Marlborough Roads Recovery Team

Level of Service Guidelines

Document History and Status

Rev	Date	Author	Signature	Approved by	Signature	Status
1	September 2021	GW / AM				DRAFT
2	2 May 2022	HH / GF				Issue 1
3	28 June 2022	MRRT / HH		SM		Issue 2
4	1 March 2023	GY / DC		Andrew Adams		Issue 3
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Rev	Notes
1	Issued for client review
2	Updated to include guidance developed between September 2021 and April 2022
3	Updated to include standardised pavement designs and culvert head wall advice
4	Re-written following the August 2022 storm event with additional design guidance
5	Updated following the Marlborough Sounds Future Access Study Key changes are: - Modification to align guidance with the MSFAS, - Addition of precedence-based approach to cut slope design, - Development of geometric design standards in Section 3.4, - Changes to pavement designs, - Addition of Technical Notes #1-4 in appendices, - General updates to design approaches across a number of sections,

Table of Contents

1 Introduction

1.1 Purpose of this guidance document

The aim of this document is to give guidance to enable the reinstatement of Marlborough District Council's road infrastructure assets that were damaged by the storm event of 17 July 2021 and the subsequent event of 17-20 August 2022. The guidance is specifically targeted towards the storm recovery efforts and has been updated in July 2024 to take into account the recommendations made in the Marlborough District Council's "Marlborough Sounds Future Access Study" (MSFAS).

These guidelines are intended to be a living document and may continue to change as recovery programme progresses. It indicates the intended level of service (LoS) that designers should target at each site, though deviations from this LoS may be accepted and agreed with the Client and Assurance team on a case by case basis. This is typically where practical, pragmatic solutions are possible, but depart from the LoS guidance and the client will need to accept risk. In making these decisions it is important that the risks are clearly outlined to the client for consideration.

The guidance covers:

- The design philosophy intended for different types of fault,
- The technical standards to be applied to the design solutions, and
- Photographic examples of different fault types.

Currently there are three stages identified on this project:

- Phase 1: Response and Recovery from the July 2021 event as well as the Response and initial recovery to the August 2022 event primarily focused on Queen Charlotte Drive,
- Phase 2: Recovery to both events outside of the MSFAS area.
- Phase 3: Recovery works following the MSFAS.

1.2 Who this guidance is intended for

This guidance is intended for the use of:

- The Marlborough Roads Recovery Team ("MRRT"), and
- All other practitioners and designers (geotechnical, stormwater, road safety, structural, pavement, etc.) providing services to the July 2021 and August 2022 recovery programme.

1.3 Outcomes of the Marlborough Sounds Future Access Study

The MSFAS looked at five geographical areas, recognising that they each had distinct access issues. For each area, the MSFAS recommended a 'Emerging Preferred Option' which specifies the proposed level of service to be reinstated as part of the Marlborough Roads Recovery programme. The business case was endorsed by Marlborough District Council on 3 October 2023 and by New Zealand Transport Agency Waka Kotahi (NZTA) in December 2023. Final decisions regarding levels of service and funding are still to be made at the time of this update.

The geographical areas and proposed levels of service for key roads are listed in the table below. Full detail about the MSFAS and the varying Preferred Options can be found in the MSFAS documents and will not be repeated in detail here. Consultants using this LoS Guideline document as a tool should be aware of the preferred option for their site and take it into account when proposing remedial options.

Table 1: MSFAS Emerging Preferred Options

Zone	Road name	ONRC	Emerging Preferred Option
Rai Valley to Te Aumiti / French Pass	Ronga Road Croisilles Road (Rai Valley to Okiwi Bay)	Secondary Collector	**Protect -** Build back stronger (no additional restrictions)
	Croisilles-French Pass Road (Okiwi to Elaine Bay)	Access	**Protect** - Build back stronger (with additional restrictions)
	Croisilles-French Pass Road (Elaine Bay to French Pass) Tennyson Inlet Road Archers Road Duncan Bay	Access Low Volume	**Accommodate -** Build back with targeted improvements (and with additional restrictions)
	Port Ligar turnoff to Port Ligar D'Urville Island	Low Volume	**Essential Repairs -** Build back with essential repairs only
Te Hoiere / Pelorus	Kaiuma Bay Road (to Brooklyn Bay) Daltons Road	Access	**Accommodate -** Build back with targeted improvements (no additional restrictions)
	Kaiuma Bay Road (Brooklyn Bay to Kaiuma Bay)	Access / Low Volume	**Essential Repairs -** Build back with essential repairs only

Kenepuru	Kenepuru Road (Linkwater to Portage) Beyond Kenepuru Heads	Secondary Collector Access	**Accommodate -** Build back with targeted improvements (with additional restrictions)
	Kenepuru Road (Portage to Heads) Moetapu Bay Road	Access	**Essential Repairs -** Build back with essential repairs only
	Torea Road	Access	**Protect** - Build back stronger (no additional restrictions)
Queen Charlotte Drive	Queen Charlotte Drive	Primary Collector	**Protect** - Build back stronger (no additional restrictions)
	Anakiwa Road	Secondary Collector	**Accommodate -** Build back with targeted improvements (and additional restrictions)
Te Whanganui / Port Underwood	Port Underwood Road (Waikawa to Oyster Bay)	Secondary Collector / Access	**Protect** - Build back stronger (no additional restrictions)
	Port Underwood Road (Oyster Bay to Rarangi) Tumbledown Bay Road	Access Low Volume	**Accommodate -** Build back with targeted improvements (no additional restrictions)
	Oraumoa/Fighting Bay Entrance to road end	Access	**Accommodate -** Build back with targeted improvements (and additional restrictions)

Roads outside of the Marlborough Sounds were not part of the MSFAS. When designers are using this document for faults outside of the MSFAS area, they should take into account the One Network Road Classification (ONRC) of their site when proposing remedial options.

The MSFAS also recognised the potential for future significant events that may cause damage to the network, and as a result, each geographical area also has a ‘Hazard Adaption Pathway’ option which represents a potential long-term move to a lower level of service for the route. Hazard adaption pathways are not addressed in this document.

2 Overview of Level of Service Guidelines

This LoS Guideline document is intended to help designers working on the Marlborough recovery assess faults, then recommend and design appropriate solutions for their sites. All road faults in the recovery have been classified into one of 3 categories; Minor, Simple or Complex.

- Complex sites – Consultant-led design, with market-engaged consultants managed by MRRT,
- Simple sites – MRRT-led design through the internal Design Hub team, practical solutions based on general engineering advice / minor design input,
- Minor sites – Contractor-led without consultant or design input, managed by MRRT.

The previous focus of recovery in Marlborough has been based around putting back like-for-like, with improvements to resilience where possible. Following the MSFAS, this focus has shifted to ‘put back better’ in terms of engineering standards, while trading off the road-user level of service where appropriate – i.e. reduced road widths and increased single lane sections. These changes will be implemented with respect to the existing road environment and traffic volumes, with user safety as a priority. Section 3.4 and Appendix 4 of this document discuss the design approach applicable for the changes in road-user level of service.

Where the designer considers that the fault being rectified predates the July 2021 event they are requested to bring this to the attention of the MRRT for guidance, who in turn will confirm action required with Marlborough Roads.

Designers and those specifying works are to consider solutions that can minimise the effect of the proposed construction on the network. Large volumes of imported material result in frequent heavy vehicle movements which can cause significant damage to pavements. Optioneering should consider design-types or material choices that could minimise vehicle movements, particularly at remote sites.

Design solutions should aim to be kept to within the existing road reserve. Where the preferred proposed works extend onto private property this will need specific approval from Marlborough Roads before proceeding.

2.1 Producer Statements & Building Consent

Solutions are to be fit for purpose and comply with building regulations, the Marlborough District Council's Environmental Management Plan and the Resource Management Act. Designs should be carried out by suitably qualified design professionals in accordance with this Level of Service guidance (which may be a reduced level of service in comparison to industry standard guidelines). Construction monitoring will be required and typically be at a CM2 level.

Following the August 2022 storm, to expedite the design process and speed the recovery programme, MRRT applied for global Building Consent Exemptions for retaining walls constructed within the road corridor as part of the Marlborough Roads Recovery. Specific Building Consent or exemption may still be required for complex structures (i.e. bridges) or retaining walls which cross into private land.

Producer Statements will be required for Type A & B retaining (See Section 3.1.2). Consultants should refer to the Exemption numbers in Table 2 in their Producer Statements.

Table 2: Building Consent Exemptions

Date	Type*	Exemption No.	Requirements
23 March 2023	Type A Retaining Walls	Sch1Ex23005	Exemption granted on the basis that the building work is likely to comply with the Building Code. Producer Statements will be required as evidence.
03 May 2023	Type B Retaining Walls	Sch1Ex23015	Exemption granted on the basis that the building work is likely to comply with the Building Code. Producer Statements will be required as evidence.
06 July 2023	Type C Retaining Walls	Sch1Ex23026	Exemption granted on the basis that the building work may not comply with the Building Code but it is unlikely to endanger people or any building, whether on the same land or on other property

*Refer to Section 3.1.2 for retaining wall type classification.

2.2 Zonal Resource Consents

MRRT has approved, operational Resource Consents for each of the zones of the recovery programme. Consent numbers for each zone are shown in the table below. Copies of the Resource Consent conditions can be supplied to designers on request.

Table 3: Zonal Resource Consent Application Numbers

Zone	Consent Number
Kenepuru	U220515
Queen Charlotte	U220516
Awatere	U220518
Waihopai	U220522
Northbank	U220537
Port Underwood	U230235
French Pass	U230236

Site specific resource consent may still be required,

2.3 Deviations from these guidelines

Where a designer considers it appropriate to deviate from the level of service set out in this document, they should raise the issue with MRRT at the earliest possible opportunity. Additionally;

- Deviations should be flagged in early sections of any reports and during optioneering,
- Deviations should be raised early in the detailed design stage prior to any deliverables,
- Designs must be shown to still meet the Building Code, even where they deviate from these guidelines,
- MRRT must review and accept deviations before design proceeds (unless otherwise agreed). If the deviation is significant, approval may need to be sought from MDC prior to proceeding.

3 Design Standards

3.1 Geotechnical Design

3.1.1 Updated Seismic Hazard Model

On 7th December 2021, the NZ Geotechnical Society released an updated Earthquake Geotechnical Engineering Practice – Module 1. The update was based on the most recent understanding of the New Zealand seismic hazard. The updated Module 1 provided interim advice that the seismic hazard in the Marlborough Region given in the previous revision of Module 1 (and in the Bridge Manual) was under predicted by around 33 %. The revised National Seismic Hazard Model has subsequently been released on 4th October 2022 confirming the revision of seismic hazard in Marlborough.

Marlborough District Council have confirmed that seismic loading in terms of the Bridge Manual 3rd Edition (May 2022) is to be applied to recovery work.

3.1.2 Retaining Walls

3.1.2.1 Wall classification

Following the August 2022 storm, retaining wall design processes are intended to be standardised for pile retaining walls (cantilevered and anchored) where practically possible to increase design/construction efficiency. For this purpose, Table 4 below has been developed to provide a guide on which set of standard design details could be used based on the basic geometry of each site. Additional practical guidance for retaining wall construction will be provided in the Materials and Constructability Guidance, separate to this document.

All wall types other than pile retaining walls (i.e. mechanically stabilised earth, soil nailed shotcrete, gravity walls, etc.) fit under Type A and will require site specific design.

Table 4: Standard design categories – Retaining Walls

	Type A	**Type B**	**Type C**
Wall type	Large or complex walls	Low height retaining walls	Rail iron retaining walls*
Importance Level **(BM Table 2.2)**	IL1 for wall height <5m IL2 for wall height >5m	IL1	IL1
Design type	Site specific design	Site specific design or standardised design	Standardised design details

		details	
Design life	50 yrs	25 – 50 yrs	25 yrs (with uncertainty based on rail iron condition)
Wall height	> 2.5 m OR < 2.5 m with complexity*	< 2.5 m	< 2.5
Toe slope & bench width	Any slope & any bench width	Any slope with 0.5m bench in front of wall	< 40 degrees with 0.25-0.5 m bench
Offset to edge of seal from back of wall	As designed	>0.5 m	>0.5 m

*Type C Rail iron retaining walls constructed on 'Protect' routes may not be built as cantilever walls. Deadman tie-backs or other form of anchoring must be incorporated to ensure the walls add to route resilience.

*Complexity may be indicated by one of the following situations:

- Retaining wall is located directly above private dwellings / appurtenant structures / access ways and may have an impact on resident use.
- There are significant stormwater issues at the site and/or large culvert penetrations are required
- The wall is located within a deep-seated global movement or other challenging geology
- Retaining walls above the road should be considered Type A structures
- Other

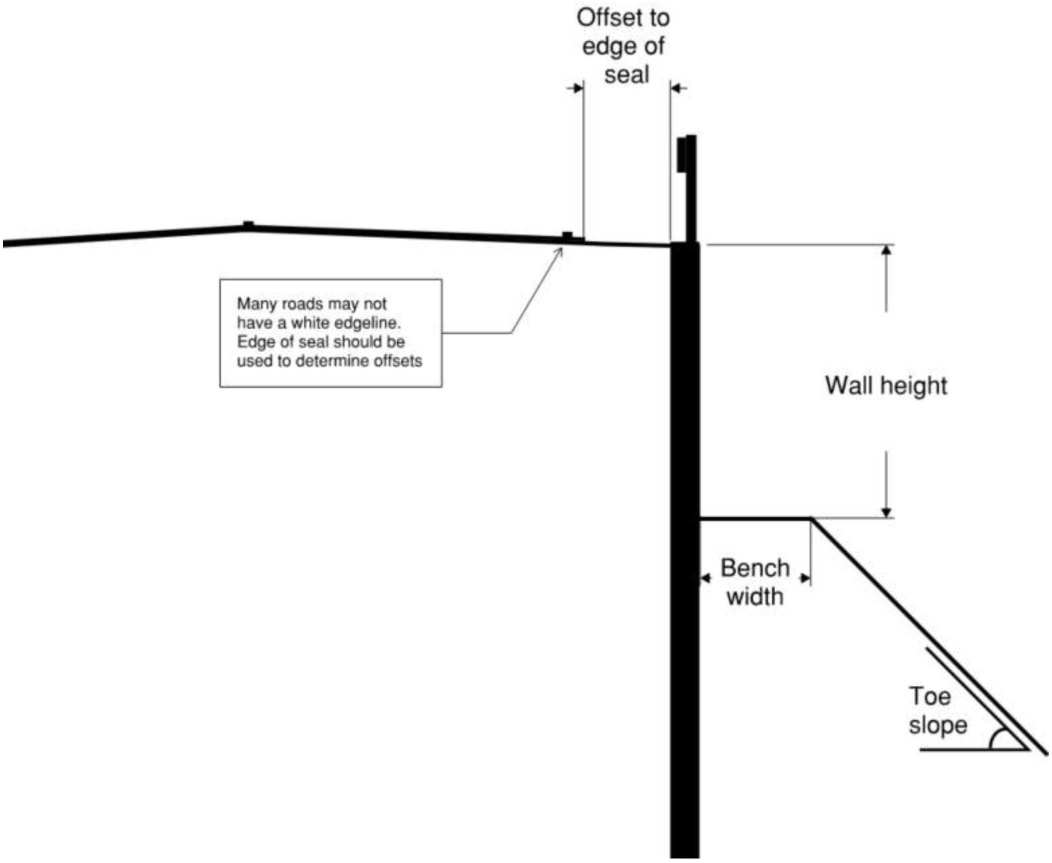


Figure 1: Pile retaining wall schematic

3.1.2.2 Type A – Large or complex retaining walls

The design standards below are based on criteria from the NZTA Bridge Manual.

