.	Minor positive effect on coastal resilience. The concrete seawall allows for some adaptation without full redesign (crest walls, spray deflector) for sea-level rise or climate change effects. Any significant change in future sea-level rise or climate change forecasts are likely to require redesign/rebuild at least once over 100-year timeframe at significant cost and consenting hurdles. There is a high carbon footprint for disposal.
Ecology	Large footprint and permanent habitat loss, particularly of intertidal areas. Use of natural boulder riprap enables nesting habitat and ability for sessile marine benthic invertebrates to colonise.	Reduced footprint compared to revetment. Concrete provides some opportunity for colonisation by sessile marine benthic invertebrates.
Landscape and Urban Design	The revetment profile can fit in with existing landscape features and reduce the effect on natural character.	Concrete seawall in keeping with existing sea wall structures in the area. Enhanced proximity to the sea (physically and visually), although this may be reduced by requirement for fall from height balustrades / screens.

6.1 Option A – Rock Revetment

This is the baseline 5 metre shared path concept. The concept is to provide a rock revetment backed by fill with the shared path located on top of the fill.



6.2 Option B – Off Shore Control Reef/ Breakwater

This option involves the construction of a submerged structure of sufficient size to dissipate wave energy reducing the impacts on the existing beach areas. This would involve construction over large areas of the seabed in locations defined by detailed analysis. These areas are likely to conflict with high value habitat areas. A revetment or structure is also required for the construction of the path.

Artificial submerged breakwater

The figure above shows a typical example of the off-shore location and the submerged profile of this type of control

6.3 Option C – Shore- normal control structure groyne (Figure 0018)

This option involves the creation of longitudinal structures, typically timber or rock in construction formed perpendicular to the shoreline. The function is to dissipate the wave energy in small sections as it approaches the shore. Alterations to address SLR could be as simply as placing more rock to the groyne, but protection of the path will also be required. A revetment or structure is also required for the construction of the path.



The figure above shows typical examples of rock formed and timber groynes

6.4 Option D – Gabion Basket Seawall

This option involves the construction of a vertical or pre-determined sloping profile using rock filled basket. These vary in size and shape to suit design requirements with the enclosing baskets are made from wire mesh or uPVC. The thickness and size of rock infill would be determined through detailed design. This design would not necessarily be able to meet the 100 year design life due to the mesh types.

The figure above shows a typical example of a vertical rock filled gabion basket seawall

The figure above shows a typical example of a sloping rock filled gabion basket seawall

6.5 Option E – Blanket Reinforced Concrete Units

This option involves the construction of 'Articulating Block Mats' to form a cable-reinforced concrete block mattress to resist erosive wave forces. They are often constructed where a revetment is exposed to frontal attack by wave action. These are difficult to modify for SLR.


The figure above shows a typical example of a blanket type concrete seawall

6.6 Option F – Reinforced Concrete Cantilever Structure

This option involves the construction of a reinforced concrete wall structure approximately along the line of the existing seawall. This supports a cantilever deck which carries the path. Whilst this option as constructed limits impacts on the coastal marine area it is also:

a) ,Very expensive

b) Will limit traffic loading, or become even more expensive

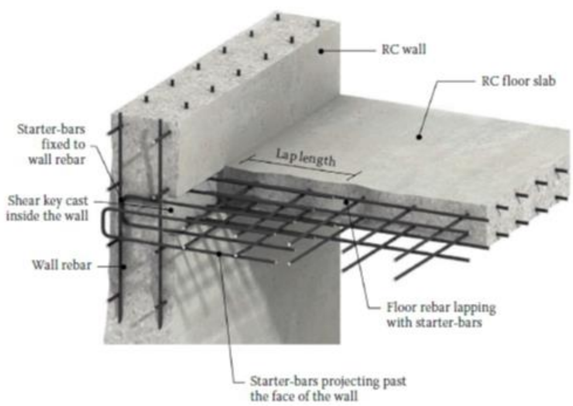
c) Difficult to build adjacent the road corridor

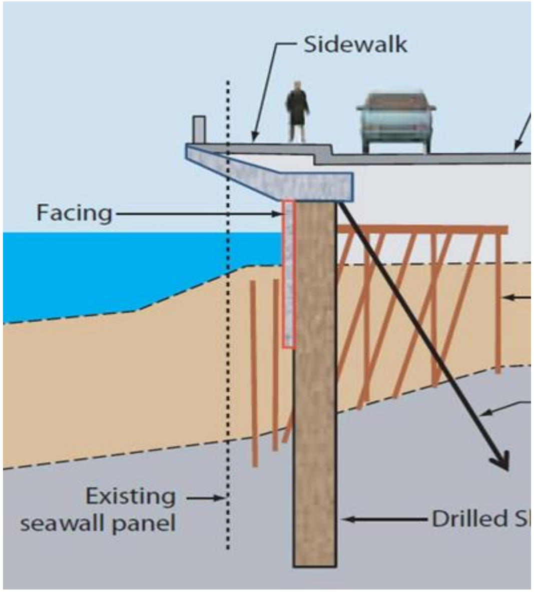
d) Creates issues with coastal processes, wave actions and overtopping

