Operational Road Traffic Noise Mitigation Plan

OMA-TS-01140-0-DD-RP-0001|A

DOCUMENT NAME	STATUS	DOCUMENT NO.	AUTHORS
Operational Traffic Noise Report	Final	OMA-TS-01140-0-DD-RP-0001	s 9(2)(a)

Document History and Status

REVISION	DATE	AUTHORS	REVIEWED BY	APPROVED BY	STATUS
A	24/07/2023	Sharon Yung	s 9(2)(a)	s 9(2)(a)	Final for OP

Revision Details

REVISION	DETAILS
A	Issued for Outline Plan of works

QUALITY ASSURANCE STATEMENT	
Prepared by:	s 9(2)(a)
Technical Reviewer:	
Project Reviewer:	
Waka Kotahi Reviewer:	
Approved for issue by:	

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GLOSSARY OF TERMS AND ACRONYMS

TERM/ACRONYM	DEFINITION
dB	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa).
$L_{Aeq(t)}$	The A-weighted time-average sound pressure level over a period of time (t), measured in units of decibels (dB).
$L_{Aeq(24h)}$	The A-weighted time-average sound pressure level over a period of twenty-four-hour period, measured in units of decibels (dB).
L_{Amax}	The maximum A-weighted sound pressure level, measured in units of decibels (dB).
$L_{A10(18h)}$	The A-weighted sound pressure level that is exceeded for 10% of the time interval between 0600 and 0000 (18 hours), measured in units of decibels (dB).
$L_{A95,t}$	The A-weighted sound pressure level that is exceeded for 95% of the measurement interval, t, measured in units of decibels (dB). This is commonly referred to as background noise level.
PPV	Peak Particle Velocity – measure of maximum vibration velocity in an orthogonal axis.
AADT	Annual Average Daily Traffic – the total volume of traffic passing a roadside observation point over the period of a calendar year divided by the number of days in that year.
AC	Asphaltic concrete
Alignment	The horizontal or vertical geometric form of the centreline of the carriageway.
AUP	Auckland Unitary Plan
BPO	Best Practicable Option
Carriageway	The portion of road devoted to the use of travelling vehicles, including shoulders and shared path.
Centreline	The basic line, at or near the centre or axis of a road or other work, from which measurements for setting out or constructing the work can conveniently be made.
CH	Chainage
CRTN	Calculation of Road Traffic Noise
Designation	"Defined in section 166 of the RMA as: “a provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of schedule 1.”
Design life	The period during which the performance of a mitigation measure is expected to remain acceptable.
Design speed	A speed fixed for the design of minimum geometric features of a road.
Design year	The predicted year in which the design traffic volume would be reached.
Detailed design for construction	The final design that forms the basis for noise mitigation built on site.
EPA	epoxy modified porous asphalt
Façade Level	Description of a location 1 m from the façade of a building.
Free-Field (noise)	Description of a location at least 3.5 m from any significant sound reflecting surface other than the ground.
HCV	Heavy commercial vehicle
Interchange	A grade separation of two or more roads with one or more interconnecting carriageways.
Intersection	A place at which two or more roads cross at grade or with grade separation.
Noise	Unwanted sound
Notice of requirement	A notice given to a territorial authority (under section 168 of the RMA) or by a territorial authority (under section 168A of the RMA) of a requirement for land, water, subsoil or airspace to be designated.
OGPA	Open graded porous asphalt

TERM/ACRONYM	DEFINITION
PPF	Protected premises and facilities – buildings used for certain noise sensitive activities.
RMA	Resource Management Act 1991
SEA	Significant ecological area
SH	State Highway
SMA	Stone mastic asphalt
SUP	Shared Use Path
Traffic flow	The number of vehicles passing a given point during a specified period of time.
Traffic lane	A portion of the carriageway allotted for the use of a single line of vehicles.
Traffic volume	The number of vehicles flowing in both directions past a particular point in a given time (e.g. vehicles per hour, vehicles per day).

1 INTRODUCTION

1.1 PROJECT OVERVIEW OF O MAHURANGI PENLINK PROJECT

The O Mahurangi Penlink Project (the Project) is for the construction, operation, use and maintenance of a new approximately 7 km transport connection (road), including a shared use path (SUP) between the Whangaparāoa Peninsula and Dairy Flat, bypassing the constrained Silverdale interchange. The Wēiti River will be traversed by an extradosed (cable stay style) bridge. The location and extent of the Project is shown in **Figure 1-1** below.

Figure 1-1: Location of the Project Corridor

The road corridor will connect with State Highway 1 (SH1) just south of Dairy Flat via a new interchange, including south-facing ramps. The corridor will then cross over East Coast Road and continue north-east towards Stillwater providing two new connections to future communities.

The corridor then runs just north of the Stillwater area and settlement, including a new connection for that community, before continuing north-east across Wēiti River towards Whangaparāoa. The corridor then connects to Whangaparāoa Road opposite the New World supermarket at Stanmore Bay.

O Mahurangi Penlink will create an alternative access route to the Whangaparāoa Peninsula that will connect to SH1. It is an important part of the region's infrastructure development to support urban growth in north Auckland, in particular to help development in Silverdale and the Whangaparāoa Peninsula.