Table 5: Design Criteria for Type A Walls

Criteria	Design Requirements
Traffic Loading	HO (overload) traffic loading must be used for roads approved for full High Productivity Motor Vehicle (HPMV) use. Refer to the Waka Kotahi website here for information: https://www.nzta.govt.nz/commercial-driving/high-productivity/full-hpmv-network/ HN (normal) traffic loading may be used for all other roads.
Seismic load cases	SLS = 1/25 yr DCLS = 1/250 yr * *For an IL1 wall, the DCLS earthquake return period in BM Table

Criteria	Design Requirements
	2.2 is 1/500yr for a design life of 100 yr. This can be scaled down to 1/250yr for a 50 yr design life.
Road safety barrier designs	Safety barriers designed to resist collision loading are not required. Timber sight rails as per C20 and RTS5 should be specified. **Note:** This document acknowledges the Safe System approach and that humans make errors. Edge protection to prevent errant vehicles from falling should be considered as part of a network wide approach. For the purposes of this project, road safety barriers are excluded from design.
Corrosion resistance	o 50 year corrosion life o Preference for sacrificial steel piles and walers. o Anchors to be Class 2 protection (galvanised or epoxy coated). Corrosion of anchors to be allowed for after the loss of galvanic protection. See Appendix A – Technical Note #1 for further guidance on self-drilling anchors. o Denso tape wrap to be used on anchor heads. o Penetrations through timber to be greased. o Fixings in timber may be stainless steel where required. No requirement for stainless steel structural elements.
Acceptable displacement limits in seismic events	Bridge Manual table 6.1, AADT<2500
Performance requirements for DCLS event	Modify table 6.2 to Supporting 1 lane of HN
Global Stability target factors of safety**	Static FS = 1.5, Seismic FS = 1.25 Bridge Manual 6.6.3 for deep seated failure

**Target factors of safety may not always be achievable and lower FoS may need to be agreed with client. Global stability is discussed further in section 3.1.6.

3.1.2.3 Extracts of relevant sections of the Bridge Manual

Relevant tables from the Waka Kotahi Bridge Manual 3rd Edition are reproduced below for ease of reference.

Bridge Manual Table 6.1: Total settlement, differential settlement and horizontal displacement limits

Structure, wall and slope scenario	Structure, retaining structure and slope type	SLS load combinations (including seismic events detailed in 6.1.2(b)(iii))		DCLS load combinations		
		Maximum total settlement	Maximum differential settlement	Maximum total settlement	Maximum differential settlement	Maximum total horizontal displacement[*]
Soil structures supporting road carriageway with AADT < 2500	Rigid wall	50mm[†]	1/300[†]	Refer to table 6.2		100mm
	Flexible wall or slope capable of displacing without structural damage	50mm[††]	1/100[††]			200mm

Bridge Manual Table 6.2: Seismic performance requirements for soil structures not affecting bridges after a design (DCLS) event

Post-earthquake –immediate	Slope stability factor of safety (FoS) > 1.1 for post-seismic stability with residual shear strengths and zero peak ground acceleration
Post-earthquake function – short term	Usable by emergency traffic (as defined in 5.1.2) and capable of supporting ~~two~~ one lane of HN (normal) loading with a slope stability FoS > 1.3 under static strength conditions
Post-earthquake function – after reinstatement	Feasible to reinstate for all design (ULS/DCLS) level actions
Acceptable damage	a. Damage possible: capable of permanent repair. b. The detailing foundations formed within or upon soil structures and facing panels should be such that the predicted DCLS displacements do not result in damage to these elements beyond repair. Necessary reinstatement works should be limited to removal of facing panels and barriers, reconstruction of panel footings, reinstatement of barriers and panels to original levels or other lessor level acceptable to the road controlling authority and reconstruction of road pavement.

In the table above modify Post-Earthquake function – short term to be 1 lane of HN, rather than 2 lanes.

3.1.2.4 Type B – Low height retaining walls

The following design standards are proposed for recovery works where the height of the wall is less than 2.5 m of retained height and there is no specific complexity associated with the site. These are walls that are not being designed for global slope stability but are for local retention of the road corridor.

Seismic design is excluded for Type B walls and static design will govern.

Table 6: Design Criteria for Type B Walls

Criteria	Design Requirements
Traffic loading	HO (overload) traffic loading must be used for roads approved for full High Productivity Motor Vehicle (HPMV) use. Refer to the Waka Kotahi website here for information: https://www.nzta.govt.nz/commercial-driving/high-productivity/full-hpmv-network/ HN (normal) traffic loading may be used for all other roads.
Seismic load cases	No requirement for seismic design. As per the MBIE Module 6: Earthquake Resistant Retaining Wall Design, earthquake design is recommended for retaining walls with retained heights >3.0 m.
Road safety barrier designs	Safety barriers designed to resist collision loading are not required. Timber sight rails as per C20 and RTS5 should be specified. **Note:** This document acknowledges the Safe System approach and that humans make errors. Edge protection to prevent errant vehicles from falling should be considered as part of a network wide approach. For the purposes of this project, road safety barriers are excluded from design.
Corrosion resistance	○ 50 year corrosion life (25 years may be agreed upon for standard design details). ○ Preference for sacrificial steel piles and walers. ○ Anchors to be Class 2 protection (galvanised or epoxy coated). Corrosion of anchors to be allowed for after the loss of galvanic protection. See Appendix A – Technical Note #1 for further guidance on self-drilling anchors. ○ Denso tape wrap to be used on anchor heads. ○ Penetrations through timber to be greased. ○ Fixings in timber may be stainless steel where required. No requirement for stainless steel structural elements.
Global Stability target factors of safety**	Static FS = 1.2 – 1.3 This is below the requirements of the Bridge Manual 6.6.3 for deep seated failure.

** Global stability is discussed further in section 3.1.6.

3.1.2.5 Type C – Rail iron retaining walls

Similar to Type B walls, Type C rail iron retaining walls are used for walls less than 2.5 m retained height where there is no specific complexity associated with the site. These are walls that are not being designed for global slope stability but are for local retention of the road corridor. MRRT a standard design for Type C walls which will be provided to designers to use in their optioneering approach.

Type C retaining walls constructed on 'Protect' routes must have deadman tie-backs or some other form of anchoring applied. Cantilever rail iron walls are not suitable for Protect routes as they do not provide sufficient future resilience.

Seismic design is excluded for Type C walls and static design will govern.

Table 7: Design Criteria for Type C Walls

Criteria	Design Requirements
Traffic loading	Type C walls will be designed for HN loading only. These walls should be applied with caution on roads which are approved for HPMV use. Refer to the Waka Kotahi website here for information: https://www.nzta.govt.nz/commercial-driving/high-productivity/full-hpmv-network/
Seismic load cases	No requirement for seismic design. As per the MBIE Module 6: Earthquake Resistant Retaining Wall Design, earthquake design is recommended for retaining walls with retained heights >3.0 m.
Road safety barrier designs	Safety barriers designed to resist collision loading are not required. Timber sight rails as per C20 and RTS5 should be specified. **Note:** This document acknowledges the Safe System approach and that humans make errors. Edge protection to prevent errant vehicles from falling should be considered as part of a network wide approach. For the purposes of this project, road safety barriers are excluded from design.
Corrosion resistance	○ Corrosion life is assumed to be <25 years where rail irons are used. ○ Tie-backs to be formed from additional driven rail irons and reinforcing steel as per standard details. ○ Penetrations through timber to be greased.

Criteria	Design Requirements
	○ Fixings in timber may be stainless steel where required. No requirement for stainless steel structural elements
Global Stability target factors of safety**	Static FS = 1.2 – 1.3 This is below the requirements of the Bridge Manual 6.6.3 for deep seated failure

** Global stability is discussed further in section 3.1.6.

3.1.3 Overslips

- Clearance of overslips is typically a contractor-led process and does not require design input. Geotechnical advice or supervision may be requested by the contractors where the slip sites are large in volume/height, or may result in a high residual risk to road users, or amenity of private property.
- Cleared overslips will commonly show signs of ongoing movement. This may be rock fall and frittering of cut slopes, collapsing and rotational slumps in batter slopes/overslip scarps or sediment loss and minor flows following rainfall. The scale of these failures may impact on the level of service of the road, however it is anticipated to be such that they can be cleared by regular maintenance crews or response crews following trigger events. This risk is understood and accepted by the client.
- Where there is significant ongoing movement or a high residual risk of rockfall that is likely to impact the road level of service on an ongoing basis, slope stability assessment / earthworks modelling could be carried out. This should be done in accordance with section 3.1.5 ‘Cut Slope Design for Road Retreats’.
- If there is a high likelihood that an overslip will continually release material, block roadside channels and cause stormwater to overtop the road, then the consultant should consider cost-effective methods to reduce risk on the downslope shoulder (i.e. bunding water to a controlled discharge location),
- Some exposed faces may need stabilisation within Te Hoiere Catchment (Pelorus, Kenepuru) to minimise sediment runoff (confirm catchment requirements). This may include angled benches to bring water to road level in a controlled manner, hydro seeding/mulching with a mix specification supplied by DoC or MDC.
- Channels need appropriate treatment in Te Hoiere Catchment for sediment capture requirements.

3.1.4 Debris Flows

The steep hillsides in Marlborough result in catchments that may be prone to reoccurring debris flows. For roads with a 'Protect' MSFAS status, if the fault was caused by a debris flow and reoccurring debris flows are considered highly likely, then the designer should consult with MRRT for additional guidance on their design philosophy.

For culverts which have been impacted by debris flows or are located on potentially susceptible catchments, assessment requirements are noted in Section 3.3.2.

3.1.5 Cut Slope Design for Road Retreats

'Road retreats' is the term given to the remedial option of cutting into the hillside above the road in order to shift the road alignment away from an unstable slip. Retreats are often seen as providing additional resilience to a route, by shifting the outside lane away from shoulders than may be marginally stable due to poor road construction methods (side cast fill), and onto a stable platform. Overslips are typically easier and cheaper to construct than repairing underslips, so marginally stable cut batters are seen as a lower risk to the network.

This Level of Service provides two methods for detailing a road retreat design:

- Precedence-based approach – Likely better suited to rock dominated slopes
  - Allows the consultant to assess the performance of nearby slopes (with similar soil/rock characteristics), and use those as a basis for design slope angles and heights.
- Bridge Manual-based approach – Likely better suited to soil dominated slopes
  - Requires consultant to model the slope using limit equilibrium slope stability software and show acceptable performance on the basis of Factors of Safety and the Bridge Manual requirements.

Designers should indicate which approach they recommend for a site.

Table 8: Cut slope design approaches

	Precedence-based approach	Bridge Manual-based approach
Design Philosophy	• Observational approach to specifying cut slope designs through the assessment of performance of existing cut slopes in the area • Led by experienced, local geo-professional Strong site presence during construction to manage risks • Suitable for rock slopes (not soil)	• Analytical approach to specifying cut slope designs, through modelling performance in limit equilibrium software • Importance level of IL1 unless the slope is potentially impacting private property in which case design as IL2* • Includes high groundwater and seismic design cases • Suitable for soil or rock slopes
Design inputs	• Comprehensive desktop assessment • Geomorphic mapping of soil/rock exposures, defects, failures • May include geotechnical investigations (i.e. test pits)	• Comprehensive desktop assessment • Geomorphic mapping of soil/rock exposures, defects, existing failures • May include geotechnical investigations (face scrapes, test pits, boreholes)
Performance and risks	• Expected performance is communicated in terms of risk to third parties and to the road corridor. • Risks managed during construction by making changes to gradients and benching based on encountered conditions	• Performance is modelled using limit equilibrium slope stability software Risks are communicated in terms of Factor of Safety and seismic deformation • Retreat is constructed to designed alignment, though changes may be made during construction if conditions are worse than expected
Potential issues with approach	• Provides no quantitative assessment of performance in static or seismic conditions • Relies heavily on the experience of the geo-professional • Changes made during construction to resolve geotechnical risks can cause geometric deficiencies not originally envisaged.	• Without investigations, a lack of real data regarding subsurface information and groundwater can put limits on the validity of results – 'box ticking exercise' • Changes made during construction to resolve geotechnical risks can cause geometric deficiencies not originally envisaged.

*Impacts to private property include: dwellings, appurtenant structures and/or accessways.

- MRRT will expect a high quality of geomorphic mapping for the design of cut slopes. Quality of mapping is critical for a precedence-based approach but should be carried out regardless of the approach taken.
- It is understood that existing hillslopes in Marlborough may not have factors of safety that meet or exceed the FS=1.5 required by the Bridge Manual. In these cases, a precedence-based approach to cut slope design is likely to be preferred. This is because a Bridge Manual-based approach is likely to yield the same outcome with respect to a high risk-acceptance by the client regarding long term performance of the slope.
- Engineering works required to improve the factors of safety of a slope (i.e. rock bolting, active mesh stabilisation, etc.) are likely to be cost-prohibitive and are not preferred.
- Benching of cut slopes is at the designers discretion but should be considered for cuts of significant height, or low angle slopes. Benches should be graded and shaped to prevent water ponding and divert to appropriate discharge location and in some cases to facilitate maintenance.
- Relaxation of the rock mass and frittering of rock is likely in the months following a road retreat – where possible there should be space left at the base of the slope to catch debris before it blocks surface water channels.
- Rockfall assessment of completed cuts will not typically be required, however unknown weak zones, structural defects and seepages may be encountered during earthworks which could pose a long term risk of instability. Cut slopes should be inspected by a qualified geo professional during earthworks. If weak zones or significant defects are encountered, slopes should be battered or benched further to avoid the need for hard engineering measures to be installed after completion.
- Soil layers at the top of cut batters should be trimmed back at a shallower angle compared to the rock materials. Large trees within 1 m of the top of the cut should be removed (with consideration to trees of high ecological value).

3.1.6 Global Stability & Global Movements

3.1.6.1 Global landslide movements

- A ‘global movement’ describes where the road has dropped over the full width of the carriageway and it is evident that the head scarp is upslope of the road, and the toe is daylighting below the road (by say 5 or 10m downslope). Presence of a global landslide movement may be indicated by:
    - Transverse cracking across the road,

- Local foliation strike-dip measurements that vary significantly from the GNS regionally-mapped strike-dips, indicating rotation of the rock mass,
- Marlborough 1m LiDAR models showing geomorphic evidence of slope movement (note that some areas in SmartMaps have post-August 2022 LiDAR available)

- These landslips are common in the Sounds, typically occurring in zones mapped on the geological maps as 'Undifferentiated Pleistocene to Holocene landslide deposits' where large, historical landslides have remobilised. The location of all potential global movements is not known but tend to be present in gully features. They tend to move in discrete pulses triggered by high rainfall when the soil has a high antecedent moisture condition and groundwater is elevated. Movement in excess of 1 m vertical settlement has been observed.
- In these instances the remedial works is not about trying to stabilize the hillside but is to provide the appropriate carriageway across the slip, improving the resilience of the specific site where feasible and identifying the risks to the client. The following strategies are recommended:
    - Retaining walls should typically not be built within a known global landslide movement.
    - Check and improve drainage where possible. Culverts may need replacing when damaged and/or re-locating to the new low point of the road. Subsoil drains may be appropriate below the swale, where they can discharge to appropriate location. Open cracking in the table drains and road corridor should be infilled with concrete/bentonite mix where possible.
    - Re-level the road by re-building the pavement and fix any minor pavement cracking. This may include a ramp in / ramp out rather than rebuilding the road up to the original level, or may involve lowering the road level.

