Mount Messenger Bypass

Landscape and Environment Design Framework

Quality Assurance Statement		
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Revision Schedule		
Rev. Number	Date	Description
0.	December 2017	Draft for consent lodgement
1.	May 2018	Updated for council
2.	July 2018	Drawings updated only

Note: While aspects of this LEDF have been developed to reflect the outcomes of engagement with key stakeholders, this document has not yet been presented to stakeholders and will continue to be updated as the engagement process continues.

Disclaimer

Contents

1.0 Introduction

1.1 Overview

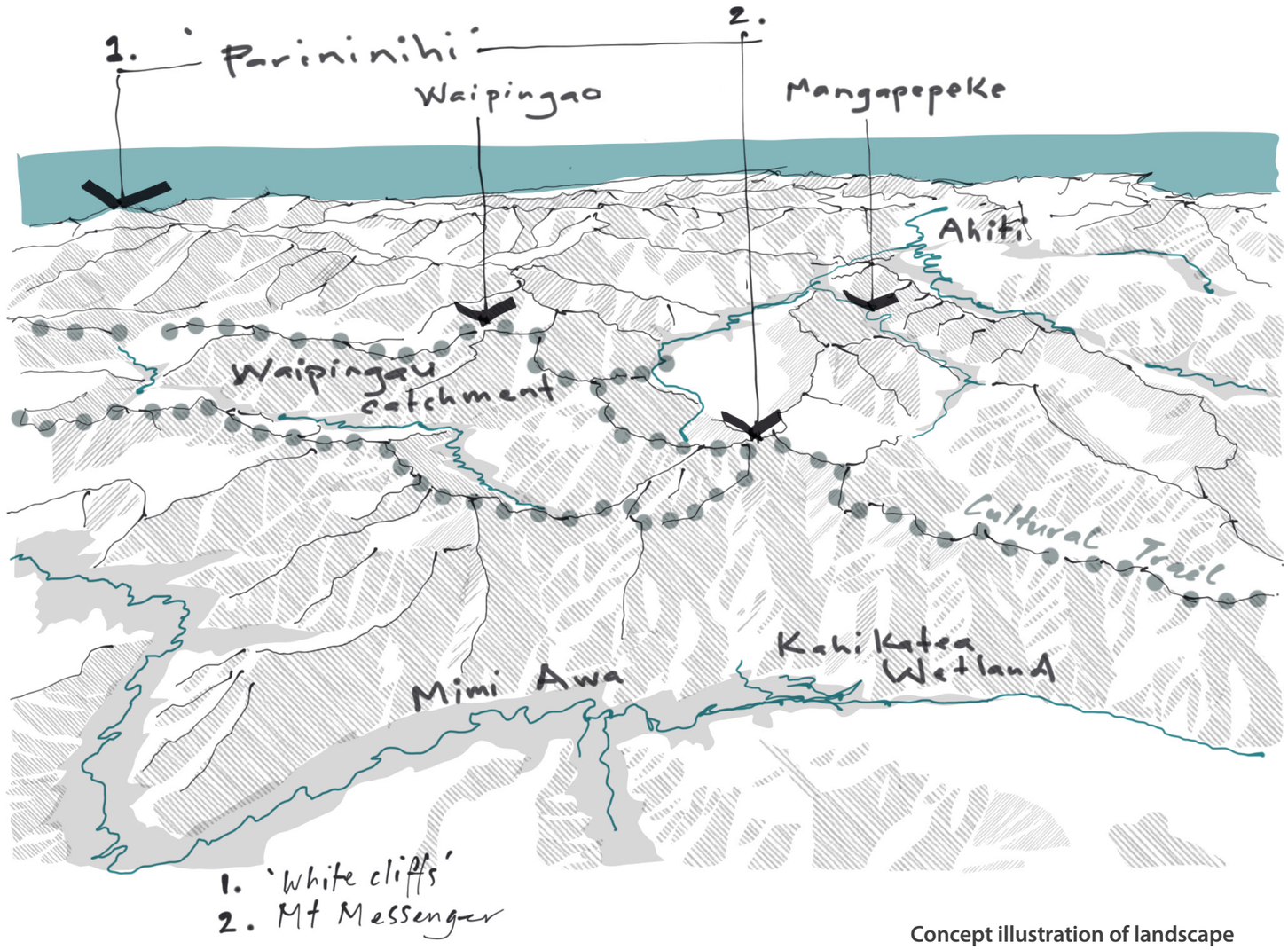
This Landscape and Environmental Design Framework (LEDF) has been prepared for the NZ Transport Agency's (Transport Agency) Mount Messenger Bypass (the Project).

The Project involves the construction and ongoing operation of a new section of State Highway 3 (SH3), generally between Uruti and Ahititi to the north of New Plymouth. This new section of SH3 will bypass the existing steep, narrow and winding part of the highway at Mount Messenger.

Specifically, the Project comprises a new re-routed section of two lane highway 6 km's in length, located to the east of the existing SH3 alignment.

The primary objectives of the Project are to enhance the safety, resilience and journey time reliability of travel on SH3 and contribute to enhanced local and regional economic growth and productivity for people and freight.

The Project objectives include managing the immediate and long term landscape, ecological, cultural, social, land use and other environmental impacts of the Project by, so far as practicable, avoiding, remedying or mitigating any such effects through route and alignment selection, highway design and proposed conditions of consent.



Concept illustration of landscape connections between Parininihi Cliffs and Mt Messenger - indicative of the wider "Parininihi Landscape"

1.2 The Landscape and Environment Design Framework

1.2.1 Process

This is the "approvals version" of the LEDF. The LEDF is a 'living document' within which further design principles, technical and stakeholder inputs can be embedded throughout the design, consultation, planning and implementation process.

The LEDF sets out the landscape and environmental design principles for the Mount Messenger Bypass, and is intended to be used as a guiding design document during subsequent Project phases. It will inform detailed design and construction method development so that the Project's permanent and temporary works are integrated into the surrounding landscape and topography; having regard to the local landscape character and context.

The LEDF is a technical report supporting the Assessment of Environmental Effects (AEE) and Notice of Requirement for the Project.

While it has been prepared cognisant of the Resource Management Act 1991 (RMA) requirements, a separate Landscape and Visual Effects Assessment has been prepared to address specific RMA considerations.

The LEDF has been prepared by qualified landscape architects in collaboration with the Project team, acknowledging the connections between the LEDF and other Project disciplines:

- Ecology
- Planning
- Designers (architects, civil and structural engineers).

As this document is developed it will include further elements of consultation and collaboration with Ngāti Tama, who are mana whenua for the area, as well as inputs from other key stakeholders.

1.2.2 Purpose

The purpose of this LEDF is to outline the landscape and environmental design outcomes for the Project and how these fulfil the Transport Agency's landscape and urban design policy requirements.

Design measures incorporated into the Project to avoid, remedy and mitigate adverse landscape effects are described in the 'Landscape and Environment Design Framework: Approvals Version' (LEDF). The LEDF is based around four overarching landscape design principles:

- "Keeping low in the landscape" – thereby minimising physical landscape effects;
- "Letting the landscape speak" - a clean uncluttered highway where the surrounding landscape provides the scenic amenity;
- Recognising culture – which means appropriately recognising human relationship to the land, including continuing the partnership with Ngāti Tama through the detail design process to express their mana whenua and kaitiakitanga;
- Connecting 'Landscape' and 'Ecology' – responding to and reflecting natural elements, patterns and processes through design.

LEDF structure

The LEDF is structured as follows:

Section 1: Introduction
Provides an outline of the LEDF and project description. This section also provides an overview of the national, regional and local planning context, including the Transport Agency's landscape and design policy and protocols, New Plymouth District Council and Taranaki Regional Council policies relevant to the Project.

Section 2: Project Overview
Provides a high level overview of the Project

Section 3: Landscape Context
Assesses the landscape, environmental and cultural context of the Project area, including the landform, hydrology, land uses, ecological aspects, character areas, and cultural values.

Section 4: Design Objectives and Principles
This section outlines the design themes and principles for the Project.

Section 5: Design Approach
Provides an overview of the treatment of engineered landscape forms and structural elements and how these new features integrate with the existing landscape and vegetation.

Section 6: Landscape Concept Plans
Sets out the preliminary landscape concept plans including areas of mitigation planting, highway rehabilitation and potential stopping areas and specific sites for cultural expression, to be developed in consultation with Ngāti Tama.

Consultation

Note: While aspects of this LEDF have been developed to reflect the outcomes of engagement with key stakeholders, this document has not yet been presented to stakeholders and will continue to be updated as the engagement process continues.

1.2.3 Transport Agency Strategy and Guidelines

Key Transport Agency policy, strategy and guidance documents relevant to landscape and urban design aspects of state highway projects include:

- Bridging the Gap: NZTA Urban Design Guidelines - Transport Agency, 2013;
- Landscape Guidelines - Transport Agency, Final Draft 2014;
- Environmental Design Framework Guidelines: Highways and Network Operations Guideline- Transport Agency, 2010;
- Transport Agency P39: The Standard Specification for Highway Landscape Treatments: which sets out minimum standards, covering such matters as site preparation; quality control, inspections and reporting; plant and animal pest control; plant propagation; topsoil supply; planting; grass; hydroseeding and specialist treatments; irrigation; maintenance;
- Environmental and Social Responsibility Policy 2011, which includes a policy to integrate good design in all state highway projects -Transport Agency, 2011; and
- Other Standards: such the 'Safe System'1 approach to highway design which forms part of the Transport Agency's commitment to the 'Safer Journeys Strategy' and other specific requirements including:
  - Bridge Design Manual
  - Guide to Road Tunnels.

1.2.4 Transport Agency Urban Design Guidelines

Bridging the Gap
The Transport Agency recognises that roads and streetscapes form an important part of a place's character and influence the living environments of New Zealanders.

The guidelines seek to ensure that:

- Transport networks fit in sensitively with the landform and the built, natural and community environments through which they pass;

- All systems of movement along and across the transport corridor are integrated into the design of projects with good connections and access to communities;

- The design contributes to the quality of the built environment, public space and the road-user experience.

The Guidelines set out 10 over-arching urban design principles, and provide advice and direction on specific highway elements:

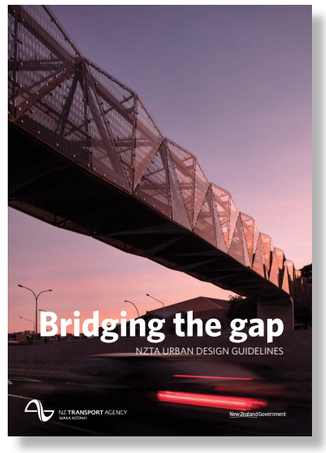
1. Designing for the context
2. Integrating transport and land use
3. Contributing to good urban form
4. Integrating all modes of movement
5. Supporting community cohesion
6. Maintaining local connectivity
7. Respecting cultural heritage values
8. Designing with nature
9. Creating a positive road-user experience
10. Achieving a low maintenance design

1.2.5 Transport Agency Environmental Design Framework Guidelines

Environmental Design Framework
As described in the Transport Agency's Highways and Network Operations guideline:

'The integration of large scale and/or complex road infrastructure projects into the surrounding environment involves complex issues that need to be addressed to ensure the 'best fit' and that the best possible project is delivered for the benefit of all users.'

The purpose of an LEDF is to ensure that the urban (to the extent relevant) and landscape design concepts for these projects are appropriately defined, developed and implemented. It provides a forum to capture and integrate the various elements of a project, and to ensure that the expertise of different members of the Project team are working together.



1.3 Planning Policy

1.3.1 Statutory Documents

The Project design and LEDF has been informed by a range of policy documents.

The key statutory and policy considerations are contained in the following:

- Resource Management Act 1991 (RMA);
- Taranaki Regional Policy Statement (TRPS);
- New Plymouth District Plan (NPDP).

Resource Management Act 1991

The overarching framework of the RMA is set out in Part 2, including the purpose of the Act set out in section 5. Matters of national importance are set out in section 6. Those that are particularly relevant to landscape matters for the Project include:

- section 6(a):the preservation of the natural character of wetlands and rivers, and the protection of them from inappropriate subdivision, use and development;
- section 6(b): the protection of outstanding natural features and landscapes from inappropriate subdivision, use and development;
- section 6(c): the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna;
- section 6(e): the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.

Key relevant 'other matters' from section 7 of the RMA include sections 7(a): kaitiakitanga; 7(aa): the ethic of stewardship; 7(c): the maintenance and enhancement of amenity values; and 7(f): the maintenance and enhancement of the quality of the environment.

Taranaki Regional Policy Statement

The Taranaki Regional Policy Statement (TRPS) provides an overview of the resource management issues in the Taranaki region. Section 10 of the TRPS ('Natural features and landscapes (NFL), historic heritage and amenity value') includes policies and methods in relation to landscape and visual amenity. The TRPS does not identify or map any outstanding natural landscapes, but states that 'outstanding' refers to "those natural features or landscapes of exceptional value or eminence or distinction on a national regional or district level".

A summary of the key landscape objectives and policies in the TRPS relevant to the Project is set out below.

- NFL Objective 1: To protect the outstanding natural features and landscapes of the Taranaki region from inappropriate subdivision, use and development, and to appropriately manage other natural areas, features and landscapes of and landscapes of value to the region to the region.
- NFL Policy 2: Recognition shall be given to the appropriate management of other natural areas, features or landscapes not covered by Policy 1 above, but still of value to the region for one or more of the following reasons:
  - (a) the maintenance of water quality and quantity;
  - (b) soil conservation;
  - (c) the avoidance or mitigation of natural hazards;
  - (d) natural character amenity and heritage values and scientific and educational significance;
  - (e) geological and geomorphological, botanical, wildlife and fishery values;
  - (f) biodiversity and the functioning of ecosystems;
  - (g) 'sinks' or 'pools' for greenhouse gases; and
  - (h) cultural features of significance to tangata whenua.
- NFL Policy 3: The protection of outstanding and where appropriate, other natural features and landscapes of value shall be achieved by having regard to the following criteria in determining appropriate subdivision, use and development:
  - (a) The protection of outstanding and where appropriate, other natural features and landscapes of value shall be achieved by having regard to the following criteria in determining appropriate subdivision, use and development:
  - (b) the degree and significance of actual or potential adverse effects on outstanding natural features and landscapes or other important natural
  - (c) features and landscapes, including cumulative effects, and the efficacy of measures to avoid, remedy or mitigate such effects;
  - (d) the benefits to be derived from the use and development at the local, regional and national level;
  - (e) the extent to which the subdivision, use or development recognises or provides for the relationship of tangata whenua and their culture and traditions with their ancestral lands, water, sites, wāhi tapu and other taonga;
  - (f) the need for use or development to occur in the particular location;
  - (g) the sensitivity or vulnerability of a natural feature or landscape to change, and its capacity to accommodate change, without compromising the values of the feature or landscape;
  - (h) the degree of existing modification of the natural feature or landscape from its natural character;
  - (i) the degree to which financial contributions associated with any subdivision, use and development can be used to offset actual or potential adverse effects arising from those activities.

“Overlooking the Three Sisters (2 now) from the Pilot Rd road-end…with Taranaki in the hazy distance.”

(Image source: https://nzfrenzynorth.wordpress.com/h11/)

1.3.2 New Plymouth District Plan

The New Plymouth District Plan (NPDP) manages land use activities across the District. The NPDP regulates a number of proposed activities related to the Project, including landscape, amenity and rural character. The Project is located in the rural environment area, as shown on Planning Map B10.

There are no specific notations in the NPDP relating to landscape that overlap with the Project route / designation. There is a Regionally Significant Landscape immediately to the west of the existing SH3, which will not be affected by the Project.

The District Plan contains a range of objectives and policies in relation to landscape and amenity, as summarised below.

- Objective 1: To ensure activities do not adversely affect the environmental and amenity values of areas within the district or adversely affect existing activities.
- Policy 1.1: Activities should be located in areas where their effects are compatible with the character of the area.
- Objective 2: To avoid, remedy or mitigate the adverse effects of light overspill and glare, noise, and the consumption of liquor on amenity values and health.
- Objective 4: To ensure the subdivision, use and development of land maintains the elements of rural character.
- Policy 4.6: Retain vegetation, particularly indigenous vegetation and require the planting of new vegetation to mitigate the effects of activities.
- Objective 14: To preserve and enhance the natural character of the coastal environment, wetlands, and lakes and rivers and their margins.
- Policy 14.2: The natural character of wetlands and rivers and lakes and their margins should not be adversely affected by inappropriate subdivision, use or development and should, where practicable, be restored and rehabilitated.
- Objective 15: To protect and enhance outstanding landscapes and regionally significant landscapes within the district.
- Policy 15.2: Subdivision, use and development should not result in adverse visual effects on, and should enhance, where practicable, the following regionally significant landscapes:
- White Cliffs and associated conservation forest.

1.3.3 The New Plymouth Landscape Assessment

The New Plymouth District Landscape Assessment (LA4 Landscape Architects - prepared in June 1995) identifies a number of landscape units across New Plymouth District. The Project area is predominantly within Landscape Unit 4: Eastern Hill County – Bush.

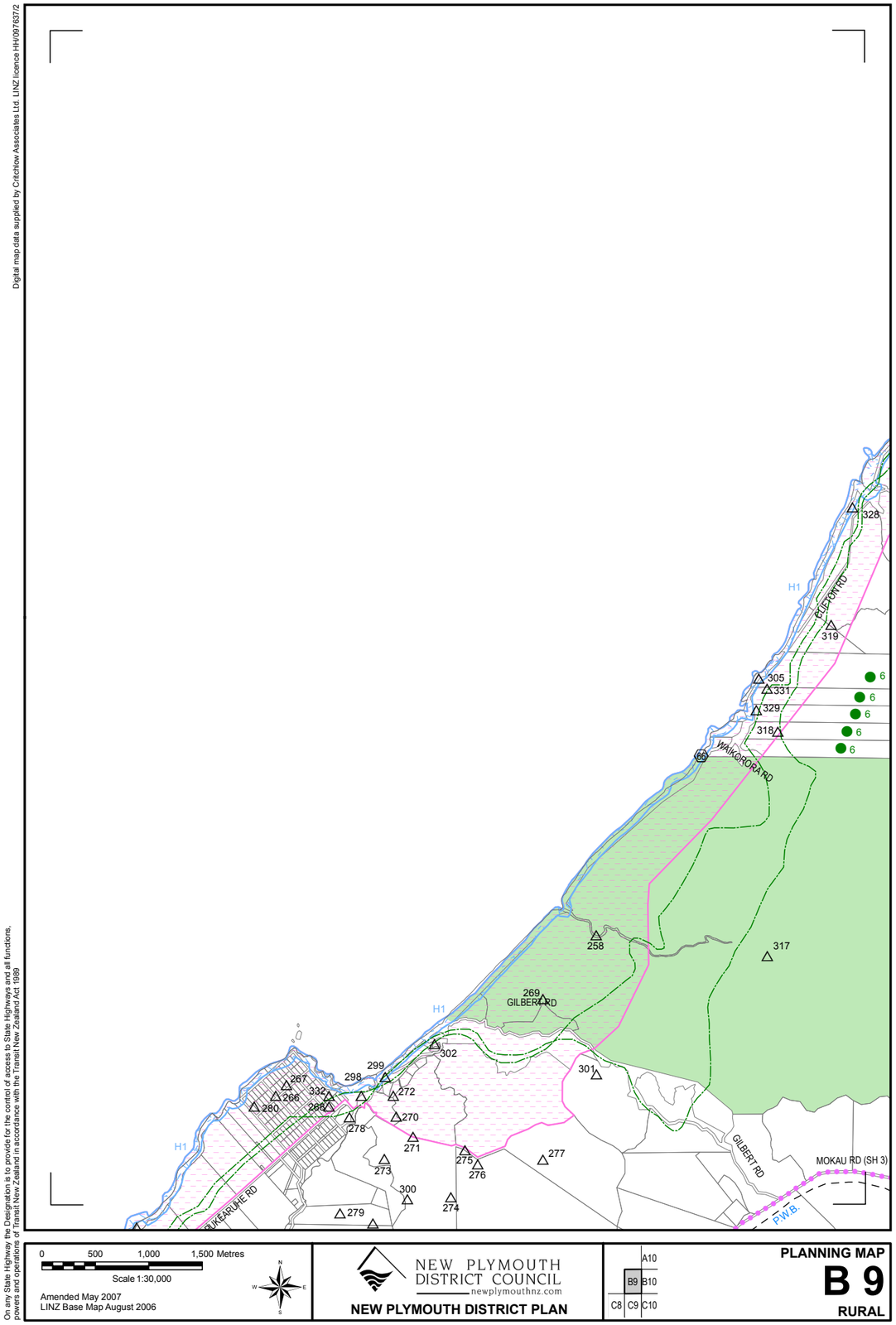
Landscape Unit 4 is described as being predominantly remote bush covered hill country with strong underlying landform, characterised by:

- Steep ridges rising to 400m
- Peaked and angular landform
- Clearly defined stream gullies
- Mature and regenerating native vegetation
- An enclosed landscape quality form strong landform and solid bush cover
- Skyline landform backdrops which frame lower valley views
- Extensive and homogenous bush landcover
- Lack of development / activities
- Strong ridged landform is listed as heightening sensitivity

The assessment identifies cuts in the hillsides and cliffs associated with the SH3 corridor through the Mount Messenger area as an adverse landscape element. The Landscape unit is also identified as being sensitive to change (overall sensitivity rating 5 out of 7) and is recommended as a Regionally Significant Landscape. Elements that make the unit sensitive are listed as

The unit is listed as having a viewing audience limited to SH3 users. Key qualities that contribute to the assessment of regional significance (and therefore – protection) are

- Remoteness
- Large undisturbed areas of bush
- Strong landforms with bush cover forming backdrops



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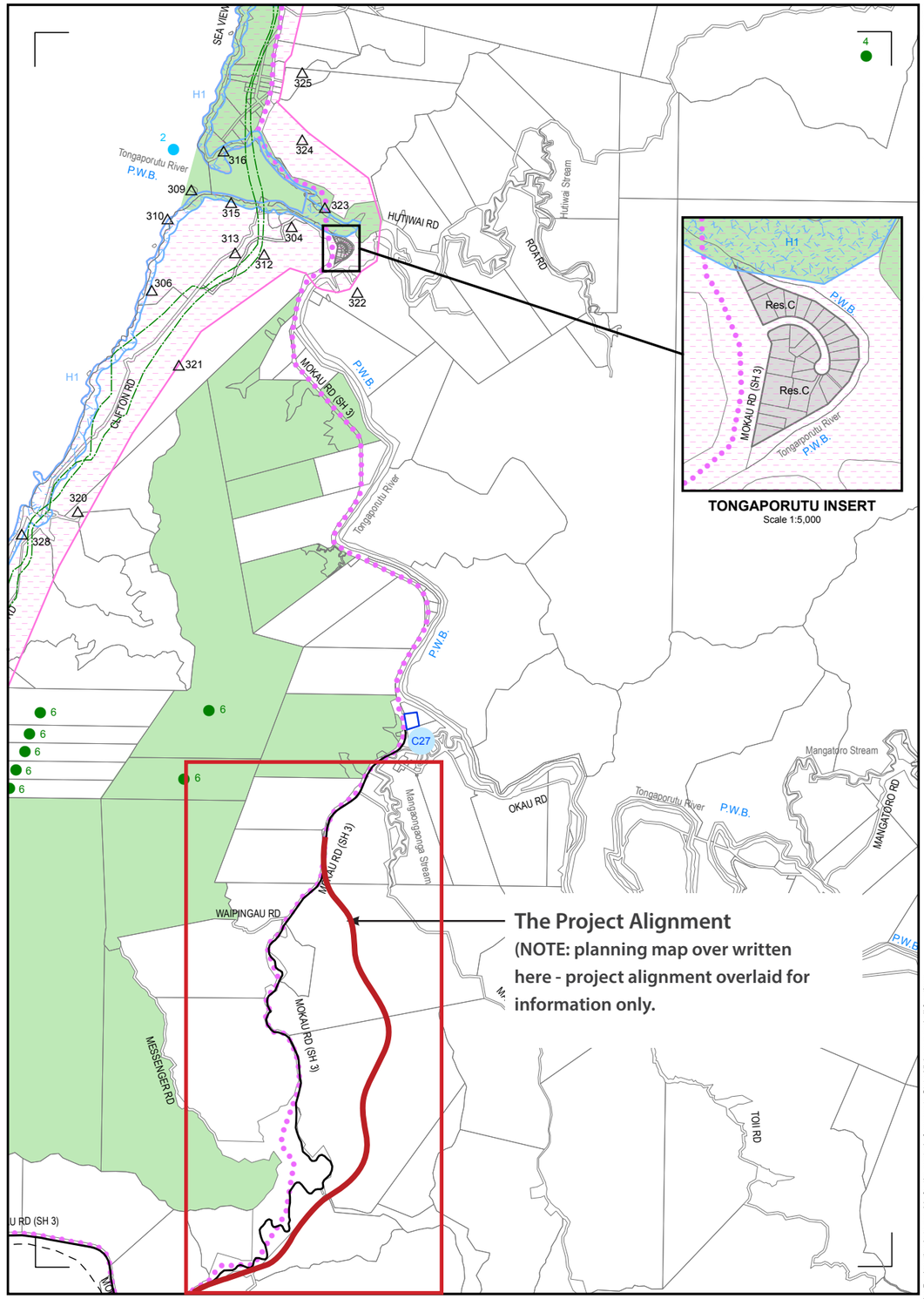
Scale 1:30,000
Amended May 2007
LINZ Base Map August 2006

NEW PLYMOUTH DISTRICT COUNCIL
newplymouthnz.com
NEW PLYMOUTH DISTRICT PLAN

A10
B9 B10
C8 C9 C10

PLANNING MAP
B 9
RURAL



The Project Alignment
(NOTE: planning map over written here - project alignment overlaid for information only.

TONGAPORUTU INSERT
Scale 1:5,000

PLANNING MAP
B 10
RURAL

A10 A11
B9 B10 B11
C9 C10 C11

NEW PLYMOUTH DISTRICT COUNCIL
newplymouthnz.com
NEW PLYMOUTH DISTRICT PLAN

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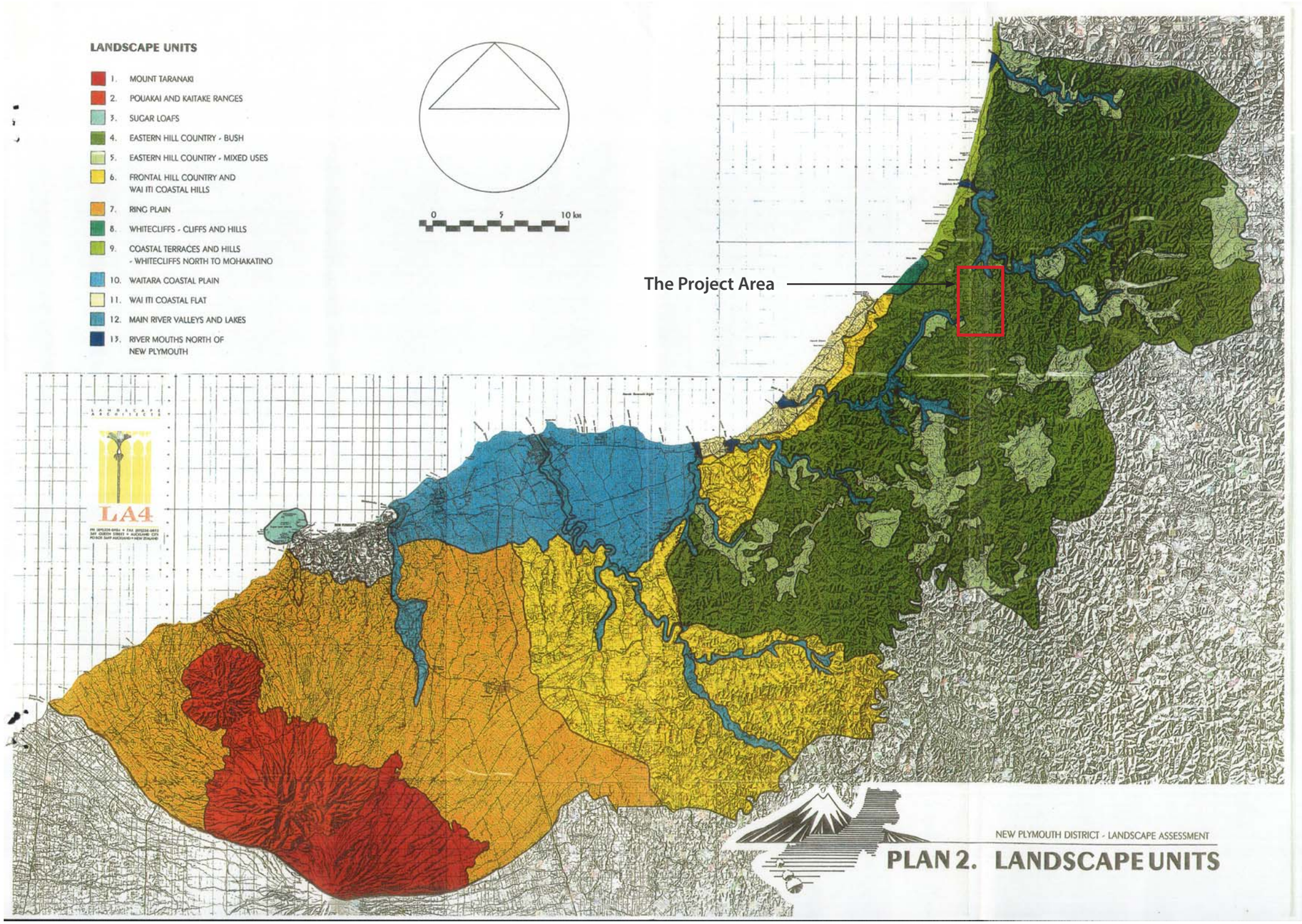
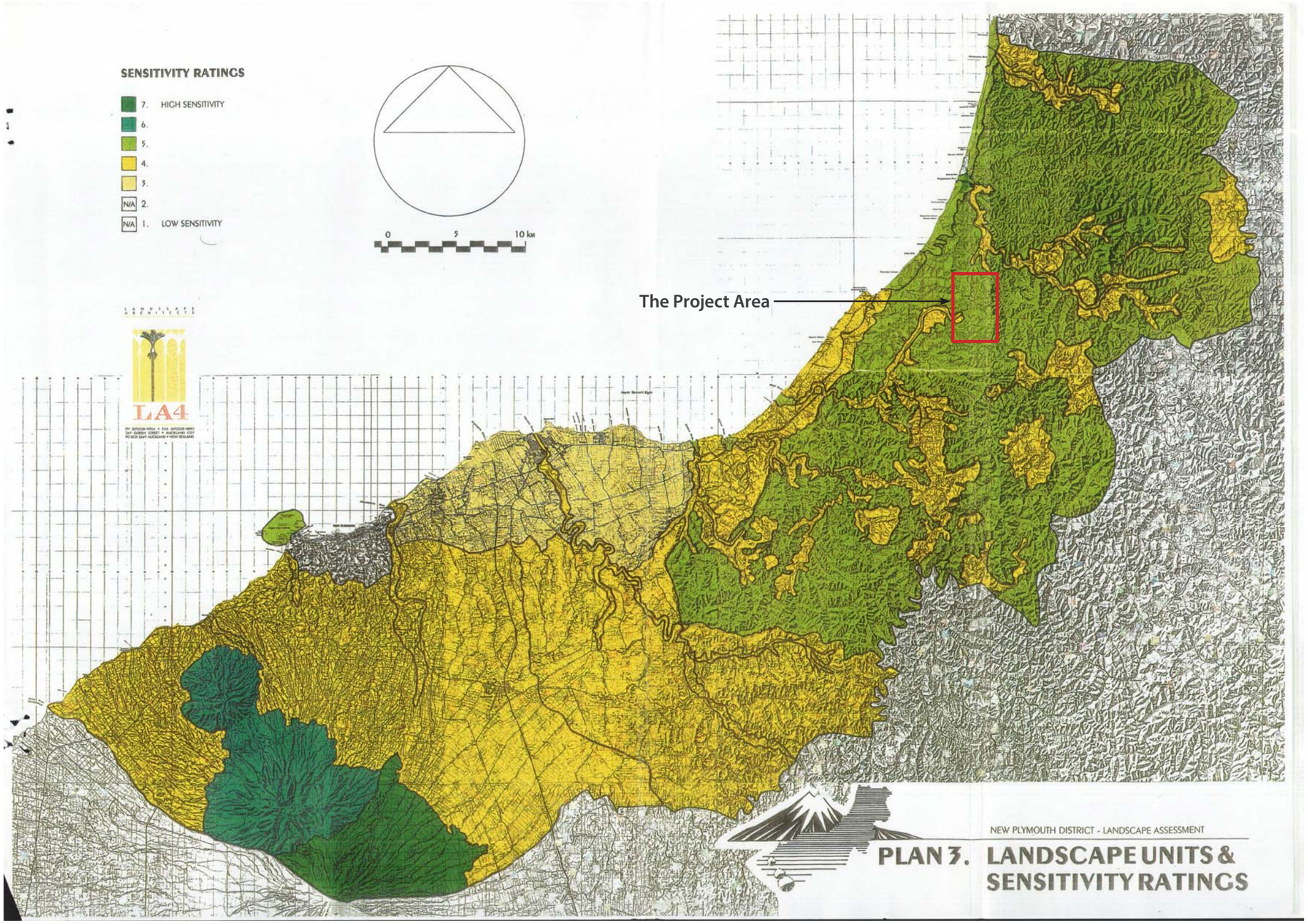
LINZ Base Map August 2006