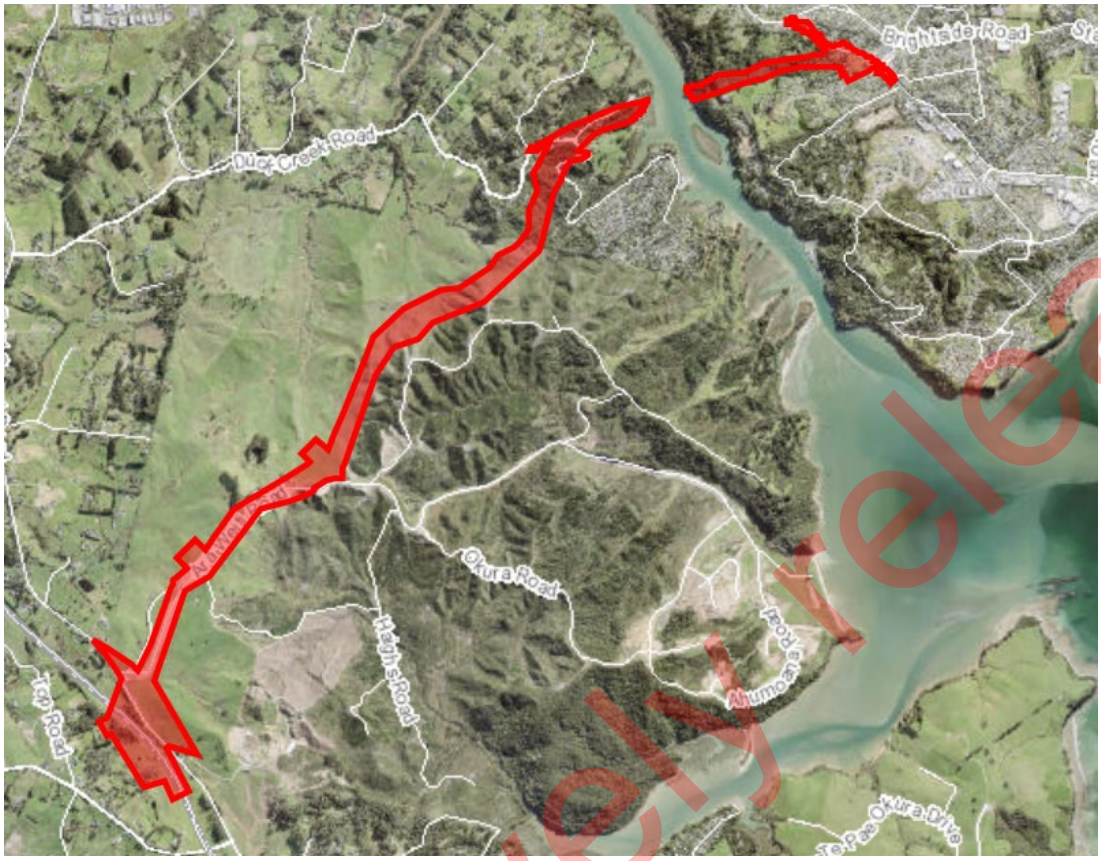
1.1.1 Project design features

The key Project design features for the main alignment are as follows:

- A new 7 km, two-lane median divided and access-controlled state highway;
- South-facing ramps to SH1;
- Local road connections and associated bridges, underpasses and roundabouts at Duck Creek Road (Stillwater Township) and East Coast Road;
- A two-lane extradosed (cable stay style) bridge across the Wēiti River; and
- A separated SUP for people on foot and wheels between CH 6700 and East Coast Road, including two lookout points.

1.2 REQUIRING AUTHORITY, DESIGNATION DETAILS

Waka Kotahi (New Zealand Transport Agency) is a Requiring Authority as defined under section 166 of the Resource Management Act 1991 (RMA). The existing designation which authorises the proposed Project work is Designation 6777 in the Auckland Unitary Plan (Operative in Part) 2016 (AUP)[1]. Designation 6777 extends from SH1 to Whangaparāoa Road, Stanmore Bay as shown in **Figure 1-2**.



Source: AUP planning maps

Figure 1-2: Extent of Designation 6777

The Project was designated and consented in 2001 (Auckland Council reference 14340) and generally provided for a ~7 km two lane road connecting SH1 at Redvale to Whangaparāoa along the alignment, including pedestrian linkages across Duck Creek Road.

In 2014, the designation was altered, and additional consents obtained[2] to provide for a wider four laned highway and a SUP (noting that the SUP was provided for between Whangaparāoa Road and Duck Creek Road). The designation alteration and resource consents were granted in 2015.

Table 1-1: Designation 6777 details

FEATURE	DETAIL
No.	6777
Designation title	Wēiti Crossing
Requiring Authority	Waka Kotahi
Plan	Auckland Unitary Plan (Operative in Part) 2016

[1] Designation 167, Auckland Council District Plan (Rodney Section) 2011

[2] The additional consents and alteration to the designation were based on the application package lodged with Auckland Council, referenced NZI-8973077-68 Assessment of Environmental Effects, the responses to the section 92 Request for Further Information and any subsequent amendments of the resource consent conditions schedule (following the Environment Court hearing and confirmed in its decisions).