3.1.6.2 Global stability design case

- 'Global stability' is a term used to describe the design case where a slip surface is assessed passing below the base of a retaining wall, through the hillside below, without interacting with the structural elements of the wall.

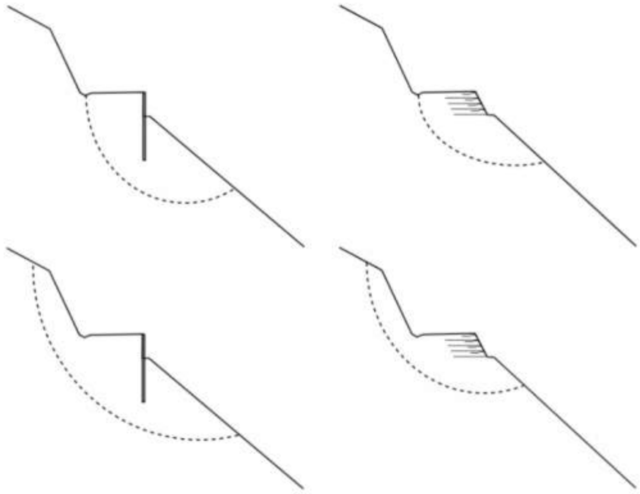


Figure 2 - Schematic example of global failures below pile retaining walls and MSE walls

- A low factor of safety for a global stability case does not necessarily indicate that there is a ‘global movement’ at the site in question. The design process for determining rock strength parameters of weathered schist is inherently conservative, which means predicting the true confined rock strength at depth is challenging.
- Site mapping and a geomorphological assessment of desktop and site notes is the best tool for determining if a ‘global movement’ is present at a site and poses a credible global stability risk.
- Where global stability factors of safety targets are not able to be met in design, the residual risk must be outlined for acceptance by the client.

3.1.7 Slope erosion protection

Slope erosion protection refers to measures used to help stabilise or reduce erosion on slip faces to reduce the likelihood of regression affecting the road seal or slopes below retaining walls.

- Slope protection should typically be considered where:
    - the slip scarp is > 0.5 m away from the edge of seal,
    - the slope below the base of the wall needs to be protected,
    - a road retreat has occurred and the underslip requires treatment to reduce regression risk, or
    - The slope is within the road reserve and discharges into the Te Hoiere catchment, where there is a requirement to minimise erosion and sediment loss.
- Slope protection works will typically take the form of pinned geotextile/biodegradable mesh combined with hydroseed/hydro mulching and or planting. Where slope angles are < 2H:1V, planting should be considered as a mechanism to provide long term

stabilisation and reduce erosion. Guidance on landscape planting can be found in Appendix C – Technical Note #3.

3.2 Landscape Planting

Much of the Marlborough Roads Recovery is occurring in areas of high amenity and outstanding natural landscapes. Due to this, as part of MRRT's Zonal Resource Consent applications, we are required to consider how to reduce the visual and environmental impact of engineering structures and earthworks.

A key mechanism for this is through re-planting of low-gradient slopes and cleared areas after completion of remedial works. Designers should include requirements on their drawings for landscape planting in appropriate areas. Guidance on planting and what to include can be found in Appendix C - Technical Note #3.

3.3 Stormwater and Drainage Design

3.3.1 Surface water channels

MRRT have standard details for certain stormwater elements, including surface water channels. These generic designs will be provided to consultants for use at their sites (where applicable). The generic designs have a decision-flow chart to determine the appropriate channel detail to apply to a site.

- Where site evidence suggests that the existing roadside channels have insufficient capacity, designers should carry out catchment assessments to determine the 10% AEP flow in the channel and ensure replacement channels are sized appropriately.
- Where a site has complex or specific requirements that are not covered by the generic designs, designers should consider the following:
  - Concrete channels should typically only be applied in situations where there is a history of scour in the channel, there is limited space in the corridor, or the designer wants to limit water infiltration into the pavement. Unlined channels are easier to maintain on remote roads and typical concrete dish channels have low conveyance capacity.
  - Concrete channels should have subsoil drains installed beneath them to drain pavement layers,
  - Vehicle safety on narrow roads with poor geometric alignment should be considered if the designer is specifying a particular channel section. Large vehicles may need to drop a wheel into the channel and some channel designs are considered un-traversable.

- The preference is not to concentrate flows by introducing a kerb/bund on the downslope edge of the road however there are some situations where a kerb/bund might be warranted:
    - Where there is private property already being impacted by runoff,
    - Where the camber of the road tends to concentrate flows and cause scour, or
    - Where there is a pre-existing failure or new structure on the downslope side that might be impacted by water runoff.
- If kerb/bunds are being installed where they haven't existed previously, there should be an assessment of the scour and slope stability (where required) at the kerb termination. Scour protection / flow dissipation is likely to be required at these points.

3.3.2 Culverts

MRRT have standard details for certain stormwater elements, including headwalls at culvert inlets. These generic designs will be provided to consultants for use at their sites (where applicable). These generic designs have a decision-flow chart to determine the appropriate headwall detail to apply to a site.

The process for determining whether or not to carry out catchment assessment and replace a culvert is laid out in Table 9.

Table 9: Stormwater catchment assessment approach

Road Category	Fault Category	SW Analysis / Repair process
Accommodate - Build back with targeted improvements **Essential Repairs - Build back with essential repairs only**	**Simple –** Culvert is part of the solution	• If evidence of regular overtopping: Undertake desktop catchment calculation. • If no evidence of regular overtopping: Replace culvert to original sizing with a minimum size of 427mm ID
	Simple – Culvert in vicinity of the solution	• If evidence of regular overtopping, potential cause to the fault: Undertake stormwater analysis and replace culvert to the recommended sizing. • If evidence of regular overtopping, no cause to the fault: Record culvert for future improvement • If no evidence of regular overtopping: No action
	Complex - Culvert is part of the solution	• Always complete a stormwater analysis, include recommended culvert size in design
	Complex – Culvert in vicinity of the solution	• If evidence of regular overtopping, potential cause to the fault: Undertake stormwater analysis and replace culvert to the recommended sizing. • If evidence of regular overtopping, no cause to the fault: Record culvert for future improvement. • If no evidence of regular overtopping: No action

Road Category	Fault Category	SW Analysis / Repair process
Protect - Build back stronger **Roads not part of the MSFAS**	**Simple –** Culvert is part of the solution	• Always complete a stormwater analysis, include recommended culvert size in design
	Simple – Culvert in vicinity of the solution	• If evidence of regular overtopping, potential cause to the fault: Undertake stormwater analysis and replace culvert to the recommended sizing. • If evidence of regular overtopping, no cause to the fault: Record culvert for future improvement • If no evidence of regular overtopping: No action
	Complex - Culvert is part of the solution	• Always complete a stormwater analysis, include recommended culvert size in design
	Complex – Culvert in vicinity of the solution	• If evidence of regular overtopping, potential cause to the fault: Undertake stormwater analysis and replace culvert to the recommended sizing. • If evidence of regular overtopping, no cause to the fault: Record culvert for future improvement. • If no evidence of regular overtopping: No action

- Catchment calculations are to be carried out in accordance with:
  - For low volume / access roads (unless they service a large resident population) – sized to support a 20% AEP storm with no blockage, with climate change scenario RCP6 2080-2100.
  - For all other roads – sized to support a 10% AEP storm with no blockage, with climate change scenario RCP6 2080-2100.
  - Heading up will be allowed for the design storm, where it will not result in overtopping of the road. Where heading up is likely, the consultant should indicate what the potential consequences might be – i.e. overloading a culvert downstream, overtopping onto an unstable slope below the road.
  - The minimum culvert size for MRRT-replacement culverts is a 427mm inner diameter. The absolute minimum size of a new culvert on the MDC road network is 375 mm.
- Secondary flow path assessment:
  - A secondary flow path assessment involves checking where stormwater will flow in the event that a culvert is completely blocked, and assessing the stability of the discharge location on the downslope side of the road. Scour protection or flow dissipation on the secondary flow path may be necessary to prevent underslips on the downslope side of the road.
  - Secondary flow path assessment is required for AEP 1% events for culverts on catchments prone to debris flows, where full blockage is likely.

- Consultants should indicate to MRRT if they believe a secondary flow path is likely to have negative impacts upon private property below the road.

- The preferred culvert types are HDPE SN8 (any supplier) with a minimum allowable cover of 600mm. Where culvert cover is between 0.6 and 1.2 m, design is required to confirm culvert capacity. Reinforced concrete pipes should be considered where there is reduced cover.
- Designers should indicate if they believe a new culvert(s) would be beneficial to redirect stormwater away from a vulnerable site they have been engaged to remediate. New culverts would ideally discharge into public land, or direct to the foreshore, as resource consent may be required if they discharge into private property.
- For remote areas with little or no house access, consider options to install splash fords over the top of culverts. Multiple small culverts are not preferred due to potential for blockage.
- Debris catch area at inlet to be included in the design where feasible. For most sites, this will simply comprise a widened, unlined table drain. Do not oversteepen the upslope bank (i.e. steeper than existing) to create catch areas as this may result in instability.

3.3.3 Scour protection below culverts.

Outlet scour protection (sock, rocks or flume) is required where the downslope angle is >15 degrees as per MDC Environmental Management Plan. MRRT have standard details for certain stormwater elements, including scour protection below culverts. These generic designs will be provided to consultants for use at their sites (where applicable).

The generic designs contain a decision-flow chart to determine the appropriate scour protection option for a site. This flow chart indicates the applicability of the generic designs and will dictate if further site-specific design is required.

Designers should take the following into account:

- Location of the discharge point of flumes and socks must be considered where there is private property below the road.
- Where we are changing the volume of stormwater runoff or introducing a new discharge location onto private property below the road, the downslope impacts must be considered and will need to be agreed with the client.
- The ability/cost to source rock of sufficient size at the location in question.

3.3.4 Fish passage

Fish passage assessment is required where culverts are being replaced at sites where the stream is marked as a watercourse on NZ Topo 1:50k maps. Some fish habitat assessments have already been carried out as part of the Zonal Resource Consents following the July 2021 storm. Where there is fish habitat upstream of the culvert, design of the culvert will need to allow for fish passage. MRRT may carry out fish passage assessment directly through use of a small local consultant, in which case they will advise designers of the required outcomes.

See Appendix B – Technical Note #2 for additional information on design of culverts for fish passage.

3.3.5 Scour protection adjacent to rivers

The below guidance has been provided by the MDC Rivers Engineer for design of scour protection (revetments and the like) adjacent to rivers:

- For sites where access for construction and repairs post future floods is difficult – use 1 % AEP river flows
- For sites where access for construction and repairs post future floods is easy – use 5 % AEP river flows

3.4 Transport Engineering and Geometric Design

The purpose of this section is to outline expectations and provide guidance for road design. In general designers shall follow the principles of Austroads and NZTA guidance documents and design standards. Road design philosophy and level of service shall align with the existing surrounding road environment. Designers are expected to balance level of service with best practice.

3.4.1 Design Vehicles

The MSFAS allows for the introduction of new restrictions to the length or weight of vehicles able to be used on different roads in the Marlborough Sounds. Where repairs are being carried out that will alter the alignment or pre-existing width of the road, geometric design will be required. This will involve checking:

- **The Design Vehicle** – does not cross the centreline while traversing corner (therefore is able to safely pass another design vehicle), and
- **The Check Vehicle** - the maximum vehicle size that will be assessed for a particular road. It is able to traverse all corners, however generally will cross the centreline to do so.

The design and check vehicles are presented in Table 10 and on a spatial plan in Appendix D and are based on the Auckland Transport Urban and Rural Roadway Design Guide and NZTA RTS 18.

MDC may introduce permit or piloting requirements for vehicles longer than the design vehicle on different routes. Permit/pilot requirements and recommendations are not included in this document.

Where sites are proposed to be reduced to one lane, the guidance in Appendix E – Technical Note #4 should be applied.

If the road width or alignment is not being altered, or the alterations are considered negligible and consistent with the surrounding road environment, MRRT will not typically require geometric design to be carried out. It is understood that some existing sections of roads may not meet the geometric requirements of Table 10 below – MRRT do not require the geometrics at these sites to be improved unless it is a cost-effective part of remedial works for a fault.

3.4.2 New One Lane Sections

The process for applying a new one lane section to a piece of road that was previously two lane is outlined in Appendix D – Technical Note #4.

3.4.3 Design Speed

- Proposed posted speed limits shall be taken into consideration for determining appropriate design speeds.
    - Kenepuru Road and all side roads are proposed to have a reduction in the posted speed limit to 60 km/hr (with some lower speed limits around specific settlements). Designers should consult with MRRT when determining the appropriate design speed to use.
- An appropriate design speed shall be selected by the geometric designer for each site or curve in accordance with the procedures to determine operating speeds as outlined in Austroads.
- The selected design speed(s) shall be clearly shown on the drawings.

3.4.4 Sight Distance:

- Safe Sight Distance (SSD) shall be provided in accordance with Austroads.
- Where appropriate, Safe Intersection Site Distance (SISD) shall be provided in accordance with Austroads.
- The geometric designer must identify vegetation (current and future potential growth) and other objects that may impact sight distances, including sight rail, signs, vehicles, or other obstructions.

3.4.5 Horizontal Alignment:

- New curves with a design speed above 50km/h shall be transitional.
- New circular curves (non-spiral) are permitted where design speeds are 50km/h or less.
- Minimum centreline radius (even at very low speeds) should not be less than 20m. Some sites may require smaller radii, the geometric designer shall consider this on a site-by-site basis and if radii less than 20m are selected shall provide evidence to support.

3.4.6 Crossfall / Superelevation:

- Typical crossfall for all sealed roads is -3.0%.
- Typical crossfall for all unsealed roads is -3.5%
- For design speeds 25km/h or less, crossfall of up to -5.0% may be permitted (including adverse crossfall on horizontal curves where vertical geometry permits).
- Super elevation shall be applied on a site-by-site basis. Generally reinstated as per the previous condition to a maximum superelevation of 10%.
- Where existing site limitations prevent vehicles travelling in excess of 50km/h, superelevation is not required. Where posted speed limits are 50km/h or lower, superelevation is not required.

- Cross fall may be crowned or mono, geometric designer to consider geotechnical and stormwater expectations on a site-by-site basis. Higher warp rates than specified in the SHGDM may be acceptable where required for stormwater management.

3.4.7 Swept path analysis speed:

Turning speed for large design and check vehicles should generally have a minimum speed of 10-25km/h, giving regard to road design speed differential and desirable deceleration for the turn. Turning wheels at a stop is not permitted.