Regionally significant landscape notation (NPDC)

Landscape Units plan from the New Plymouth District Landscape Assessment, 1995, by LA4 Landscape Architects



Sensitivity Ratings plan from the New Plymouth District Landscape Assessment, 1995, by LA4 Landscape Architects



2.0 Project Overview

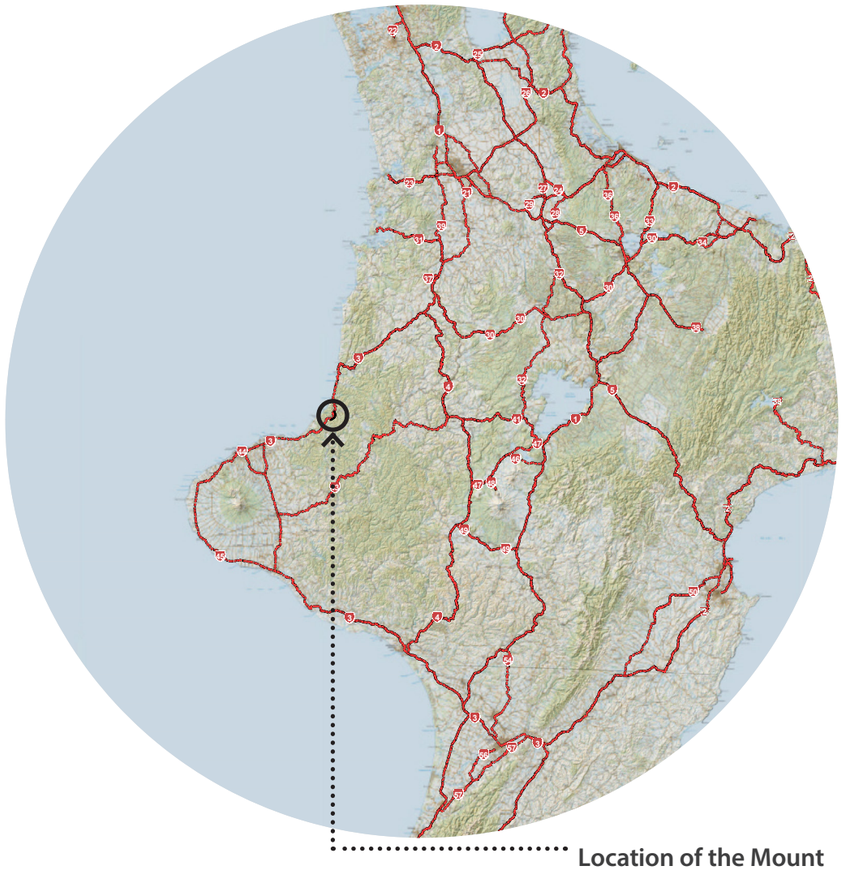
2.1 Location

The wider Project area that has been considered for the Mount Messenger Bypass includes: the steep to very steep bush hill country from the coastal terraces south of the Tongaporutu River; south to the pastoral flats of the Mimi Valley; west to the coast and the Parininihi Cliffs and; east to the Mangaonga Road Corridor and the Department of Conservation (DOC) Mount Messenger Forest.

The alignment represents an appropriate and well considered landscape design response to the wider hill country setting within which it is located. The route will be a recessive human influence within a predominantly natural landscape setting representing an appropriate landscape "fit".

This has been achieved, in the first instance, by selecting a route corridor that;

- Avoids the most sensitive landscapes of the Project area and associated Regionally Significant Landscape areas;
- Minimises effects on sensitive wetland areas;
- Reflects underlying landform with a direct valley to valley alignment that passes through only one ridgeline; and
- Presents an opportunity to develop a positive scenic landscape route consistent with the wider character of SH3 as a lowland / valley route.



Location of the Mount Messenger Bypass

The Mount Messenger Bypass alignment

LEGEND

Option E1 | State Highway (SH3) | River | Rivers/Streams | Stream Order 5 Catchment

2.2 The Project

2.2.1 The alignment and landscape response

The alignment works with the natural valley landform of the Mangapepeke Valley in the north and the mid-Mimi Valley in the south, with a tunnel under a single ridge to the south of Mount Messenger, joining the two valley systems.

The alignment stays low in the landscape, working with the underlying landform rather than against it. The Project presents an opportunity to enhance ecological and cultural values of the site, and improved ecological conditions along the corridor will stitch together a landscape that is currently fragmented.

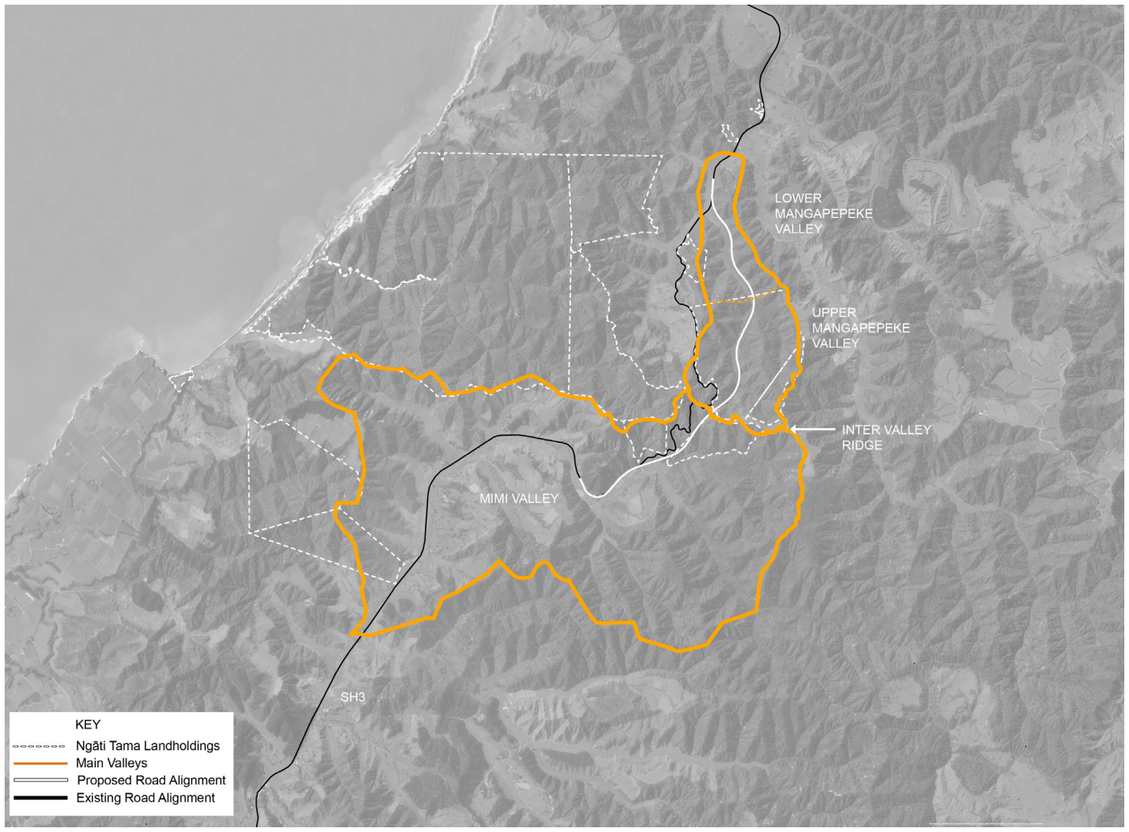
All landscape treatment, rehabilitation, mitigation and structural elements are designed to aid the integration of the proposed Bypass into the landscape. Natural revegetation, hydrology and landform patterns inform landscape moves, and these natural processes will be allowed to soften the modified landscape over time.

In addition to the guidance detailed in the Transport Agencies Landscape Guidelines and Bridging the Gap, the following principles have been developed for the Project.

General landscape principles

The principles below have been developed to help resolve the concept design, these will be further resolved to deliver a unique rural highway that:

- Retains a key **ridgeline** by using a tunnel, minimising effects on **landform** and bush;
- **Minimises** stream and valley crossings by keeping to the sides of the valleys;
- Develops cut faces that **echo natural** slope angles;
- Promotes **natural succession** re-vegetation;
- Integrates landscape and **ecological rehabilitation**;
- Provides an opportunity for **cultural expression** and recognition; and
- Promotes a **scenic** driving experience.

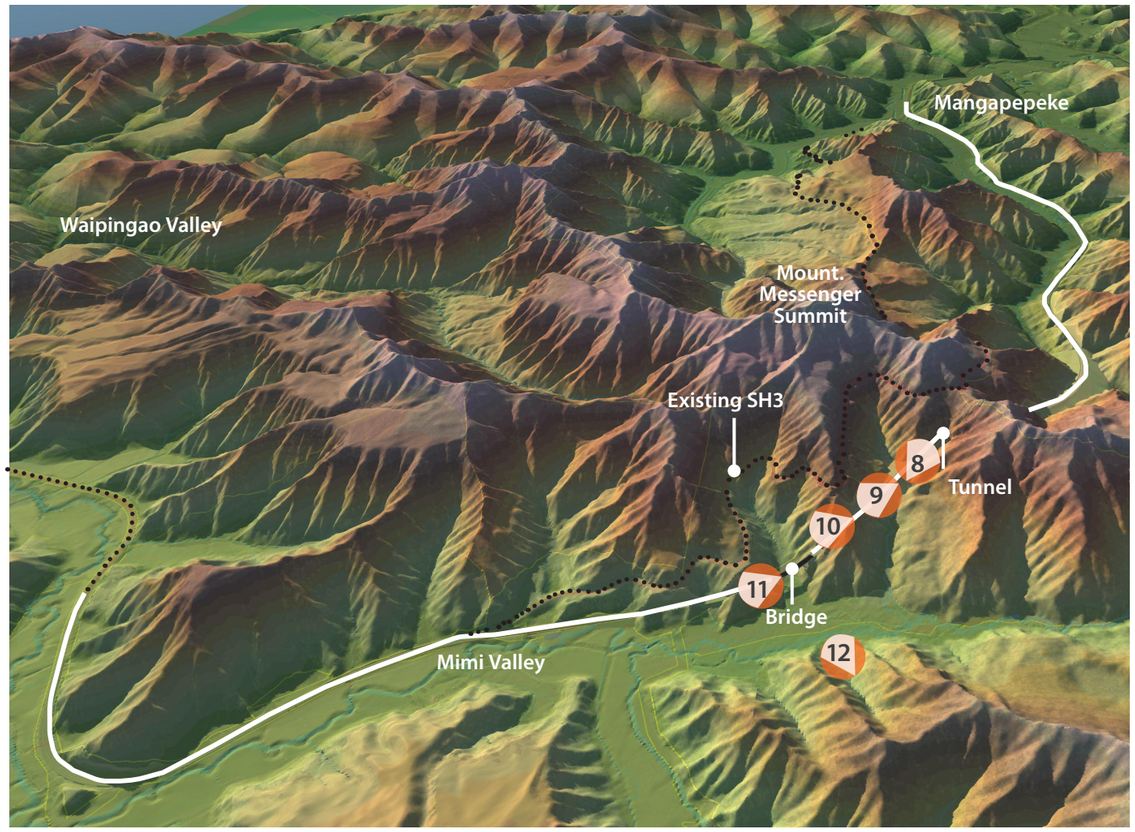


Map showing the two principal catchments of the project area, the Mimi and the Tongaporutu

Right: Aerial contextual landscape perspective of Mt Messenger (left of frame) looking northwards down the Mangapepeke Valley.

Right: Contextual aerial view to the south west looking towards Mt Messenger (centre frame) and the Mimi Valley (left of frame).

Elevation model of alignment



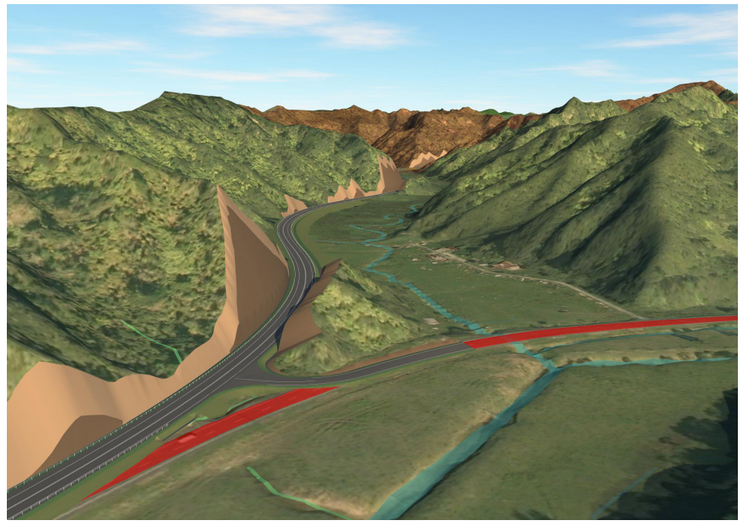
Above: elevation model looking from the south to the north showing how the bypass relates to the grain of the landscape with its strong east-west pattern.

Note: Viewpoint locations numbered, as shown on following pages VIEW THIS WAY 4

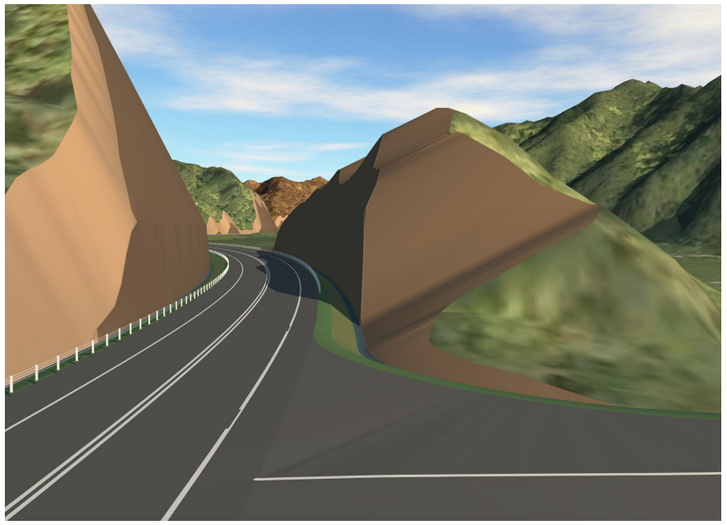
Above: elevation model looking from the north to the south showing how the bypass aligns with the foothills.

Landform Model Illustrations of the Project

The following 3D terrain model images provide a general illustrative understanding of the nature of the Project in relation to the existing SH3 alignment and the surrounding terrain. These images show the outputs from the 3D digital terrain model used for the project development. This is a base terrain model and shows the alignment, cut slope areas, fill areas, and the underlying terrain. These images are not intended to be used as a photo simulation of the completed Project, and do not include existing vegetation or proposed revegetation.

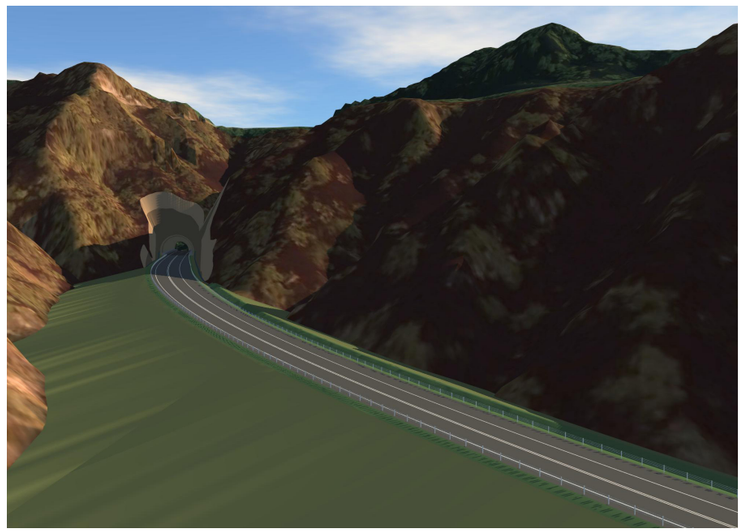


Viewpoint 1. Southerly view at the northern tie-in with the existing SH3 showing toe slope rock cuts and the highway to the east of the valley floor.

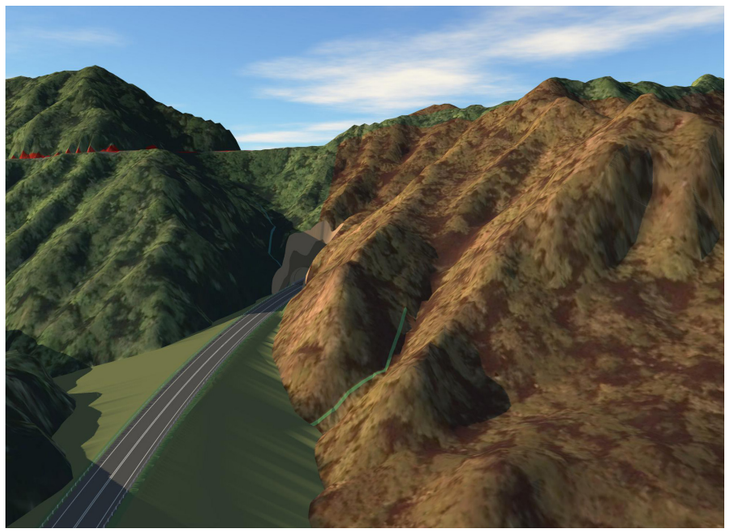


Viewpoint 2. View south of the road corridor looking at the start of the Mangapepeke Valley

Viewpoint 3. View of the road corridor looking south up the Mangapepeke Valley

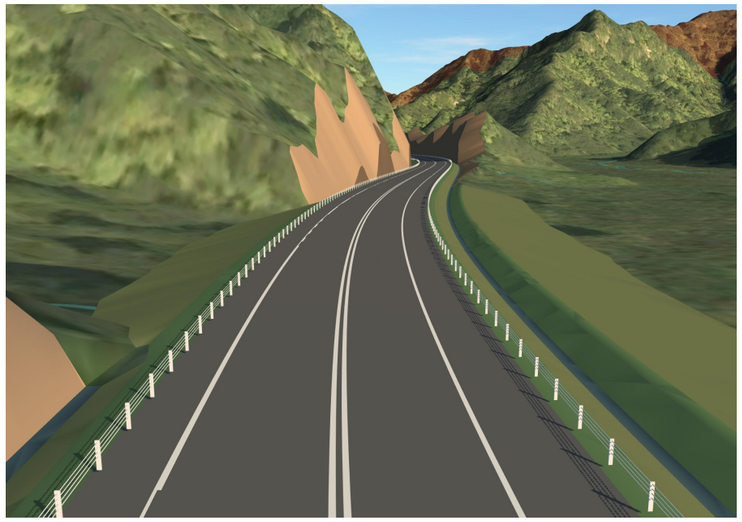


Viewpoint 7. The northern tunnel portal with Mount Messenger on the skyline right of frame.

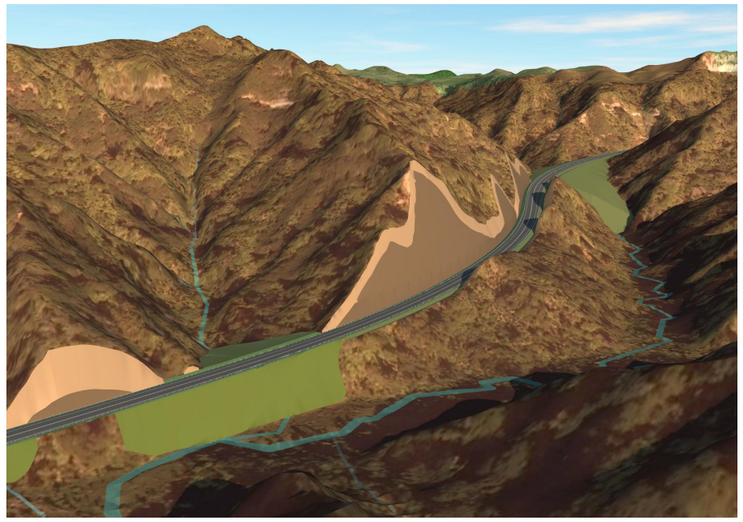


Viewpoint 8. The southern tunnel portal and fill with Mount Messenger left of frame

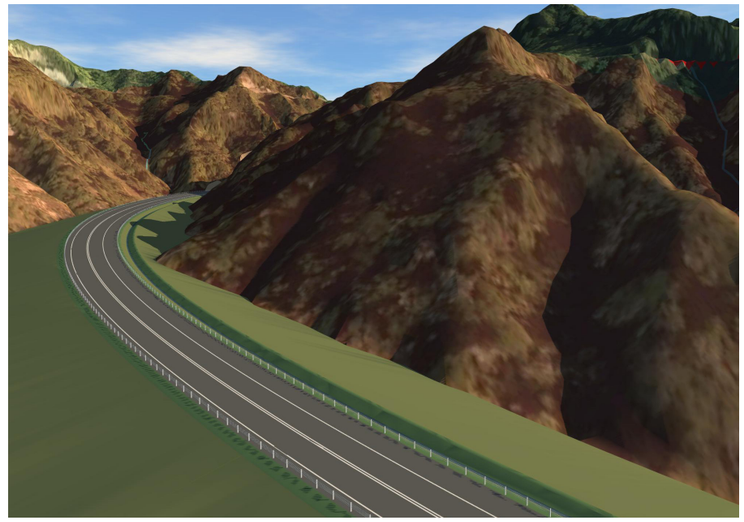
Viewpoint 9. The bridge roadway looking to the south into the Mimi Valley



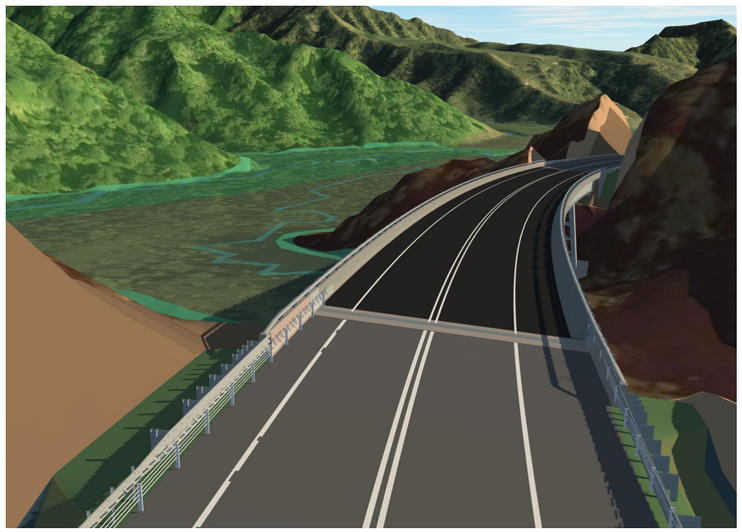
Viewpoint 4. View of the road corridor looking south up the Mangapepeke Valley



Viewpoint 5. View of the road corridor looking across the Mangapepeke Valley toward the MSE wall mid valley

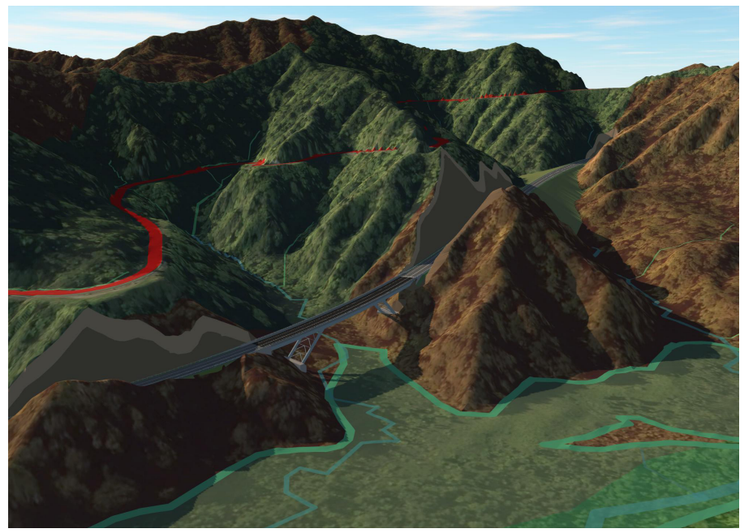


Viewpoint 6. South westerly view of the upper mangapekepe valley fill and Mount Messenger (right of frame) on the approach to the northern tunnel portal



Viewpoint 10. The bridge roadway looking to the south across the Mimi Valley and Kahikatea wetland

Viewpoint 11. The roadway looking to the south across the Mimi Valley and the rural landscape



Viewpoint 12. Looking north across the gully bridge with the southern tunnel approach to the existing SH3 alignment, with the Kahikatea wetland gin the foreground and Mount Messenger on the skyline.

3.0 Landscape context

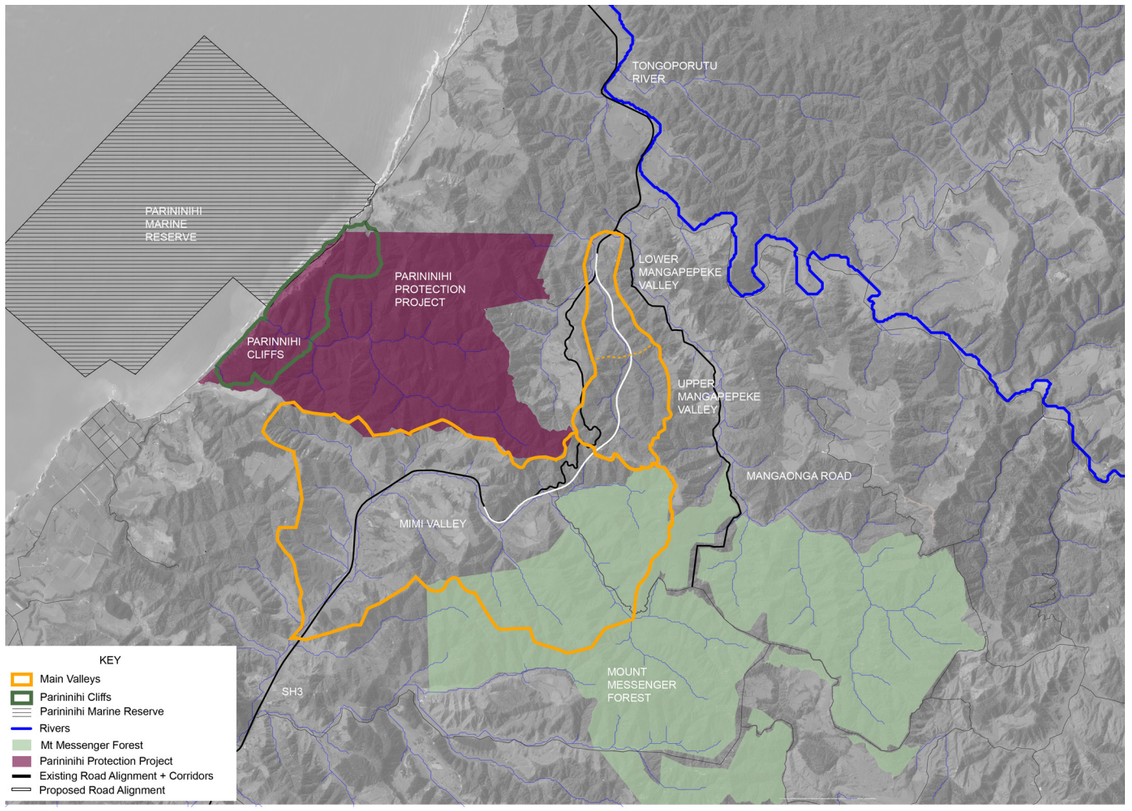
3.1 Landscape context of the Project area

The existing SH3 corridor north and south of Mount Messenger follows relatively simple, open rural valleys. These lowland landscapes are separated by very steep, topographically complex bush hill country, some of which is of high ecological and cultural landscape value.

The wider landscape context of the Project area includes the steep to very steep bush hill country from the coastal terraces south of the Tongaporutu River; south to the pastoral flats of the Mimi Valley; west to the coast and the Parininihi Cliffs and; east to the Mangaonga Road Corridor and the Mount Messenger Forest. In general terms, the Project area traverses a landscape predominantly characterised by steep to very steep bush hill country. This includes a pattern of fragmented areas of ecologically significant bush as well as areas of high value but unprotected bush.

Of particular importance is the landscape continuum from the coast through to inland hill country of the Mount Messenger Forest. This is particularly relevant to the Waipingao catchment to the west of the Mount Messenger summit. This catchment is of unique and high ecological, cultural landscape and landscape value and includes a regionally significant landscape notation. The Waipingao Valley's landscape value as a near pristine wilderness environment is in part derived from the undisturbed, natural landscape continuum from the coast up to Mount Messenger.

This landscape connectivity extends further eastwards inland into extensive areas of the Department of Conservation estate further adding to its value in the broader landscape context.



Map showing Project location and key surrounding features of the wider Project area.