FEATURE	DETAIL
Legacy reference	167, under Auckland Council District Plan (Rodney Section) 2011
Location	East Coast Road, Redvale (crossing Wēiti River) to corner Whangaparāoa Road and Cedar Road, Whangaparāoa
Purpose	Wēiti Crossing
Lapse date	31 December 2035 unless given effect to prior

1.2.1 Purpose and scope of this report

This report provides the findings and assumptions of the assessment of traffic noise associated with the operation of the Project based on detailed design.

The purpose of this acoustic assessment is to:

- Predict and assess future road-traffic noise levels against the Project criteria;
- Recommend measures as appropriate to avoid, remedy or mitigate potential adverse operational noise effects; and
- Present a summary of the BPO mitigations to be implemented to meet Project criteria.

The purpose of this report is to document the detailed noise mitigation design for the Project necessary to satisfy the designation conditions' requirement for BPO (see section 2.1 below) and to provide documentation for peer review. It is not intended as an RMA assessment of effects, rather it seeks to implement the requirements of the assessment of noise and vibration effects undertaken as part of the NoR in 2014.

This report also demonstrates compliance with the Waka Kotahi/ NZ Transport Agency specification for noise mitigation (P40)[3].

1.2.2 Personnel

The P40 specification requires that noise mitigation design is conducted by a suitably qualified professional. Mitigation design and preparation of this NMP has been undertaken by Sharon Yung and overseen by Darran Humpheson. Sharon Yung has over nine years' experience in acoustics and holds memberships of the Institute of Acoustics (IOA) and Acoustical Society of New Zealand (ASNZ). Darran Humpheson has over 30 years' experience in the acoustics industry and also has memberships with the IOA and ASNZ. They meet all the requirements set out in the P40 specification as suitably qualified professionals.

[3] NZ Transport Agency (2014), SP/SP40: 2014 1409016, Specification for noise mitigation.

2 PROJECT CRITERIA

The original base design for Penlink was designated (6777 – Wēiti Crossing) and consented in 2001. In 2014, the designation was altered and re-consented to provide for a wider four laned highway, with a SUP between Whangaparāoa Road and Duck Creek Road.

The following criteria and standards for road traffic noise are applicable for this Project, in addition to the Waka Kotahi requirements[4]:

- The 2014 designation conditions
- Transit Guidelines[5]
- NZS 6806:2010[6].

New Zealand Standard NZS 6806:2010 *Acoustics – road traffic noise* is the current road traffic noise standard and has superseded the Transit Guidelines. NZS 6806:2010 applies to the management of noise for new and altered roads. All noise levels presented in this report are façade levels in accordance with the designation conditions which is different to most other Waka Kotahi reports in the last ten years.

2.1 DESIGNATION CONDITIONS

The following designation conditions relating to operational noise are applicable to this Project.

Table 2-1: Designation conditions – operational noise

Condition	Content	
3.5	The road alignment shall be designed to achieve the following noise standards: a) For the properties identified in Table B - the relevant traffic noise design limit contained in Table B b) For all other dwellings, the relevant noise standards contained in Transit New Zealand's Draft Guidelines for the Management of Traffic Noise for State Highway Improvements, December 1999	
	Table B – Traffic Noise Design Limits	
	Location	**Traffic Noise Design Limits Leq (24 hours)**
	Dwelling A (at the western end of the proposed road as indicated on the AEE document) (1695 East Coast Road)	65 dBA
	All other existing* dwellings west of the Wēiti River	55 dBA
	Dwelling 1 on Lot 1 DP 138956 (43 Cedar Tce)	55 dBA
	Dwelling 2 on Lot 4 DP 64380 (45 Cedar Tce)	
	Dwelling 3 on Lot 6 DP 64380 (41 Cedar Tce)	
	Dwelling 4 on Lot 7 DP 64380 (39 Cedar Tce)	
	Dwellings at 7 to 37 Cedar Terrace inclusive	62 dBA
	Dwellings at 39A – 39H Cedar Terrace inclusive	57 dBA
	All existing* dwellings on Whangaparāoa Rd	65 dBA or ambient (whichever is greater)
	**Existing at 22 September 2015*	
	Note: The assessment point for Table B is 1m in front of the most exposed point on the facades of the dwellings.	

[4] Including but not limited to Waka Kotahi Guide to assessing road-traffic noise using NZS 6806 for state highway asset improvement project, v1.1, Aug 2026; P40 Noise mitigation specification, SP/SP40, Sept 2012
[5] Appendix 6: Transit New Zealand's guidelines for the management of road traffic noise – state highway improvements, 1 December 1999
[6] New Zealand Standard 6806:2010 Acoustics – road traffic noise – new and altered roads