3.4.8 Other vehicle considerations:

If a Design or Check vehicle will not fit within the site effectively, it may be necessary to use an alternative design vehicle and check vehicle. Geometric designer to consider pre-existing road alignments adjacent to the site and make recommendations of alternative design and check vehicle selections. In this case, document recommendation and seek acceptance.

Where the designer is considering multiple consecutive sites, lay-by areas for pilot vehicles, large vehicles and queuing traffic may need to be considered. Designers should check with MRRT to confirm these requirements.

3.4.9 Traffic calming:

Where there is a risk of vehicles entering a section of road at higher speeds than achievable design speeds allow. The geometric designer shall consider and recommend appropriate traffic calming and visual cues to help drivers adapt to the road environment. This may include road narrowings, additional pavement markings, audio tactile profile (ATP) road markings, additional signage, sight rails, differing road paving materials, or entry/ gateway treatments.

Vertical deflection devices, such as speed humps, speed cushions and speed tables are generally not expected to be acceptable, except in areas where vehicle speeds are high and pedestrian activity is high.

3.4.10 Safe System Audits:

Independent Safe System Audits (SSA), previously Road Safety Audits (RSA), will not typically be required. The need for SSA shall be confirmed on a site-by-site basis and they can be instigated at the request of the principal, the geometric designer or an independent party.

Table 10: Design vehicle requirements

Zone	Road name	MSFAS Emerging Preferred Option	Design Vehicle	Check Vehicle
Queen Charlotte Drive	Queen Charlotte Drive	**Protect** - Build back stronger (no additional restrictions)	DV1 – 12.6m truck no hitch DV2 – 85th car with caravan (Auckland Transport)	17.9m semi trailer (RTS-18)
	Anakiwa Road	**Accommodate -** Build back with targeted improvements (and additional restrictions)	No Design Vehicle	17.9m semi trailer (RTS-18)
Te Hoiere/ Pelorus	Kaiuma Bay Road (to Brooklyn Bay) Daltons Road	**Accommodate -** Build back with targeted improvements (no additional restrictions)	No Design Vehicle	17.9m semi trailer (RTS-18)
	Kaiuma Bay Road (Brooklyn Bay to Kaiuma Bay)	**Essential Repairs -** Build back with essential repairs only		
Kenepuru	Kenepuru Road (Linkwater to Portage)	**Accommodate -** Build back with targeted improvements (with additional restrictions)	No Design Vehicle	17.9m semi trailer (RTS-18)
	Kenepuru Road (Portage to Heads)	**Essential Repairs -** Build back with essential repairs only		
	Kenepuru Heads roads	**Accommodate -** Build back with targeted improvements (with additional restrictions)		
	Torea Road	**Protect** - Build back stronger (no additional restrictions)		

	Moetapu Bay Road	**Essential Repairs -** Build back with essential repairs only	No Design Vehicle	12.6 m rigid truck no hitch (Auckland Transport)
	Te Mahia Road Onahau Road	No status specified	No Design Vehicle	11.5 m rigid truck (RTS-18)
Rai Valley to Te Aumiti / French Pass	Ronga Road Croisilles Road	**Protect** - Build back stronger (no additional restrictions)	DV1 – 12.6m truck no hitch DV2 – 85th car with caravan (Auckland Transport)	17.9m semi trailer (RTS-18)
	Croisilles-French Pass Road (Okiwi Bay to Elaine Bay) Elaine Bay Road	**Protect** - Build back stronger (with additional restrictions)	B99 Vehicle (AS/NZS 2890.1:2004)	17.9m semi trailer (RTS-18)
	Tunakino Road	**Accommodate -** Build back with targeted improvements (with additional restrictions)		
	Croisilles-French Pass Road (Elaine Bay to French Pass) Port Ligar Road and side Roads	**Accommodate -** Build back with targeted improvements (with additional restrictions) **Essential Repairs -** Build back with essential repairs only	No Design Vehicle	17.9m semi trailer (RTS-18)
	Tennyson Inlet Road Duncan Bay Road Archers Road	**Accommodate -** Build back with targeted improvements (with additional restrictions)	No Design Vehicle	17.9m semi trailer (RTS-18)

Te Whanganui / Port Underwood	Port Underwood Road (Waikawa Whatamango Bay)	**Protect** - Build back stronger (no additional restrictions)	DV1 – 12.6m truck no hitch DV2 – 85th car with caravan (Auckland Transport)	17.9m semi trailer (RTS-18)
	Port Underwood Road (Whatamango Bay to Oyster Bay)	**Accommodate -** Build back with targeted improvements (with no additional restrictions)	No Design Vehicle	17.9m semi trailer (RTS-18)
	Port Underwood Road (Oyster Bay to Rarangi)	**Accommodate -** Build back with targeted improvements (with no additional restrictions)		
	Tumbledown Bay Road (Oyster Bay to Oraumoa/Fighting bay)	**Accommodate -** Build back with targeted improvements (with no additional restrictions)		
Other	Roads outside of the MSFAS	Not Applicable	Request instruction from MRRT	17.9m semi trailer (RTS-18)

3.4.11 Sight Rails and Edge Marker Posts

- Sight rails are to be applied to locations where:
  - The driver eye is needed to be guided around an out of context curve as the is no dense vegetation performing that function.,
  - Along the top of retaining walls,
  - In locations where the shoulder is not considered trafficable, and
  - Other locations considered necessary.
- Edge marker posts (flexible plastic white posts with red markings) are a permanent alternative to sight rails. They are not the preferred option due to their lower visibility, however they have applicability where:
  - Existing sight rails have a history of damage due to vehicle strike (i.e. on the inside of tight bends),
  - There is limited road width available on a low volume route, and it is deemed appropriate by MRRT.

Sight rails are not traffic control devices; however, they are sometimes used as a form of delineation at curves or intersections. Sight rails are not barriers and are not intended to stop errant vehicles. They should not be installed unnecessarily as they create cost and maintenance requirements. Designers should consult MRRT when in doubt.

The below standards are to be applied to sight rail design.

- Sight rails must not be embedded in concrete. Concrete embedment significantly complicates future maintenance following vehicle strike. Posts should be installed in holes with backfill compacted around them.
- Timber sight rails and posts shall comply with NZTA P/24.
- The timber sight rails shall be rectangular with call dimensions of 200mm x 25mm – single layer only
- Galvanised fittings shall be used.
- Posts Size (maximum): 100mm x 100mm or 10,000mm2
- Spacing: 1.5m max
- Maximum length (L): 1.5m of each rail, i.e. there is a joint at every post to aid the frangibility.
- Mounting height (H) to centre of rail: 550 mm

- Materials H3 Tanalised timber / H4 for ground contact or approved frangible material
- Fixings Galvanised or stainless steel nails or screws,
- Finish painted white, with two paint coats to stop sap bleeding through.

Note: The sight rail should be clearly visible to approaching drivers and if possible be illuminated by vehicle head lights. Care also needs to be taken at intersections to ensure visibility is not reduced by the rail. Specialist road safety engineering input may be required to confirm sight rail configuration on difficult sites. In some scenarios, depth of post may be increased if stability issues mean the posts may be undermined.

3.5 Pavement Design

Pavement repairs are generally required as reinstatement for adjacent faults (under slips, over slips, culvert reinstatement). The below standardised pavement designs in Table 11 are to be applied to MRRT work. These pavements have been agreed with MDC. Designers should shown pavement tie-in locations on their plans, and add the following comment to their drawings:

- “Pavement design and tie-in details to be determined by the Contractor, based on the Level of Service Guidelines.”

Other considerations:

- Subgrade CBR readings to be through inferred Scala Penetrometer results,
- Construction and testing of pavement layers as per NZTA guidelines TNZ B/02:2005,
- Cement stabilisation of the basecourse only recommended where the pavement will be left unsealed for longer duration of time, or where pavement will be under higher than standard stresses. To be determined by MRRT.
- Tie-in of pavement layers,
    - 1.0m joint offset between subbase and basecourse layers for full pavement rehabs,
    - 0.5m joint offset between subbase and basecourse layers for patches and trenches,
    - 100-300mm seal overlap over the existing chipseal surface.
- 2-coat chipseal, grade 3/5, to be applied as a first coat on pavement repairs.

Designs have been prepared based on the road AADT and HCV traffic.

Table 11: MRRT Pavement Designs

AADT	%HCV	Road Names	Subgrade CBR 1	3	5	7	10	15
			Pavement Thickness (mm) (Top 150mm to be AP40, balance to be AP65)					
>500	15*	MAHAKIPAWA HILL GROVE TRACK QUEEN CHARLOTTE DRIVE NORTHBANK ROAD (NORTHBANK) (SEALED SECTIONS)	910	550	410	340	275	210
200 to 500	30*	High HCV (Routes where pavement is subjected to High HCV use, i.e. Forestry routes etc)	885	530	400	330	270	200
200 to 500	10*	KENEPURU ROAD (LINKWATER-HEADS) MOETAPU BAY ROAD ONAMALUTU ROAD WAIKAKAHO ROAD CROISILLES-FRENCH PASS ROAD CROISILLES ROAD ANAKIWA ROAD WAIHOPAI VALLEY ROAD	780	470	360	290	240	180
>200	10*	AWATERE VALLEY ROAD2 (MEDWAYJORDAN) AWATERE VALLEY ROAD3 (JORDANLIMESTONE) AWATERE VALLEY ROAD4 (LIMESTMOLES) TOREA ROAD TE MAHIA ROAD ELIE BAY ROAD MANAROA ROAD TITIRANGI ROAD KENEPURU ROAD (HEADS-RAETIHI) CHURCH LANE TE ROU ROAD TOP VALLEY ROAD WAIMARAMA STREET LEATHAM ROAD PORT UNDERWOOD ROAD TENNYSON INLET ROAD TUMBLEDOWN BAY ROAD URE ROAD KAIUMA BAY ROAD KAIUMA ROAD PUKENUI ROAD TEPUIA HEIGHTS TYNTESFIELD ROAD	690	420	320	260	210	160
	* Where high levels of HCV movements are anticipated a site-specific pavement design should be done to confirm required pavement depth							

4 Fault Examples

4.1 Underslips

4.1.1 Surficial slides & side cast fill failures

Figure 3: KEN-602-20535

Figure 4: QCD-706-3526

4.1.2 Scour related underslips

Figure 5: QCD-716-6160

Figure 6: AVR-857-14206

4.1.3 Global / Deep-seated movements

Figure 7: KEN-602-5836

Figure 8: KEN-602-39650

4.1.4 Retaining wall failures

Figure 9: KEN-602-28545

Figure 10: KEN-602-12795

4.2 Over Slips

Figure 11: KEN-602-1754

Figure 12: KEN-602-1684

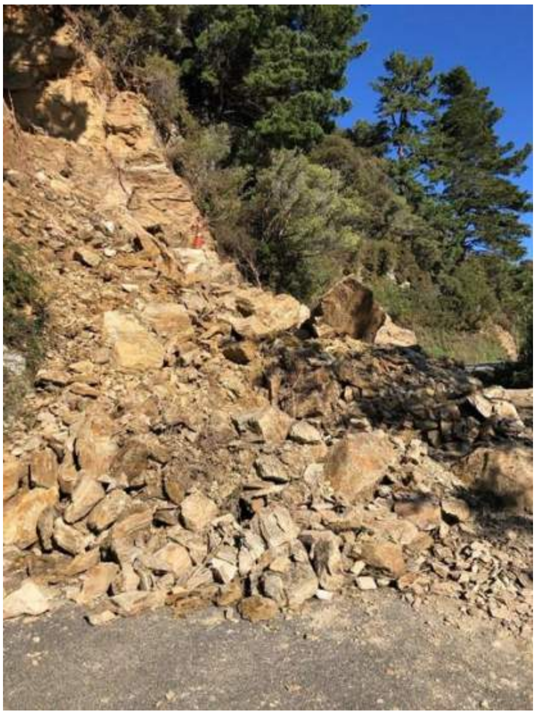


Figure 13: KEN-602-19640

4.3 Culverts

Figure 14: AWA-856-1184-1184

Figure 15: AWA-857-11005

Figure 16: QCD-629-1004

Figure 17: QCD-716-12172

4.4 Scour

Figure 18: AWA-857-14247

Figure 19: PEL-596-112

Figure 20: NOR-5

Figure 21: OTH-788-2614

Figure 22: OTH-805-28177

Appendix A

Technical Note #1

Hollow Bar Anchors

9 Sheffield Street
Riverlands, Blenheim
Telephone 0800 213 213

Memorandum

To	Steve Murrin, Andrew Adams
From	Gina Yukich
Cc	Ken Clapcott, Dan Chamberose, Raquel Miller Sigfrid Dupre
Date	4/07/2024 (Version 2)
Subject	Technical note – Hollow bar anchors

Background

Design being undertaken for the Marlborough Recovery Team (MRRT) under a design & construct contract for remediation of the underslip and upslope cut batter at 216 Duncan Bay Road (FRP-528-02196) has proposed the use of Ischebeck Titan T30/11 hollow bar, self-drilling anchors.

The MRRT Level of Services Guidelines sets out the standards which designers are required to use for projects on the Marlborough recovery. This document does not currently mention use of hollow bar anchors. Where not covered by the LoS Guidelines, the NZTA Bridge Manual (current edition) should be used to inform design. Technical Advice Note #20-10 sets out Waka Kotahi's position on the use of hollow bars which states that the system does not comply with the Bridge Manual and raises concerns around its durability (Waka Kotahi, 2020).

This technical note is intended to provide a discussion on the use of hollow bar anchors on the Marlborough recovery in the context of low volume local roads with infrastructure design life targets of 50 years.

Note: The term 'anchor' is being used in this in this document to encompass all systems using grouted steel tendons – i.e. soil nails, bolts and tie-back anchors. The terms 'passive' and 'active' or 'tensioned' will be used to differentiate between different use cases.

Ischebeck Titan Anchors

Ischeheck Titan bars are hollow steel bars that serve as both the drill string and the permanent anchoring tendon. They are drilled into the ground using a sacrificial, hollow drill bit that has a larger diameter than the bar. Grout is pumped through the bar, flushing the hole of soil and rock chips and filling the anulus. The system has benefits at sites with collapsible ground conditions as it removes the need install casing. Even without the need for casing, the system has benefits in speed of construction in comparison to traditional open hole drilling methods and can significantly reduce costs.

When compared with traditional drilling methods, there has been research showing that grout-ground bond strengths with hollow bar anchors were higher for the same drill-bit diameter (Federal

Highway Administration, 2015). This is due to the widening of the hole diameter during the drilling process and pressure filling of the grout, assumed to create more pronounced roughness features.

Discussion

The MRRT Level of Service Guidelines allow for the use of Class 2 corrosion protection for anchors (galvanised or epoxy coated), provided that sacrificial corrosion of the anchor bar is allowed for after loss of galvanic protection. This is a reduction in the level of service required by the NZTA Bridge Manual which may require Class 1 (double corrosion protection) in certain instances, such as aggressive soil conditions or when failure may affect nearby buildings (NZ Transport Agency, 2022).

Hollow bar, self-drilling anchors, even when galvanised and epoxy coated, do not comply with the Class 2 Bridge Manual requirements primarily due to concerns about durability. Hollow bar tendons can be subject to high abrasion and friction during installation, resulting in possible damage to the epoxy and galvanised coatings and reduction in their life. The extent of coating damage likely to occur is uncertain. It is also known that galvanised coatings have a level of abrasion resistance due to their cathodic protection effect on steel and so, where used for non-critical parts of a structure, allowing for sacrificial corrosion over the design life may be considered an acceptable approach.