Photos showing landscape context of Project area

3.1.1 Landform

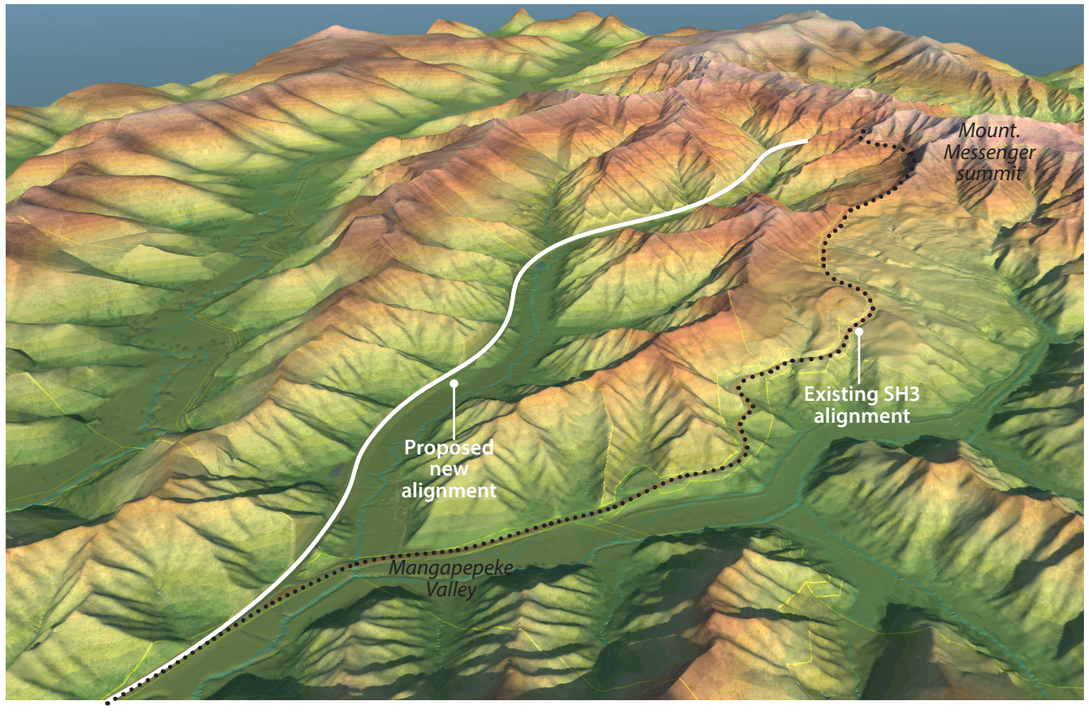
Strong ridgeline patterns and lowland valleys predominate the Parininihi-Mount Messenger landscape. The area is predominantly remote bush covered hill country with strong underlying landform, characterised by:

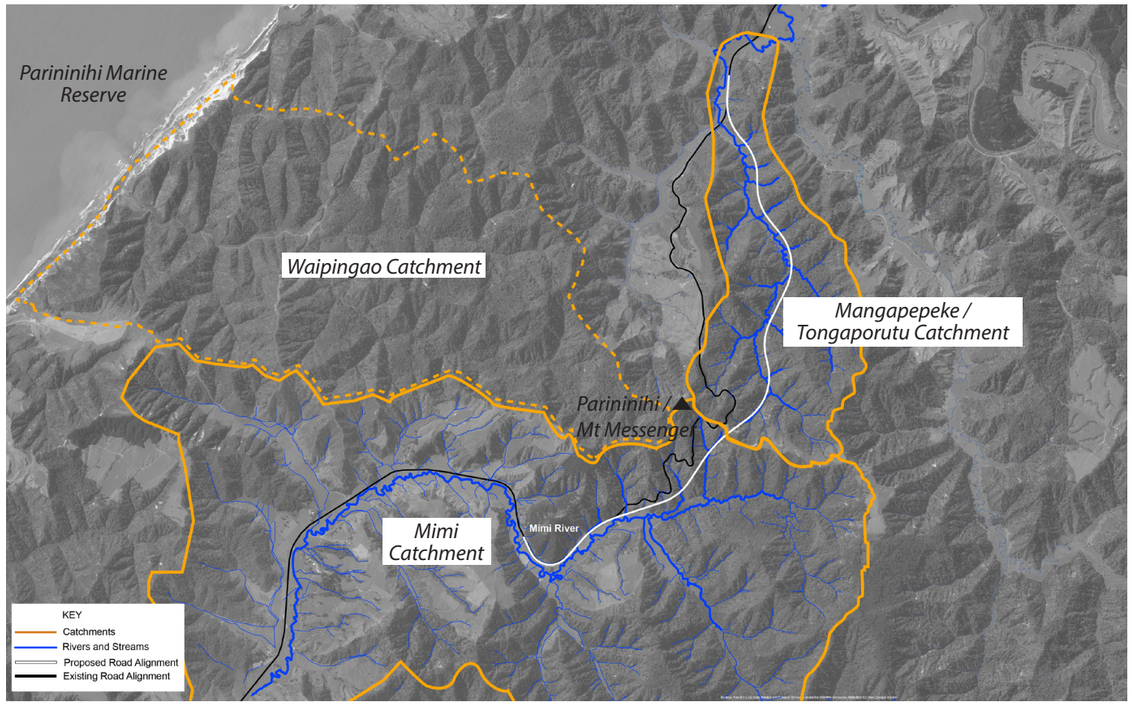
1. Steep ridges rising to 400m
2. Peaked and angular landform
3. Clearly defined stream gullies

These features characterise the inland landscape context to the east. The Taranaki coast (including the Parininihi Cliffs and Marine Reserve) characterise the coastal hill and terrace country in the west.

3.1.2 Hydrology

The alignment's valley-to-valley path is defined by the Mimi River and Valley in the south, and the Mangapepeke Stream and Valley in the north. The Mimi Valley is within the Mimi Catchment, and the Mangapepeke Valley forms part of the larger Tongaporutu Catchment. The alignment avoids the more sensitive Waipingao catchment to the west of Mt Messenger.





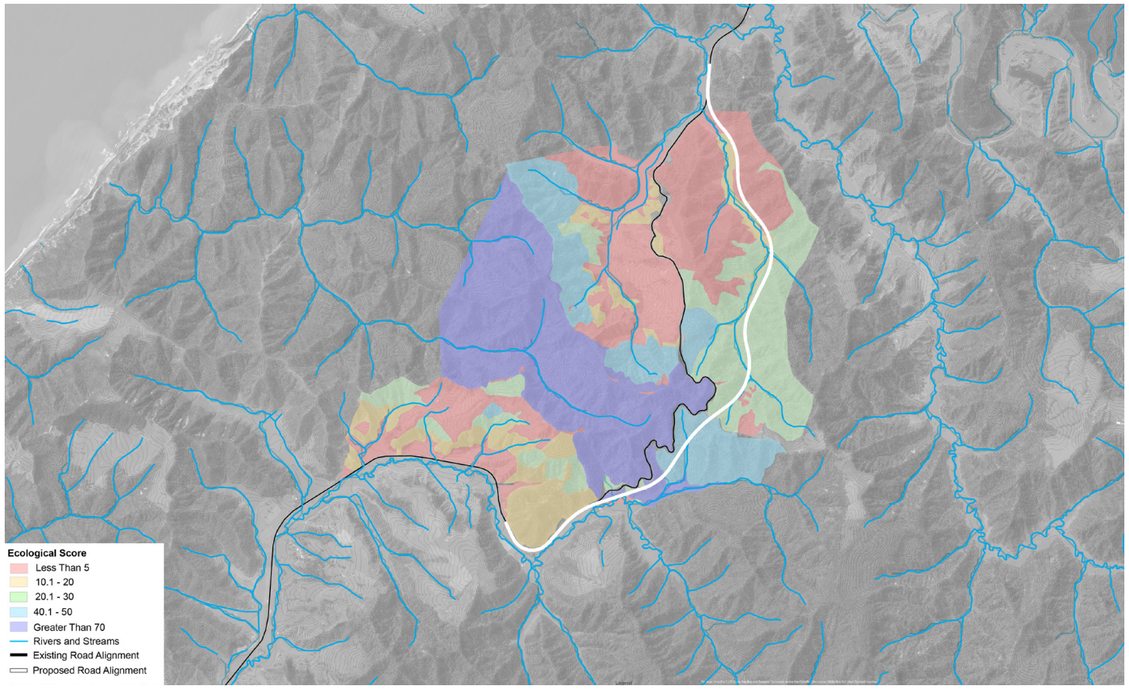
3.1.3 Landcover: ecological value and species mix

The Parininihi-Mount Messenger forest is a mosaic of different age classes, due to the steepness of slopes and the occurrence of frequent landslides, with areas of vegetation and soil slipping back to raw bed rock. This results in varied vegetation composition with a significant proportion in younger stages of succession, developing towards mature broadleaved dominant forest. Broadleaved dominant forest has an abundance of lianes and epiphytic plants with smaller areas of the valley floor forest and wetland communities of kahikatea and wetland vegetation.

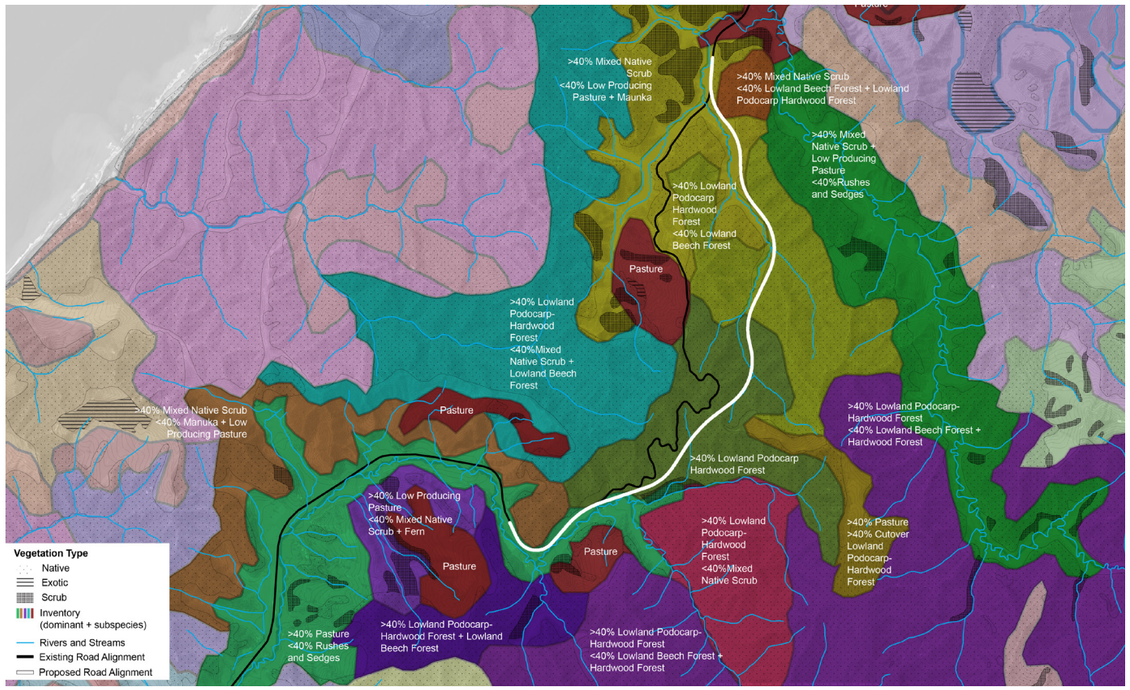
Modifications to the original forest pattern have occurred as a result of both human land development (vegetation clearance for agriculture and the SH3 construction and operation and pest induced dieback.

The Mount Messenger area straddles an ecological boundary between two broad forest classes with podocarp, broadleaved forest largely in the Mimi catchment (mapped as "Rimu tawa forest") and the upper Mangapepeke Valley with podocarp, broadleaved, beech forest (mapped as "Rimu tawa beeches") within the lower Mangapepeke Catchment and northwards.

For more detailed and descriptive classification and mapping refer Technical Report 7a, Volume 3 of AEE, Singers & Rogers 2014, Taranaki Region (Singers, unpublished 2015).



Map showing ecological scores (refer Technical Report 7a in Volume 3 of AEE), the higher the score the higher the value of the vegetation cover.



Map showing species composition within the Project area source, http://www.lcdb.scinfo.org.nz/.

3.1.4 Landscape character

For contextual analysis, the Project area has been categorised into landscape character sub-units.

The sub-units serve to broadly identify areas of landscape quality and the capability of the landscape to accommodate or 'absorb' the type of change anticipated by the Project.

Landscape quality was assessed taking into account the following matters:

- Biophysical values such as the natural science values of landform, vegetation, waterways.
- Perceptual values such as aesthetic quality, legibility, distinctiveness and memorability.
- Shared and recognised associative factors, particularly values that tangata whenua and others might associate with a landscape.

The **highway absorption capability** is an appraisal of the likely degree of effects that would result from the Project taking into account such matters as:

- Likely modification to natural landforms, waterways or vegetation.
- Likely prominence, including density of dwellings, proximity to settlements, the ability to fit a road to the contours, potential screening by vegetation or topography.
- Likely extent of change to existing character – taking into account the landscape's complexity and existing degree of modification.

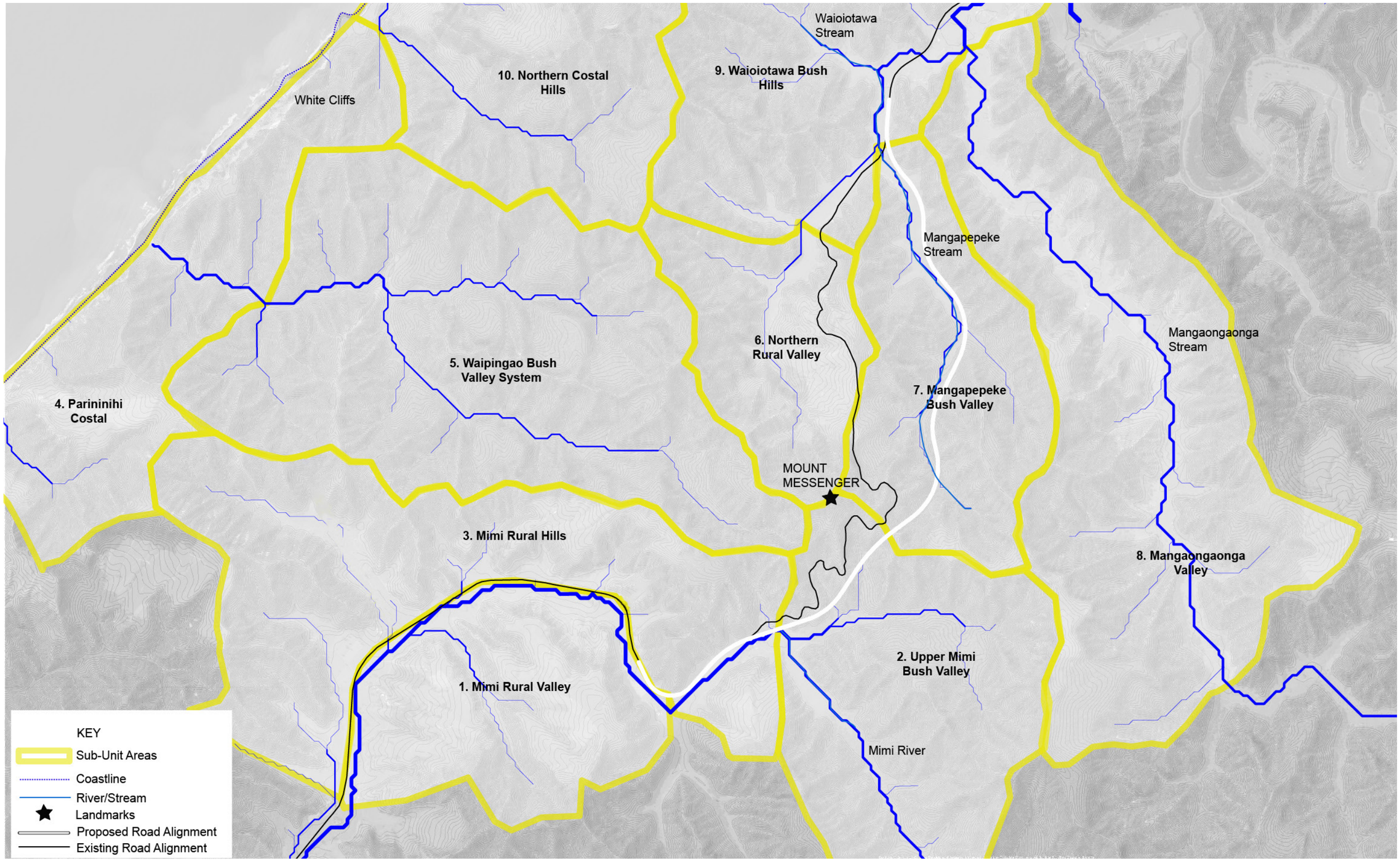
The sub-units are relatively defined landscape subunits, which demonstrate differences in landscape characteristics and the capacity of each unit to accommodate landscape change associated with the Project.

Note: see page 25 opposite for map of landscape character sub-units. Only those directly affected by the alignment are listed. Also see MCA1 (Multi Criteria Assessment 1)Technical Report for character area description.

The landscape sub-units within the Project footprint are as follows.

- **1. Mimi Rural Valley:**
  - Moderate to steep pastoral hill country in the south.
  - Pastoral rural hill country character predominates
  - Includes existing SH3 corridor
  - Overall modified rural landscape
  - Features Mimi River system (meander) and valley
  - Low quality / High capacity to accommodate landscape change
- **2. Upper Mimi Bush Valley**
  - Very Steep Bush Hill country (includes DOC estate)
  - Complex stream systems
  - Sensitive Wetland / stream system (Mimi System and confluence)
  - Includes existing SH3 corridor in the Northwest.
  - Modified lowland valley
  - SH3 roadway south of Mount Messenger
  - High quality / Moderate to Low capacity for landscape change
- **3. Mimi Rural Hills**
  - Steep south facing spurs and scarps.
  - Strong and defined landforms patterns
  - Visually prominent from SH3 northbound approach in the south
  - Modified farmland remote open rural character
  - Fragmented bush
  - Frames existing corridor in the north
  - Low quality / Moderate capacity to accommodate landscape change
- **7. Mangapepeke Bush Valley**
  - Well defined and visually contained bush valley
  - Moderate ecological values
  - Partially modified (grazed in the north) with an unmanaged 'scruffy' rural character partially the valley floor
  - Assumed cultural landscape values associated with landownership
  - Moderate quality / Moderate capacity to accommodate landscape change
- **9. Waioiotawa Bush Hills**
  - Steep bush hill country
  - Dissected and strong landform and streams
  - Includes lowland pastured flats near existing SH3 corridor
  - Moderate to high quality / Moderate to low capacity to accommodate landscape change

Photos showing landscape context of Project area


Waioiotawa Stream
10. Northern Costal Hills
9. Waioiotawa Bush Hills
White Cliffs
Mangapepeke Stream
Mangaongaonga Stream
6. Northern Rural Valley
5. Waipingao Bush Valley System
7. Mangapepeke Bush Valley
4. Parininihi Costal
MOUNT MESSENGER
3. Mimi Rural Hills
8. Mangaongaonga Valley
2. Upper Mimi Bush Valley
1. Mimi Rural Valley
Mimi River
KEY
Sub-Unit Areas
Coastline
River/Stream
Landmarks
Proposed Road Alignment
Existing Road Alignment

3.1.5 Notable landscape features

The following noteworthy natural features are also included within the broader Project area, though none are directly affected by the Project footprint:

The Parininihi Cliffs.
Well-recognised and prominent coastal features listed as a regionally significant landscape (NPDP). These cliffs have significant cultural value, as well as ecological and natural character value.

Mount Messenger
A prominent and recognisable landform feature with associated strong contiguous ridgeline patterns that are visible from the SH3 corridor. This landform and associated ridges are also recognised as having significant cultural landscape value.

The Waipingao Catchment.
This area is part of the Parininihi Protection Project (PPP), the conservation project managed by Ngāti Tama for over 30 years to protect and enhance the biodiversity values of the catchment. It is an area recognised as having very high ecological and cultural values. This catchment is also listed as a regionally significant landscape in the NPDP. The Waipingao catchment flows into the sea at the Parininihi Marine Reserve. The marine reserve is of high ecological significance and high natural character value including the Pariokariwa offshore reef featuring and rare sponge communities.

"Marine biologist Chris Battershill (a renowned expert on marine sponges) rates Pariokariwa Reef as one of the top sponge spots in the world. Many of these fantastic "undersea gardens" remain unexplored and may yield further scientific discoveries" (DOC, Parininihi Marine Reserve Brochure). In this regard, the Waipingao Catchment represents a particularly sensitive natural environment from ridge (Mount Messenger) to reef.

Mount Messenger: Significant cultural landscape values

The Mouth of the Waipingao Stream and valley extending east to Parininihi (Mount Messenger) & Parininihi Cliffs. *Ngāti Tama* - Regionally Significant Landscape. *Photo source: http://parininihi.co.nz/gallery/#!*

Parininihi Cliffs: *Ngāti Tama* - High natural character, cultural and landscape values. *Photo source: http://parininihi.co.nz/gallery/#!*

3.2 The cultural landscape, shared and recognised values

3.2.1 Cultural landscape

The Bypass Project sits within the important cultural landscape of Parininihi, the name by which the area is known to Ngāti Tama. Ngāti Tama are acknowledged as mana whenua.

The Whitecliffs Sites and the Mount Messenger Sites are collectively known by Māori as Parininihi and were returned to Ngāti Tama in 2003 as part of a Treaty of Waitangi settlement. Parininihi is proudly protected and maintained by iwi.

The Parininihi landscape is of cultural, spiritual, historical, and traditional importance to Ngāti Tama, symbolising the spiritual links between this community and its environment.

3.2.2 Ngāti Tama

Ngāti Tama is an iwi of Taranaki and its members are the descendants of Whata, Rakaeiora, and Tamaariki of the Tokomaru waka.

Ngāti Tama, the northern most Iwi of the eight Taranaki Iwi, are tangata whenua and kaitiaki or guardians of Parininihi and the wider landscape; a triangular area of land from The Mokau River southwards to a place named Titoki, two miles south of Puke-aruhe pa and inland to Ohura.

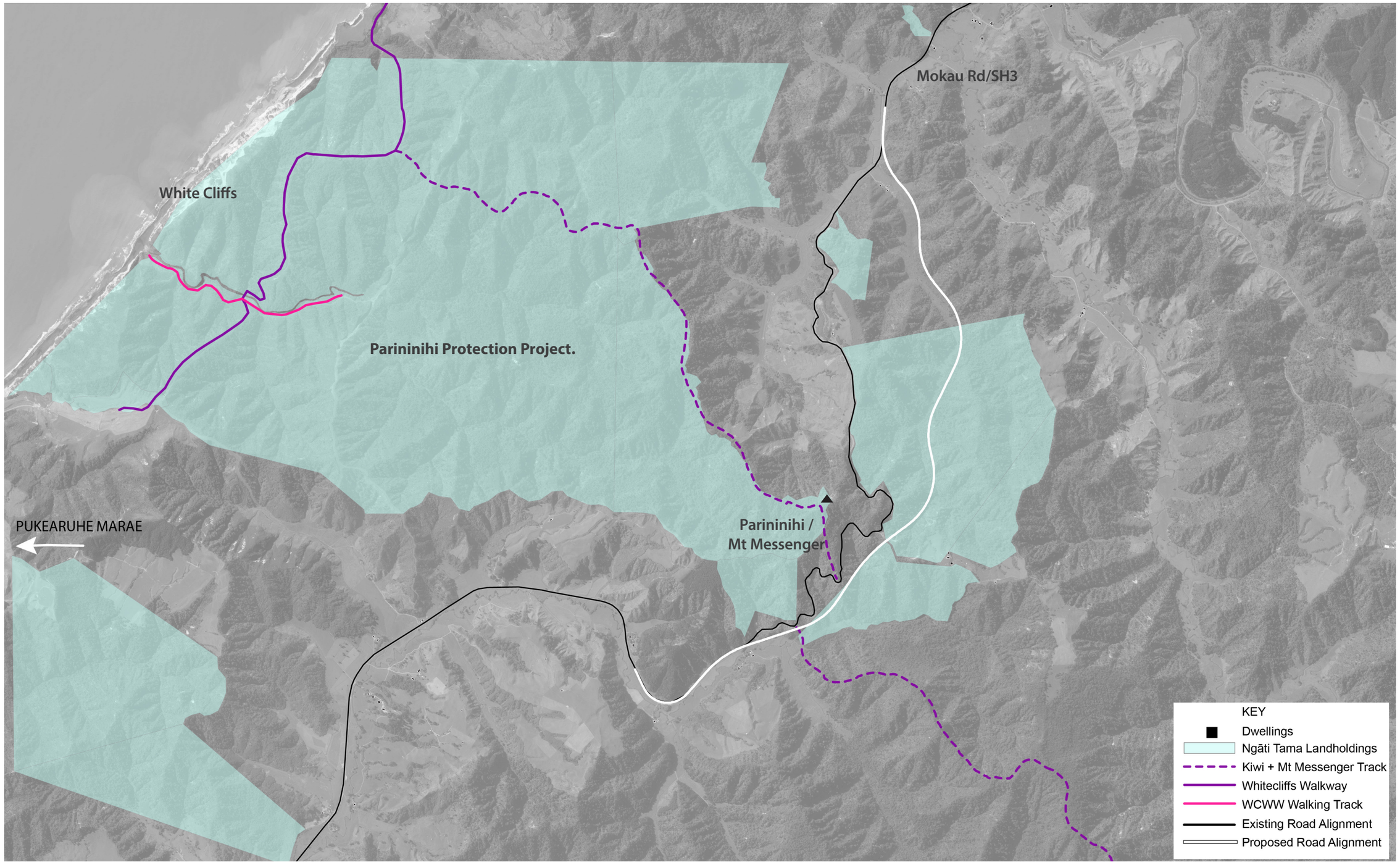
Inland bush areas including Parininihi are of particular importance to Ngāti Tama where, *'…The associations with the inland bush area played an important role in the customary practices of Ngāti Tama, along with the many streams, ridgelines and peaks of this area, and continue to do so today…'* Wording taken from the Deed of Settlement between the Crown and Ngāti Tama summary. (trc.govt.nz)

This is also reflected in important landscape connections between coastal and inland areas including coastal pa and inland tracks and peaks, in particular, the importance of ridgeline walking tracks between the coast and the Mount Messenger. These pathways have cultural significance to Ngāti Tama as the source of Mauri. Important waterways which flow to the coast and Parininihi Cliffs are also of major cultural significance to Ngāti Tama (Cultural Values Assessment in relation to the SH3 Mount Messenger Project, Atkins Holm Majurey Ltd March 2017.)

Note: While aspects of this LEDF have been developed to reflect the outcomes of engagement with key stakeholders, this document has not yet been presented to stakeholders and will continue to be updated as the engagement process continues.

'As Māori we have a unique sense of our cultural landscapes. It includes past present and future. It includes both physical and spiritual dimensions. It is how we express ourselves in our environments, it connects whānau, whenua, awa and moana through whakapapa, it includes both urban and rural, it is not just where we live it is who we are.'

(Te Aranga Maori Cultural Landscape Strategy 2006: www.tearanga.maori.nz)



The LEDF is a living document and this map will be developed further in consultation with key stakeholders. Map currently showing Ngāti Tama Land holdings/Parininihi and the Proposed Alignment of the Project

3.2.3 Shared and Recognised Values

Landscape can be explained as a reflection of the relationship between people and place. The landscape's sensory qualities and the spiritual, cultural and social associations within the area helps to inform the shared, recognised and community values associated with the wider landscape.

To fully understand the shared and recognised values of the Parininihi landscape, ongoing engagement and consultation will be undertaken with key project stakeholders.

The Ngāti Tama iwi have been active in the restoration and protection of a 2000ha area within their lands: the Parininihi Protection Project. This area is considered the largest continuous piece of lowland coastal forest in the North Island.

To understand and respond to the shared and recognised values, a conversation on narrative is yet to come.

The Parininihi Protection Project (PPP) area is located west of Mount Messenger within the Waipingao catchment and western coastal hills, where the bush runs from the coastal cliffs to Mount Messenger.

These lands hold high cultural, historic and spiritual significance to Ngāti Tama. Ngāti Tama strive to maintain the health of Parininihi and have been working to control animal pests and re-introduce species that have been lost. This iwi-led conservation Project is the first of its kind in Taranaki.

The PPP objectives are to protect ecosystem health, enhance biodiversity and enable community participation. The PPP has a well established group of supporters and volunteers, and includes people from Ngāti Tama and the wider community.

It is the combination of these values and qualities (natural science factors, patterns and processes; sensory qualities; and spiritual, cultural and social associations) that are reflected in the Regionally Significant Landscape notation of the Waipingao Catchment in the NPDP.

Parininihi project area. *Photo source: http://parininihi.co.nz/gallery/#!*

3.3 Existing character of SH3

3.3.1 Landscape setting of Mokau Rd (SH3)

SH3 to the immediate north and south of the Project area can be characterised as a lowland valley road corridor which 'keeps low in the rural landscape'.

The existing Mokau Rd (SH3) north of the Project area consists of a more open and rolling pastured valley characterised by the disturbed landslide landform, dissected sub-catchment valleys and drained valley floor. This Valley is defined by the strong ridgelines of the northern Waipingao catchment and Mount Messenger summit. Landcover on these northern slopes is generally more mixed, including areas of pasture, regenerating bush and exotic forestry.

The existing corridor follows the Mimi River valley in the south before turning eastwards at the south facing toe slopes and spurs of the west east running ridgeline that defines the southern catchment boundary of the Waipingao. These slopes are characterised by regenerating bush on the steeper scarps and pasture on the more moderate spur flanks.

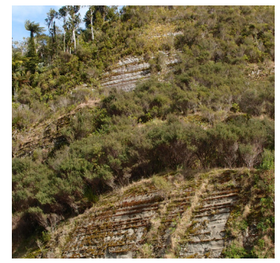
A prominent conical landform with exotic forestry marks the southern SH3 hill climb towards Parininihi / Mount Messenger with the existing highway winding up to the summit and saddle and rest area. Here there are panoramic views of indigenous forest and remnant emergent trees along with views across to the upper Mangapepeke Valley. A short tunnel characterises the highway north of a rest area at the catchment saddle between the Mangapepeke Stream and the Mimi Valley.

This tunnel is cut directly into the slope face revealing the underlying papa strata. Roadside cuts through this area are generally well vegetated demonstrating the recolonisation and diversity of successional indigenous plant communities, creating a highly naturalised roadside character.

The existing roadside environment represents surprisingly natural qualities that have developed over time particularly on moist south facing cut faces north and south of the existing Mount Messenger tunnel .

Settlement patterns within the Project area along the edges are sparse and determined predominantly by the access afforded by SH3. A small number of dwellings are located along SH3.

The State highway provides access to several walking tracks within the surrounding area.



Looking south towards the Mangapepeke Valley from SH3 with pastoral valley flats to the right of frame (north of the project alignment). The Mangapepeke valley landform itself is not visible from this view.

Existing SH3 at Mount Messenger showing the existing highway, bush hill country landscape context and naturalistic roadside character.

Images of naturally-occuring revegetation on cut faces beside the existing SH3

3.4 The alignment landscape setting

The alignment of the Mount Messenger Bypass is contained within two valley systems: the well defined Mangapepeke Valley in the north and the south facing slopes of the upper Mimi Valley in the south.

As outlined in section 3.1.4 the alignment travels through landscape character subunits of the;

- Mangapepeke Bush Valley;
- Waioiotawa Bush Hills.
- MImi Rural Valley;
- Upper Mimi Bush Valley; and
- Mimi Rural Hills (sub units a /b/ c);

The Mangapepeke Valley

The Mangapepeke Valley is a well-defined landform contained by steep bush covered ridges to the west and east and associated minor spurs and toe slopes that work down to a flat valley floor. The lower valley floor is predominantly grazed and includes the meandering Mangapekepe Stream. A single rural dwelling with associated farm machinery and ancillary buildings is located at the northern head of the valley and is accessed from SH3. Further south (upstream) this valley becomes more closed and dissected, as the two main ridges and steep spurs combine in the upper catchment. The more incised first order stream feeds into the main Mangapepeke Stream.

The Mangapekepe Valley is relatively visually discrete from the existing SH3 alignment with southbound views from the southern approach dominated by the western spur that divides the valley from the existing SH3 highway.

The northern valley near SH3 is characterised by pastured flats contained by steep surrounding bush slopes and the farm buildings and machinery of the property at 3072 Mokau Road.

Further south the pastoral qualities of the valley flats become less defined with a predominance of sedge/rushland vegetation . These grazed valley flats remain distinct from the surrounding bush with a clear 'bushline' boundary.