Condition	Content
3.6	In addition to the standards in Table B above, the road alignment shall be designed with the appropriate noise mitigation measures to achieve compliance with a single event noise limit of 78 dBA Lmax at the facade of any residential building situated within 12 metres from the new road carriageway. This shall not apply to residential buildings currently located within 12 metres of the existing road carriageway. Explanation: This is in accordance with the Transit New Zealand Draft Guidelines for the Management of Road Traffic Noise, 1994
3.7	If the adoption of the BPO for noise mitigation within the road corridor is insufficient to meet the Design Limits in condition 3.5, then prior to completion of the road, the Requiring Authority (or its agents) shall: a) With the agreement of the owner of the dwelling and if so required by them, provide insulation (and, if required mechanical ventilation and provision for adequate thermal comfort where windows must be closed) to all living rooms (including kitchens) and bedrooms, to ensure that an internal criterion of 40 dBA Leq (24 hours) is not exceeded. This offer and mitigation shall be applied in conjunction with the adoption of the BPO for minimisation of noise in the road corridor; or b) If it is impracticable to design mitigation to achieve this internal criterion then the Requiring Authority (or its agents) shall, with the agreement of the owner, and at a price not exceeding market value, purchase the property.
3.8	Without limiting the requirements for consultation imposed under condition 3.7, the Requiring Authority shall consult with the owners of 236 Duck Creek Road, being Part Lot 3 DP 26549 and 266 Duck Creek Road, being Lot 2 29403 ("the Webster properties") in relation to the location, nature and extent of any proposed noise mitigation measures.
3.9	In undertaking this consultation the Requiring Authority shall give special consideration to the need for additional or alternative noise mitigation measures which mitigate to the greatest extent practicable the acoustic and amenity effects of the designation upon the Webster properties within the noise limit set out in condition 3.5.
3.10	In undertaking consultation with the owners of the Webster properties the Requiring Authority shall: a) provide copies to the owners of all relevant reports and plans prepared by it in relation to the proposed noise mitigation measures; and b) ensure that the owners have at least two weeks to peruse this material and respond to the Requiring Authority with their position; and c) the Requiring Authority shall obtain (at its reasonable cost) a peer review of the proposed mitigation measures and consequential effects on the Webster properties to identify other mitigation measures which may be cost effective and meet the noise limits set out in condition 3.5 and shall give special consideration to the findings of any peer review in deciding what noise mitigation measures it implements for the Webster properties.
3.11	The Requiring Authority shall, at appropriate locations, install signs advising motorists to avoid using engine braking in residential areas.

Where dwellings along Whangaparāoa Road have an ambient noise level greater than 65 dB $L_{Aeq(24h)}$ (designation Condition 3.5), then ambient levels as visually represented in **Appendix A** have been used (as taken from the NoR technical noise assessment[7] Appendix B Table 1). These ambient levels were measured in 2014 to support the NoR process. Urban growth in the area since then will likely have increased existing ambient noise levels due to increased road traffic volumes. It is therefore considered a conservative approach to assess against these levels.

Designation Condition 3.5 Table B noise limits are visually represented in **Figure 2-1** to show the approximate areas where the different limits apply east of the Wēiti River. All receivers west of Wēiti River are subjected to a designation limit of 55 dB $L_{Aeq(24h)}$.

[7] Penlink – Assessment of Acoustic Effects, Ep 002 R04 2014038A, Marshall Day Acoustics, 6 November 2014