Consistent grout cover is harder to control with self-drilling anchors. Grout-flushing is recommended where grout is pumped through the bar and a good return is achieved at ground surface to provide certainty that all voids have been filled. Actual grout volumes should be monitored against theoretical volumes. Water flushing should not be used as it has been shown to impact bond strengths (Federal Highway Administration, 2015).

Note: The grout anulus around the bar is not considered a form of corrosion protection due to the probable formation of shrinkage cracks during curing, and subsequent widening of these cracks under tensioning of the anchors. For passive anchors with no pre-tensioning, crack formation is anticipated to be minimal and some self-healing of cracks occurs. The assumption of no protection from the grout therefore may be conservative.

Going forward, we recommend that hollow bar anchors be considered on a site-by-site basis for Marlborough Roads recovery. Designs would be required to meet the following conditions:

- A maximum design life of 50 years
- Only galvanised and epoxy coated Ischebeck Titan bars are used.
- Grout cover is not used as a form of corrosion protection. Sacrificial corrosion after breakdown of the galvanic protection is allowed for in design. Conservative corrosion rates should be used.
- Drill holes are grout flushed. No water flushing may be used. Air-flushing may be used during drilling provided some grout flushing occurs during the last drilling lengths to maximise grout encapsulation.
- Hollow bars are only used as passive anchor systems where there is no pre-tensioning load.
- There is redundancy in the system and failure of an individual element would not result in catastrophic failure of the entire structure or slope.
- Corrosion protection in the form of petrolatum wrap and PVC tape is applied to a nominal ‘unbonded’ length at the face of the slope where elongation, oxygen exposure and potential exposure to sea spray is likely to be the highest.

Hollow bars other than the Ischebeck Titan bars may be considered on a site by site basis.

References

Federal Highway Administration. (2015). *Soil Nail Walls Reference Manual.* US Department of Transportation .

NZ Transport Agency. (2022). *Bridge Manual (SP/M/022)* (Third Edition, Amendment 4 ed.). Wellington: Waka Kotahi.

Waka Kotahi. (2020, April 30). *#20-10 Use of hollow bar ground anchors and soil nails*. Retrieved from Technical Advice Notes: https://www.nzta.govt.nz/resources/20-10-use-of-hollow-bar-ground-anchors-and-soil-nails/

Appendix B

Technical Note #2

Fish Passage

9 Sheffield Street
Riverlands, Blenheim
Telephone 0800 213 213

Memorandum

To	Steve Murrin, Andrew Adams
From	Simon Smith, Gina Yukich
Cc	Ken Clapcott, Dan Chamberose, Raquel Miller, Geoff Ward
Date	1/09/2023 FINAL
Subject	Technical note – Fish Passage

Note: This technical note was provided to MDC and updated following advice on the definition of 'bed width' - the definition in this technical note has been updated to state that the bed width should be based on the normal / average active flow width of the channel (as opposed to the 'current' flow width as previously stated).

Culvert Installation Requirements

1. If the culvert is to support / carry stormwater run-off and drainage from the road surface and hillside only, then no fish passage requirements are needed.

   For these culverts, they must be flumed as per the Level of Service Guidelines to prevent downstream / release erosion as well as be protected from scour erosion around the pipe at the entry and exit points.

2. If the culvert is to support / carry an ephemeral or permanently flowing water channel and it is recognised as a 'blue line' waterway on a NZ Topo 50,000 map, or the previous culvert pipe was installed in a manner that has supported fish passage until the storm event, then fish passage provision **MUST** be provided for in the new installation.

   The installation must meet the criteria below as far as practicable, which is extracted from Subpart 3 of the National Environmental Standard for Freshwater, Condition 71.

Conditions (NES-F)

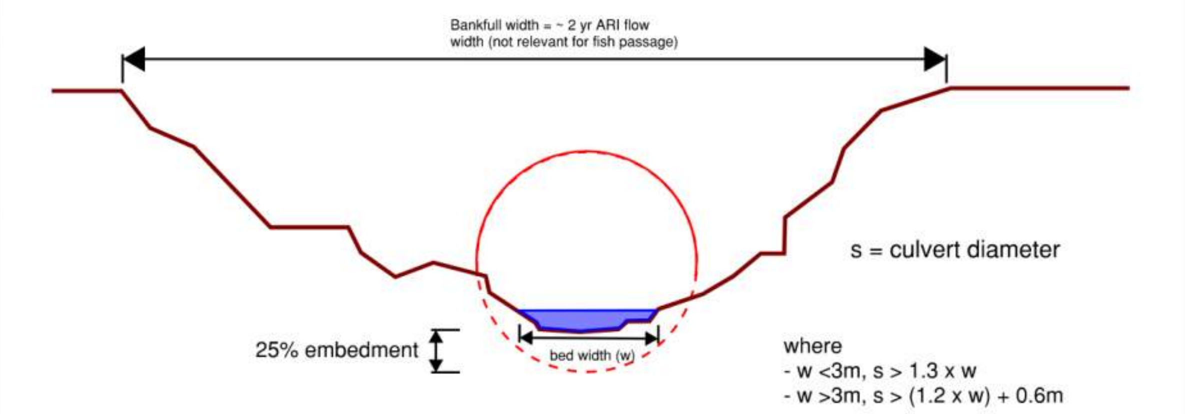
(a) the culvert must provide for the same passage of fish upstream and downstream as would exist without the culvert, except as required to carry out the works to place, alter, extend, or reconstruct the culvert; and
(b) the culvert must be laid parallel to the slope of the bed of the river or connected area; and
(c) the mean cross-sectional water velocity in the culvert must be no greater than that in all immediately adjoining river reaches; and
(d) the culvert's width where it intersects with the bed of the river or connected area (**s**) and the width of the bed at that location (**w**), both measured in metres, must compare as follows:
   (i) where $w \leq 3$, $s \geq 1.3 \times w$:

(ii) where w > 3, s ≥ (1.2 × w) + 0.6; and

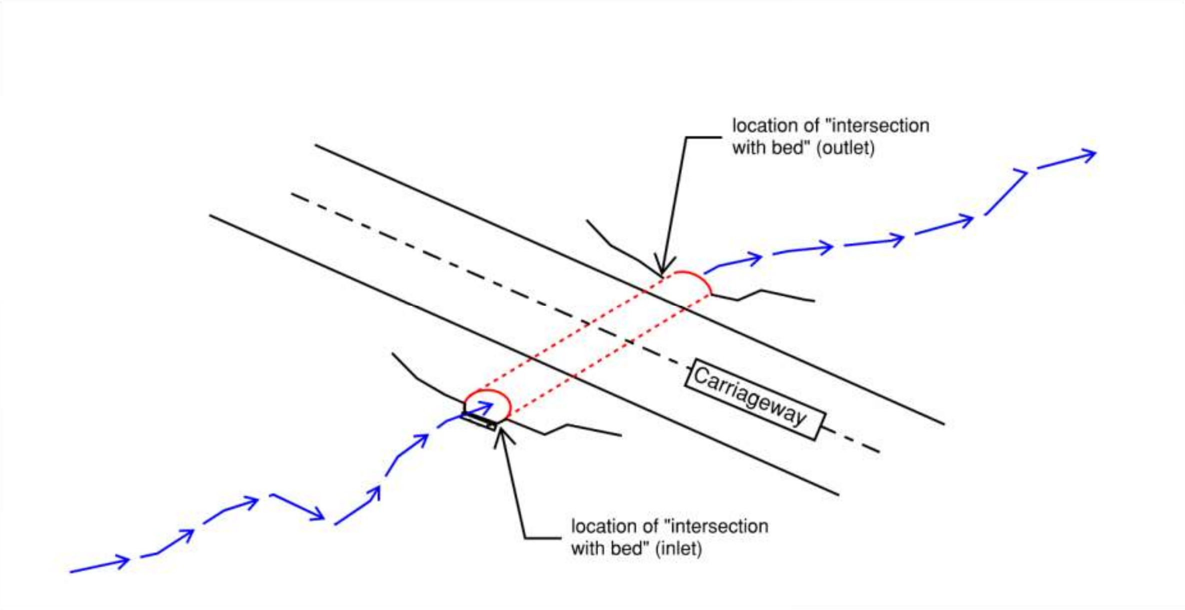
(e) the culvert must be open-bottomed or its invert must be placed so that at least 25% of the culvert's diameter is below the level of the bed; and

(f) the bed substrate must be present over the full length of the culvert and stable at the flow rate at or below which the water flows for 80% of the time; and

(g) the culvert provides for continuity of geomorphic processes (such as the movement of sediment and debris).



Note:
- Bed width (w) doesn't appear to have a consistent definition in the NES-F
- For MRRT projects, in lieu of a site -specific assessment by a qualified person, bed width (w)will be taken at the normal, active flow channel width / wetted flow channel width. During site inspection, bed width should be assessed with consideration to whether the stream is at high/low flow
- an example of "width of the culvert where it intersects the bed" would be the diameter of a circular culvert (s) at the inlet should be 1.3 x the width of the bed at the same location (or the outlet if it is larger).



Other structures

If you are looking to install anything other than a culvert within the flow channel – e.g. weir, dam, ford, flap gate, apron or ramp, please STOP and contact the MRJV Environmental Advisor (details on next page) or review the NES-F guidelines for these structures:

https://www.legislation.govt.nz/regulation/public/2020/0174/latest/LMS364099.html#LMS364310

Fish Passage approved methodology by Waka Kotahi – Initiative adopted after July '21 Event

This methodology is intended for use on the Marlborough Recovery Programme. Culvert sizing and fish passage design process shall be as follows:

(a) Culverts to be sized appropriately to allow 25% embedment as per the NES-F
(b) Culvert widths to be sized appropriately to ensure culvert diameter (s) is correct with respect to bed width (w) as per the NES-F
(c) Culvert beds shall either have a natural bed substrate installed through the length of the culvert to achieve the 25 % embedment criteria, OR an artificial substrate formed from concrete & rock baffles as outlined below:

During pouring of concrete footings or culvert bases, add local stream rock to create baffles to provide for water velocity reduction and rest areas for migrating fish.

No sizing or placement specifications, but space them apart and choose rocks of a size not to block debris. Rock sizing should mean they are likely only visible at lower seasonal flows, see examples below.

300mm pipe diameter - Wakamarina

1.5m pipe diameter – Awatere

If you are unsure of whether the waterway you are working on requires fish passage or not, contact Simon Smith – MRJV Environmental Advisor on simon.smith@marlboroughroads.com

You can review whether the waterway is a 'blue line' waterway in Marlborough using the MDC Smart Maps application https://smartmaps.marlborough.govt.nz/smaps/

Further examples provided on the following page.

Drainage culverts installed appropriately, minimising erosion

Culvert Installations supporting fish passage

Appendix C

Technical Note #3

Landscape planting

9 Sheffield Street
Riverlands, Blenheim
Telephone 0800 213 213

Memorandum

To	Steve Murrin, Andrew Adams
From	Simon Smith, Gina Yukich
Cc	Ken Clapcott, Dan Chamberose, Raquel Miller, Geoff Ward
Date	04/07/2024 (Version 2)
Subject	Technical note – Landscape planting

Background

As part of the Zonal Resource Consent Applications, MRRT submitted a Landscape Management Plan (LMP) to Marlborough District Council. This plan addresses the fact that much of the recovery programme is taking place in areas of 'High Amenity' landscape and 'Outstanding Natural Landscape Areas (ONLs). These facts mean that MRRT needs to consider how we reinstate sites to reduce the visual and environmental impact of engineering structures and earthworks. The objective of the Landscape Management Plan is to provide a landscape that appears as natural as possible.

This document specifically has been written, based on the LMP, to outline a simplified approach to re-planting sites where possible as mitigation for the vegetation removal that is occurring as part of remedial works. Some re-planting is occurring as a requirement of private land acquisition negotiations.

Scenarios

Vegetation removal is occurring in the following scenarios:

- Road retreats – large scale earthworks cutting into the slope above to road to move the road away from an underslip. Resulting slopes are typically very steep >50 degrees.
- Earth fills & MSE walls – large earthworks in gullies below the road to build up engineered slopes to remediate underslips. Resulting slopes range from 30 – 70 degrees.
- Construction access for retaining structures, culverts & other works – smaller areas of vegetation clearance as required to enable construction works.

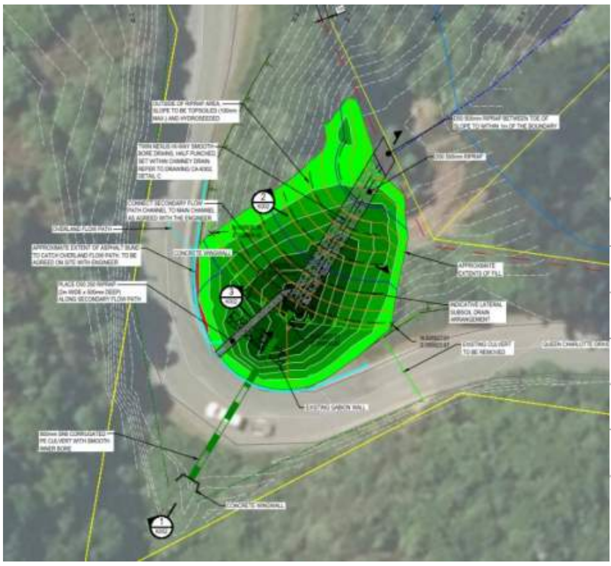
Our Zonal Resource Consent requirements put onus on MRRT to keep vegetation removal to a minimum and replant where possible. The LMP provides guidance on planting on low angle slopes (14 – 27 degrees) however the steep terrain in Marlborough has made this infeasible in most locations. The LMP also provides detailed lists of suitable plant species for each of the zonal recovery areas where work will be undertaken, and should be reviewed when plant selection is being considered.

Advice

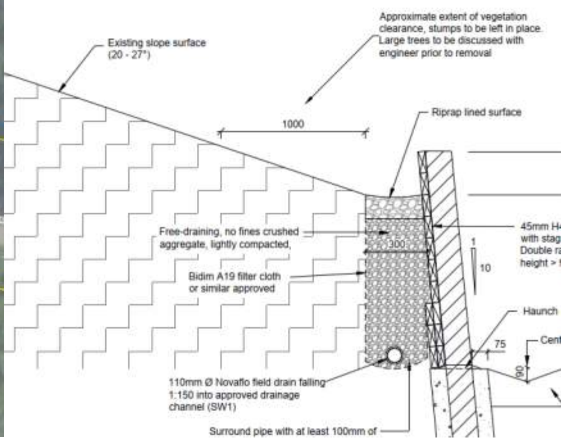
Slope angles <2H:1V (<27 degrees)

This is likely to be small areas where vegetation has been cleared for access tracks & work areas, low angle slopes in front of retaining walls, or larger sites, like DP-020 QCD-561-00514 Pukenui earth fill.