This relatively extensive area of rough grazed mixed vegetation flats continues southwards up the valley and includes bush edges characterised by Kahikatea forest remnants and isolated large individual native trees. These trees are identified in the ecological assessment reporting as including rimu, miro, matai and hinau.

The character of the valley floor transitions to a more mixed lowland forest character still further south (above right) before becoming more enclosed and broken reflecting the more incised and steep upper catchment terrain of the first order Mangapekepe Stream system.

Left: Rough pasture transitioning up the Mangapepeke Valley framed by the surrounding bush slopes and ridgelines.

Above: Mangapepeke Valley- Kahikatea remnant bush edge featuring large prominent individual trees

The Upper Mimi Valley

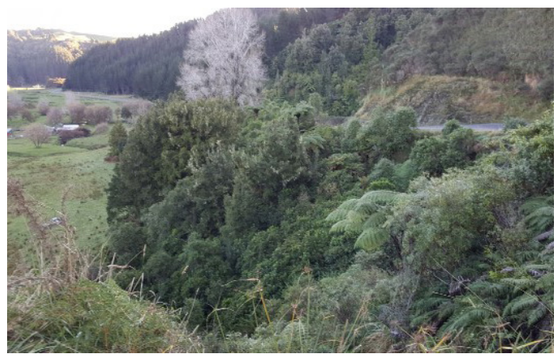
The alignment preserves the main ridge divide between the Mangapekepe Valley by tunnelling low through the intervening ridge. The southern portion of the alignment is characterised by the south facing slopes of the upper Mimi Valley transitioning to the more open pastoral flats of the mid Mimi Valley to the south west.

Like the Mangapepeke Valley, the landscape setting of this southern section of the alignment is predominately characterised by steep bush hill country. However, the Mimi Valley is a larger and more open valley system characterised by broader pastoral flats particularly in the south west.

Pastoral farming and grazing are the main land uses along the majority of the SH3 corridor south of the Mount Messenger climb. Further upstream, the landscape becomes a contiguous area of indigenous forest vegetation (including Kahikatea swamp forest) adjoining the Mount Messenger Forest.

Above: North-easterly view across the modified pastoral flats and existing road corridor of SH3 south of Mt Messenger

Below: View to the south west showing the modified SH3 corridor and the adjoining pastoral flats to the south.



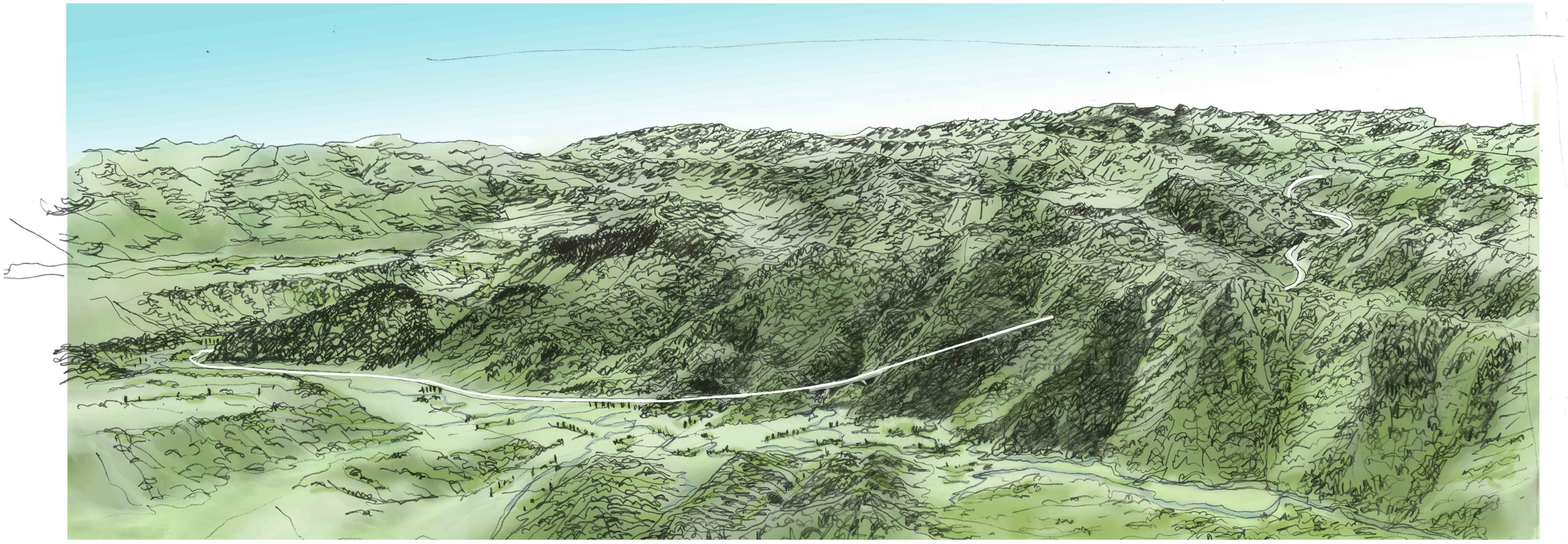
4.0 Design approach

The design approach, like the alignment itself, lets the landscape speak.

The specific design treatment of landscape and built elements is developed to minimise clutter, mitigate effects of the highway construction, and facilitate re-establishment of natural vegetation.

Landscape treatments and planting are designed to follow and allow the natural landform, hydrological and vegetation patterns to re-establish themselves. Manmade elements provide an opportunity to use precast units in a resourceful and meaningful way. The combined family of elements and treatments allow the existing landscape to be the most dominant feature- to 'let the landscape speak.'

Below: Conceptual illustration of the Project working with the grain and letting the landscape speak.



4.1 Design approach

4.1.1 Design principles

The overall design concept for the Mt Messenger Bypass is for an alignment that is integrated with the landscape and delivers an outstanding scenic highway. The Project will form a new valley to valley bypass of the mountain and existing SH3 alignment. The design is underpinned by the following general design principles:

Simplicity
The Project alignment is set **low in the landscape,** following the natural valley patterns as closely as possible. The alignment should is intended to be understated and to allow the **landscape to 'speak'**. The valley to valley concept will be expressed in strong yet simple landform patterns where appropriate, with clear definition of 'thresholds'.

Cultural Context
Interpretation and celebration of the cultural landscape narrative is a key design principle for the Project and will be reflected in the significant natural landscape patterns – particularly those of the southern and northern valleys which form part of the wider vegetated Taranaki hill country system. **'Recognising culture'** and the human relationship to the land, including continuing the partnership with Ngāti Tama through the detail design process to express their mana whenua and kaitiakitanga. For example, through the development of appropriate vegetation clearance and management protocols, to be detailed in the Ecological and Management Plan for the Project.

Integration
The highway will enable natural and ecological landscape patterns and processes to be rehabilitated and enhanced where appropriate.

Future proofing - which means responding to the future growth for Taranaki and surrounding areas. The Bypass will maintain and provide enhanced connectivity between the Waikato and Taranaki, while ensuring cultural and recreational linkages and connections. These will be developed with key stakeholders throughout the design process.

4.1.2 Cultural values

The following cultural values will be brought into the design process:

Rangatiratanga
The right to exercise authority and self determination within ones own iwi / hapū realm.

Kaitiakitanga
Managing and conserving the environment as part of a reciprocal relationship, based on the Māori world view that we as humans are part of the natural world.

Manaakitanga
The ethic of holistic hospitality whereby mana whenua have inherited obligations to be the best hosts they can be.

Wairuatanga
The immutable spiritual connection between people and their environments.

Kotahitanga
Unity, cohesion and collaboration

Whanaungatanga
A relationship through shared experiences and working together which provides people with a sense of belonging.

Mātauranga
Māori / mana whenua knowledge and understanding.

4.1.3 Celebration of the cultural footprint of mana whenua in the landscape

The following cultural values also provide general guidance to Te Ao Maori:

- **Mauri (life force):** The interconnectedness of all things means that the wellbeing of any part of the environment will directly impact on the wellbeing of the people.

- **Kaitiakitanga (guardianship rights and responsibilities):** The obligation to protect and enhance the mauri of all natural resources, for the benefit of ourselves, other people living in our homeland and for future generations.

- **Ki uta, ki tai (from inland to the sea):** The mauri of waterways is also viewed holistically and includes from the source of the waterway to the sea and reinforces the view that activities upstream also impact on the well-being of the river downstream.

4.1.4 Design strategies

The strategies below have been developed to help resolve the concept design, these will be further resolved to deliver a unique regional highway that:

- Follows the **'grain'** of the landscape. Aligning the highway to follow the detailed topography and landscape patterns, such as the edges between bush and pasture, and the edges between valley floor and hill slopes.
- Expresses the **cultural footprint** and values of mana whenua in the landscape:
- Creates an **aesthetically** pleasing experience for travellers that derives from the highway following and 'fitting in' with the natural landscape patterns.
- Avoids localised **natural features** such as significant trees, waterbodies and distinctive landforms. Retains key **landforms** and **ridgelines** by employing a tunnel.
- **Minimises** stream crossings by following the true right side of the Mangapepeke valley
- Integrates cut and fill batters into the landscape to **echo natural slope** angles, and promoting natural re-colonisation by indigenous pioneer species)

- **Protects** and **rehabilitates** natural processes and patterns, including restoring natural riparian vegetation along the Mangapepeke Stream and valley floor;
- Promotes **natural succession** as a means of landscape rehabilitation
- Creates a straight-forward and uncluttered aesthetic to the highway by such means as attention to the details of the highway edge, and a refined and pared-back suite of elements (such as barriers, signs, drainage structures.

4.1.5 Expected design outcomes

The expected design outcomes and intention will ensure the design and alignment of the new regional road generally:

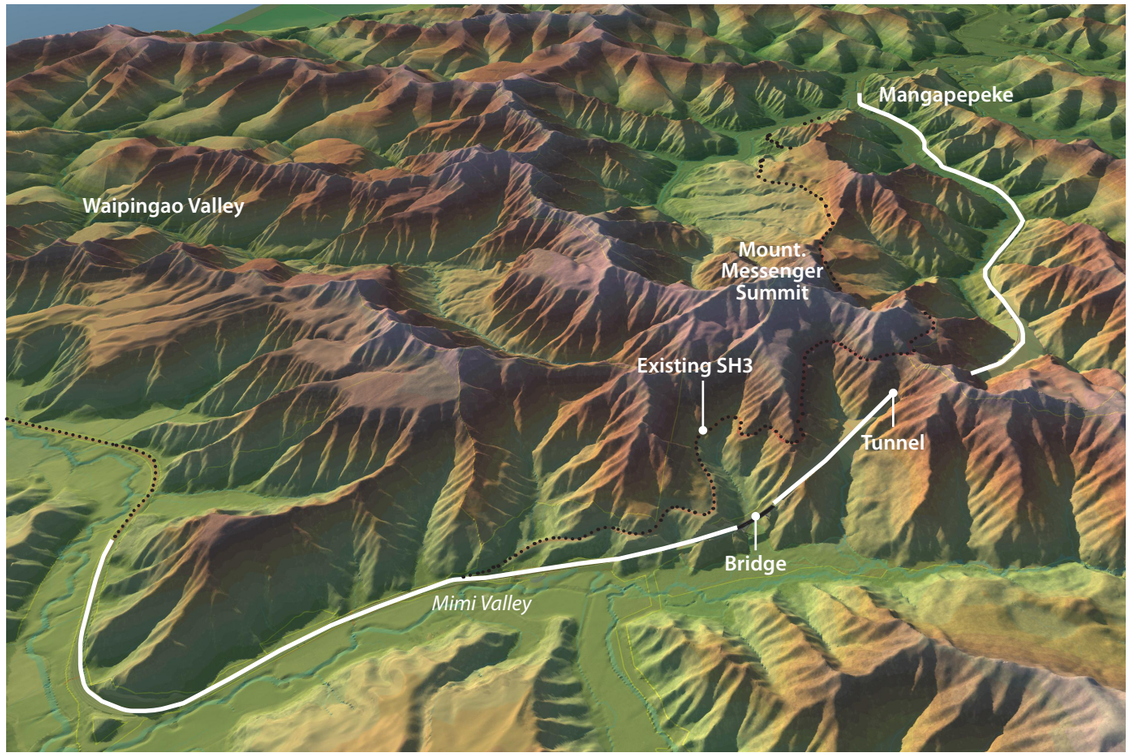
- Responds to the regional landscape context
- Follows a low profile that provides a 'best' fit within the landscape pattern and form.
- Considers and provides for storm water run-off, including conveyance and treatment where appropriate
- Minimises the effects on native ecology and vegetation
- Endeavours to maximise road safety benefits and minimise environmental impacts
- Considers the scenic and landscape experience of the road user
- Includes appropriate recognition in recommended mitigation and landscape treatment
- Reflects the significance of the environment to Iwi, Department of Conservation (DOC) and other stakeholders

Where possible

- The current design will result in the potential loss of a number of significant trees. Refer to Technical Report 7a, Volume 3, of the AEE. These may have cultural value to Ngāti Tama and where appropriate reuse strategies could including use of timber as per Ngāti Tama requests

Other potential vegetation reuse strategies include:

- Tree tops have large community of flora and fauna which could be transferred to appropriate sites where practicable.
- Felled trees should be placed back on to the land (off-alignment) where practicable and potentially also into the forest understorey in close proximity to where they were felled.
- A percentage of felled trees to be used as wood corduroy for temporary access purposes, if appropriate. This material can be left insitu to break down over time.
- Retain dead wood for forest regeneration and succession processes and habitat creation for example to assist fauna such as lizards and weta within this material to survive.
- Eco source seed material and duff to grow on plant material for rehabilitation and mitigation.
- Use direct transfer methods with soil, duff, understorey slash and epiphytic vegetation, where practicable, relocated to areas which require restoration.
- Direct transfer of selected species e.g. to mark stopping areas - tree-ferns and nikau palms.



Above: elevation model looking from the south to the north showing how the alignment relates to the grain of the landscape with its strong east-west pattern.

5.0 Landscape design and treatment

5.1 Earthworks - Cut and Fill Slopes

Conceptually the alignment 'flows' through the landscape. However, the cut and fill batters are arguably the most prominent element of the highway with the potential to detract from the surroundings and user experience. They therefore warrant particular attention.

5.1.1 Use of forest material

The road development will require the removal of large amounts of vegetation, forest duff, topsoil and wood. The well considered reuse and placement of forest material will have direct ecological benefits to degraded areas of vegetation, stream diversion, rehabilitation, mitigation planting and regeneration, work. Suitable sites include bare earth areas affected by construction as well as degraded pasture areas such as within the Mangapepeke Valley.

5.1.2 Integrating cut and fill slopes into the landscape

The alignment has been designed to optimise cut and fill balances, and with larger cuts and fills located in landscape areas that are best able to absorb them. Slope angles range from 1v to 4h up to 85 degrees. Small cut remnants along the toe slopes and spurs should be avoided, where these result in landform patterns that are inconsistent.

Treatment of earthworks is designed to facilitate natural integration into the landscape as follows:

- The visual effects of cut slopes will be reduced by blending and feathering the tops of cut slope edges to avoid the appearance of engineered landforms, scarifying the cut faces where practical to assist in the retention and keying in of topsoil.
- Fill slopes, where possible, will be graded to the immediately adjoining landform particularly within rural farmland areas to balance cut and fill volumes.
- The overarching revegetation strategy is to utilise existing natural seed sources, re-use existing forest material where possible, and facilitate natural successional practices.

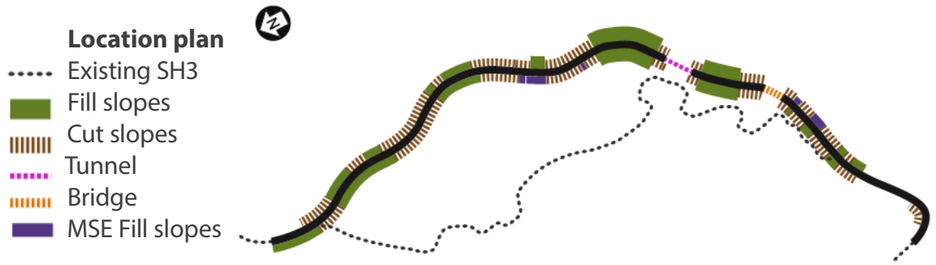
Overall objectives for landscape treatment for cut slopes is as follows

1. Step 1 - Stabilise engineered sites. *Stabilising works of engineered cuts, fill, stream diversion, stormwater ponds and swales.*

2. Step2 - Vegetate. *Establish vegetation on all engineered sites, get vegetation cover up and running as quickly as possible to limit/reduce sediment loads to streams and receiving environment.*

3. Step 3. Natural vegetation. *Allow natural succession to colonise engineered cut and fill sites as this will win out in the long term.*

Below: Natural vegetation patterns have re-colonised and softened the rock faces of cuts along the existing SH3.



Right: As an option to address sensitive areas, a ponga wall system could be placed through a process of direct transfer after construction to help stabilise, mitigate and vegetate certain areas.

5.1.3 Cut batters

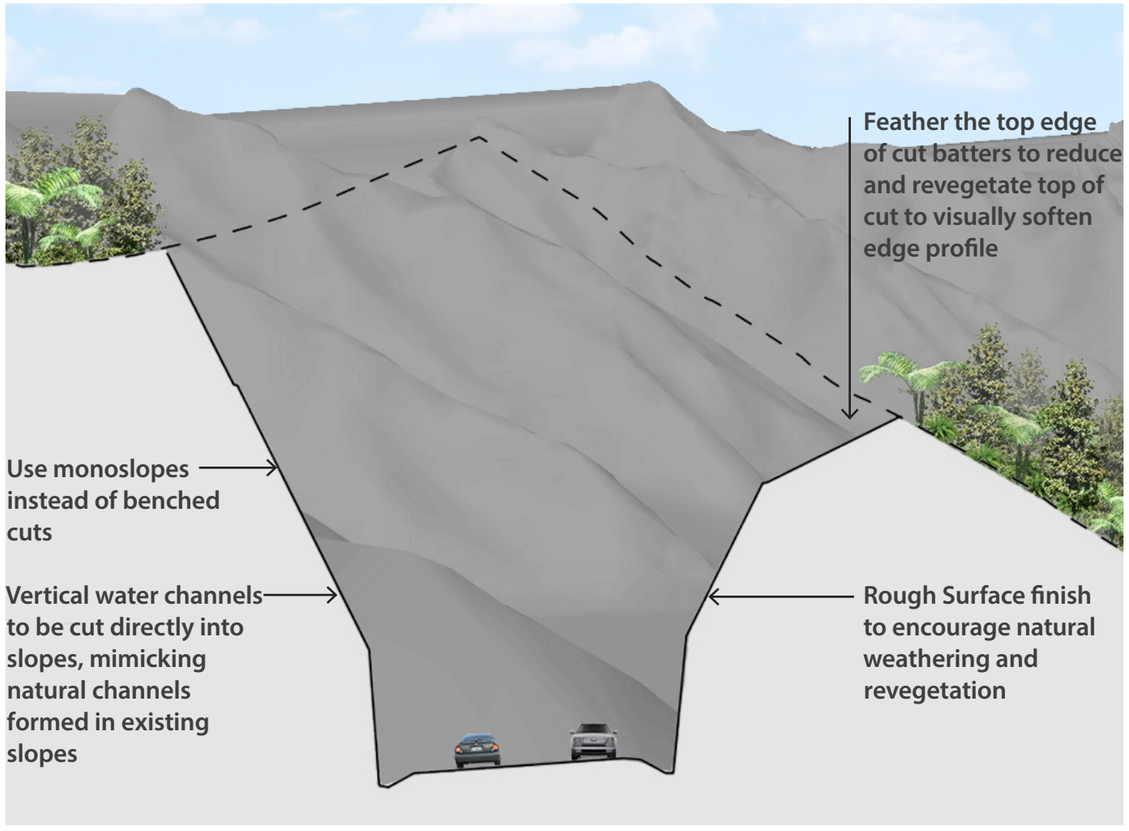
Cut formation
Cut batters are designed to reflect the natural geological slopes of the surrounding steep terrain. Treatment of the cut faces will be minimal, encouraging natural revegetation over time.

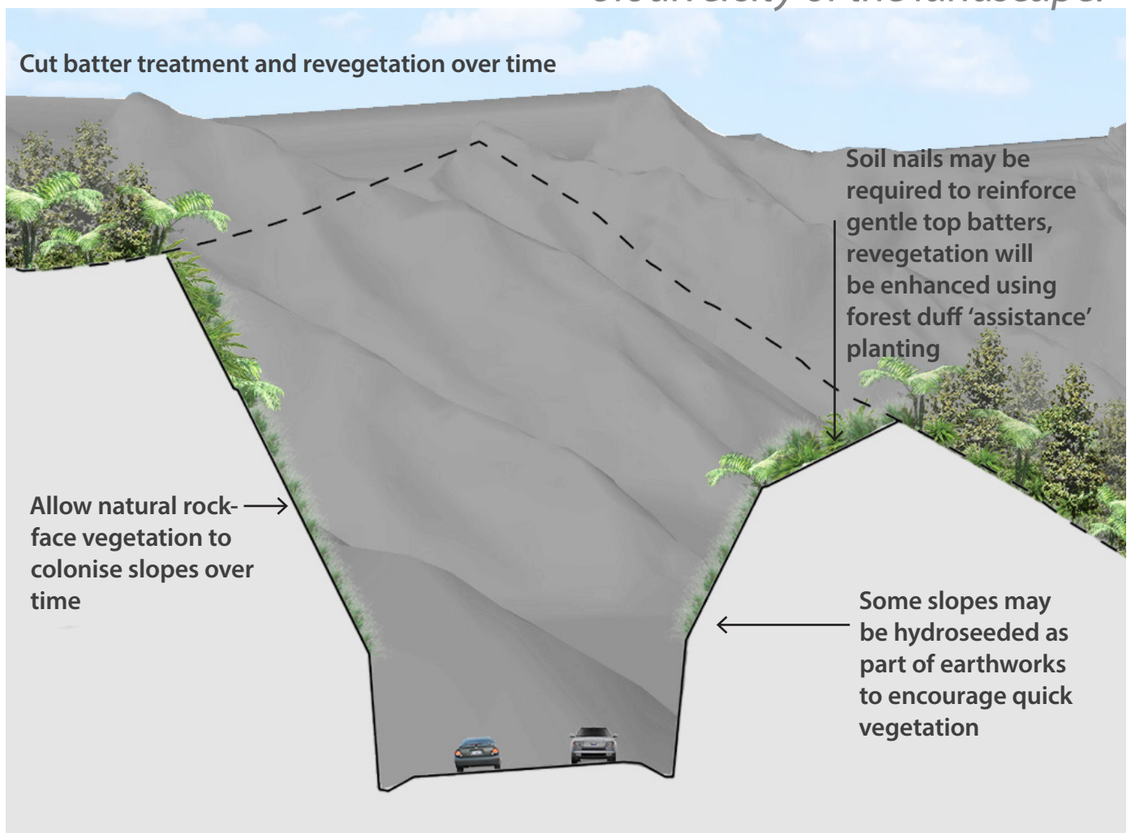
Where the ground is stable and competent 'formation' rock, the cut face should be steep and left as exposed rock.

Where the rock is unstable (weathered rock and/or 'Northland Allochthon' material), the batter slope should be graded, topsoiled and revegetated by scarifying and planting.

Cut vegetation strategy
Steepest slopes of cut batters should be left to revegetate on their own, allowing natural processes to soften the cut face. Gentler upper batter slopes may need to be reinforced with rocknails over which forest duff and 'assistance planting' will encourage natural revegetation.

Hard-to-establish species can be planted at tops of slopes to encourage seed to spread downhill, and enhance biodiversity of the landscape.

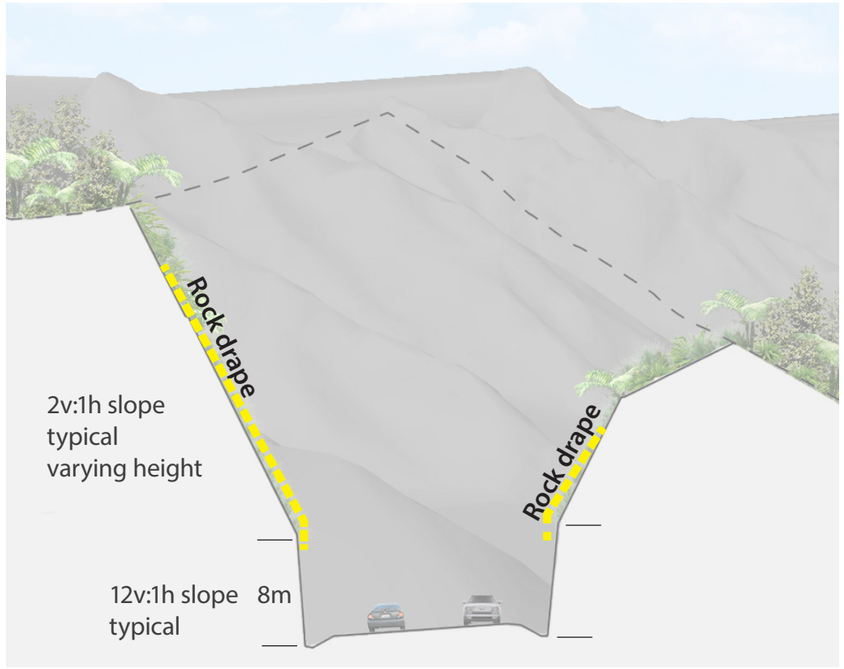




5.1.4 Cut-face - vertical water channel

Where ephemeral waterways flow down existing slopes to meet the new cut slopes, naturalistic channels will be cut into the rock face to direct water down the face of the swale at the edge of SH3. This technique mimics the natural channels that form on cut faces along the existing SH3 road. Over time, dampness on the rock face will attract naturally occurring plant species, mosses and lichens.

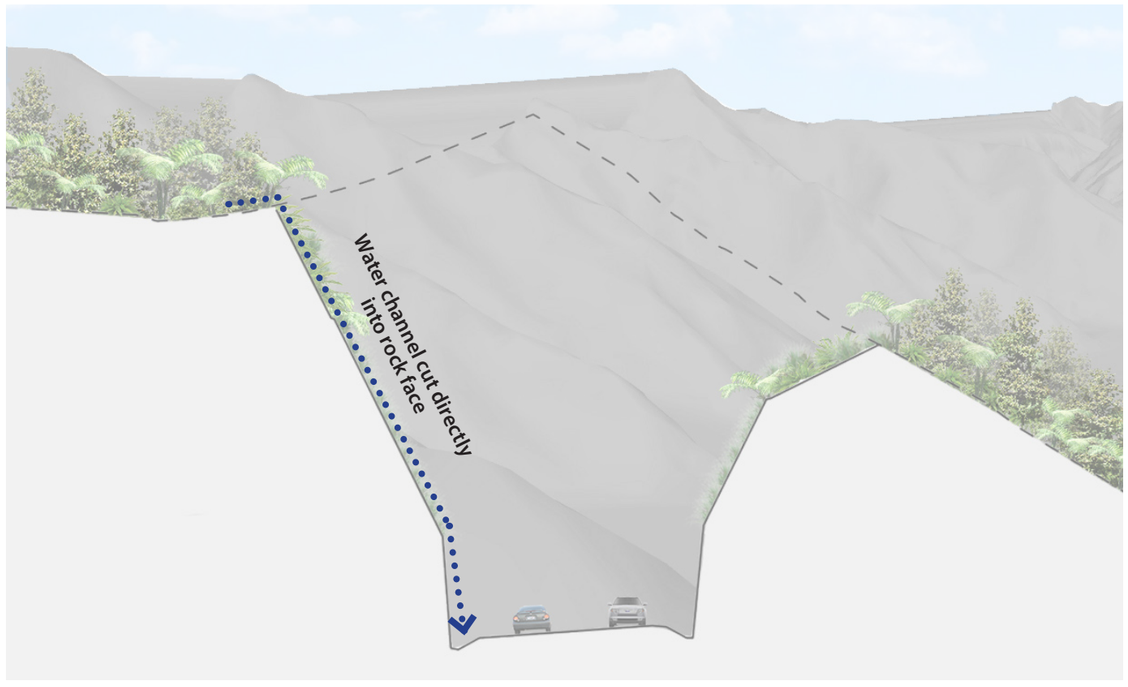
Constructed flumes and plastic pipes are to be avoided on the cut slopes. Rockfall protection measures such as rock drape or road side barriers may need to be used on cut faces. If rock drape measures are to be used (not preferred) they will be set to keep the first 8m clear.

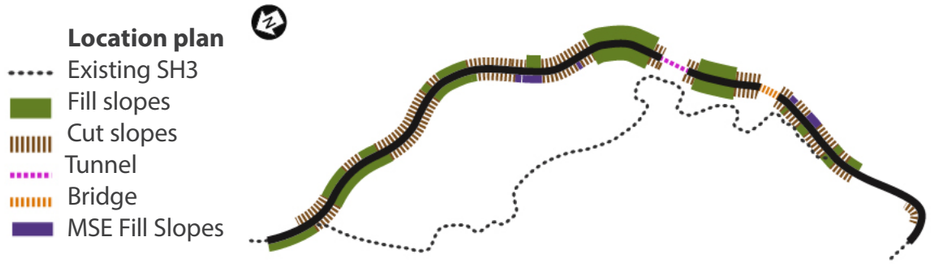


Right: Rock drape on typical cut section

Rockfall protection drape on upper cut faces

Below: natural water channels form along cracks in the existing SH3 cut rock face





Above: MSE system with vegetation cover

Right: Manuka slash will help manuka seedlings to quickly establish and stabilise banks while natural vegetation patterns restore over time.

5.1.5 Fill slopes

Fill formation
The Project includes a number of fill areas ranging from minor roadside batter slopes to more significant valley fills. Larger fill areas are generally located in more topographically contained areas, where they can be integrated into the surrounding terrain.

Fill slopes can mimic the form, vegetation patterns and hydrology form of a natural slip. Natural revegetation patterns will be encouraged to maximise a blending between the new and existing landforms.

Fill vegetation strategy
Revegetation of fill slopes should integrate with adjacent vegetation where appropriate, to maintain the landscape character of that area and should be appropriate to the new landform.

Natural succession is encouraged, and will be achieved using a combination of direct planting, seed cover and mulch. Plants will be established on steeper slopes using MSE socks lined with native seed source. Slopes 1v:2h or gentler may be laid with manuka slash, forest duff, or mulched to encourage natural regeneration with planting in specific locations to integrate built structures and for cultural expression.

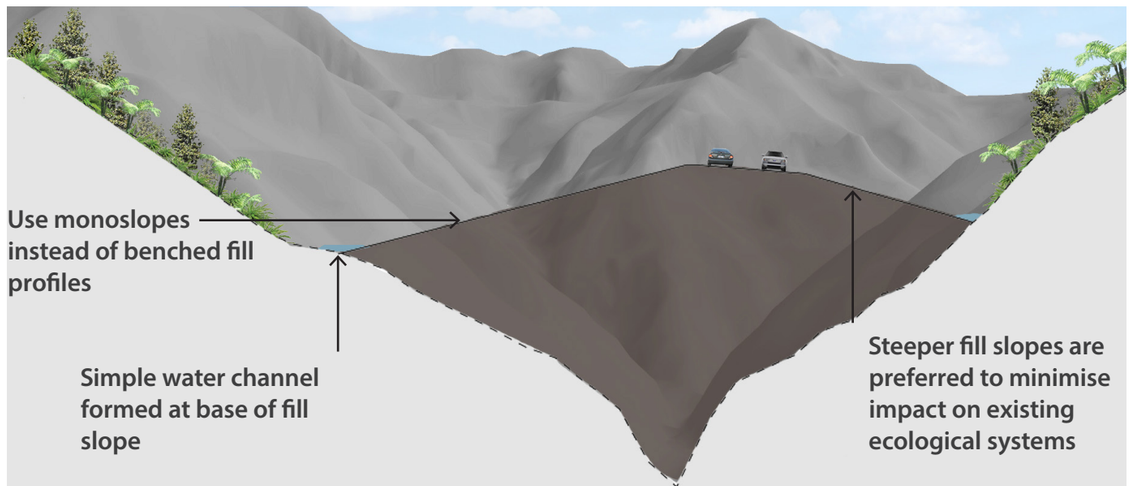
Mechanically engineered slope reinforcement
Cut and fill slopes will use a range of engineered reinforcement systems that minimise visual impact.