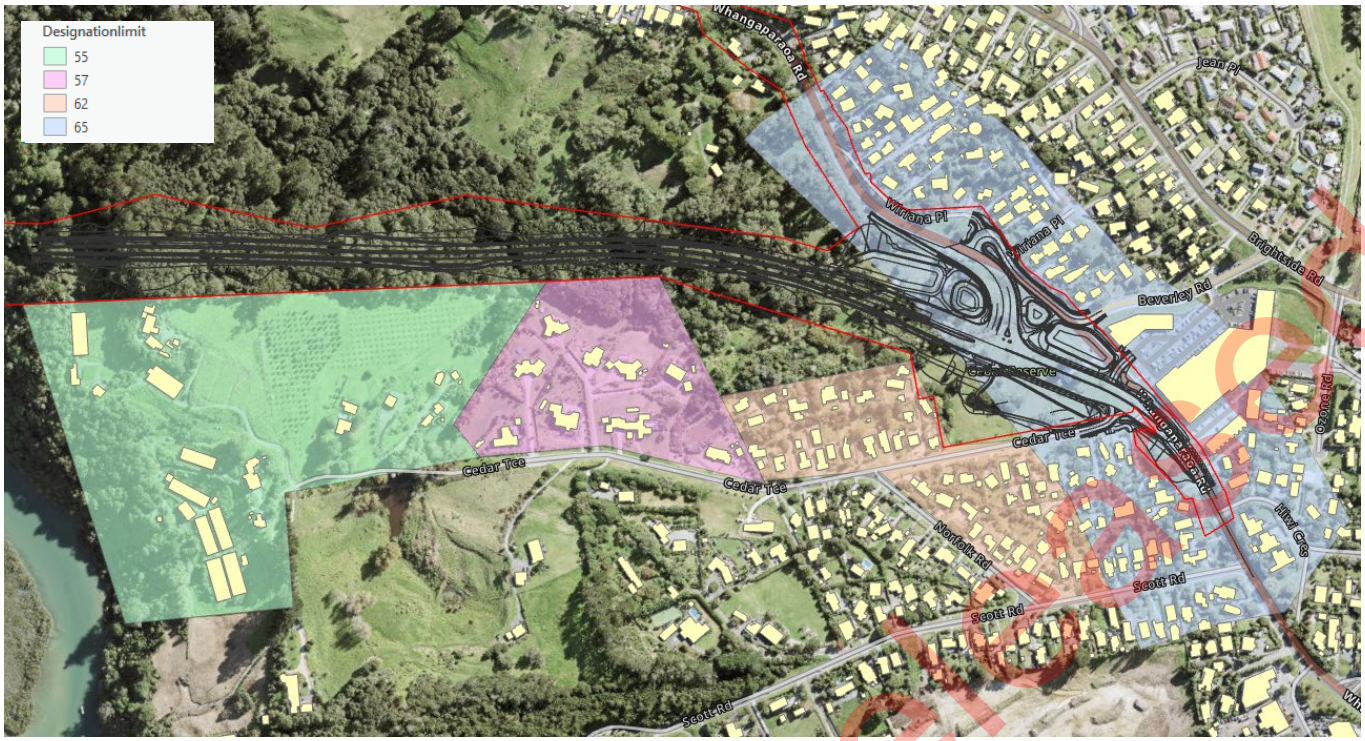


Figure 2-1: Designation noise limits areas (east of Weiti River)

2.1.1 Transit Guidelines

The Transit New Zealand Guidelines for Management of Road Traffic Noise – State Highway Improvements, effective at 1 December 1999 (Transit Guidelines), outlines the road traffic noise design criteria. The Average Noise Design Levels limits as reference for Designation Condition 3.5(b) are replicated in **Table 2-2** below. The ambient noise level is required to be established to determine the appropriate criterion as recognised within the Designation conditions.

The design noise criterion applies at 1 m from the most exposed façade of permanent buildings used for residential and educational purposes only.

Table 2-2: Road traffic noise modelling parameters

Noise Area	Ambient Noise Level , dB $L_{Aeq(24h)}$	Average Noise Design Level, dB $L_{Aeq(24h)}$
Low	Less than 43	55
	43 – 50	Ambient + 12
Medium	50 – 59	62
High	59 – 67	Ambient + 3
	67 – 70	70
	More than 70	Ambient

As mentioned, this guideline has been superseded by NZS 6806:2010. Whilst the Transit Guidelines was intended only to apply to State Highways, NZS 6806 is applicable to both local roads and State Highways.

3 MODELLING METHODOLOGY

3.1 THE APPROACH

Current Waka Kotahi guidance and standard practice is to assess new and altered highways and local roads using NZ 6806:2010. The standard is a tool which provides performance targets and requires assessment of a number of

different options for noise mitigation (ranging from low-noise road surfaces and barriers to building modification – acoustic treatment). These options are subject to an integrated design process in which the costs and benefits are considered. The performance targets in NZS 6806:2010 are set to achieve reasonable noise levels taking into account adverse health effects associated with noise on people and communities, the effects of relative changes in noise levels, and the potential benefits of new and altered roads.

The designation conditions originally created in 2001 for noise and vibration were based on the Transit Guidelines. Whilst the Transit Guidelines have now been superseded by NZS 6806:2010, when the Designation was altered and re-consented in 2014, it was agreed that the Designation conditions relating to noise and vibration should remain largely unchanged due to expectations of the community.

There are many differences between the Transit Guidelines and NZS 6806:2010. A key difference is that the Transit Guidelines requires the ambient noise level in order to establish the criterion at specific locations, which in turn focuses simply on achieving a specific sound level. NZS 6806:2010 provide performance targets and requires assessment of a number of different options for noise mitigation. The primary external criterion of NZS 6806:2010 is 57 dB $L_{Aeq(24h)}$ for new roads and 64 dB $L_{Aeq(24h)}$ for altered roads. Transit Guidelines are based on noise levels at façade, whilst NZS 6806:2010 are free-field. Façade levels are + ~2.5 dB higher than free-field levels to account for reflections, for example a 55 dB design limit is equal to a 53 dB (rounded) free-field limit.

The Designation condition criteria (based on Transit Guidelines) take precedence over NZS 6806:2010 for this Project and therefore, the Project's noise limits are more stringent than those in NZS 6806:2010 for new roads.

To meet Waka Kotahi requirements and the Designation conditions, this assessment has adopted the NZS 6806:2010 methodology where appropriate to meet specific Designation condition noise criteria as replicated in **Table 2-1**.

3.2 ROAD TRAFFIC NOISE MODEL

3.2.1 Operation scenarios

The traffic volumes of the opening year 2038 were used to determine compliance with the relevant Designation conditions over a reasonable operational life of the road.

Two base scenarios have been considered within this assessment:

- Reference design not tolled (2038) – reference design alignment with not-tolled road traffic volumes as provided in Table 5 of the NoR noise assessment. This scenario has been used to verify the road traffic noise model.
- Do Minimum – the Project with tolled 2038/2048 traffic volumes and minimum road surface design requirements (section 3.2.5).

Having assessed the do minimum scenario, the Project was then considered in discrete areas as shown in **Figure 6-1**. Up to three mitigation options were investigated for each area as summarised in **Table 6-1**. Assessment of mitigation options are detailed in Section 6.

3.2.2 Receivers

NZS 6806:2010 requires noise effects to be assessed at noise sensitive locations within set distances of any project. These locations are known as protected premises and facilities (PPFs) and include existing houses, schools, marae and various other premises as defined in NZS 6806:2010. Commercial and industrial premises do not fall within the definition of a PPF. Future (unbuilt) noise-sensitive premises and garages are not PPFs, unless they have already been granted building consent.