- High amenity area:
    - Place topsoil at a thickness of 100 – 300mm
    - Apply mulch or biodegradable coir matting on the slope.
    - Plant locally sourced plants through the coir matting, suited to the Inner Marlborough Sounds (or relevant to the region of Marlborough where the works are located). Species selection to be carried out by the landscape subcontractor and plants to be spaced appropriately for their size.
    - Planting should be carried out between the beginning of May and beginning of September to maximise success.
    - **Note:** proposed vegetation must not block sight lines around corners and on single lane sections
- Low amenity area (i.e. not visible from road, Link Path or shoreline)
    - Hydroseed directly onto insitu soil.



DP-020 – Pukenui earth fill



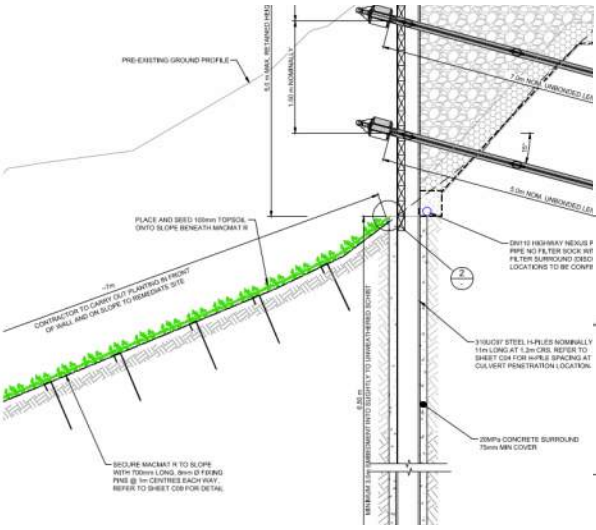
DP-085 CFP RP11.050 Retreat

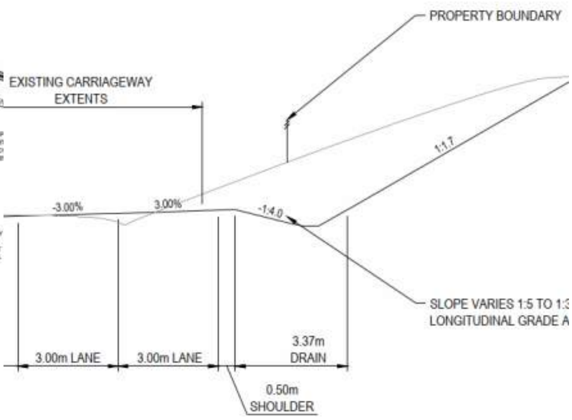
Slope angles 2H:1V – 1H:1V (27 – 45 degrees)

This is likely to be low angle cut batters (in soil), embankments and reinforced soil slopes and in some cases, underslip scarps below the road. Example sites – DP-025 QCD-561-02407 retreat, DP-002 QCD-716-01400 Aussie bay (below the wall)

- Soil slope:
    - Apply biodegradable coir matting to the slope, or in areas of high erosion potential, pin Geomat, Macmat R or equivalent product to the face of the slope.
    - Plant locally sourced plants through the matting, suited to the Inner Marlborough Sounds. Species selection to be carried out by the landscape subcontractor and plants to be spaced appropriately for their size.

- o Planting should be carried out between the beginning of May and beginning of September to maximise success.
  - o The entire area of the slope does not require planting if the slope is high / access is difficult. Planting should be focused on a strip close to the road corridor or the most visually impactful area (Link pathway).
  - o The portions of the slope not planted should have hydroseed directly applied.
- Rock slope:
  - o No treatment unless rock is sufficiently weathered for hydroseed to strike.





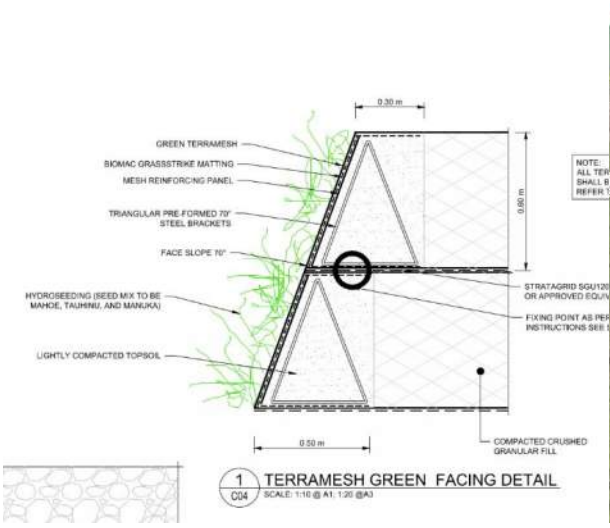
DP-002 – Aussie Bay underslip

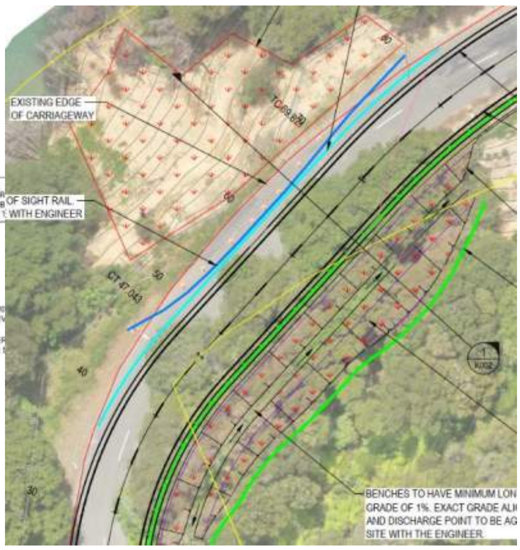
DP-025 Grove Track Ceramics road retreat

Slope angles >1H:1V (>45 degrees)

This is likely to comprise of cut slopes above the road, steep slip faces below the road and 70 degree MSE wall faces.

- Hydroseed directly onto slope face only where there is soil that is likely to have a successful seed strike,
- Consider if there are access tracks or work areas around the work site that could be re-planted as per advice above.





Appendix D

Design Vehicle and Check Vehicle map of the Marlborough Sounds

LEGEND:

- (blue line) DESIGN VEHICLE 1: AUCKLAND TRANSPORT - TRUCK - 12.6m - NO HITCH
  DESIGN VEHICLE 2: AUCKLAND TRANSPORT - 85th - CAR WITH CARAVAN
  CHECK VEHICLE: RTS-18 SEMI TRAILER (17.9m)
- (green line) DESIGN VEHICLE: AS/NZS 2890.1:2004 B99 VEHICLE
  CHECK VEHICLE: 17.9m SEMI TRAILER (RTS-18)
- (magenta line) DESIGN VEHICLE: NONE
  CHECK VEHICLE: 17.9m SEMI TRAILER (RTS-18)
- (orange line) DESIGN VEHICLE: NONE
  CHECK VEHICLE: 12.6m RIGID TRUCK

DESIGN VEHICLES:
DESIGN VEHICLES ARE THE LARGEST VEHICLES THAT FREQUENTLY USE PARTICULAR ROADS. THEY ARE EXPECTED TO BE ABLE TO REMAIN WITHIN THEIR ALLOTTED TRAFFIC LANE.

CHECK VEHICLES:
CHECK VEHICLES ARE LARGER VEHICLES THAT MAY BE EXPECTED TO USE A ROAD FROM TIME TO TIME. THEY MAY NOT BE ABLE TO REMAIN WITHIN A TRAFFIC LANE AT ALL TIMES.

TYPICAL ROAD EXAMPLE:
DESIGN VEHICLE 1: AUCKLAND TRANSPORT - TRUCK - 12.6m - NO HITCH
DESIGN VEHICLE 2: AUCKLAND TRANSPORT - 85th - CAR WITH CARAVAN
CHECK VEHICLE: RTS-18 SEMI TRAILER (17.9m)

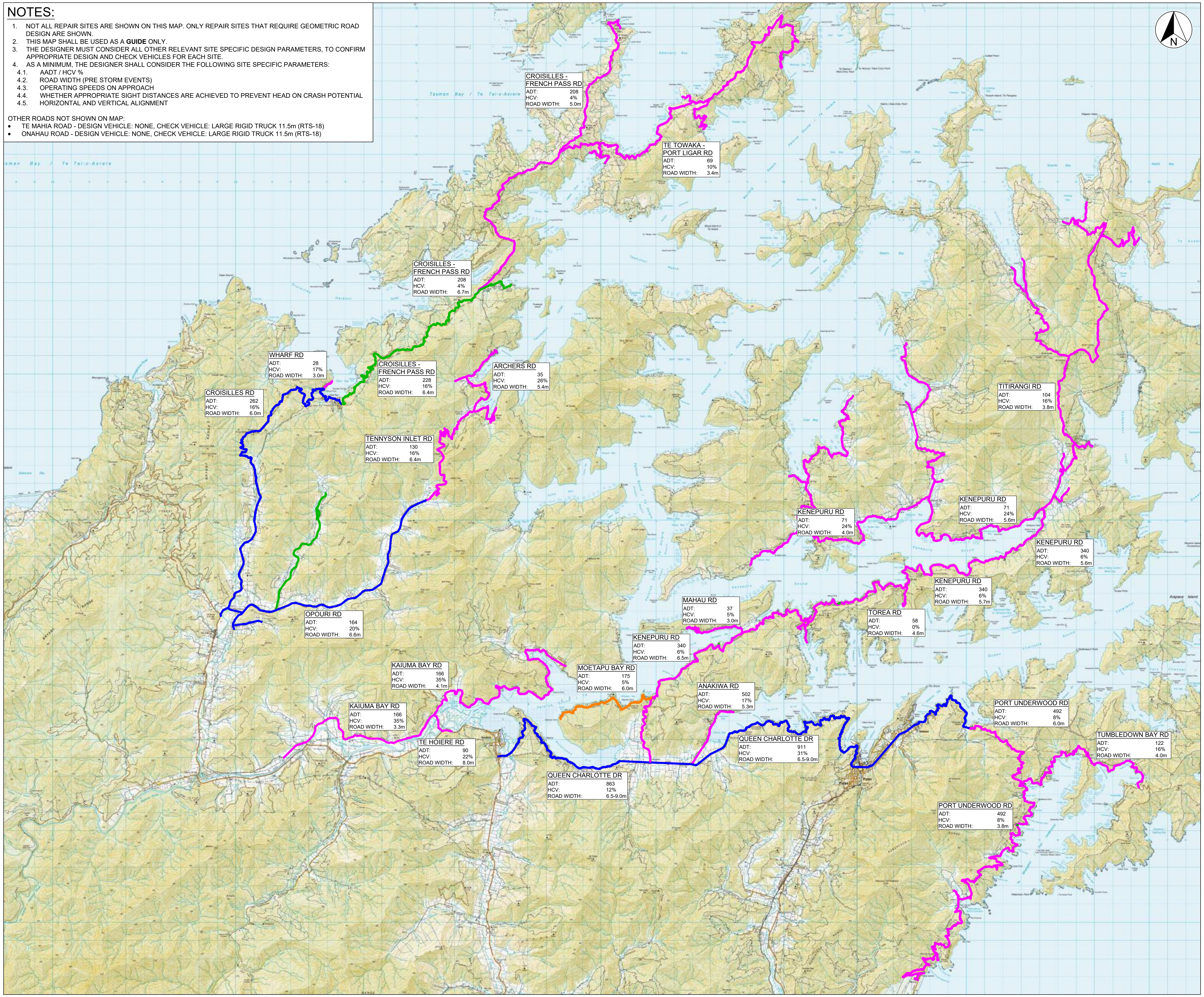
TYPICAL ROAD EXAMPLE:
DESIGN VEHICLE: AS/NZS 2890.1:2004 B99 VEHICLE
CHECK VEHICLE: 17.9m SEMI TRAILER (RTS-18)

TYPICAL ROAD EXAMPLE:
DESIGN VEHICLE: NONE
CHECK VEHICLE: 17.9m SEMI TRAILER (RTS-18)

NOTES:

1. NOT ALL REPAIR SITES ARE SHOWN ON THIS MAP. ONLY REPAIR SITES THAT REQUIRE GEOMETRIC ROAD DESIGN ARE SHOWN.
2. THIS MAP SHALL BE USED AS A **GUIDE** ONLY.
3. THE DESIGNER MUST CONSIDER ALL OTHER RELEVANT SITE SPECIFIC DESIGN PARAMETERS, TO CONFIRM APPROPRIATE DESIGN AND CHECK VEHICLES FOR EACH SITE.
4. AS A MINIMUM, THE DESIGNER SHALL CONSIDER THE FOLLOWING SITE SPECIFIC PARAMETERS:
   - 4.1. AADT / HCV %
   - 4.2. ROAD WIDTH (PRE STORM EVENTS)
   - 4.3. OPERATING SPEEDS ON APPROACH
   - 4.4. WHETHER APPROPRIATE SIGHT DISTANCES ARE ACHIEVED TO PREVENT HEAD ON CRASH POTENTIAL
   - 4.5. HORIZONTAL AND VERTICAL ALIGNMENT

OTHER ROADS NOT SHOWN ON MAP:
- TE MAHIA ROAD - DESIGN VEHICLE: NONE, CHECK VEHICLE: LARGE RIGID TRUCK 11.5m (RTS-18)
- ONAHAU ROAD - DESIGN VEHICLE: NONE, CHECK VEHICLE: LARGE RIGID TRUCK 11.5m (RTS-18)



Appendix E

Technical Note #4

New One Lane Sections

9 Sheffield Street
Riverlands, Blenheim
Telephone 0800 213 213

Memorandum

To	Steve Murrin, Andrew Adams
From	Rhys Palmer, Ken Clapcott
Cc	Gina Yukich, Dan Chamberose, Raquel Miller, James Cooper
Date	March 2024
Subject	Technical note #4 – New one lane sections

Document history and Status

Rev	Date	Author	Approved by	Status
Draft	March 2024	RP/KWC		DRAFT
1	April 2024			Issue 1
2	July 2024	JC	AA	Issue 2

This document outlines the expected design procedure for sites selected to be **new** one lane sections of road with priority control. There are many sections of road within the Marlborough Sounds less than 5m in total carriageway width that typically have no centreline but dual edgelines. Treatment of a narrow carriageway is not covered by this guidance note.

When considering if a section of road should be treated as a 'narrow carriageway', designers should look at the adjacent 5 kilometres of road. For example, it is expected that Kenepuru Road (Portage to Heads) would be a narrow carriageway and therefore not require consideration under this guidance.

Specific sites selected for new one lane sections have been identified by the MRRT design hub.

The purpose of this document is:

- Confirm roles and responsibilities.
- Provide context and guidance to designers to achieve a consistent network wide end user experience.
- Confirm appropriate levels of safety are provided for road users to minimise risk of serious injury or death.
- Ensure new one lane sections of road are fit for purpose.
- Confirm the minimum required design elements for verification & documentation.

This document must be read in conjunction with the MRRT Level of Service Guidelines.

Roles and Responsibilities for road design of new one lane sections:

Simple Sites:	Complex Sites:
Client: Overall acceptance of project designs	Client: Overall acceptance of project designs
Client Assurance Team: Confirm designs provide value for money.	Client Assurance Team: Confirm designs provide value for money.
MRRT Design Hub: Complete design and documentation	MRRT Design Hub: Identify sites, manage consultants, confirm consultant designs are fit for purpose
	Design Consultant: Complete design and documentation

Design Parameters

Designs must fit within the context and environment of the current road network and vehicle restrictions / allowances. If it is challenging to design to the context and environment, apply the following as guidance to assist, failing this refer to the Design Hub for further guidance and support

1. **Operating Speed**

Operating speeds of vehicles approaching the site must be determined to inform an appropriate design speed for each site. Designers are expected to consider various methods to select an appropriate design speed, refer to the Design Hub for clarification or guidance if required:

a. Where straights are longer than 200m and radii are larger than 50m, section 3 of Austroads Guide to Road Design Part 3 shall be used.
b. Review nearby existing curve radii and make an informed assessment.
c. Megamaps GPS data can be used to help to inform operating speeds but should not solely be relied upon.
d. Visit site and document floating speeds.
e. If design cannot use a combination of some of the above methods to confirm, the design shall consult the design hub or client for advice and recommendations.