Cut slopes will employ reinforcement through a grid of rock nails on the upper soil horizon area.

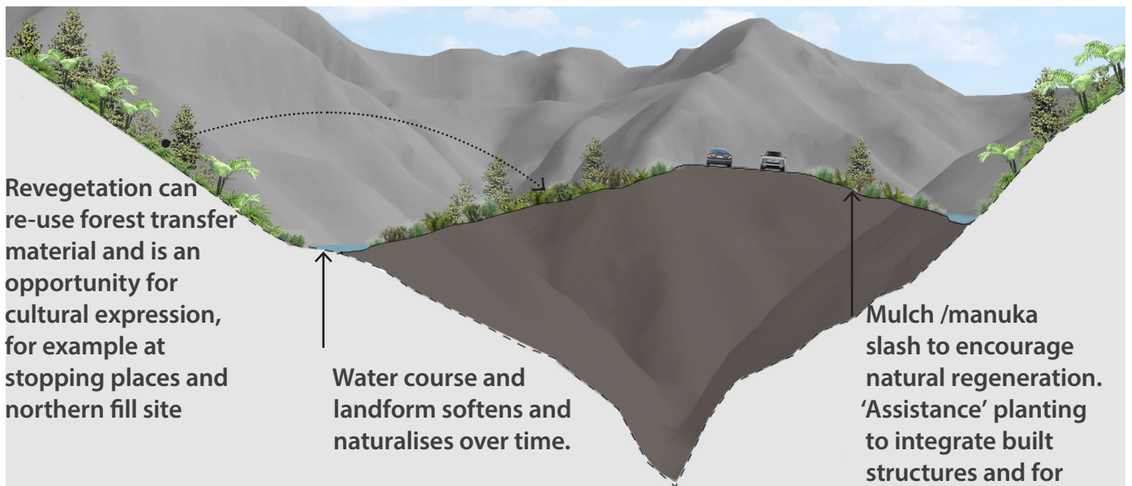
Fill slopes will employ MSE (mechanically stabilised earth) systems that will provide vertical stability up to 85 degrees and will become vegetated walls over time. These systems reduce site disturbance and allow natural drainage and revegetation to take place.

Streams and waterways
Simple channels will be formed on fill sites to facilitate diversion of existing waterways. Refer to the Streams, Wetlands and Swales section 5.3 for stream diversion principles.

Over time, creeks, streams and waterways will form a natural course along the base of fill sites, softening and naturalising the landscape.



Fill slope formation *(typical section, Mangapepeke Valley fill site)*



Fill slope treatment and revegetation over time *(typical section, Mangapepeke Valley fill site)*

5.1.6 Typical cut and fill sections

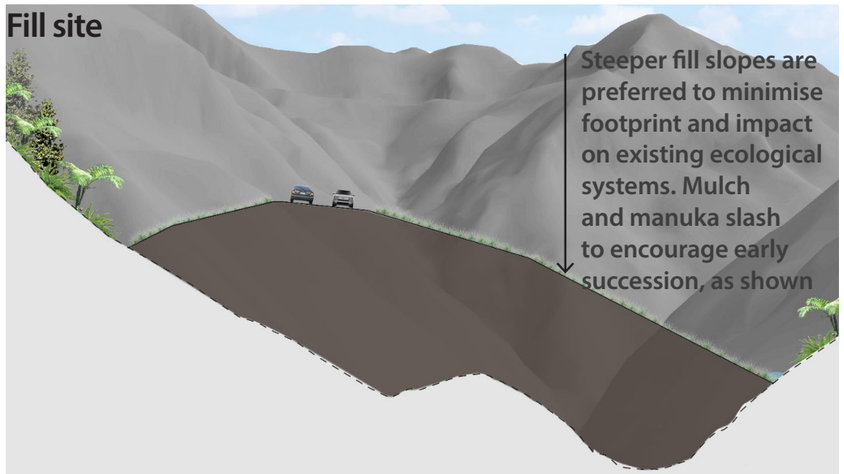
The scale of cut and fill areas vary throughout the Project alignment. However, the principles for the treatment of cut and fill sites described in section 5.1 should be applied to all areas. Revegetation should be appropriate to the existing vegetation context, and enhance existing ecological systems.

Cut and fill slopes will be integrated with other key highway elements including stormwater management devices.

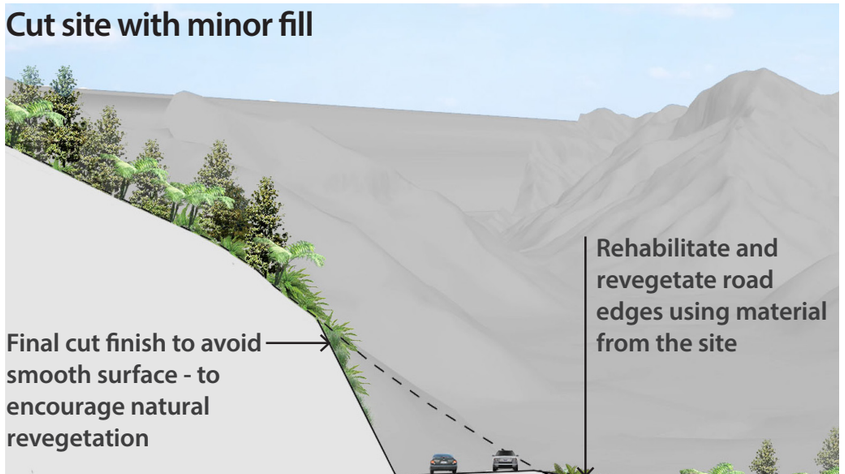
General guidelines

- Avoid encroachment into waterbodies or indigenous vegetation by making batter slopes as steep as feasible.
- Replant all fill batters that coincide with stream courses (i.e. at culverts).
- Ensure retaining walls or other measures used to stabilise cut batters have an appearance in keeping with the outcome of 'a clean, uncluttered highway'.

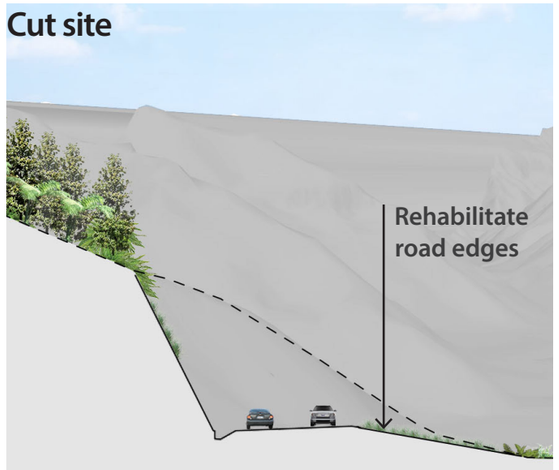
Below: Examples of natural dimple on cut slope on existing SH3 / Mt Messenger showing naturalisation and colonisation of native vegetation



Typical cross section of the fill site - upper Mangapepeke Valley



Typical cross section of cut site - Mangapepeke Valley



Typical cross section of cut site

5.1.7 Northern disposal site

The project is likely to result in an excess of fill material of up to 130,000m3. Excess fill is proposed to be disposed of in contingency sites including the lower Mangapepeke valley, grazed side gully areas in the west of the Lower Mangapepeke and in a contained pastoral side valley in the south of the Project area . It is understood that the nature of the disposal in side valleys is generally a flat layered landform approach reflecting the underlying landform of the existing gully floors.

In the north of the Project a more comprehensive approach is proposed including contouring to match the surrounding landforms. This northern area has been selected as a disposal area in part due to its low existing ecological values. As such final contouring and shaping of this area represents an opportunity to develop a 'naturalised' constructed amenity landscape including off line constructed ponds complimentary to the wider ecological mitigation that is proposed for the Mangapepeke valley section.

Where possible, all disposal areas should be designed to integrate with the immediately adjoining landform and deposit greater volumes of material in upper gully areas where there is steep landform context. This is preferable to creating the appearance of artificial or engineered landforms that would be more obvious and contrasting in proximity to the valley flats.

Artist impression of northern disposal site looking north showing mature revegetation

Artist impression of northern disposal site looking south showing mature revegetation

5.2 Structures

Within the upper reaches of the Mangapepeke and Mimi Valleys', three engineered elements (bridge, fill and tunnel) provide the transitional land link between the two valleys'.

These elements present an opportunity for cultural expression to be explored and embedded within the landscape of Mount Messenger and the Mangapepeke Valley.

These design moves would facilitate cultural expression and 'tell a story' to align with the design intent of the project and to 'let the landscape speak'. It is essential to achieve meaningful forms of expression with a consistent aesthetic across the project to provide for, and recognise, opportunities for co - design, to explore the narrative *'the Jaws of Ngāti Tama '*.

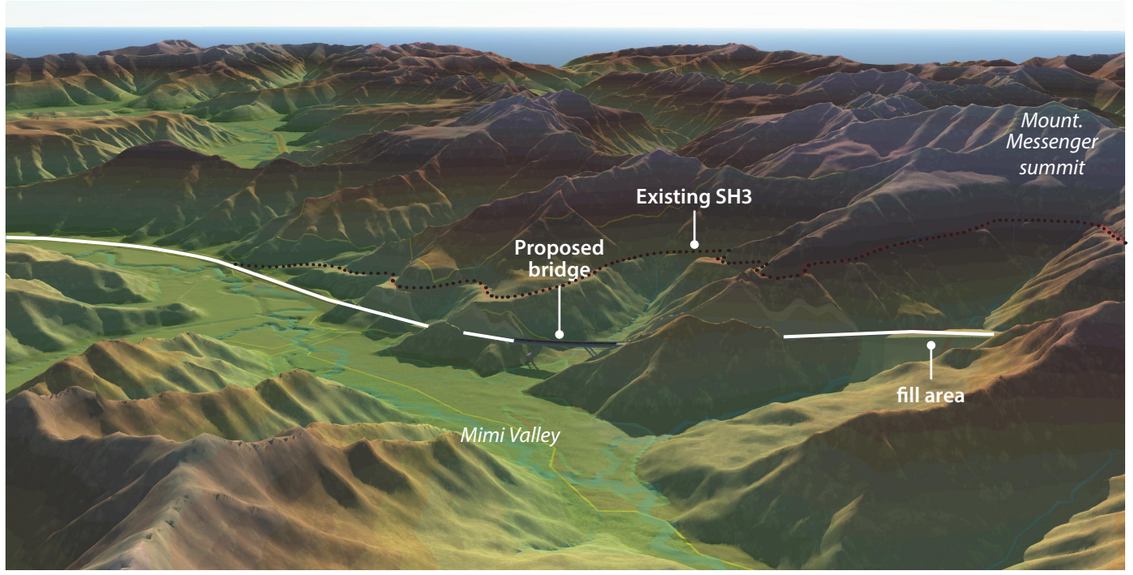
Cultural narrative and expression will be explored further with Ngāti Tama and other stakeholder groups.

5.2.1 Bridge

The project has one significant bridge crossing over a side tributary of the Mimi River. The form and proportion of the bridge is appropriate to its landscape context and is specifically designed to minimise land disturbance. The angled piers help to minimise the footprint of the foundations within the valley floor. They are structurally preferable and allow for a more open valley landscape than vertical piers would.

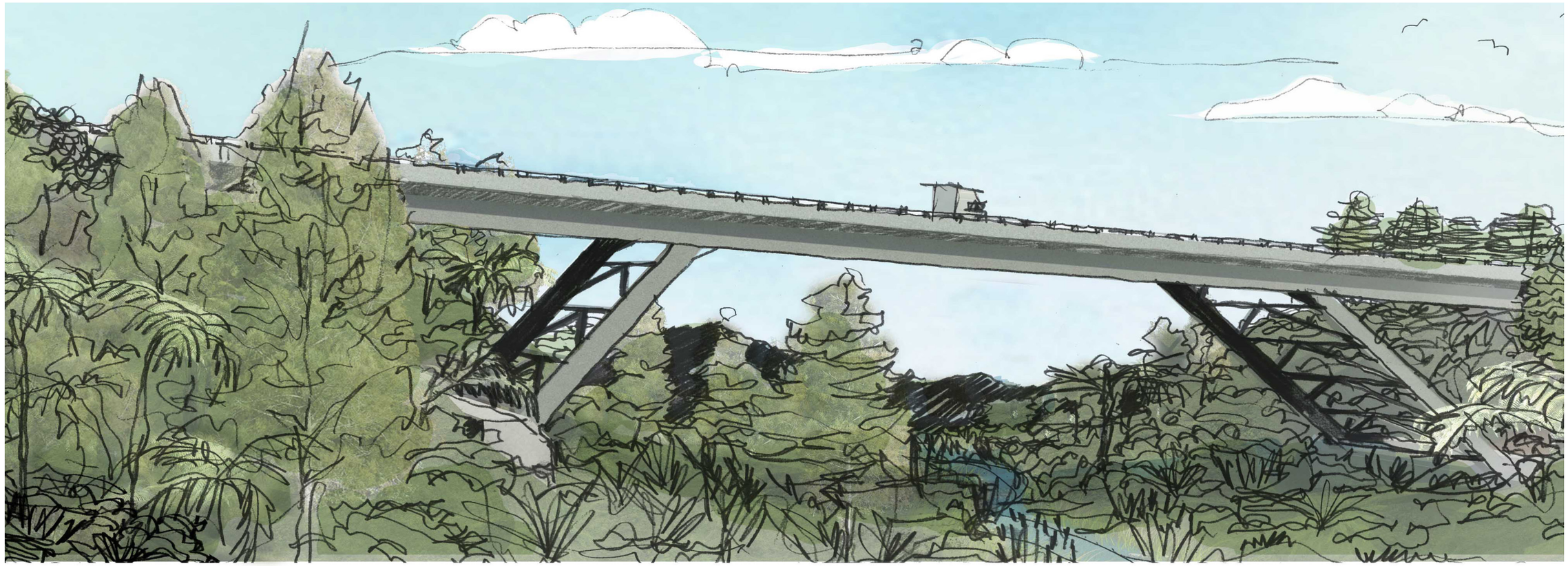
Views from the bridge have scenic amenity value and provide strong visual connection to the wider landscape. The design of the bridge should optimise opportunity for drivers to experience the landscape views. This will require specific detailed design consideration to bridge barrier and treatment.

Top rails should be open to allow views out from the structure within necessary safety standards.

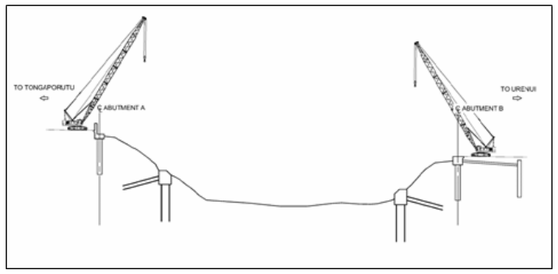


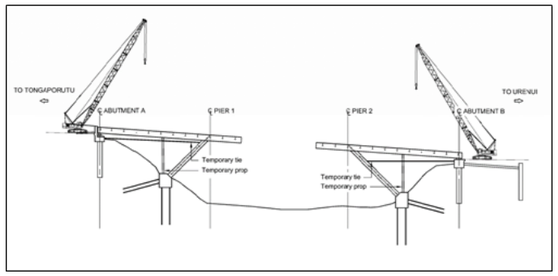
Elevation model of the bridge in its wider landscape context

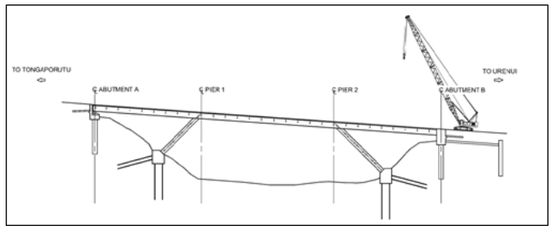
Similar bridge design over the Matahorua Gorge



Indicative sketch illustration of Bridge structure within Landscape







Left: Indicative sketches of the bridge construction process

Below: Examples for weathered steel underneath the bridge. The Corten sub-structure presents a better environmental response to the ongoing maintenance requirements of the bridge.

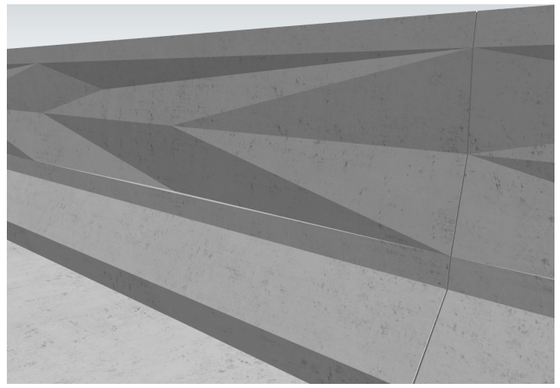
Top down construction process of the Matahorua Gorge Bridge showing top down approach

5.2.2 NZTA TL5 Bridge barrier concept

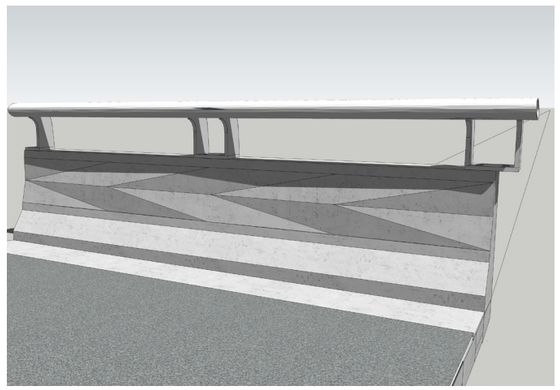
Barrier Bridge

The bridge and other constructed elements respond to and integrate with the environmental and cultural context of the local area. The bridge structure is designed to minimise the effects on the landscape and also to allow travellers to experience views of the landscape. The treatment of the bridge barrier surfaces is used as a means of cultural expression.

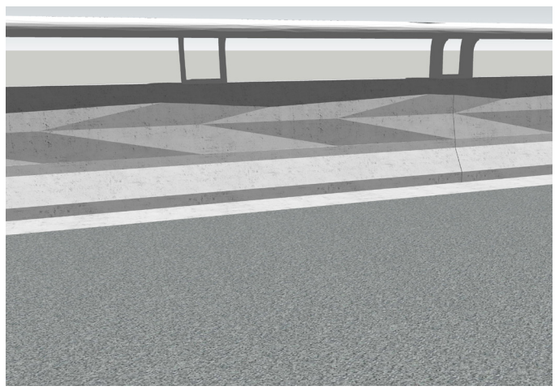
The standard precast concrete NZTA TL5 barrier provides an opportunity to respond to the context of the Project through a texture or pattern cast into the face of the barrier exploring the narrative of *'the Jaws of Ngāti Tama '*.



2. Close up of 3D relief pattern on Precast barrier

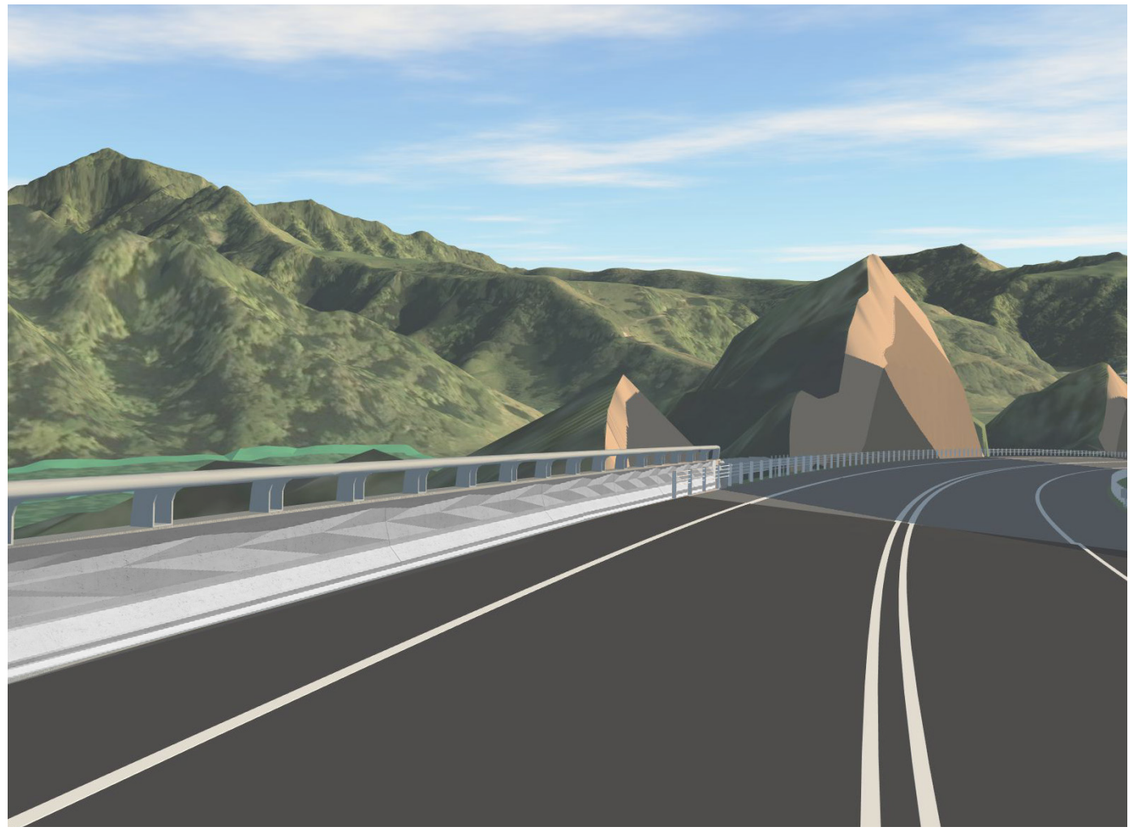


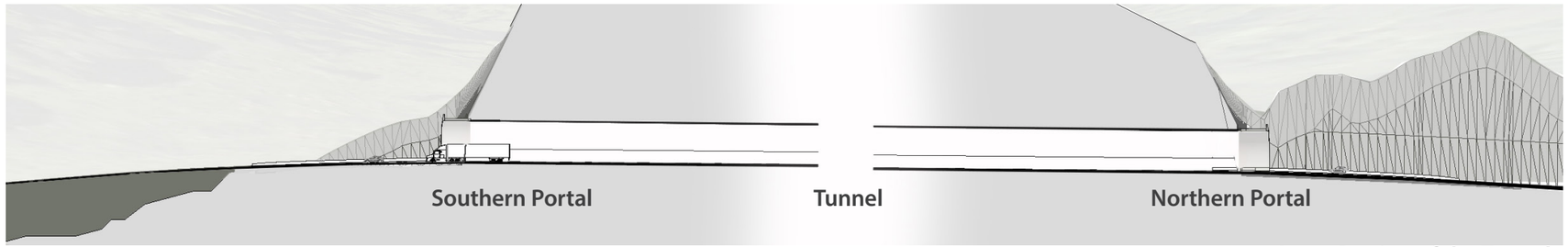
1. A standard 4.0 metre length of barrier with proposed relief patterning. The pattern shown is indicative and is expected to be refined with further consultation with key stakeholders.



3. Sections (4m) joined on site with contiguous patterning

Left: Examples of the materiality of concrete as a medium to install and express cultural symbolism (Hypatia, Khyber Pass Auckland. Ruben Kirkwood). Concepts and detailing would also be informed by construction methodology and safety requirements.

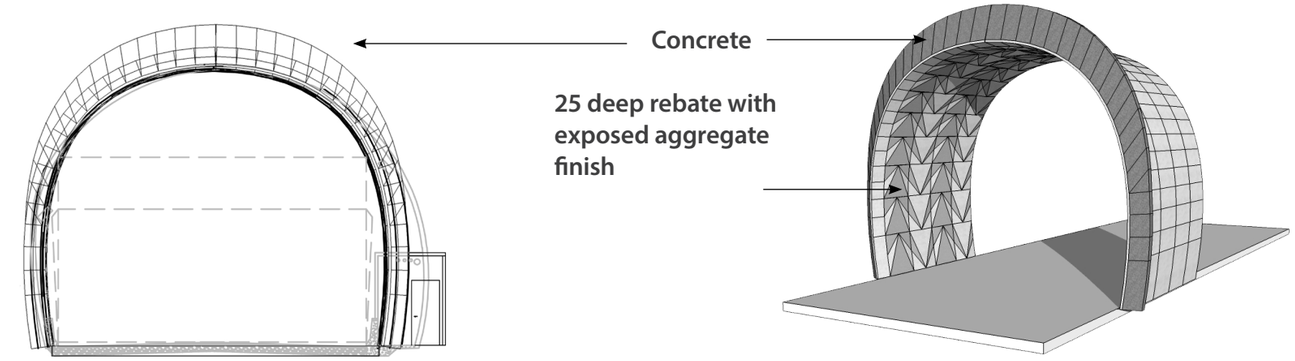




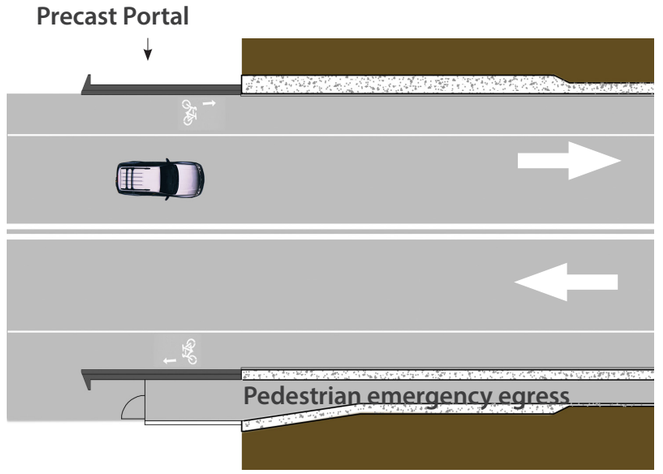
Long Section of the Tunnel

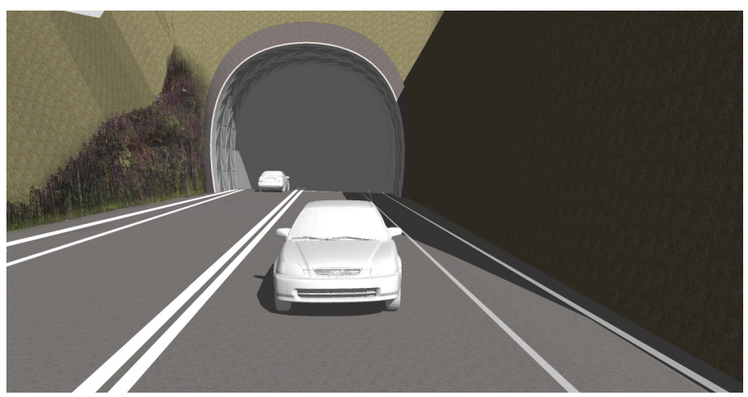
5.2.3 Tunnel threshold concept

The Tunnel is a significant gateway, with the constructed portals visually prominent. This primary constructed element in the landscape requires a design response to the tunnel threshold and portals. An ongoing design process with Stakeholders will allow for a considered response in terms of landscape and cultural amenity. The design of the tunnel portals and threshold present an opportunity for elements of cultural expression within the landscape as the road passes under the ridge from one valley system to the next. Within the tunnel, shotcrete treatment will ensure cover to rock bolts and a smooth consistent finish.



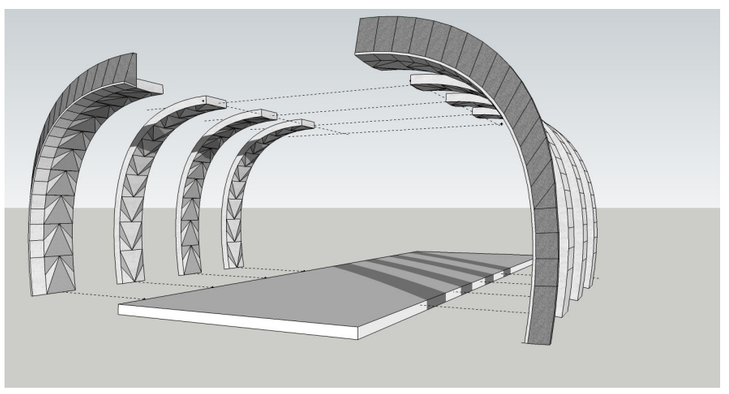
Above: Elevation of Portal





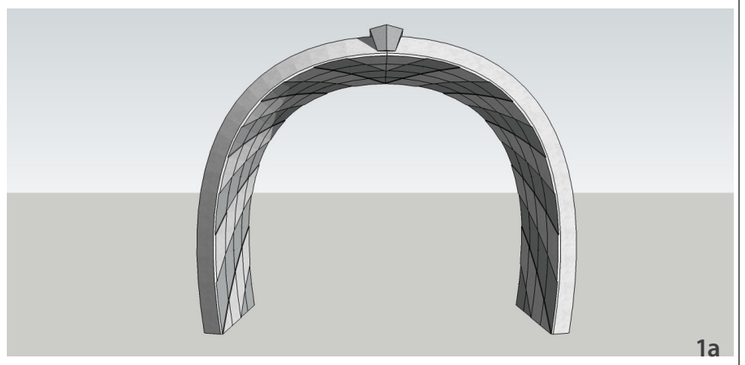
Typical View of tunnel portal approach

Illustration of Ponga treatment to cut faces at the entrance of the tunnel portals

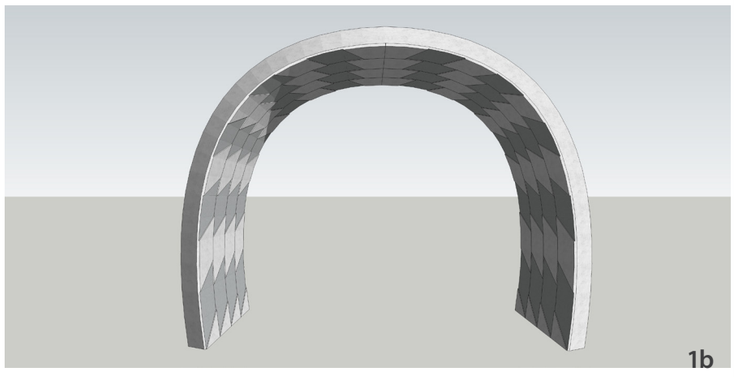


Indicative Exploded view of Precast Portal Elements with Pattern relief

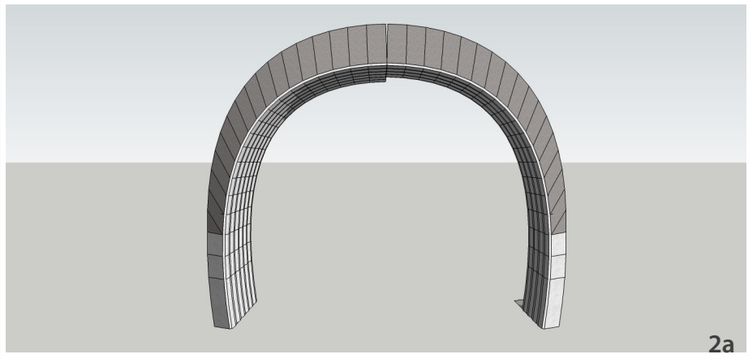
Preliminary concept images of Tunnel Portal form to be refined with further consultation with Stakeholders.