e) Has a high carbon footprint

f) Looks very engineered and not in keeping with the existing environment

g) Expensive and difficult to modify for SLR

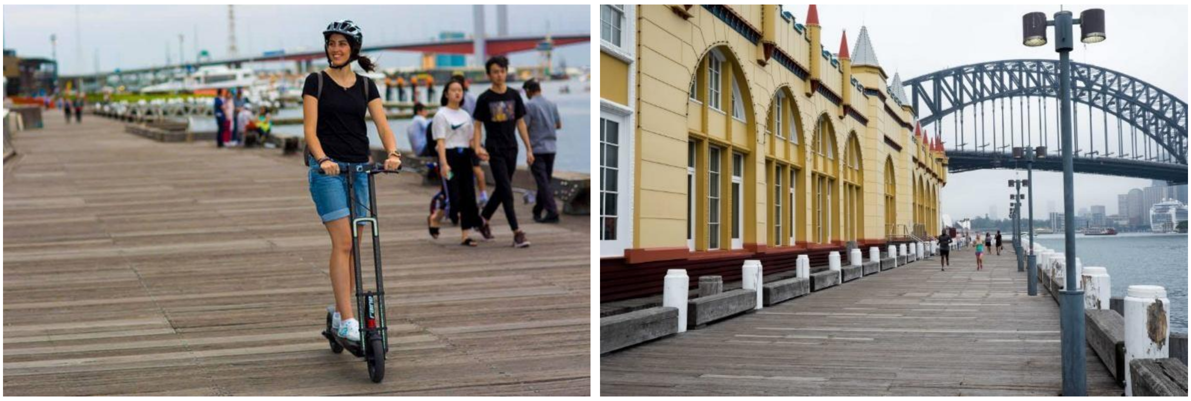




The figure above shows a typical example of a RC Cantilever Structure

6.7 Option G – Elevated Walkway Supported on Piles

This option involves a path constructed as an elevated platform mounted on piers running along both the landward and seaward sides (spacing tbc but typically 3-6m c/c). Constructions vary from timber/steel/reinforced concrete. Piles driven into the rock. The profile does not perform well under wave actions and cannot be modified to address SLR without difficulty.



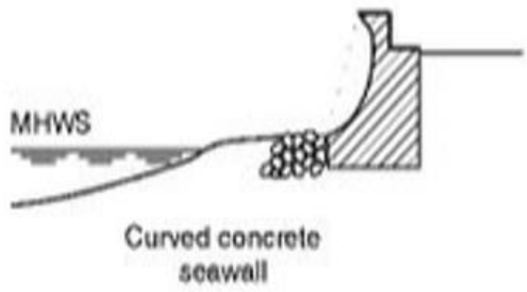
The figure above shows a typical examples of a Boardwalk Structure

6.8 Option H – Timber Seawall vertical with capping and balustrade

This option can involve many variations but is typically large diameter timber piles driven to rock with horizontal boards (whalers) retaining general fill and construction materials. The capping can take various forms but modifications to allow for SLR need to be allowed for at the outset. Achieving the 100year design life will be challenging.

6.9 Option I RC seawall – profiled shape(s) with capping beam and balustrade

This option involves the construction of a reinforced concrete wall, in this case with a curved profile to limit wave overtopping. This will also require toe protection to mitigate the loss of beach areas immediately to the front of the wall due to wave reflection. Construction activities, particularly temporary works may have a greater impact on the coastal marine areas. Increasing the height of the seawall to address SLR will be complex and expensive, this needs to be allowed for at the outset.



The figure above shows a typical example of a RC Curved Seawall

6.10 Option J - Sheet pile seawall – vertical with capping beam and balustrade

This option involves a wall of half box shape steel sheets which interlock forming a continuous wall, driven into rock. Capping can be steel or concrete. Retains general fill and construction materials.

The figure above shows a typical example of a Steel Sheet Pile Structure (without a capping beam)

6.11 Option K Reinforced Concrete seawall – vertical with capping beam and balustrade

This option involves the construction of a vertical (or near vertical) reinforced concrete wall, usually cast insitu but could be with precast units. Both retain general fill and construction materials. Modifications to address SLR can be provided for. Erosion of the beach areas due to wave reflection could be an issue.

The figure above shows a typical examples of a RC Wall Structure

6.12 Option L - Modular Concrete Forms (X Block or similar)

These are cast concrete forms of various proprietary shapes supported by layers of rock armour and fill similar to the rock revetment