Site-specific changes to regulatory speed limit restrictions that lower the posted speed limit for the section of road shall not be expected or relied upon. However, if there are several one lane sections closely spaced or the one lane section is very close to an existing change in regulatory speed, this may be recommended by the designer for Client consideration.

2. **Sight Distance**

Sight visibility of the whole length of the one lane section must be available from each end of the site. In the case of multiple one lane sections, the minimum requirement is to provide sight between each section with a layby to allow a driver to make a decision and react, then proceed into the next one lane section.

Designers shall identify if there are vegetation envelops that need to be kept clear in order to achieve the minimum sight distance requirements.

3. Advance Warning Signage

Queuing vehicles which are stopped in the live lane present a potential hazard for approaching vehicles. The placement of the limit line and queuing area must consider whether Stopping Sight Distance is achieved. It is accepted that due to existing site constraints, providing Stopping Sight Distance may not be possible in some circumstances. Where this is the case, additional signage to warn road users of potential hidden queues shall be considered by the designer.

Advance warning signs to the one lane section (shall be considered if the road alignment does not provide SSD visibility to the one lane signs, or the vehicles queuing at the single lane approach at each end of the site.

The designer shall check SSD to the rear of a queue length of 6m and 12m at each end of the site.

Available SSD shall be shown and documented on the design drawings.

4. Selection of priority direction:

The approach that is given priority shall be considered on the basis of the full section of road surrounding the proposed one lane site. Road sections considered should be approximately 5 km long, but may be shorter if the road environment has a significant change in character (such as crest of significant hill). The following factors shall be considered:

a. The approach with the most visibility typically gives way.
b. If the approach with the most visibility is inconsistent with an adjacent one lane arrangement, then check if there is enough visibility for the alternative approach to give way and operate safety. i.e. is there Site Stopping Distance (SSD) available on both approaches?
c. If the approach with the most visibility is inconsistent with an adjacent one lane arrangement, can visibility be improved by way of vegetation trimming or sight bench construction (with appropriate geotechnical advice and approval)?
d. If not, can the adjacent one lane section priority be modified as discussed in 2 & 3 above?

Once priority is determined, install the R2-7 and R2-7.1 priority give way signs to highlight the change to approaching vehicles.

Note: it is critical that avoiding the creation of a situation of 'blind priority' whereby road users with inadequate visibility for safe stopping prior to the single lane section might otherwise be encouraged to 'press on' and be unable to avoid a collision with an oncoming vehicle.

4. Vehicle tracking envelopes

The Design and Check vehicles are specified in the MRRT Level of Service Guidelines. Vehicle tracking envelopes shall be provided with the design drawings which demonstrate:

a. Queuing areas are sufficient to allow opposing design vehicles to pass each other with 300mm absolute minimum clearances between vehicles and obstacles.
b. Check vehicles can navigate the whole length of the site, Check vehicles can use the whole carriageway width if required (including the queuing areas).
c. For any sites where Check vehicles do not allow a design vehicle to queue without being struck, a design drawing showing appropriate pilot hold locations must be

provided by the designer. Note, implementation of any future restriction or requirement for a pilot vehicle is outside of the process of this project.

Where the road does not have a design vehicle specified in the Level of Service (only a Check Vehicle), the assessment steps above should be carried considering a AS/NZS 2890.1:2004 B99 car passing a car towing a caravan.

5. Queue space to two adjacent one lane sections

The queue space between two closely spaced one lane sections shall be a minimum distance of 30m (plus tapers). This shall be provided to allow vehicles to layby and thus two way traffic to pass between two closely spaced one lane sections. The width of this two lane section shall be sufficient to allow two design vehicles to pass, or for roads with no design vehicle, to allow a AS/NZS 2890.1:2004 B99 car to pass a car towing a caravan.

6. Layby Passing Bay within long one lane section

A layby passing lane space within a one lane section may be provided to 'bridge' visibility between each end. The layby Passing Lane layout is shown in attachment 2. Detail of example the layby sizes are shown in attachment three, the designer must check site specific tracking to confirm suitability. Three width options are shown to suit the available space on site in attachment 3. The three widths however do require different tapers and lengths to accommodate the design vehicles.

7. Surfacing

The single lane section approaches shall be sealed unless:

- Clear uninterrupted visibility of 2 x SSD is available; or
- The single lane section is not signed as the road has a low LoS as discussed in the application section above.

The seal is to provide a high skid resistance surface on the approach to potential conflict situations and to minimise the corrugation formation at locations that vehicles are accelerating and decelerating.

8. Traffic Light Control

Traffic light control is considered as a last resort due to low compliance and high operation and maintenance costs. Traffic light control should not be expected to be accepted by the client and requires approval from MDC before being developed at a site. Interim guidance available at https://www.nzta.govt.nz/assets/resources/intelligent-transport-systems/specifications/ITS-01-003-202111-STD-OLB-Interim.pdf

Proximity of a power source should be considered.

9. Road Safety Barriers

Typically on a section of one lane that is as a result of an underslip the road edge will be delineated with a timber sight rail. A road barrier to NZTA M23 standard should be treated as a departure.

10. Safe System Approach

Designers are encouraged to consider the safe system principles and apply them to these sites. If designers identify any areas where serious injury or death is at an increased risk than pre-design. These concerns and any recommendations must be raised to the client for consideration.

One Lane Priority – Design Process

If a single lane section appears the most appropriate way forward, but doesn't meet all the guidance and standards then a departure can be requested. The process of designing a one lane section and determining if a departure is required in shown in the flow chart below.

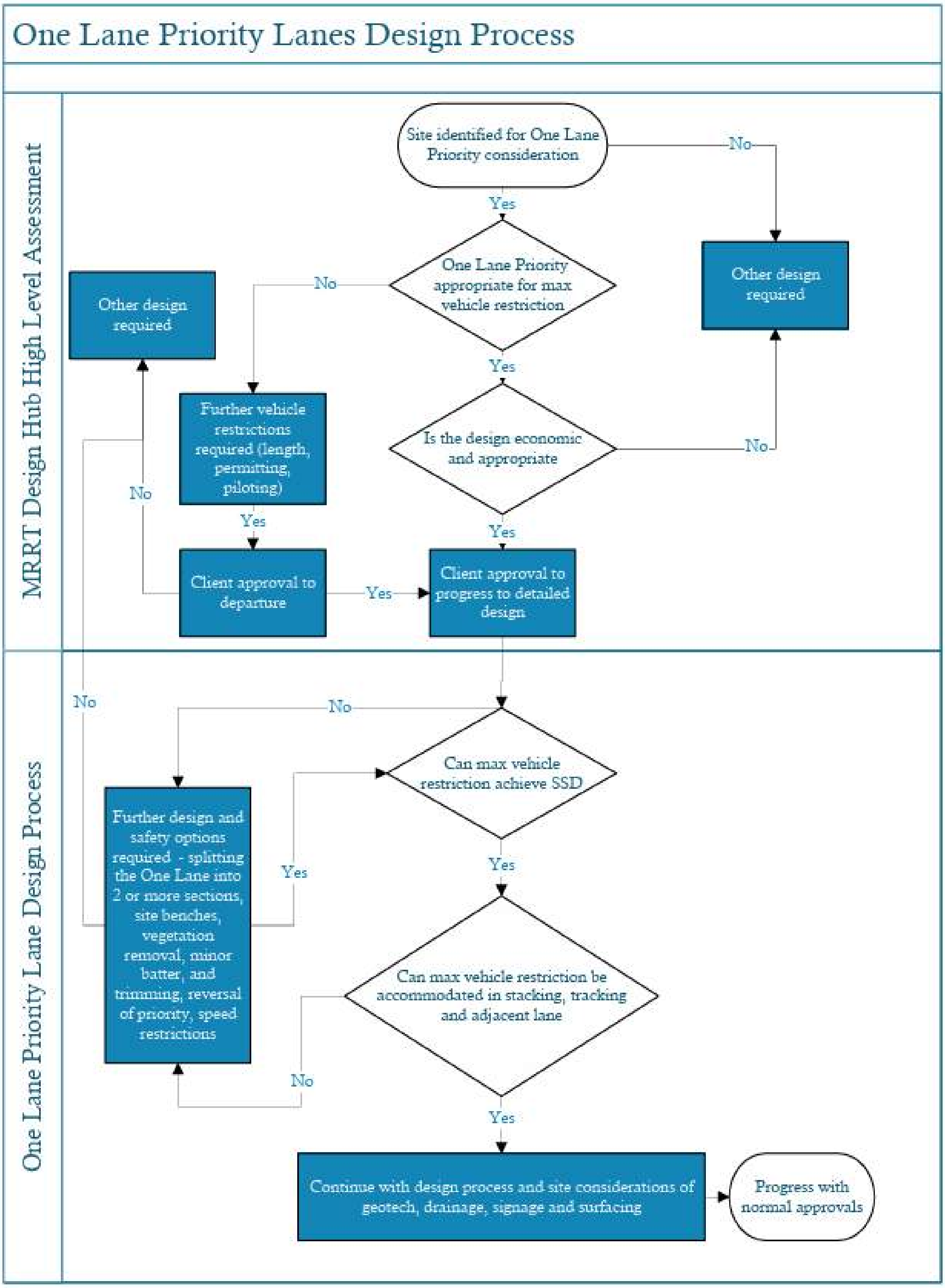
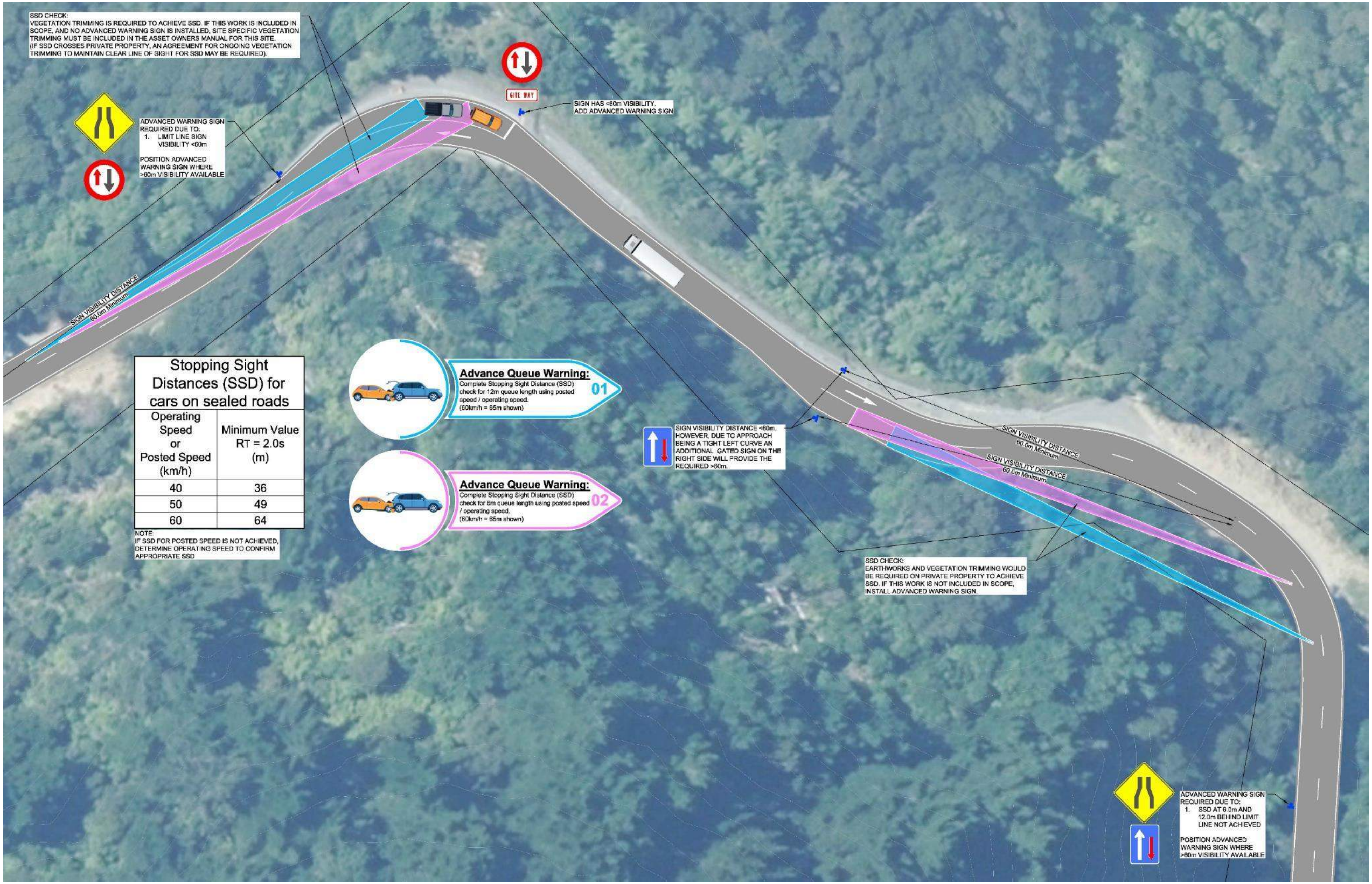