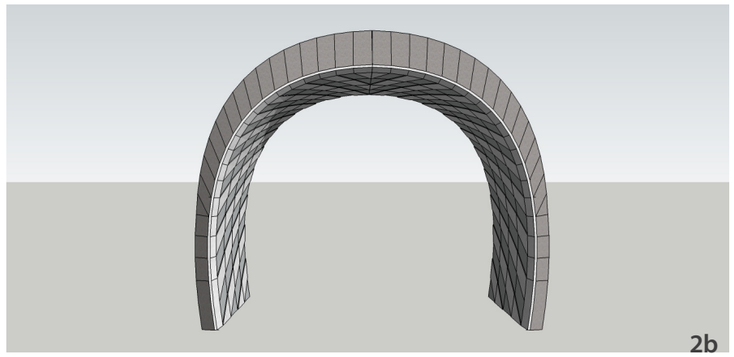


Option 1a-Pattern embossed on inner face with keystone feature.

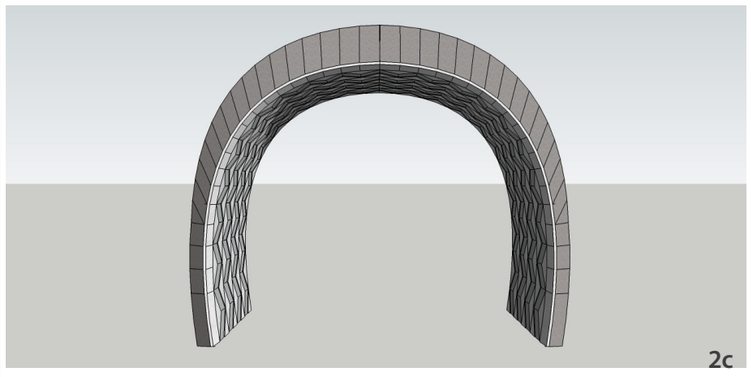


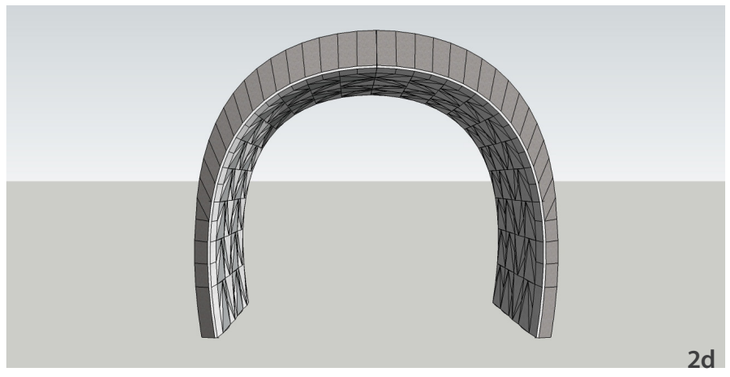
Option 1b-Pattern embossed on inner face without keystone feature on top.





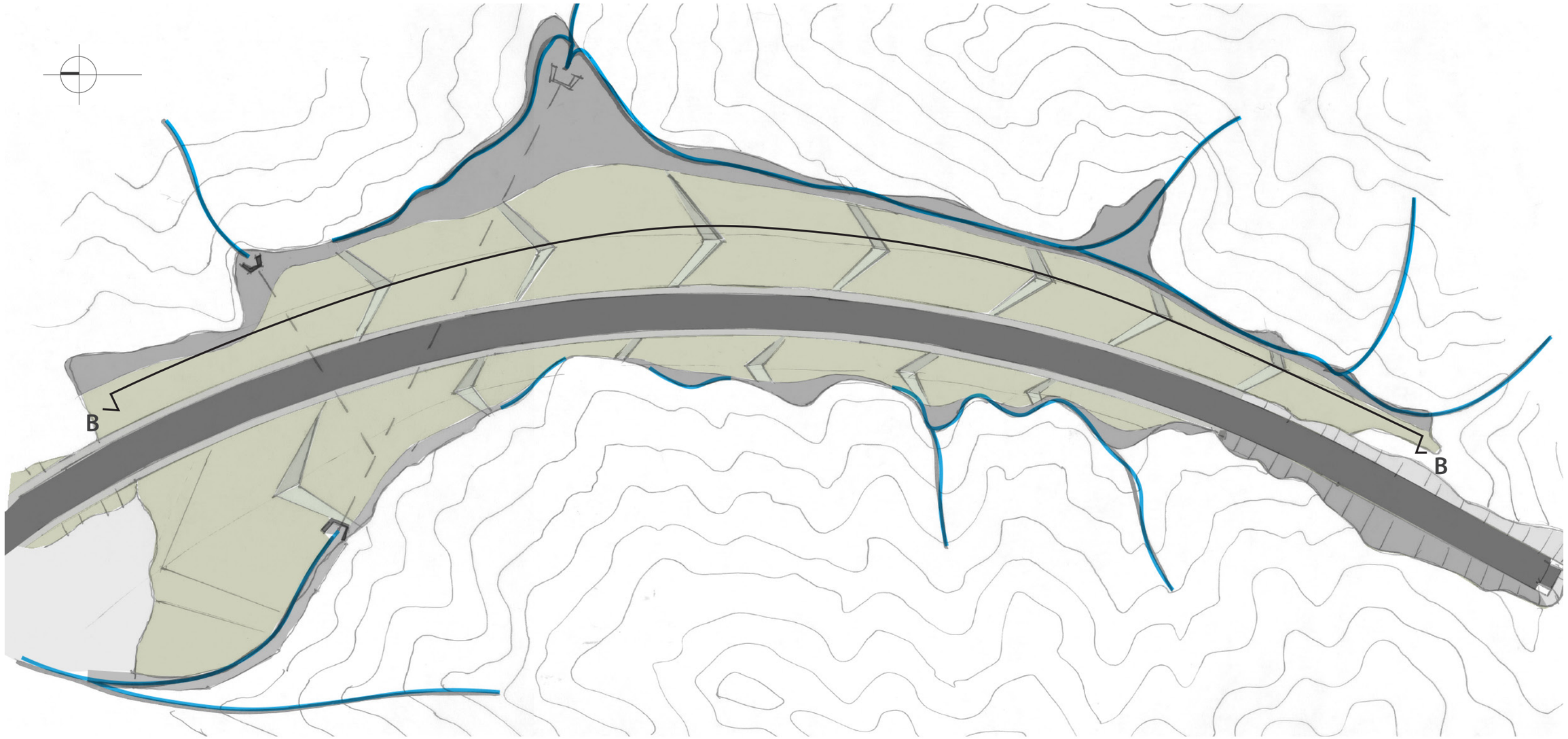
Option 2- Pattern embossed on inner face with rock barrier





Artist impression of tunnel approach view from the roadway corridor showing the main tunnel portal threshold and safety egress barriers.

Artist impression, elevated 'bird's eye' view showing the tunnel portal extending clear of the adjoining papa rock face. This allows for a clear rock fall barrier to protect the roadway from the potential of rock fall debris.

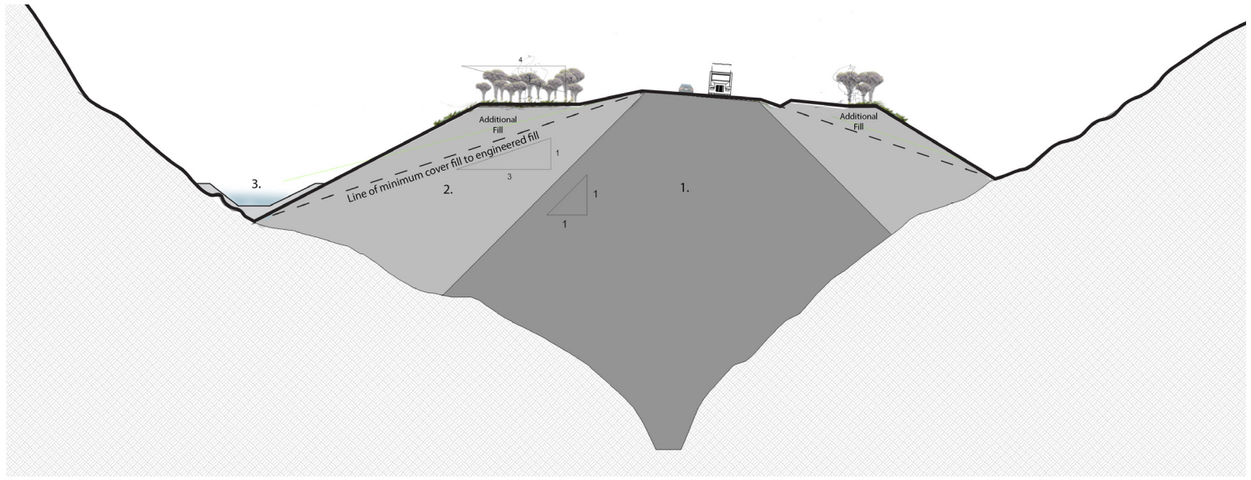


Northern Fill Site Illustrative Concept (tbc), Refer 5.2.4- Plan view of Mangapepeke Northern Portal fill site provides an opportunity for an explicit landart response. The landart installation would be a temporal response referencing the narrative of '*the Jaws of Ngāti Tama*'. This landform will overtime be 'given back' to the natural processes of succession and revegetation patterns of the wider site.

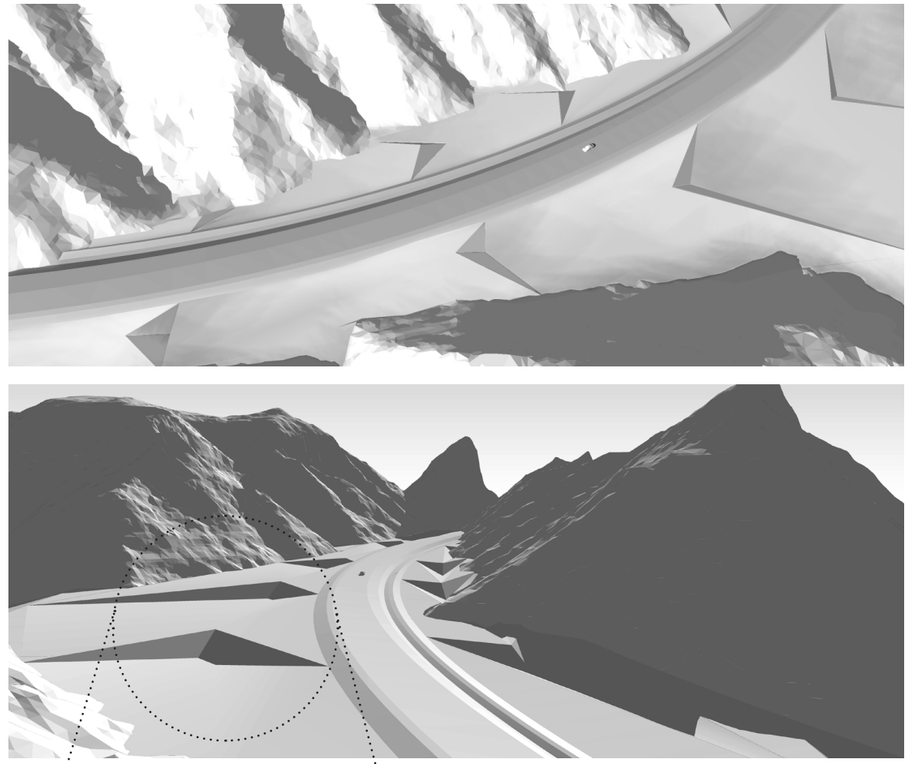
Note: While aspects of this LEDF have been developed to reflect the outcomes of engagement with key stakeholders, this document has not yet been presented to stakeholders and will continue to be updated as the engagement process continues.

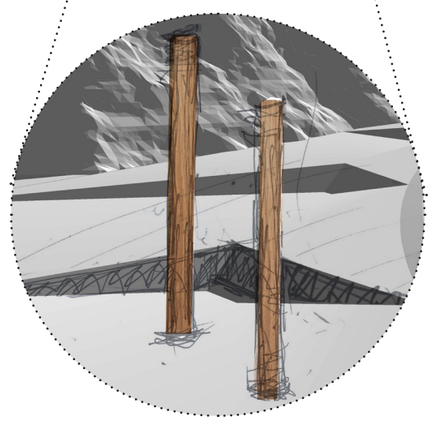
5.2.4 Northern fill site

A significant volume of fill is proposed to be placed within the upper reaches of the Mangapepeke Valley. The overarching intent of a cultural expression strategy for this site is to enhance the experience of landscape by making visible the stories of the landscape and the connection with its people.



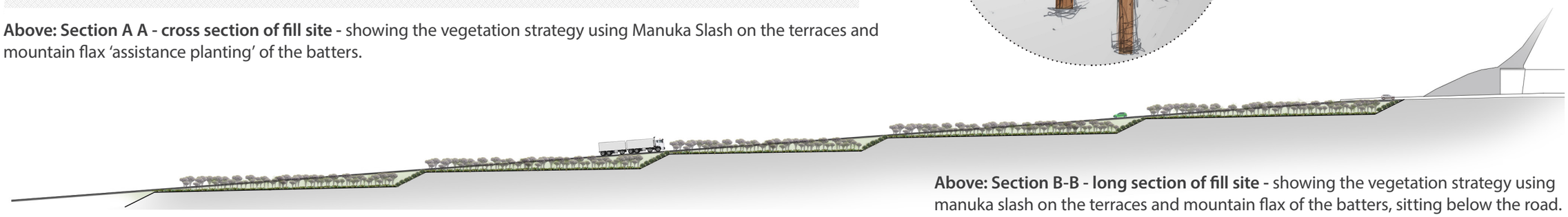
Above: Section A A - cross section of fill site - showing the vegetation strategy using Manuka Slash on the terraces and mountain flax 'assistance planting' of the batters.





Above: 3 dimensional images from concept form model showing large scale terracing sitting below the road level

Left: Indicative sketch of possible 'sentinals' of *Ngāti Tama*



Above: Section B-B - long section of fill site - showing the vegetation strategy using manuka slash on the terraces and mountain flax of the batters, sitting below the road.

5.2.5 Hydrant Tank

As a safety requirement for the new tunnel, a fire-fighting water reserve is imperative. The hydrant water tank will be located above the tunnel on the existing rest area on SH3 Mokau Road. Exact location, configuration and treatment to be confirmed as appropriate to final design and use of existing road.

125 kL x 3

6m diameter
4.5m height

Three 6m diameter tanks placed within the existing rest area

Three 6m diameter steel tanks placed within the existing rest area, with screen planting

5.2.6 Stopping Places

The future of the existing SH3 is still under discussion but it could provide walking and cycling opportunities as well as access to bush tracks and properties. Opportunities for stopping areas on the bypass will also be explored during the detailed design phase and in accordance with the New Zealand Transport Agency's Highway Stopping Places Strategy. Overall these options are seen as positive design opportunities and potential enhancements.

There are possible opportunities for stopping places (rest areas, viewing places cultural places, or composite places) across the Project that could be developed along the alignment (within the constraints of traffic safety arrangement), including to further share the cultural and wider landscape narrative (e.g. information signage (as per the New Zealand Transport Agency's Highway Stopping Places Strategy and section 4.21 of Bridging the Gap Urban Design Guidelines).

It is recognised that NZTA guidance notes the following Factors to be considered in determining the appropriate location and spacing of stopping places:

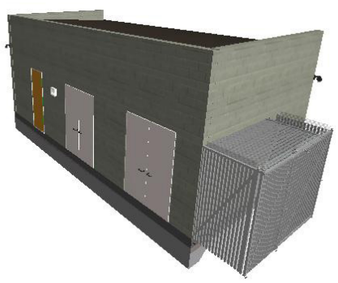
- Traffic volumes, types and predominant trip length;
- Proximity to existing stopping opportunities such at towns and villages:
- Potential co-location benefits ie development in pairs on either side of double carriageway: and
- The frequency of quality stopping places.

5.2.7 Tunnel Control Building

The overarching principle of staying **'low in the landscape**' should be carried through for auxiliary structures and buildings to reduce visual clutter and effects.

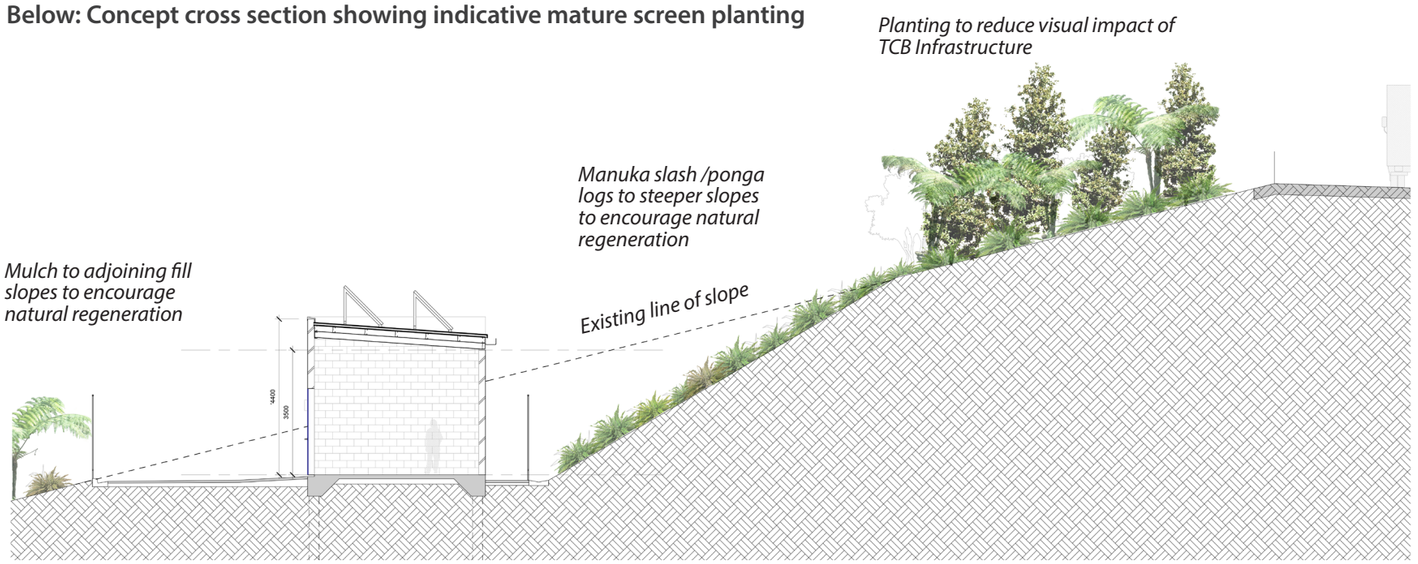
Concept for keeping elements 'low in the landscape' as part of the engineered landforms

Below: 3D image of Proposed Tunnel Control Building



Above: Indicative Tunnel Control Building grading and planting to soften and screen views, adjoining fill slopes mulched/ manuka slash to encourage natural regeneration

Below: Concept cross section showing indicative mature screen planting



5.2.8 Culverts

The Project requires a number of culverts to maintain existing waterways which are affected by fill sites -for more detail refer Freshwater Ecology Report. The following outcomes apply where any culverts are to be used.

- Minimise culvert length
- Construct culverts to incorporate fish passage across the highway in accordance with Taranaki Regional Council requirements and the Transport Agency 'Fish passage guidance for state highways' August 2013' including:
  - Appropriate culvert gradient.
  - Culvert invert below natural stream bed to enable natural material to build up on culvert base.
  - Baffles fixed inside culvert base to promote natural material on culvert base; and
  - Armouring on downstream side to prevent scour.
- Plant indigenous shrub vegetation on fill embankments to soften the appearance of culverts and access tracks.
- Extend riparian planting onto the fill embankments at culvert crossings. Use low species near the top of fill embankments where views are to be maintained from the highway, grading to taller species toward the base of the embankment.
- Replant stream margins upstream and downstream of culverts for biophysical and visual reasons.
- Culvert inlets and outlets design and contouring are to ensure smooth transition and tie in to the surrounding earthworks design.
- All inlet and outlet pipe structures will be chamfered to match design contours of adjacent landform.
- Fish passage design, refer to Technical Report 7b, Volume 3 of the AEE.

Highway batter and culvert

Riparian planting on fill embankment

5.2.9 Safety barriers

Barriers are designed to have minimal visual impact on the landscape, and to recede into the background. They should read as belonging to the man made structure of the road.

Options for flexible road safety barriers will be considered at detailed design including posts and wires with an unpainted galvanised finish. The grey galvanised finished will blend into the papa rock face. White posts and coloured caps should be avoided as these will be a dominant visual feature in an otherwise natural landscape setting.

Above images illustrate galvanised posts and wires receding into background.

5.3 Streams, wetlands, and swales

5.3.1 Water sensitive landscape response

Water sensitive design in the landscape of the alignment involves the construction of swales and wetlands, as well as new culverts and, in some cases, stream diversions. The design of all elements should be in keeping with the intent of the Project, to let the landscape speak and enhance its natural character. A naturalistic approach is preferred, which will allow natural processes to establish themselves and continue to shape the landscape.

The existing character of the riparian and wetland areas in the Mangapepeke and Mimi Valleys include:

- Kahikatea forest, kahikatea swamp maire forest, and swamp maire forest in the northern ends of both valleys.
- Kahikatea/carex treeland in the northern catchment of the Mimi river
- Raupo reedland and raupo rautahi swamp within the northern Mimi Stream catchment

Stormwater design and stream diversion should seek to minimise the effects on and enhance the existing plant communities. Stormwater design will be further developed at the detailed design stage of the Project to integrate with other land restoration opportunities.

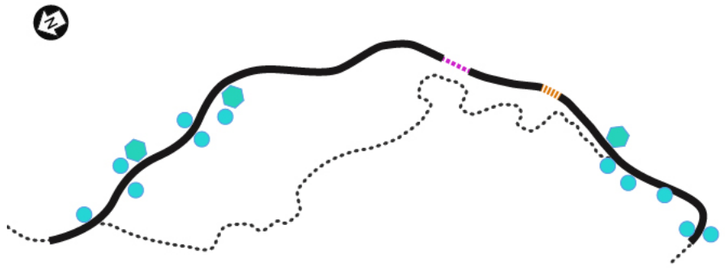
The following pages illustrate a typical planting outcome for a stormwater wetland and swale.

Below: Kahikatea wetland within the upper Mimi Valley with edge condition as trees transition to pasture.

Kahikatea wetland

Below: Mangapepeke Valley showing edge to pasture and Kahikatea bush pasture edge featuring emergent trees to the left of the frame.

Upper Mangapepeke Stream



Location plan
- Existing SH3
- Tunnel
- Bridge
- Stream diversion
- Constructed wetland

5.3.2 Stream diversion

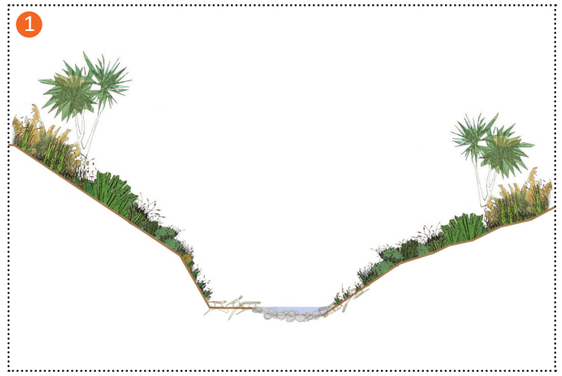
Stream diversions will be designed to replicate natural conditions where possible.

Modified streams will not be over-constructed. They will be formed with a naturalistic 'meander' within the designation area. Existing site material and planting will be re-used as practicable, such as rocks from diverted stream beds. The stream diversion will be constructed to allow the watercourse to 'find its way' through the landscape over time. Stream diversions will also take advantage of the opportunity to enhance natural landscape values, as part of the wider mitigation package for the Project.

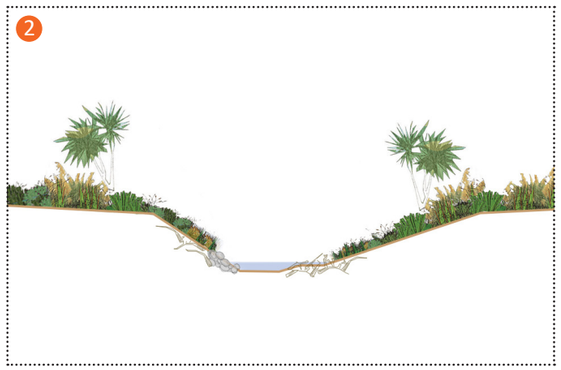
General principles for stream diversion and treatment of existing streams

- Integrate riparian planting into the overall landscape concept.
- Re-vegetate stream margins either side of highway to:
  - Enhance habitat and ecological connectivity.
  - Visually accentuate the streams as landscape features; and
  - Soften the appearance of culverts.
- Use riparian and margin species indigenous to the area.
- Integrate with wider Ecological Restoration Plan Approach.

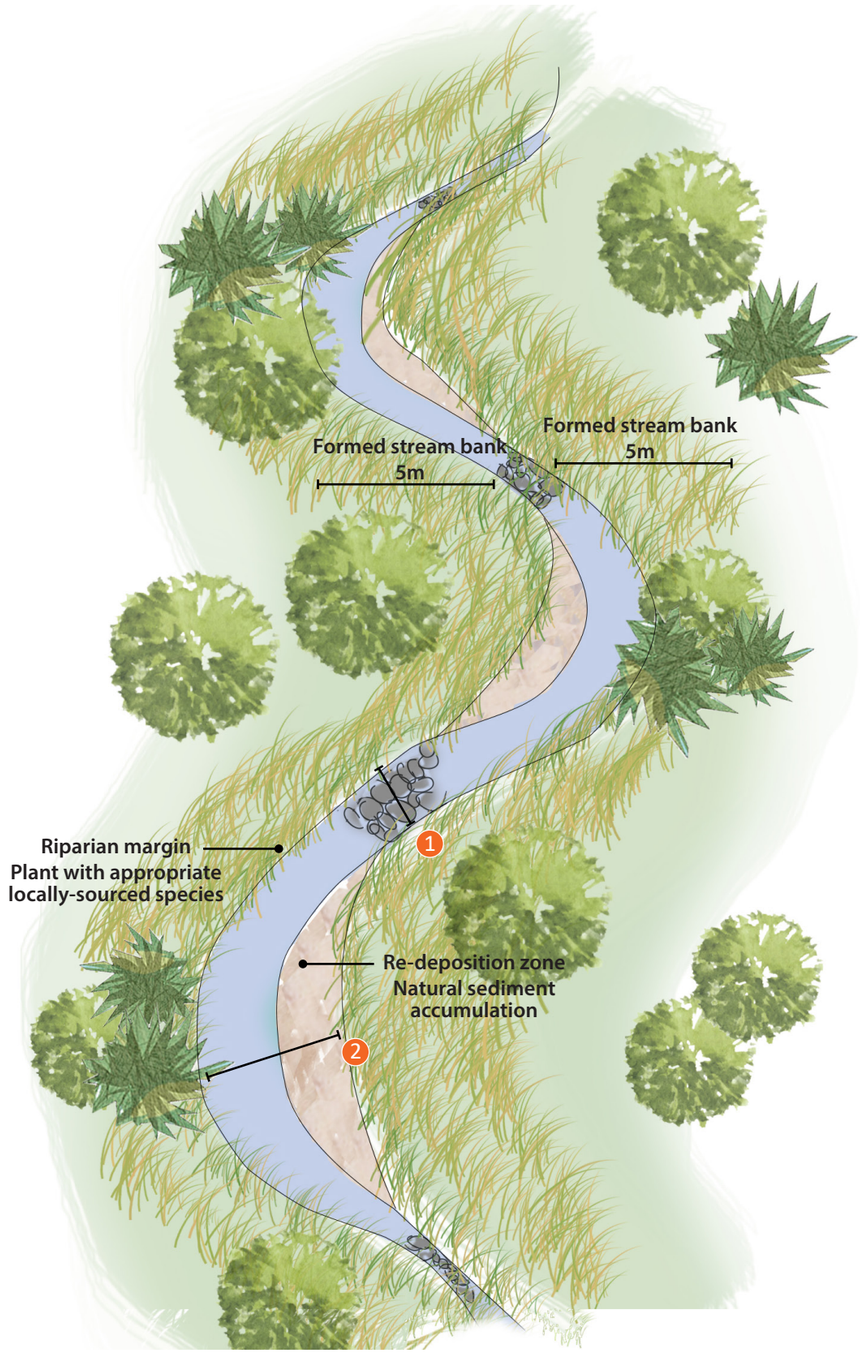
Stream diversion - indicative sections



Type 1 - Steep stream diversion - baffles and rip rap armouring to manage flows



Type 2- Lowland stream diversion - meander flows with pools and overhangs to develop over time



Stream diversion - indicative, watercourse meander formation (Valley Flats Location)

5.3.3 Typical constructed wetland design

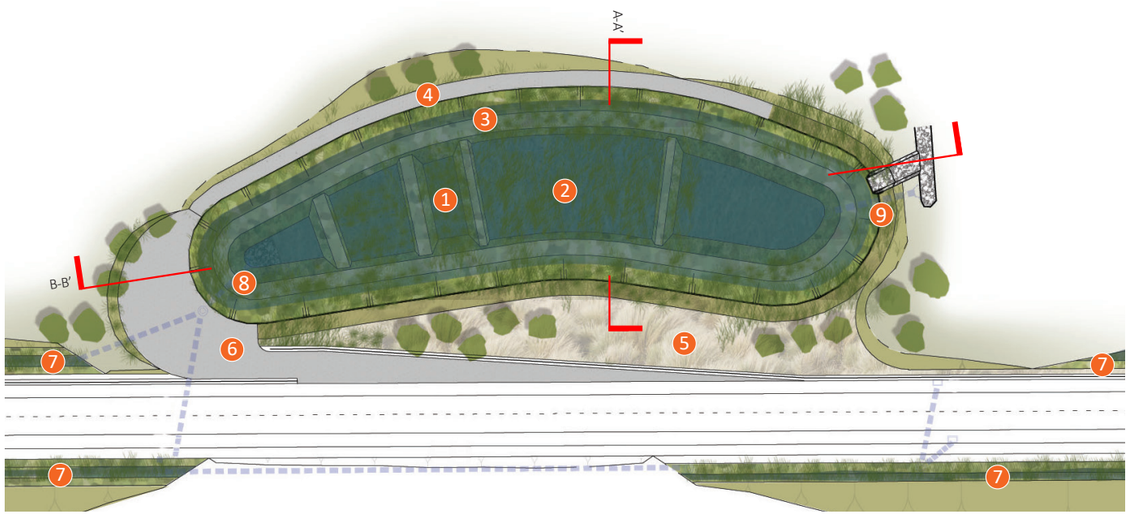
Constructed wetlands will be designed to appear like natural landscape features in the wider landscape. Planting plans for these areas will complement the wider rural character and provide ecological habitat benefits. Constructed offline ponds in the northern disposal site (refer to section 5.1.7) margins will be planted with shallow shelf and edge wetland species.

5.3.4 Typical swale design

Vegetated swales will be planted to eliminate mowing and improve filtration and stormwater flows and promote transpiration. Appropriate topsoil horizons and biodegradable erosion control materials will be applied to assist early establishment of plants and prevent preferential flow paths.

Where swales enter wetlands or are generally part of a wider open space area, they shall be widened in keeping with landform and proposed planting schemes to integrate the swales into the broader vegetated landscape, slow flows and enhance treatment.

Swale widths and paths will be considered at the detailed design stage to integrate Water Sensitive Design (WSD) planting with other typology groups where the width of the area allows. Further refinement and naturalisation of swale paths will be undertaken during detailed design.