The distances from the road within which properties are considered to be PPFs is set in the standard as:

- Urban Areas – 100 m from the edge of the nearside traffic lane
- Rural Areas – 200 m from the edge of the nearside traffic lane.

Most of the Project's extents currently fall within a rural area as defined by Statistics New Zealand. Therefore, it is appropriate for PPFs within 200 m of the Project's main alignment and 100 m along Whangaparāoa Road to be assessed in this report.

The Transit Guidelines do not specify assessment distances, but facility types to be included for assessment are similar to NZS 6806:2010. As such, NZS 6806:2010 criteria have been used and includes all specified properties and specified parcels of undeveloped land with respect to the Designation conditions.

3.2.3 Modelling methodology

An assessment of road traffic noise has been carried out in general accordance with Waka Kotahi "*Guide to assessing road traffic noise using NZS6806 for state highway asset improvement projects*". Designation noise limits have been assessed at 1 m from the most exposed point on the façades of the dwellings (as required by Transit Guidelines), and modelling has been carried out using best practice as set out in the Waka Kotahi guide.

Noise levels have been predicted using sound propagation modelling software, SoundPLAN version 8.2. The software enables noise contours and façade noise maps to be produced and location specific noise levels to be calculated within a 3-D model of the Project site and local area. The road traffic noise model employs the "*Calculation of Road Traffic Noise*" (CRTN) algorithm, as recommended in NZS 6806:2010.

The propagation of road traffic noise is affected by multiple factors which the model takes into account:

- Geometric divergence;
- Atmospheric adsorption;
- Ground effect;
- Reflection from surfaces; and
- Screening by obstacles (buildings and topography).

The CRTN methodology has been adjusted for New Zealand road surfaces in accordance with LTNZ Report No. 326 and the Waka Kotahi "*Guide to state highway road surface noise*". The model settings are described in **Table 3-1** below.

Table 3-1: Road traffic noise modelling parameters

Parameter	Setting / Source
Software	SoundPLAN 8.2
Algorithm	CRTN
Reflection	CRTN
Parameter	LAeq(24h)
Ground absorption	0.6 for urban areas; 0 for water; 0.8 for grassed areas
Receiver height	1.5 m above height of each floor
Noise contour grid	1.5 m height, 5 m resolution
Receivers and grid position	1m from façade*

* As per Designation conditions

The CRTN calculation methodology gives results in $L_{A10(18h)}$. To convert these results to a 24-hour daily traffic $L_{Aeq(24h)}$, in accordance with NZS 6806:2010, a minus 3 dB adjustment has been made. This adjustment has been implemented in the software in conjunction with the road surface adjustment as detailed below.

The CRTN model assumes that traffic is free-flowing, and does not apply to interrupted vehicle flows, such as at intersection, and for low volume roads under 2,000 Average Annual Daily Traffic (AADT).

The limitations and uncertainties of the prediction methodology, including input data, are discussed below.

3.2.4 Road traffic data

All traffic data including modelled AADT movements, percentage of heavy vehicles (%HCV) and posted speed limits have been provided to the Alliance by Waka Kotahi. NZS 6806:2010 and Transit Guidelines specify noise levels to be assessed based on forecast traffic flows at least 10 years after intended open year/completion of the road (design year). The traffic volumes used for noise assessment are based on the highest predicted AADT flows

for 2038 and 2048 data[8] (**Table 3-2**), which is 12 years after intended opening date of 2026. Diagrams of traffic data and ID references are provided in **Appendix B.**

The 24-h AADT entered into the CRTN (based on 18-h traffic) results in a +0.2 dB conservative modelling prediction.

Table 3-2: AADT 2038/2048

ID	Section	AADT Tolled		% HCV	Posted Speed
		East Bound	West Bound		
NB off	Northbound off-ramp	8,700	-	5 %	100 km/h
SB on	Southbound on-ramp	-	6,700	5 %	100 km/h
A	Penlink (Ara Wēiti Road – Link Road 1)	10,200	10,200	5 %	80 km/h
B	Penlink (Link Road 1- Link Road 2)	10,000	10,000	5 %	80 km/h
C8	Penlink (Link Road 2 to Duck Creek Road)	9,900	10,000	5 %	80 km/h
D8	Penlink (Duck Creek Road to Whangaparāoa Road)	9,900	9,900	5 %	80 km/h
E	Whangaparāoa Road (North)	5,500	6,100	5 %	50 km/h
F	Whangaparāoa Road (South)	12,600	12,800	5 %	50 km/h

source: Waka Kotahi

SH1 has not been included as part of the assessment as traffic volumes for 2038 are above 70,000 AADT, which is significantly higher than the Project. Therefore, any noise generated by the Project at receptors within 100 m of SH1 will be masked and indistinguishable. Similarly, the two link roads and Duck Creek Road have not been included as part of the assessment as traffic volumes are low and will be indistinguishable over the main alignment.

Reference design traffic data are based on 2038 non-tolled traffic volumes as replicated in **Appendix B.**

3.2.5 Road surfaces

The road surface for the base design has been modelled as per the minimum requirements with agreed departures as per the design philosophy statement.