Figure 1 - Approval/Departure Process

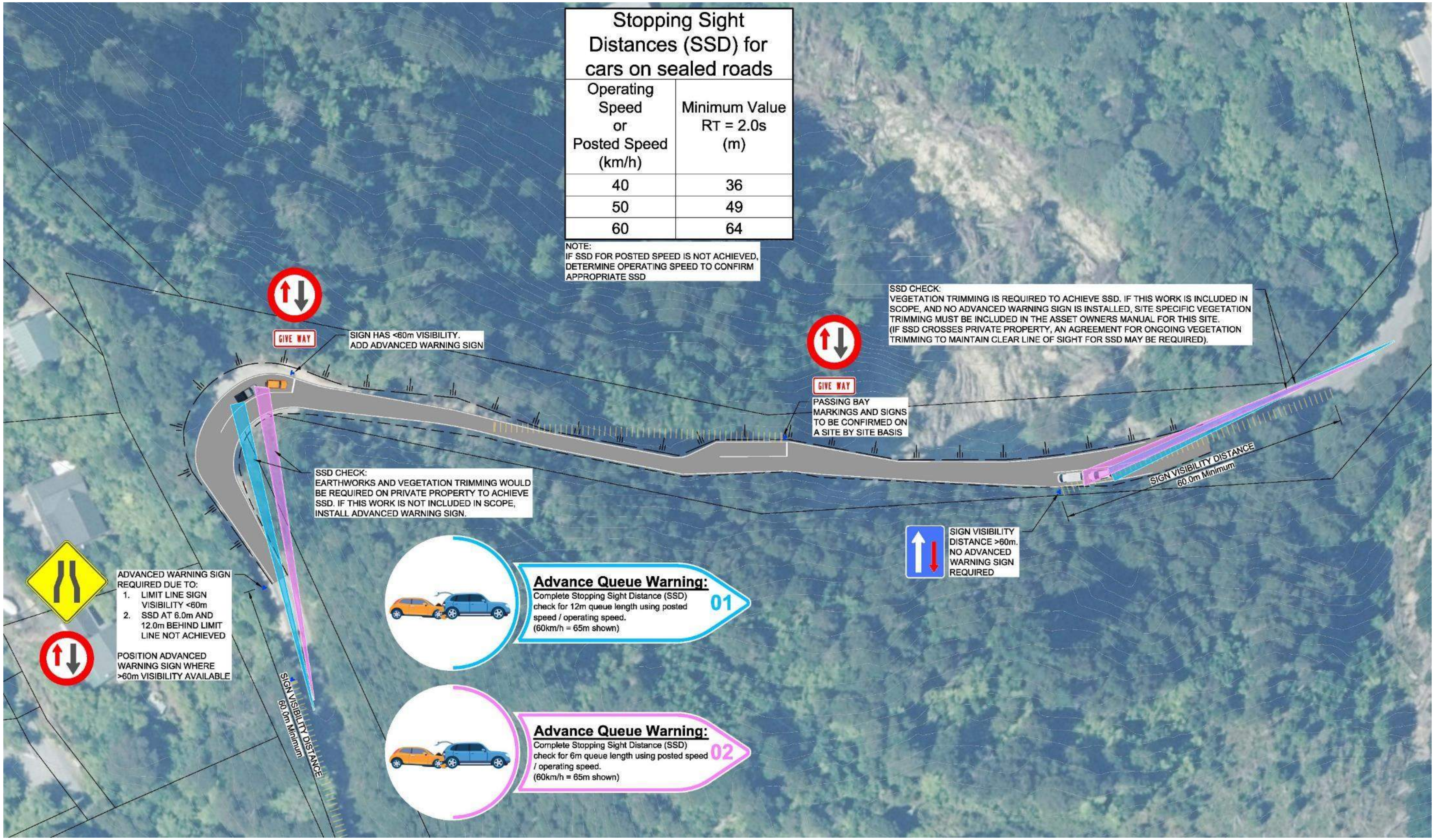
Attachment 2 – Marlborough specific examples one lane examples – Isolated One Way Section



Stopping Sight Distances (SSD) for cars on sealed roads	
Operating Speed or Posted Speed (km/h)	Minimum Value RT = 2.0s (m)
40	36
50	49
60	64

NOTE:
IF SSD FOR POSTED SPEED IS NOT ACHIEVED, DETERMINE OPERATING SPEED TO CONFIRM APPROPRIATE SSD

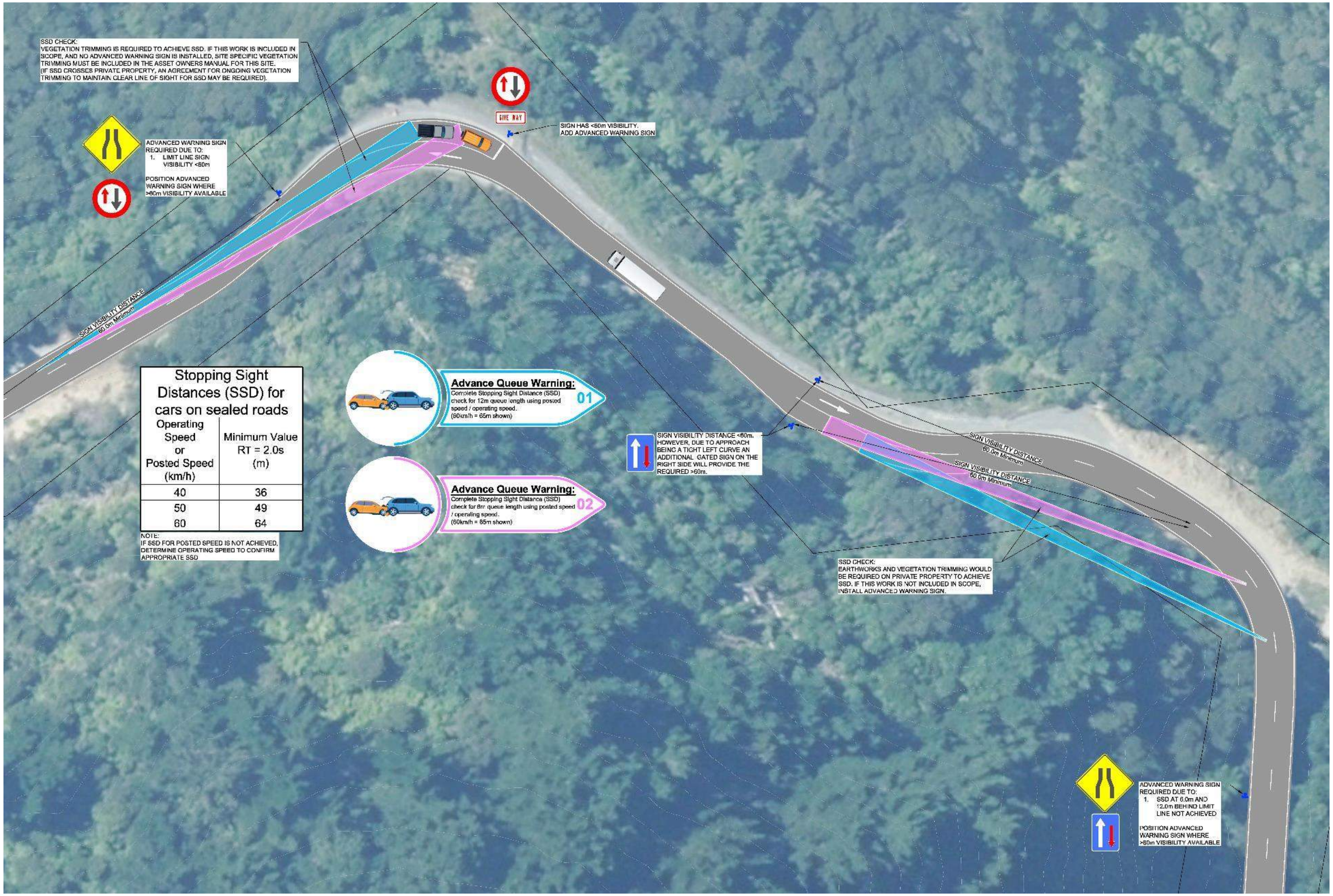
Attachment 2 – Marlborough specific examples one lane examples – One Way Section with Layby Passing Bay



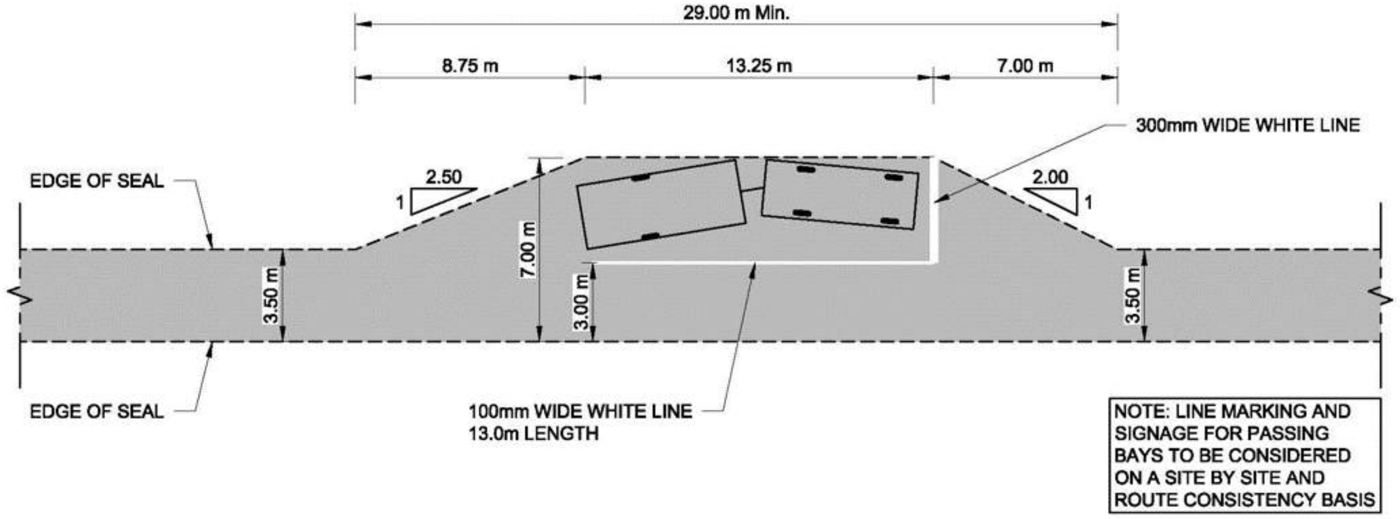
Stopping Sight Distances (SSD) for cars on sealed roads

Operating Speed or Posted Speed (km/h)	Minimum Value RT = 2.0s (m)
40	36
50	49
60	64

Attachment 2 – Marlborough specific examples one lane examples – One Way Section with advance warning signs

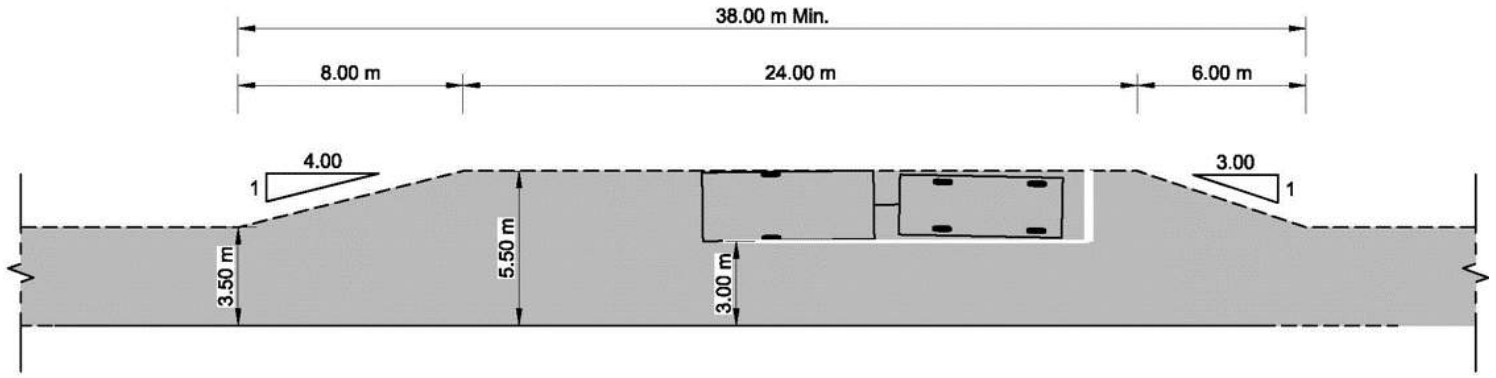


Attachment 3 –Layby Passing Bay Minimum Dimensions



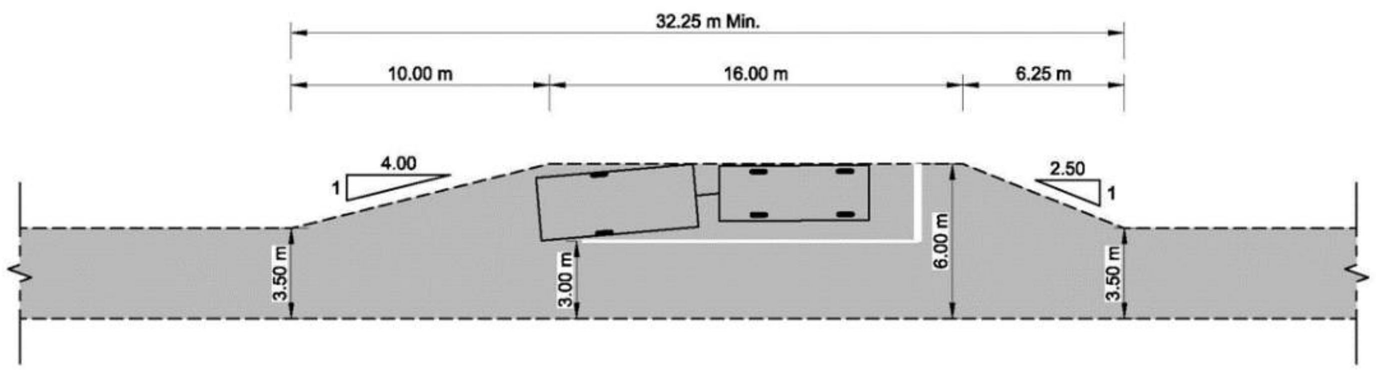
PASSING BAY EXAMPLE - 7.0m ROAD WIDTH

SCALE: 1:200 (A1) 1:400 (A3)



PASSING BAY EXAMPLE - 5.5m ROAD WIDTH

SCALE: 1:200 (A1) 1:400 (A3)



PASSING BAY EXAMPLE - 6.0m ROAD WIDTH

SCALE: 1:200 (A1) 1:400 (A3)

Attachment 4 Pilot Vehicle Layby Detail – Possible Future Maximum Vehicle Restriction

Attachment 5 Example Design Record

Calculation Sheet

Fault ID:	???-???-????	Rev:	
Calculation Details:	Example Design Record - One Lane Section	Computed by:	
		Date:	
		Checked by:	
		Date:	/

Ref						Output
	Client Representative (Accepted by):	A. Adams	Signed:	Date:		
	Designer (Prepared by):	J. Grueneberg	Signed:	Date:		
	Design Reviewer:	James Cooper	Signed:	Date:		
	Simple/ Complex:	Simple				
	Eastbound Approach Operating Speed:					
	Posted speed:	60 km/h				
	Austroads section 3 operating speed:	58 km/h				
	Review of existing adjacent curves:	55 km/h				
	Megamaps:	40km/h				
	Floating speed:	Not Checked				
	Westbound Approach Operating Speed:					
	Posted speed:	60 km/h				
	Austroads section 3 operating speed:	65 km/h				
	Review of existing adjacent curves:	60 km/h				
	Megamaps:	40km/h				
	Floating speed:	Not Checked				
	Design Speed selected:	60 km/h				
	Unsealed / Sealed Road	Sealed				
	SSD Required:	60m				
	Eastbound Approach:					
	SSD to one lane signage	No, 42m achieved				
	SSD to 6m queue	Yes, 73m achieved				
	SSD to 12m queue	Yes, 63m achieved				
	Provide advanced signage (required if any above SSD parameters not met):	Yes				
	Westbound Approach:					
	SSD to one lane signage	Yes, 78m achieved				
	SSD to 6m queue	Yes, 72m achieved				
	SSD to 12m queue	Yes, 66m achieved				
	Provide advanced signage (required if any above SSD parameters not met):	No				
	Passing bay/ Layby provided within one lane section:	No				
	Priority direction:	Eastbound				
	Vehicle tracking completed & attached:	Yes				
	Pilot hold locations required for Check Vehicle:	Yes				
	Pilot hold location plan attached:	Yes				
	Proximity to adjacent one lane section >30m	Yes				
	Departure from standards required	No				