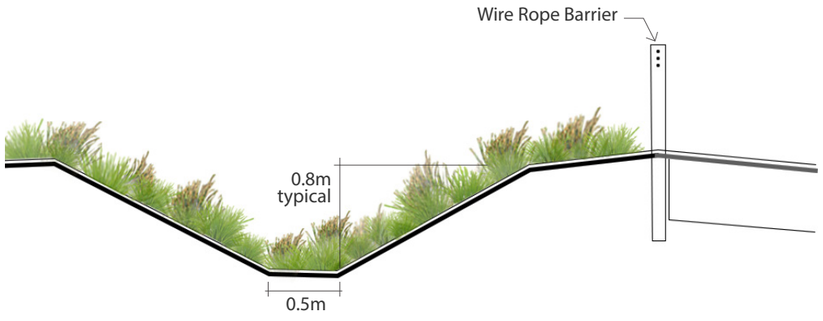
KEY

1. Wetland Planting - shallow shelf
2. Wetland planting - deep shelf
3. Wetland edge planting
4. Taller screening planting to blend into existing vegetation
5. General low planting - grasses & groundcover
6. Maintenance access
7. Vegetated swales
8. Pond inlet with rip-rap forebay protection
9. Pond outlet with rip-rap outfall protection

Indicative Constructed Wetland Planting Plan - final design/shape to be naturalised

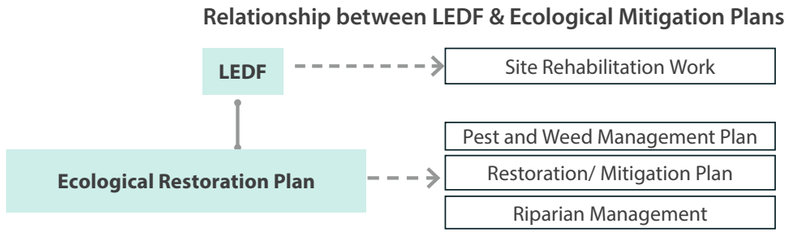
Indicative section A-A' - Constructed Wetland retention pond: deep shelf

Indicative section B-B' - Constructed Wetland: shallow shelf with pond inlet and outlet



Indicative vegetated swale section, overall width and side slope varies (not to scale) Type 1 - vegetated swale Type 2 - lined channel, refer to section 6 preliminary landscape concept plans

5.4 Vegetation Strategy



The construction of the Mount Messenger Bypass will involve the removal of 34 hectares of predominately indigenous vegetation including the following vegetation and habitat types:

- Kahikatea, swamp maire, pukatea swamp forest
- Modified rushland/sedgeland
- Dryland forest
- Secondary forest (manuka, tree fern)
- Dry cliff faces

The alignment will also result in the loss of a number of significant trees. Consideration is given to these and other trees as they will be of cultural value, to Ngāti Tama.

The selection of native species will be undertaken in consultation with Ngāti Tama. Species chosen should have significance to the landscape and its history, be appropriate to the site context and provide ecological enhancement.

The effects of the alignment on the Mangapepeke and Mimi valley's will require a comprehensive vegetation strategy to help rehabilitate and mitigate the vegetation and habitat loss within the alignment. The strategy will focus on:

- **Site rehabilitation** - will focus on the immediate effects of the new road alignments permanent and temporary works.
- **Ecological restoration** - will focus on the proposed "Mitigation Package" for the Project area landscape.

5.4.1 Rehabilitation Strategy

The ecological objective for the site rehabilitation work is to repair some ecosystem processes on altered landscapes. The trajectory and endpoint may well be different from any previous state because of the works required to create the road.

Rehabilitation work is required to the altered and modified areas of the proposed alignment, such as fill and cut slopes, vegetated swales,stream diversions, temporary works areas and stockpile sites.

The rehabilitation strategy shares a common aim with the ecological restoration plan of revegetating unpaved terrestrial areas. Specific objectives that support the aim of 'rehabilitation' are:

- to support natural regeneration and succession to native shrubland and eventually forest, and
- to minimise medium-term maintenance.

The rehabilitation strategy aims to work with the natural landscape, taking opportunities to harness and speed up natural processes, including the use of salvaged material to better the chance of successfully rehabilitating areas affected by the works. It provides the framework to enable this to occur.

5.4.2 Ecological Restoration Plan

The objective of the ecological restoration work proposed (the "Mitigation Package") is to restore a range of ecosystem processes (and therefore ecosystem function) that have been degraded by the presence of animal pests and livestock by:

- by intensive multi-species weed and pest and livestock management in perpetuity;
- the re-establishment of swamp forest and wetland habitat to areas that were once swamp forest and wetland and which retain the environmental conditions suitable for re-establishment; and
- the restoration of stream habitat by pest and stock exclusion and riparian planting.

In summary, we are setting out to "kick start" natural processes in an environment that has enough of its original components to be restored to a state close to what it might have been previously.

Our stated target for the mitigation package (and therefore the ecological restoration) is to achieve a net gain in biodiversity 10-15 years following the completion of road construction. The principles we apply to ecological restoration are:

- **Ecological equivalence.** The design and implementation of rehabilitation and mitigation should endeavour, wherever possible, to replace the affected form of biodiversity with the same or similar form or taxa (ie. preference for replacement of 'like for like').
- **High likelihood of success.** Any rehabilitation or mitigation activity should have a high likelihood of success and perseverance. In other words, it should be based on sound science and proven practice.

The **pest management** proposed has a multi-species focus (rats, mustelids, possums and goats) with the intention to hold all species to low densities in perpetuity sufficient to allow the permanent recovery of many indigenous plant and animal populations.

Restoration of the Mangapepeke Valley is proposed as part of the offset planting for the Project. This will include planting high value forest types, pest management, and restoration planting along stream margins.

Revegetation should work with the natural landscape, eco-sourced material, and integrate with the ecological context. Where possible, opportunities should be taken to enhance the value of the existing ecology. Revegetation will mimic and facilitate natural succession patterns. For example, existing road cuts along SH3 show how plants will naturally recolonise the site.

5.4.3 Rehabilitating engineered landform

Rehabilitation to native ecosystems
Slopes to be rehabilitated as native ecosystems should be stable with rough surfaces, which can be created by including logs, rocks and slash in the top layer of the slope. Successful plant growth is helped by using the 'direct transfer' method: salvaging and reusing topsoil and intact plants from the site. *(Source: Landcare Research fact sheet 5 'Guidelines for Mine Rehabilitation in Westland')*

Identification and salvage of rehabilitation and restoration resources

This flow chart is an overview of typical steps to identify and salvage materials for rehabilitation and restoration. The process should be undertaken before work starts and reviewed as more information becomes available. Together the information helps refine practical and cost effective rehabilitation and restoration options.

Overall principles for plant procurement, including guidance for **ecosourcing** - from appropriate sites - and harvest/salvage of plant material, are detailed in the Technical Report 7A Volume 3 of the AEE. Detailed protocols are to be developed in consultation with Ngāti Tama.

Above: a former mine area in the early stages of native rehabilitation using tree stumps / site material.

Site Material Reuse - Vegetation Strategy

Define footprint of works area that will be stripped or covered. (Assess the resources available for rehabilitation and mitigation process before work begins).

In consultation with Ngāti Tama

Target species

Areas with **vegetation, forest duff, top soil/subsoil, rocks from streams beds.**

Unsuitable/ unstable ground

Vegetation

Forest duff

Topsoil/subsoil

Rocks (site and stream)

Ecological seed collection

Trees >3m

Plants

For growing of eco sourced plant material (that does not have seeds available) OR direct transfer of forest duff and leaf litter as finished surfaces become available

Reuse of rock in stream diversion work

timber removed cultural purposes trees to remain within the forest (approx 20 - 30%

Testing of soil and subsoil pH to ensure suitable Retest once weathered.

No access = no salvage

Grow on for rehabilitation / restoration work

manuka slash
tree stumps
logs
tree crowns

<1M
Direct transfer (ponga logs / tree fern) Nikau

Soil with good pH: Stockpile

Soil with sub-optimal pH: Modify as appropriate

Target species relocation

Mulch/stockpile:
Logs - base of fill sites/stream diversion
Tree crowns - direct transfer to appropriate sites

5.4.4 Rehabilitation process

Step 1 - stabilise

Stabilising works of engineered cuts, fill, stream diversion, constructed wetlands, offline ponds and swales.

Cut slope treatment

- On slopes 12v:1h leave to weather and revegetate
- On slopes 2v:1h use a range of engineered systems such as rock nails and rock drape (refer section 5.1.3-5.1.4)
- On top soil profile where rock nail system may be used:
  - Wet weather process, hydroseed with native seed mix to establish cover to engineered cut sites to reduce frittering and slippage
  - Dry weather process, apply mulch and duff material, stabilise to hold in place
  - Use 'assistance' planting on stable sites to establish seed source for lower cut faces

Fill slope treatment

- Where slope is 1:1 with MSE system using sock injected with native seed source
- Slopes < 1:2 manuka slash, mulch and /or forest duff from site laid over fill sites.
  - Wet weather process, hydroseed with native seed mix, to establish cover to engineered cuts and fills and reduce frittering and slippage
  - Dry weather process, apply mulch and duff material, stabilise to hold in place.

Step 2 - vegetate

Establish vegetation on all engineered sites, get vegetation cover up and running as quickly as possible to limit/reduce sediment loads to streams and receiving environment.

Hydroseeding of annual grass species will be used if appropriate to form a relatively open vegetative cover allowing the natural germination of native seed to take place. As this process of natural succession of native species takes place the turf species will be shaded out.

Rapid rates of regeneration ehanced by mulch, manuka slash and forest duff will result in a carpet of seedlings within 2 - 3 years.

Pockets of assistance revegetation to gentler cut faces and fill sites will be used as a seed source, planted at the top of a site. If possible planting near water courses will help with the dispersal of these native species that would otherwise struggle to re-establish.

Step 3 - natural succession

Allow natural succession to colonise engineered cut and fill sites.

The context of the Project is within a large natural reservoir of local seed source which will aid and support the natural re-establishment and revegetation within the alignment.

- Manage pest plants to allow establishment of native plant material
- Reuse site material to enhance natural regeneration, including where appropriate:
  - Place wood and timber at base of fill slopes to help trap sediment to encourage natural succession through direct transfer of duff (leaf litter from neighbouring bush areas) and seed source from within the mulch; and
  - Direct transfer of material like tree ferns, epiphytes etc into appropriate locations / gaps.

Above: Natural revegetation processes along SH3

Below: Salvaged epiphytes provide excellent biodiversity for establishing plant species

5.4.5 Resoration planting

Swamp forest and replacement mitigation planting

Areas of restoration planting and replacement mitigation planting are proposed to off-set the areas lost during construction of the Bypass. (refer section 6 Preliminary Landscape Concept Plans - Restoration Planting).

Kahikatea is the dominant swamp forest species. The fertile, seasonally flooded areas, **kahikatea** trees grow densely on matted roots and silt, along with **swamp maire, pukatea, cabbage trees,** and occasionally **rimu**. The dead plant matter and silt slowly builds up under kahikatea forest, to allow shade-loving dryland trees like **tawa** and **titoki** to flourish.

The long-term aim is to create kahikatea and swamp forest habitat by restoring early succession species and the supplementary planting of canopy species once cover has been established.

The sites identified occur are largely currently in grazed pasture or rushland/sedgeland mosaic.

Restoration process:

1. Year 1: Pre-plant spray. Plant initial revegetation species in spring/summer using eco-sourced seed material and forest duff from the Mimi and Tongaporutu catchments
2. Year 2: pre-plant spot spray and fill gaps where plants have died
3. Years 3-6: Release competing weeds until canopy closure
4. After canopy closure: plant supplementary forest tree species such as kahikatea and Pukatea.

Healthy swamp forest provides habitat to birds such as the spotless crake and banded rail and may support short and long-finned eels, and various species of kokopu.

Plant Palette. Suitable initial revegetation species. All species should be eco-sourced from within the Mimi and/or Tongaporutu catchments, ensuring a high level of genetic variability.

Austroderia fulvida (Toetoe)
Stream margin and wetland species

Aristotelia serrata (Wineberry)
Associate species on imperfectly drained soils next to streams

Carpodetus serratus (Putaputaweta)
Associate species on imperfectly drained soils next to streams

Coprosma robusta (Karamu)
Locally present where goats are absent
Suitable for imperfectly drained soils next to streams.

Coprosma tenuicaulis (Hukihuki)
Dominant species planted on poor draining soils in Mimi wetland

Hoheria populnea (Houhere)
Associate species on imperfectly drained soils next to streams

Leptospermum scoparium (Manuka)
Dominant species planted on imperfectly drained soils and raised areas within poor draining soils

Lophomytus bullata (Ramarama)
Associate species on imperfectly drained soils next to streams especially abundant in Mimi - Mount messenger

Pennantia corymbosa (Kaikomako)
Associate species on imperfectly drained soils next to streams

Phormium cookianum (Whararikí)
Stream margin species

Supplementary Planting

Supplementary planting of tall trees to take place once initial revegetation species have provided shelter (2-3m height) in forest/manuka forest swamp areas . Once canopy cover has occurred it is expected that there will be natural colonisation of tree ferns.

Dacrycarpus dacrydiodes (Kahikatea)

Laurelia novae-zelandiae (Pukatea)

Syzygium maire (Swamp maire)

Minor component of rimu and matai on poorly drained soils

Riparian Planting

Riparian planting to 10m buffer each side of streams (section 6 Preliminary Landscape Concept Plans - Riparian Offset Restoration Planting).

Carex geminata (Rautahi)

Carex secta (Purei)

Cyperus ustulatus

Dicksonia squarrosa (Wheki)

5.4.6 Rehabilitation Planting

The ecological objective for the site rehabilitation work (fill and cut face works) is to repair some ecosystem processes on altered landscapes where the endpoint may well be different from any previous state because of the works required to create the road (refer section 6 Preliminary Landscape Concept Plans - Cliff Top Cut Site (with and without soil nails) and Fill Site).

Species for steeper sites and assistance planting include:

Wet cliff - *kiokio, (Blechnum novae - zealandiae) pepepe (Machaerina sinclarii) toetoe (Austroderia fulvida) and paratwaniwha (Elatostema rugosum) and kiekie (Freycinetia banksii), manuka (Leptospermum scoparium), pate (Schefflera digitata), fuschia (Fuschia excorticata), koromiko (Hebe stricta), kanono (Coprosma grandifolia) and karamu (Coprosma robusta).*

Dry cliff - *manuka (Leptospermum scoparium), koromiko (Hebe stricta), soft mingimingi (Leucopogon fasciculatus), totorowhiti (Dracophyllum strictum), whararikí (Phormium cookianum), tree daisy (Olearia townsonii), NZ native broom, (Carmichaelia australis), shining karamu (Coprosma lucida) and snowberry (Gaultheria paniculata)*

It is unlikely, or less likely that net biodiversity gain will be achieved on these site rehabilitation areas (and certainly not within 10 years).

Assistance Planting

'Assistance planting' will be carried out where possible on cliff top cut sites and on fill batters as required to help integrate structures (the tunnel control building and hydrant tanks) and as part of the strategies to integrate cultural expression e.g. at the northern fill site. Assistance planting means planting hard-to-establish species and species that are easily propagated and established, to encourage the seed to spread downhill and begin a natural revegetation process. Wet and dry cliff species may be appropriate. Species for gentler slopes include:

- *Carmichaelia australis* (NZ native broom)
- *Olearia townsonii* (coromandel tree daisy)
- *Pseudopanax laetus*
- *Pittosporum colensoi*
- *Cortaderia fulvida* (mountain toetoe)
- *Hebe stricta* (koromiko)
- *Leptospermum scoparium* (manuka)
- *Phormium cookianum* (whahariki)

Carmichaelia australis (native broom)

Olearia townsonii (Coromandel tree daisy)

Pseudopanax laetus

Cortaderia fulvida (mountain toetoe)

Leptospermum scoparium (Manuka)

Hebe stricta (koromiko)

Pittosporum colensoi (rautawhiri)

Phormium cookianum (Whahariki)

5.4.7 Constructed wetland, ponds, vegetated swale and stream diversion planting

Water sensitive design in the landscape of the alignment involves the construction of swales and wetlands, as well as new culverts (refer section 6 Preliminary Landscape Concept Plans - Constructed Wetland and Ponds (to be confirmed in detail design), Stream Diversion and Vegetated Swales).

Carex secta (Purei)

Cyperus ustulatus

Carex geminata (Rautahi)

Leptospermum scoparium (Manuka)

Coprosma tenuicaulis (Swamp coprosma)

6.0 Landscape Concept Plans

SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 6
SHEET 7
SHEET 8
SHEET 9
SHEET 10
SHEET 11
SHEET 12
SHEET 13

LEGEND

- PROPOSED DESIGNATION
- EXISTING STREAM
- MIMI SWAMP FOREST
- EXISTING ROAD
- EXISTING CULVERT
- CONSTRUCTION ACCESS
- TEMPORARY STOCKPILE AREA, REHABILITATED/ RESTORATION PLANTING
- POTENTIAL PERMANENT DISPOSAL AREA, RESTORATION PLANTING
- TUNNEL
- BRIDGE
- KEY SCENIC VIEWS
- STREAM REMOVED
- STORMWATER ROAD DRAIN
- STORMWATER CULVERT
- CONSTRUCTED WETLAND
- TYPE 1, STEEP STREAM DIVERSION
- TYPE 2, LOWLAND STREAM DIVERSION
- LINED SWALE

RESTORATION PLANTING

- RIPARIAN OFFSET RESTORATION
- SWAMP FOREST OFFSET RESTORATION
- REPLACEMENT MITIGATION PLANTING
- SWAMP FOREST/ REPLACEMENT MITIGATION PLANTING OVER TEMPORARY WORKS & ACCESS ROAD EXTENSION,SURVEY TO CONFIRM PLANTING TYPE
- EXISTING WATER COVERED WETLAND AREAS TO BE RETAINED - MINOR SUPPLEMENTARY PLANTING OF SEDGE SPECIES WHERE REQUIRED TO FILL IN GAPS

REHABILITATION PLANTING / PLANT ESTABLISHMENT

- CONSTRUCTED WETLAND PLANTING
- STREAM DIVERSION PLANTING 5M BUFFER ON EACH SIDE
- CUT SITE - PAPA ROCKFACE, EARTHWORKS FINISH TREATMENT TO ENABLE SUCCESSIONAL RE-VEGETATION
- MSE SYSTEM TREATMENT
- CLIFF TOP CUT SITE WITH SOIL NAILS, ASSISTANCE PLANTING & FOREST DUFF RE-VEGETATION
- CLIFF TOP CUT SITE WITHOUT SOIL NAILS, ASSISTANCE PLANTING & FOREST DUFF RE-VEGETATION
- FILL SITE TREATMENT, SITE MULCH, FOREST DUFF & ASSISTANCE PLANTING
- VEGETATED SWALE PLANTING
- RIPARIAN FENCING

VEGETATION VALUES

- SIGNIFICANT TREE - MODERATE VALUE
- SIGNIFICANT TREE - HIGH VALUE
- SIGNIFICANT TREE - VERY HIGH VALUE
- SIGNIFICANT TREE - REMOVED WITH TREE FELLING PROTOCOL

NOTE: REFER TO TECHNICAL REPORT 7A, VOLUME 5

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab MMA-DES-UDL-E1-DRG-1000-1010
Scales NOT TO SCALE
Original Size A1

Te Ara o Te Ata

NZ TRANSPORT AGENCY WAKA KOTAHI
Mt Messenger Bypass

MT MESSENGER BYPASS

PRELIMINARY LANDSCAPE CONCEPT SHEET LAYOUT

Approved H. MILLIKEN
Status FOR CONSENT
Drawing Number MMA-DES-UDL-C0-DRG-1000
Revision C

REHABILITATE TEMPORARY STOCKPILE AREA AND DEVELOP INTO STORMWATER POND WITH WETLAND AND RESTORATION PLANTING

REMOVE EXISTING PAVEMENT AND RETURN TO PASTURE

MANGAPEPEKESTREAM

EXISTING FARM BUILDINGS

MMA-DES-UDL-C0-DRG-1001

MMA-DES-UDL-C0-DRG-1002

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
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Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

NZ TRANSPORT AGENCY WAKA KOTAHI

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PRELIMINARY LANDSCAPE CONCEPT SHEET 1

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MMA-DES-UDL-C0-DRG-1002

MMA-DES-UDL-C0-DRG-1002

MMA-DES-UDL-C0-DRG-1003

REHABILITATE TEMPORARY STOCKPILE AREAS,
RETURN TO NATIVE VEGETATION

TEMPORARY STOCKPILE AREA TO TRANSITION INTO SWAMP FOREST
OFFSET RESTORATION & REPLACEMENT MITIGATION PLANTING

STREAM INSET

REFER TO STREAM INSET

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 2

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Drawing Number
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Revision
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MMA-DES-UDL-C0-DRG-1003

PROPERTY BOUNDARY

NGĀTI TAMA LAND

MMA-DES-UDL-C0-DRG-1003

MMA-DES-UDL-C0-DRG-1004

REHABILITATE TEMPORARY STOCKPILE AREAS, RETURN TO PASTURE OR NATIVE VEGETATION

TEMPORARY STOCKPILE AREA TO TRANSITION INTO SWAMP FOREST OFFSET RESTORATION

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 3

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Drawing Number
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Revision
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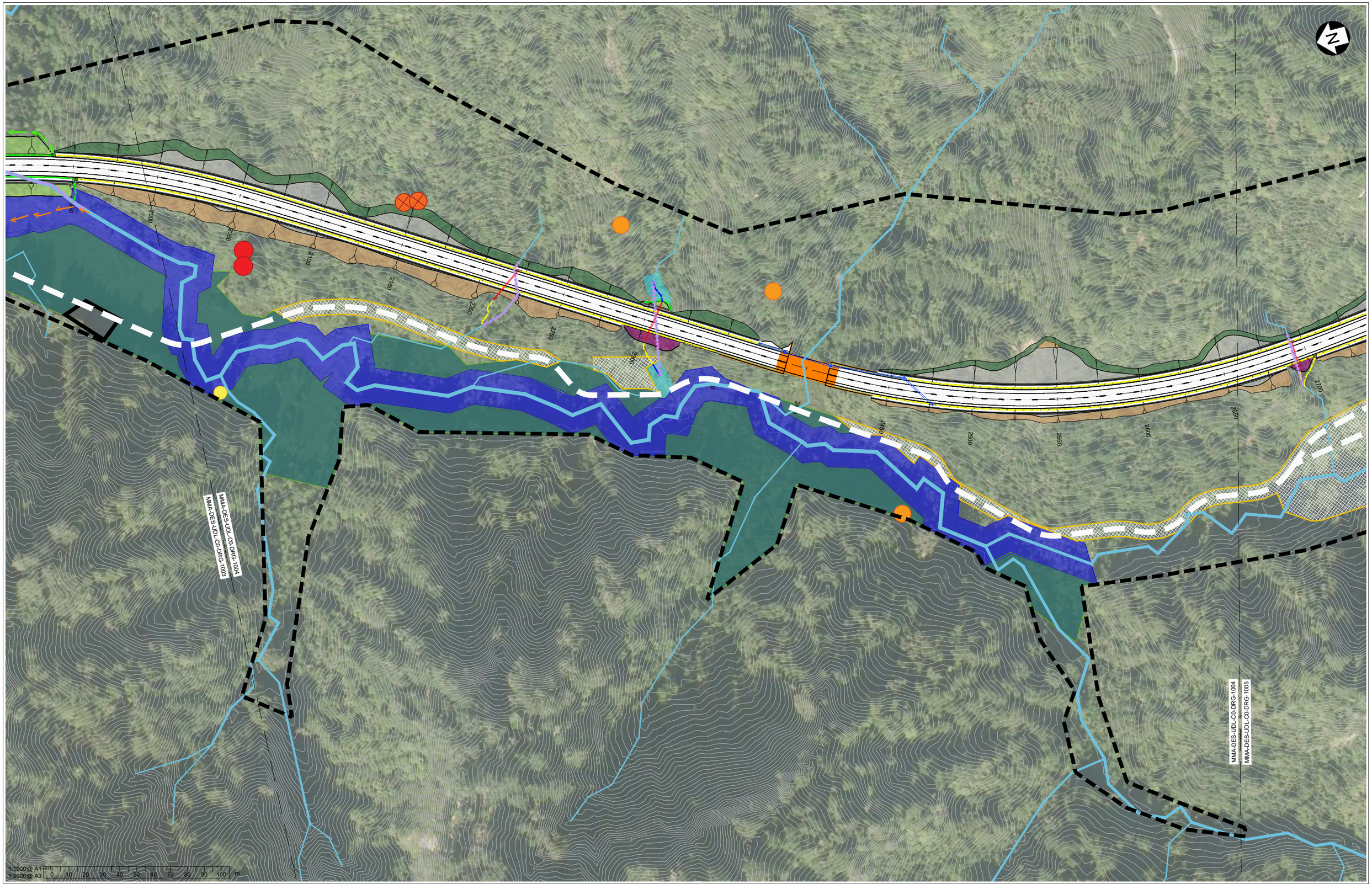

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	BRIDGE ADDED AT CH 2400	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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MMA-DES-UDL-C0-DRG-1005

MMA-DES-UDL-C0-DRG-1005
MMA-DES-UDL-C0-DRG-1006

CULTURAL EXPRESSION FOR FILL SITE NO.12 REPRESENT THE NORTHERN THRESHOLD TO BE DEVELOPED IN COLLABORATION WITH NGĀTI TAMA REFER TO LEDF SECTION 5.2.4

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 5

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Drawing Number
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Revision
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MMA-DES-UDL-C0-DRG-1006

MMA-DES-UDL-C0-DRG-1005

CULTURAL EXPRESSION FOR TUNNEL PORTAL TO REPRESENT THE NORTHERN THRESHOLD TO BE DEVELOPED WITH NGĀTI TAMA. REFER TO LEDF SECTION 5.2.3

TUNNEL CONTROL BUILDING AND PLANTING REFER TO LEDF SECTION 5.2.7

HYDRANT TANK AND PLANTING REFER TO LEDF SECTION 5.2.5

MMA-DES-UDL-C0-DRG-1006

MMA-DES-UDL-C0-DRG-1007

1:1000@ A1
1:2000@ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
B	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 6

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Revision
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MMA-DES-UDL-C0-DRG-1007
MMA-DES-UDL-C0-DRG-1008

CULTURAL EXPRESSION FOR BRIDGE TO BE DEVELOPED IN COLLABORATION WITH NGĀTI TAMA

NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

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PRELIMINARY LANDSCAPE CONCEPT SHEET 7

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Drawing Number
MMA-DES-UDL-C0-DRG-1007

Revision
C

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MMA-DES-UDL-C0-DRG-1008

MMA-DES-UDL-C0-DRG-1008

MMA-DES-UDL-C0-DRG-1009

MIMI RIVER

4550

4600

4650

4700

4750

4800

4850

4900

4950

5000

5050

5100

5150

5200

5250

5300

1:1000 @ A1
1:2000 @ A3 0 10 20 30 40 50 60 70 80 90 100 m

NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	FILL DISPOSAL SITE 3 REMOVED	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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Drawing Number
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Revision
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MMA-DES-UDL-C0-DRG-1009

INSET

INSET

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NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

1:1000 @ A1
1:2000 @ A3
mm 0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

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PRELIMINARY LANDSCAPE CONCEPT
SHEET 9

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Drawing Number
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MMA-DES-UDL-C0-DRG-1009
MMA-DES-UDL-C0-DRG-1010
MMA-DES-UDL-C0-DRG-1010
MMA-DES-UDL-C0-DRG-1012

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	UPDATE FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018
A	FOR CONSENT	CS	QDO'S	SP	LR	DK	14/11/2017

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 10

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NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

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1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	NOT ISSUED	CS	-	LR	-	-	-
A	FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018

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MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

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PRELIMINARY LANDSCAPE CONCEPT
SHEET 11

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MMA-DES-UDL-C0-DRG-1012

MMA-DES-UDL-C0-DRG-1012
MMA-DES-UDL-C0-DRG-1013

1:1000 @ A1
1:2000 @ A3
0 10 20 30 40 50 60 70 80 90 100 m

NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	NOT ISSUED	CS	-	LR	-	-	-
A	FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
1:2000 (A3)
1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 12

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Drawing Number
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MMA-DES-UDL-C0-DRG-1013

1:1000 @ A1
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NOTE: BOUNDARY OF RESTORATION PLANTING AREAS OUTSIDE THE DESIGNATION TO BE CONFIRMED WITH PROPERTY OWNERS

Rev	Revision Description	Drawn	Drawing Checked	Designed	Design Checked	Approved	Date
C	CHANGES TO SHEETS 1004 AND 1008 ONLY	CS	QDO'S	LR	BMcK	BSS	26/07/2018
B	NOT ISSUED	CS	-	LR	-	-	-
A	FOR CONSENT	CS	QDO'S	LR	LR	DK	09/05/2018

Tab
MMA-DES-UDL-E1-DRG-1000-1010

Scales
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1:1000 (A1)

Original Size
A1

Te Ara o Te Ata

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PRELIMINARY LANDSCAPE CONCEPT SHEET 13

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7.0 Stream Design Principles

7.1 Introduction

These Stream Design Principles will guide for the creation and restoration of streams that are being diverted as part of the Mt Messenger Project. The overall aim is to recreate stream sections that have the same or better hydraulic and ecological functions as sections being lost. In general, the profile of new stream sections will be constructed to replicate adjacent channels or will be improved to reflect more natural conditions by use of riparian planting and adding habitat complexity.

The general design principles for stream diversions are provided in section 7.2 with specific design considerations for each diversion discussed in section 7.3.

7.2 General Design Principles

7.2.1 Structure and morphology

- Maintain existing or restore towards a more natural stream structure.

- Where practicable, create at least the same length of stream as what is lost. Where this is not practicable, the reduction in stream habitat has been accounted for in the offset calculations for the Mt Messenger Project (see Freshwater Ecology Technical Report (December 2017) and Supplementary Report (February 2018).

- Create a stream profile which provides a base flow channel, bank-full channel and a flood plain. This will help ensure appropriate water depth, flood conveyance and connection with a flood plain. This may not be practicable in steep, incised gullies. In these situations, the focus should be on ensuring pool habitat below cascades or drops.

- Ensure the stream profile is consistent with the hydrological regime. As a rule-of-thumb use:

  - The bank-fill width should be sufficient to convey up to a 1 year return period flood. This sizing helps maintain stream habitat features and avoid excessive erosion and or sediment deposition.
  - In low gradient streams the baseflow channel should be provided. It is better to undersize the baseflow channel and manage flood flows by increasing the width and/or lowering the height of the stream's immediate flood plain. This helps ensure the stream channel maintains sufficient water depth and energy for the stream to evolve to a more reference state condition over time. The stream and flood plain profile should be shaped like a 'key hole' or stepped and allow riparian vegetation to extend close to the water.
  - The width of the stream-belt (i.e. flood plan) should be at least 4 times the bank-fill width to allow the stream to meander. If constraints mean that the belt is less than 3.5 times than the stream may need to reflect a step-pool morphology. Wider meanders are preferable if topography allows.

- Incorporate meanders in situations where the stream would naturally meander. This helps to increase complexity of the instream habitat and hydraulic regimes and improve hydraulic functions. A natural meander wavelength is typically about 7-14 times the bank-fill width, but is often less[1].

- Steeper channel sides allow for vegetation to provide cover for fish through over-hang foliage and roots. Batters on the outside bend should be steeper than on the inside bend (Figure 7.2.1).

- The created channel should provide a range of meso-habitat types, e.g. riffles, rapids, runs,

1 Madsen BL 1995. Danish watercourses – ten years with the New Watercourse Act. Danish Environmental Protection Agency. Ministry of Environment and Energy, Denmark.
Harman W.R., Starr 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington, D.C. EPA 843-B-12-005.

pools, backwaters. A primary driver of meso-habitat is channel slope, flow variability, geology and sediment supply. This creates habitat and improves ecological functions.