Do minimum road surface for the main alignment have been assumed as:

- Open graded porous asphalt (PA10) for Penlink between Chainage (CH) 0000 to CH3300 Whangaparāoa Road intersection;
- Stone mastic asphalt (SMA) for the main alignment at intersections and on the Wēiti River Bridge CH5390 to CH5925; and
- Asphaltic concrete (AC14) at the Whangaparāoa Road Intersection on the main alignment from CH6700.

Surface corrections relative to asphaltic concrete (AC10) appropriate for New Zealand were applied in accordance with Transit Research Report 28[9] and the Waka Kotahi "*Guide to State Highway Road Surface Noise*"[10]. The surface corrections for cars and heavy vehicles have been included using the relevant equation in the Waka Kotahi Guide.

3.2.6 Road alignments

Road alignments for existing and new roads were provided by the Project team as centrelines and widths for each carriageway section. Gradients have been calculated by SoundPLAN. The two-lane carriageway has been

[8] Predicted AADT flows showed generally 2038 data have the highest flows throughout the alignment with the exception of around Duck Creek Road to Whangaparāoa Road intersection. Modelling indicated this was the most sensitive area for operational traffic noise, therefore the higher 2048 AADT flows are used for Section ID C and D to consider the worst case for mitigation requirements.

[9] Research Report 28. Traffic noise from uninterrupted traffic flows, Transit, 1994.

[10] NZTA Guide to state highway road surface noise, version 1.0, Jan 2014

modelled separately as two lanes in single directions to represent the design. Acceleration/deceleration lanes and connection roads with less than 2,000 AADT have not been modelled.

3.2.7 Bridges

Wēiti River Bridge has been configured to be 'self-screening' roads, which blocks the noise of that road passing through them. The bridge has been modelled using two overlapping single lanes with safety barriers (solid concrete) manually entered in the noise model as 0.8 m high barriers set at 2 m from the road carriage edge (includes 1.5 m shoulder).

Whilst bridge joints cannot be modelled using CRTN/SoundPLAN, noise reducing plates (sinus plates) are to be used on the bridge joint to reduce surface noise. Consideration is also being given to the inclusion of absorption baffles under the deck joints. It is assumed that the vertical alignment between the road and the bridge will provide a smooth transition within Project design tolerances and therefore, there will be negligible tyre 'bump' noise as a vehicle passes over the transition.

3.2.8 Topography

Topographic contours for the existing terrain have been provided from the Project team at 1 m resolution. Contours for the design scenarios were obtained from the Project team for the assessment area and joined with the existing contours for the surrounding areas. The gradients automatically calculated by the noise software have been manually disabled for downhill sections.

All of the mitigation options and final BPO scenario are based on the do-minimum topographic contours.

Steep cuts along the alignment have been modelled as semi-reflective to represent exposed rock.

3.2.9 Buildings

The footprints for all buildings, building usage and all other structures within 200 m of the roads have been obtained from the LINZ database. All buildings have been modelled as 5 m uniform height for single storey buildings, 7 m for two storey buildings and 9 m for three storey buildings. Buildings were identified during site visits and using Google Street View. The number of floors was determined assuming 2.8 m height per floor. Low auxiliary buildings that potentially block the direct line of sight between the carriageway and the dwelling are modelled at 3.5 m uniform height.

Noise levels were calculated at 1 m from the centre of each façade, 1.5 m above each floor height with the stated noise levels being the highest of any façade.

With the exception of 239 Duck Creek Road, any buildings or structures within the Project's Designation have been removed from the model and not assessed for the scenarios as they will be removed or obtained to provide for the Project's construction.

3.2.10 Verification and uncertainties

The accuracy of the operational model is largely dependent upon the limitations of the available input data as detailed above. Uncertainties in the modelled noise levels can occur for a number of reasons. Uncertainties are typically related to the effects of topographical screening and appropriateness of the data used. For example, a change in traffic volume data by +25 % or -20% will only result in a 1 dB change in predicted noise level, which would be imperceptible. A doubling or halving of the traffic data will only result in a 3 dB change, which is only just perceptible by most people, assuming no change to heavy vehicle percentages and speeds. Therefore, for transportation noise, there can be a degree of uncertainty in the input data without resulting in a significant under or over prediction of road traffic noise levels.

Generally, measured noise levels will be used to provide verification of the model predictions. A difference not exceeding ±2 dB between measured and predicted noise levels close to the road is an acceptable tolerance for environmental noise predictions in accordance with NZS 6806:2010. However, the road traffic noise assessment for this Project informs a design change against the reference design; as such attended measurements were not carried out to verify the model.

It is assumed that the predicted noise levels in the technical noise assessment as part of the NoR were verified within the acceptable uncertainty range and suitable for use on a comparison basis. As such, to provide a level of

certainty with the predicted noise levels (**Appendix C**), the model has been checked against the reference design non-tolled 2038 traffic flow scenario as provided in Section 3.4 and Table 5 (replicated in **Appendix B**) of the NoR technical noise assessment.