- The design should include a vertical wave within the base flow channel that interacts with meanders, e.g. pools on the outside of bends and plunge pools below cascades (see generic design Figures 7.2.1 to 7.2.3). It is often the pools that provide habitat and refuge for fish.

- Use similar substrate to the existing stream and of a size consistent with natural sources (e.g. gravel, cobble, boulders etc.). Placement of boulders or logs should be used to reinforce stream morphology rather than counter-act it – e.g. as part of v-vanes or j-hooks on the outside, downstream part of meanders, or as part of constructed riffles.

- Incorporate plenty of woody debris within the stream channel. The wood used should be large (stems >150mm) and complex (i.e. a range of sizes). It can be clustered together in high energy streams. Wood increases the retention of leaves and provides habitat for fish. Large logs can be used to enhance morphology, e.g. log weirs or cover logs in association with pools (Figure 7.2.5). Woody debris is particularly important as a stable substrate and habitat in the soft sediment streams near Mt Messenger.

- Instream structures can be used to plant vegetation closer to the stream and provide immediate bank edge habitat.

- Allow the stream room to move over time. Where there are practical constraints on allowing a stream to move it is still often possible to allow movement in the base flow channel by appropriate sizing the channel width and substrate material.

7.2.2 Substrate on stream bed and banks

- Substrate should be similar to that naturally occurring in similar types of streams in the area.

- Take care not to over-size the substrate, e.g. lining of a small stream with 250 mm riprap. If the substrate is too large to be moved by floods it is likely to result in excessive periphyton growth and can result in small streams flowing under the rock instead of over it. Smaller substrate size can be used in conjunction with large rock if needed.

- In some sections it may be appropriate to add additional gravels to create riffle habitat mid-way between bends. The gravel section should be about three to four meters in length, extend across the width of the channel and be about 200 mm in depth. The natural gravel material around Mt Messenger is papa mudstone but this may not be practical to use because it is very soft. An alternative material would be acceptable so long as it is appropriately sized. Alluvial gravels should be used in preference to angular quarried rock.

- If the stream bed needs to be armoured, then care is need to ensure that the water will continue to flow over the streambed rather than disappear into the rock layer. One approach is to establish any short sections of rock protection below the level of the natural streambed; this allows the steam bed to act as a crest and water will continue to flow over the top of the armoured later. Another approach is to layer smaller gravels to fill voids between layers of large rock; for example, place a layer of gravel (< 20 mm), then a layer of rock protection (300 mm), then a layer of gravel (<20 mm), then a layer of rock protection, then a final layer of gravel (<40 mm). The top most layer should match natural stream bed material. Using a component of all-pass grade (e.g. gap 20 mm) can be effective for the layers to ensure some fines and reduce permeability through the stream bed armour.

- Pools are important habitat for fish in steep streams. Any bed armouring should be placed in a way so as to still allow pools to develop in the stream. This may require constructing depressions along the channel prior to placing the rock armour. The depth of the depressions should be at least 300 mm greater than the depth of the layer of rock armouring. These can later form plunge pool to help dissipate energy.

- Boulders and large wood can be used to provide habitat diversity or bank protection (e.g. v-vanes, J-hooks). Where clusters of boulders are used to provide habitat then allowing voids between them is beneficial.

7.2.3 Stream bank stabilisation

- New stream banks may need to be stabilised. Use biodegradable geotextile matting (e.g. coconut fibre matting) and hydro-seeding.

- Rock lining of stream banks should be minimised as it reduces vegetation connection with the stream bank. If possible, any bank lining should be set back from the baseflow channel. Generally, any stream bank lining should be incorporated with instream features such as j-hooks to reduce bank velocity and shear stress on the outside bend. J-hook vanes need specific design and construction in order to protect stream banks, direct flow, stay in place during floods and not be 'out flanked' during floods. Details designs should be made prior to construction including the grade of material. In general, they should look like the diagrams in Figure 7.2.4.

7.2.4 Riparian vegetation

- Riparian vegetation is an important part of stream ecosystems. It helps to stabilise banks, provides hanging habitat for aquatic life, shade the stream, reduce high water temperatures, provide leaf and woody debris to the stream, acts as a filter, reduce flow velocities, provide habitat for adult insects that use the stream.

- Plant riparian vegetation close to the edge of the baseflow channel to provide shade and over-hanging.

- The riparian planting should occur within the stream-belt flood plain and ideally extend about 10 m beyond the floodplain as a buffer.

- Use native species that have been eco-sourced from the district.

- Exclude stock from the planted area.

- Plant and animal pest management will be required for at least 3 years while vegetation is establishing.

- New stream banks may need to be stabilised. Use biodegradable geotextile matting (e.g. coconut fibre matting) and hydro-seeding.

7.2.5 Incorporating wood into the stream

Large wood is an important component of natural stream channels, providing habitat and food for insects, koura, fish and birds. It helps store sediment, retains organic matter, provides hydraulic diversity and cover for many fish (Figure 7.2.5). In low gradient streams with fine sediment substrate, large wood is an important stable microhabitat. Large wood is usually defined as >100 mm diameter and >1m long, however larger pieces with more complexity provide for better stability and habitat.

For the purpose of stream restoration root wads can provide excellent habitat. They can be secured by pushing the trunk into the stream bank and leaving the root wad extending into the stream channel. Branching sections are also good as they provide more habitat diversity and are easier to secure in the stream than straight logs.

There are multiple ways to secure large wood in the stream channel, including: pushing one end into the stream banks/bed, partially cover with gravels, use large boulders, anchor to the stream bed (e.g. a duck-bill anchor) secure to the stream bank, or hold in place with posts.

It is not necessary for the wood to be fixed in place permanently, however they should be sufficiently secure to stay within the reach while the stream channel stabilises and riparian vegetation grows. Wood naturally moves through river systems. The design of stream channels, substrate and wood features should allow the stream to adapt and reassemble itself over time.

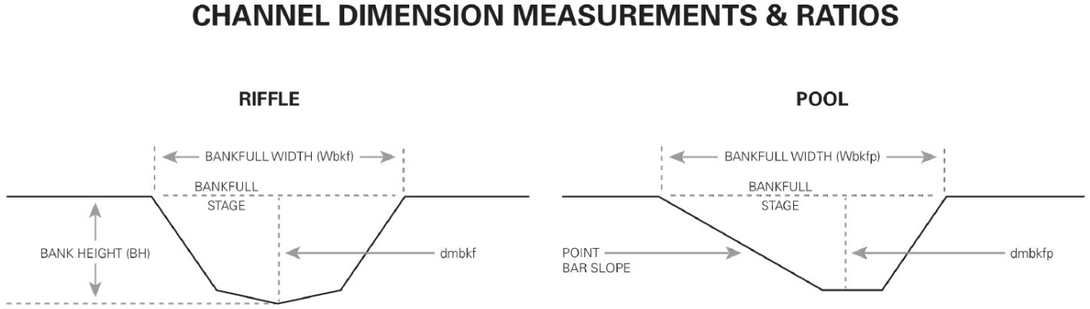
In stream restoration sites the amount of large wood placed in the stream should be similar to what occurs in natural forested systems. This is in the range of about 1 to 5 pieces per 20m of stream length[2].

During the process of vegetation removal some large wood should be put aside for use in stream restoration. Pieces to put aside include: root wads and hole tree tops and cover a range of sizes in diameter classes of >600 mm, 300-600 mm. Some lengths should be long, i.e. about 6 m. Pole kanuka should be set aside to be used as posts to secure wood to stream beds (sized about 100-200 mm diameter, and >1.2 m long).

2 Jenson DK, Leigh DS, Jackson R 2014. Scales and arrangements of large wood in first- through fifth-order streams of the Blue Ridge Mountains. Physical Geography 35(6): 532-560.

7.2.6 Generic design drawings

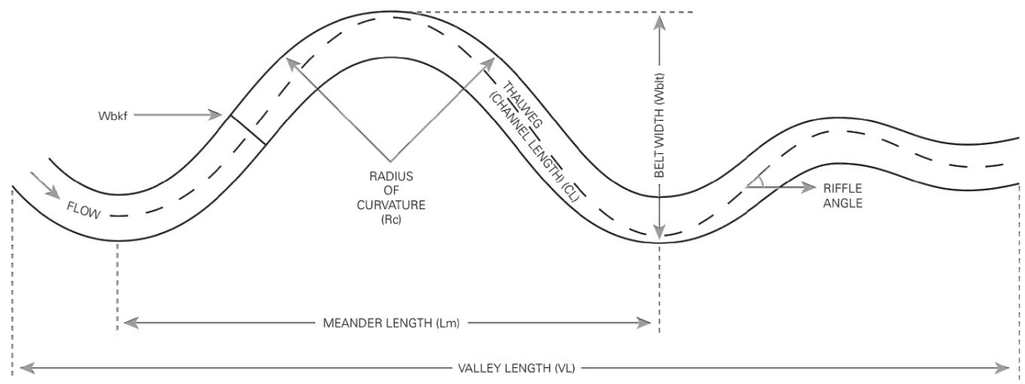
Generic drawings are shown below for a meandering stream (cross section and plan view) (Figure 7.2.1 and Figure 7.2.2). Note that the centre line of the main current flow (thalweg) takes the outside of the bends. Figure 2.2 shows channel measurements and typical design for a pool-riffle sequence and step/pool sequence. Figure 7.2.3 illustrates the typical location of pools and riffles in a low gradient meandering stream.



CHANNEL DIMENSION CALCULATIONS
POOL WIDTH / RIFFLE WIDTH (Wbkfp / Wbkf)
MAX. POOL DEPTH / MEAN RIFFLE DEPTH (dmbkfp / dbkf)
MAX. RIFFLE DEPTH / MEAN RIFFLE DEPTH (dmbkf / dbkf)
RIFFLE WIDTH / MEAN RIFFLE DEPTH (Wbkf / dbkf)

$$\text{MEAN RIFFLE DEPTH (dbkf)} = \frac{\text{RIFFLE AREA (Abkf)}}{\text{BANKFULL WIDTH (Wbkf)}}$$

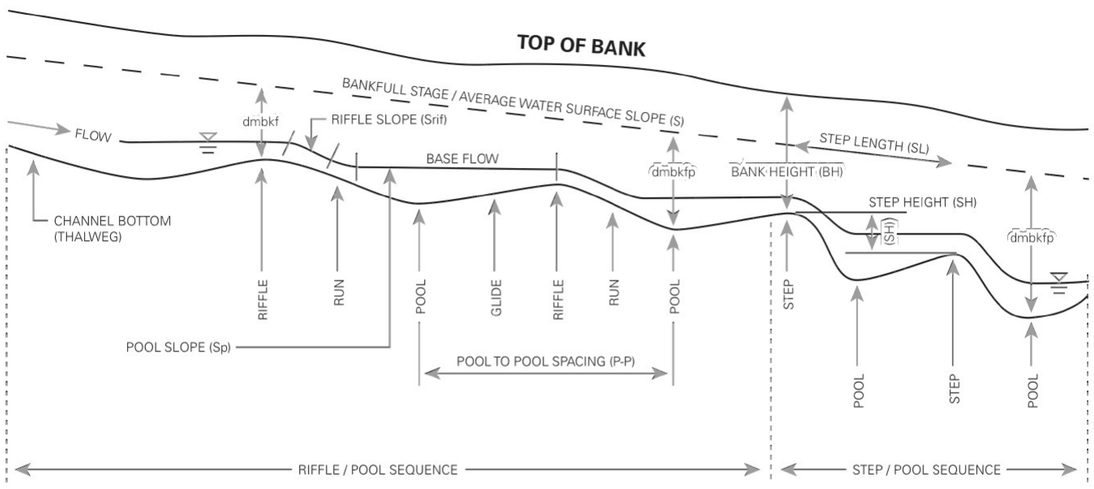
$$\text{BANK HEIGHT RATIO (BHR)} = \frac{\text{BH}}{\text{dmbkf}}$$



CHANNEL PATTERN CALCULATIONS
RADIUS OF CURVATURE / RIFFLE WIDTH (Rc / Wbkf)
MEANDER LENGTH / RIFFLE WIDTH (Lm / Wbkf)
MEANDER WIDTH RATIO (MWR = Wblt / Wbkf)
SINUOSITY (K) = CHANNEL LENGTH (CL) / VALLEY LENGTH (VL)

Figure 7.2.1 Meandering channel measurements and typical design profile and plan view[3]

CHANNEL PROFILE MEASUREMENTS & RATIOS°



CHANNEL PROFILE CALCULATIONS
PROFILE SLOPE / AVERAGE WATER SURFACE SLOPE (Srif / S)
POOL SLOPE / AVERAGE WATER SURFACE SLOPE (Spool / S)
POOL TO POOL SPACING / RIFFLE WIDTH (P-P / Wbkf)
BANK HEIGHT (BH) / MAX RIFFLE DEPTH (Dmbkf)

Figure 7.2.2 Channel measurements and typical design for a pool-riffle sequence and step/pool sequence[3]

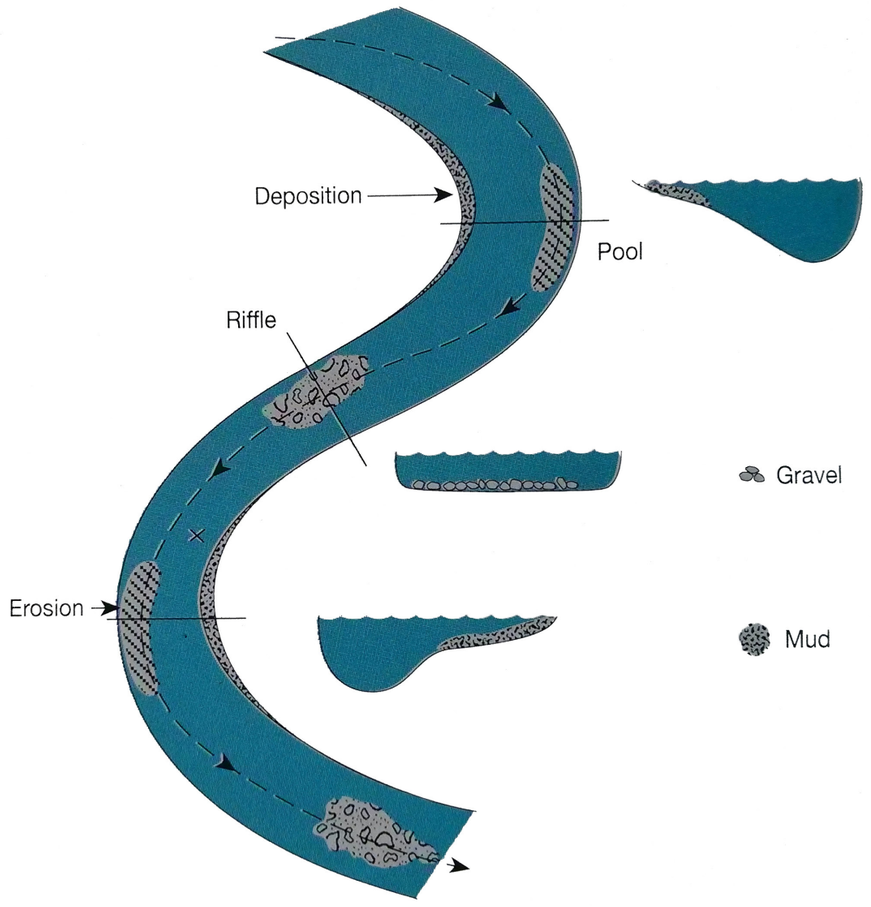


Figure 7.2.3 Formation of regular current, bend and depth conditions with a meander pattern[4]

3 Harman W.R., Starr 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington, D.C. EPA 843-B-12-005.

4 Madsen BL 1995. Danish watercourses – ten years with the New Watercourse Act. Danish Environmental Protection Agency. Ministry of Environment and Energy, Denmark.

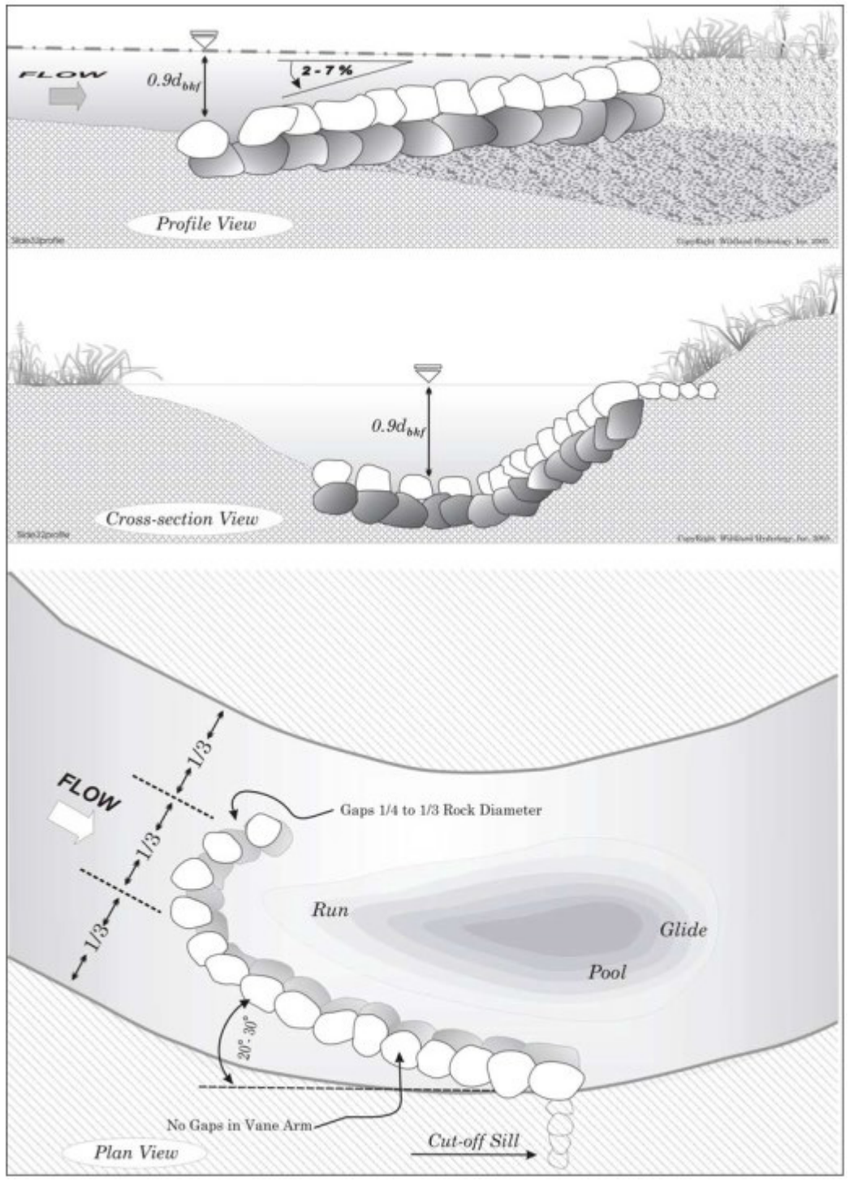


Figure 7.2.4 J-Hook vane in cross-section, profile and plan view[5]

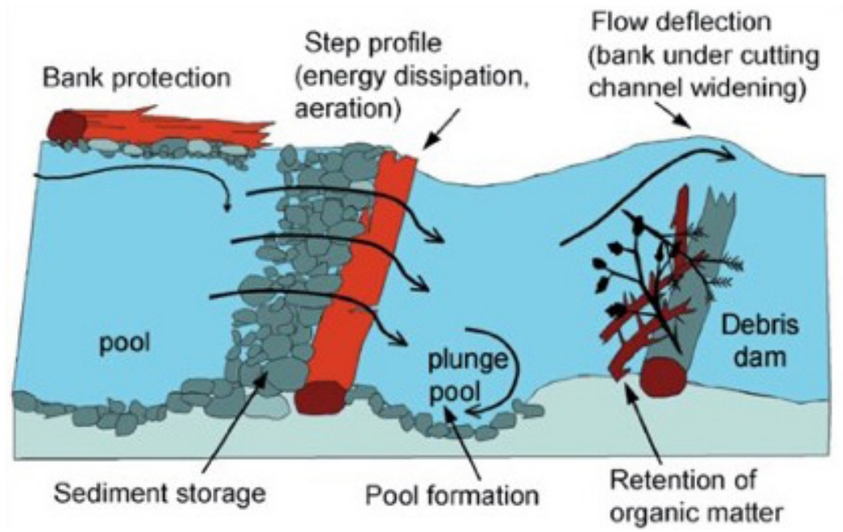


Figure 7.2.5 Benefits of wood in stream channels, providing habitat and food for insects, koura, fish and birds [6] (source Brenda Baillie, Scion)

5 Roisgen DL 2006. The cross-vane, W-Weir and J-Hook Vane structures (updated 2006), and their description, design and application for stream stabilization and river restoration. Wildland Hydrology. Colorado.

6 Access at Farm Forestry New Zealand. http://www.nzffa.org.nz/farm-forestry-model/resource-centre/tree-grower-articles/tree-grower-february-2005/wood-in-streams-size-really-does-matter/

7.3 Site specific design considerations

There are 18 stream diversions proposed for the Mt Messenger Project including three small diversions to link culverts with the existing stream and several swales to replace (and often extend) existing cut-off drains (Figure 7.3.1 and Figure 7.3.2). The detailed design of the stream diversion is being developed, some dimensions are provided in Table 7.1 below.

Site	Chainage	catchment area (ha)	Length of diversion	Project impact	Type	Bankfill width (m)	Bottom width (m)	Channel height (m)
Ea3	570	6.3	45	Culvert 3 and d/s diversion. The consent shows this as a new stream diversion but it is the existing channel.	meander	0.9	0.5	0.4
Ea4	750	1.8	75	Shift cut-off drain upslope. Existing drain replaced by similar length of grassed swales. No waterway exists where culvert is shown.	swale	1	0.5	0.4
Ea5	870	4.2	60	Culvert 5	swale	1	0.5	0.4
Ea6	1050	4.4	90	Stream cut-off at the top of the cut and directed to stormwater. No fish passage provided unless allowed via stormwater pond. No culvert at present.	step-pool	0.8	0.5	0.5
Ea7	1300	6.8	60	Culvert 6 + stream diversion. Road drainage runs to treatment pond.	step-pool	0.8	0.5	0.5
Ea8	1500	5.8	40	Culvert 7 + stream diversion.	step-pool	0.8	0.5	0.5
Ea10b	1850-1950	149	110	total of 190m of stream lost in this area. More stream lost than culvert length because diversion is shorter.	meander	2	1.1	0.7
E3	1650-1750	133	120	Stream diversion for wetland W2 near culvert 8 (chainage 1650-1750). Design change could reduce impact length from 200m to 110m. Added 100m to account for shortened stream length	meander	2	1.1	0.7
E5	2800-2900	64	80	250m of stream lost d/s Ea16. 80m to stream diversion.	step-pool	2	1.1	0.7
Ea17	3000-3350	17	300	Clean water diversion made into stream diversion.	step-pool	1.3	1	0.6
Ea18	3650-3930	6	250	Diversion both sides of CU16.	step-pool	0.7	0.8/1.1	0.6
Ea22	4600-4700	1.5	100	Collected by grass swales to stormwater treatment pond.	swale	0.9	0.5	0.4
Ea23a	4750	25	230	Fill upstream of SH3 with diversion around the disposal site (CU19)	step-pool	1.1	0.7	0.5
Ea29	5450-5750	12	340	Replace existing culvert with Culvert 21. 340m grass swale at u/s end.	swale		0.5	0.5
Ea30	6250	2	260	Main stream avoided. Cut-off drain replaced.	swale		0.5	0.4
Ea31	5225-5300	4.1	75	Cut-off drain shifted, main tributary avoided.	meander	0.8	0.5	0.4
E TL3	1050	2.1	90	Fill - diversion section.	step-pool		0.5	0.4
E TL4	1100	6.6	200	Fill - diversion section.	step-pool	0.8	0.5	0.5

Table 7.1 Stream diversion lengths and proposed dimensions

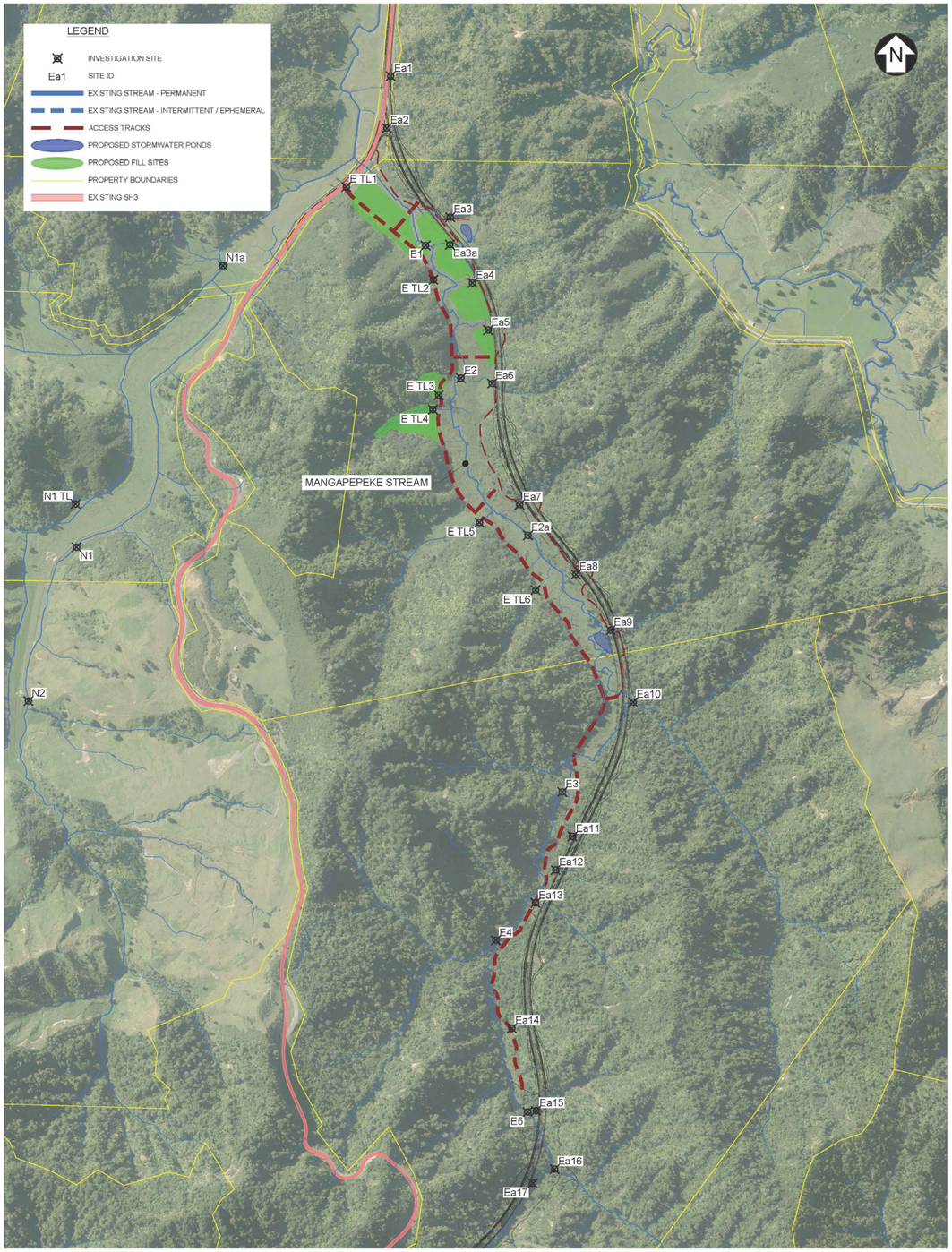


Figure 7.3.1 Mt Messenger stream diversion, culverts and stream numbers, Mangapepeke Stream catchment

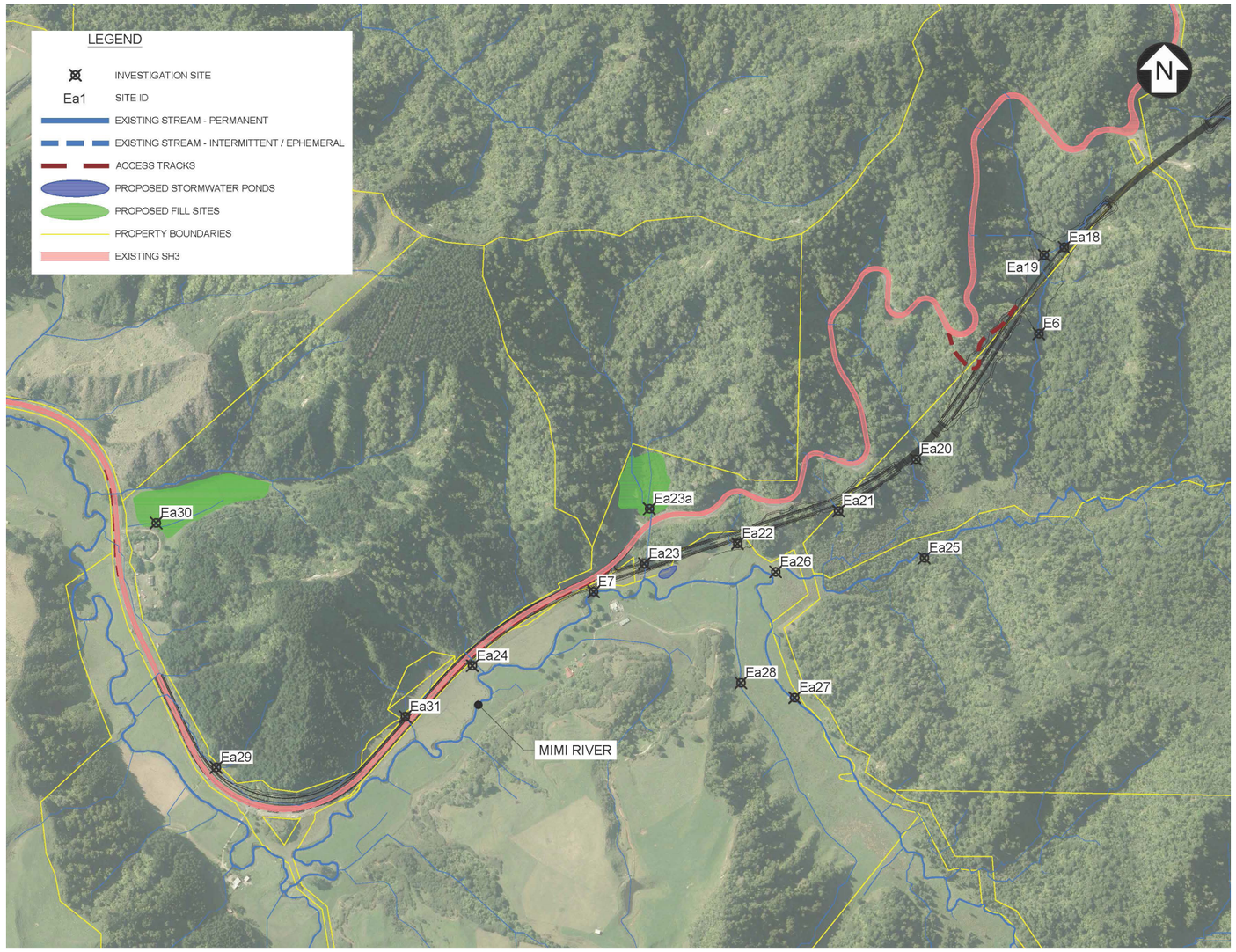


Figure 7.3.2 Mt Messenger stream diversion, culverts and stream numbers, Mimi River catchment