A copy of the original SoundPLAN model was not available to carry out an in-depth comparison between the NoR and proposed design predicted noise levels. Specific factors of influences relevant to this assessment when comparing predicted noise levels against the NoR technical assessment include the following:

- Different models version – SoundPLAN v7.3 vs SoundPLAN v8.2. The software has been significantly improved since the original assessment was carried out in 2014. Notably how the model uses terrain data. The calculation procedures are unchanged.
- More up-to date terrain data – detailed terrain data are likely to be of different resolution due to advancement in Lidar technology.

To understand these uncertainties, further calculations were carried out using the road traffic calculation tool[11] on the Waka Kotahi website. The Waka Kotahi online tool is a suitable reference calculator for predicting road traffic noise in situations without complex topography based on the CRTN method. Only simple sections of the alignment were used for this comparison. **Table 3-3** shows predicted noise levels are within +/- 2dB of both the Waka Kotahi tool predictions and the noise level results as provided in the NoR report, with the predicted noise levels generally higher than the NoR report results.

Table 3-3: Comparison of predicted levels (dB $L_{Aeq(24h)}$) for verification of road traffic model

Address	Predicted noise levels	Waka Kotahi Online Tool	NoR report Results Appendix B Table 1
301 Duck Creek Road	57	58	57
275 Duck Creek Road	55	56	54
39E Cedar Terrace	57	58	55
562 Whangaparāoa Road	67	66	66
540 Whangaparāoa Road	68	-	66
s 9(2)(a)	58	-	59

NB - Where terrain is complex the Waka Kotahi tool was not used as a basis of comparison

4 EXISTING ENVIRONMENT

Ambient noise levels for the Project areas were measured in 1998 and in 2014 when the NoR was granted and incorporate into the Designation condition noise limits, as presented in **Table 2.1**. As the Designation conditions are set limits, the existing ambient noise environment of 2022 at the start of this Project design was not required in order to carry out this assessment. Similarly, the NZS 6806:2010 assessment methodology is not dependant on the existing noise environment.

However, an appreciation of the existing environment is required to understand the potential noise effects (degree of noise change), regardless of compliance with the Project's criteria.

Urban growth around Whangaparāoa intersection since 2014 will likely have increased existing ambient noise levels by 1-2 dB due to increased road traffic volumes. Whilst the rural growth around Duck Creek Road and Cedar Terrace has not seen significant change since 2014. The ambient levels recorded in 1998 and 2014 are considered to be still appropriate to determine potential noise effects (**Figure 4-1**).

With a Designation noise limit of 55 dB $L_{Aeq(24h),facade}$, it can be easily identified that all these PPFs had an ambient noise level of less than 43 dB $L_{Aeq(24h),facade}$ when back calculating from the Average Noise Design Level using the Transit Guidelines. Similarly, dwellings 7 to 37 Cedar Terrace had an ambient noise level of between 50 – 59 dB $L_{Aeq(24h),facade}$ and dwellings at 39A – 39H Cedar Terrace had an ambient noise level of 45 dB $L_{Aeq(24h),facade}$.

[11] Road traffic noise calculator | Waka Kotahi NZ Transport Agency (nzta.govt.nz)

Table 6: Ambient noise level survey results

Survey location	dB L_{A95}	dB L_{Aeq}	Controlling noise source
1998			
Cnr. Whangaparaoa Rd/Brightside Rd	54	72	Traffic on Whangaparaoa Road
Cnr. Whangaparaoa Rd/Karepiro Dr	48	56	Traffic on Whangaparaoa Road
575 Whangaparaoa Rd	57	67	Traffic on Whangaparaoa Road
Vicinity of Duck Creek Rd	49	51	Natural sounds, intermittent traffic
2014			
43 Cedar Terrace	41	47	Bird noise, wind in vegetation
9B Cedar Terrace (park side)	48	52	Traffic on Whangaparaoa Road
554 Whangaparaoa Road	53	61	Traffic on Whangaparaoa Road
606 Whangaparaoa Road	50	58	Traffic on Whangaparaoa Road
Opposite 239 Duck Creek Road	40	45	Boat horn, wind in vegetation
250 Duck Creek Road	40	51	Traffic on Duck Creek Road
Between SH1 and East Coast Road (1676 East Coast Road)	54	59	Traffic on SH1 and East Coast Road

Source: NoR technical noise assessment

Figure 4-1: Replicated ambient noise level survey results

5 PREDICTED NOISE LEVELS

Façade noise maps for each modelling scenario have been calculated for PPFs within 200 m of the edge of the Penlink alignment. Full graphical façade noise maps and tabulated predicted noise levels at all PPFs are presented in **Appendix D**. The façade noise maps show the highest road traffic noise level experienced at each building, i.e. the closest and most exposed façade and the highest floor.

Grid noise maps are modelled at 1.5 m above ground level in line with noise survey measurements undertaken in accordance with NZS 6801:2008 to enable comparison. Where buildings are more than one storey high, predicted façade levels may be greater than those shown on the grid noise contours. Colour coding has been used to highlight the different noise level bands.

Predicted noise levels for a selection of PPFs are presented below in **Table 5-1**, which identifies properties that are in exceedance of the Designation noise limits. The proposed alignment transverses through rural land with no receivers until near Duck Creek Road. The identified PPFs in **Table 5-1** are representative of properties across the different criteria limits along the Project's alignment, as shown in **Appendix E**.

Predicted noise levels based on the tolled scenario are generally in compliance with the Designation noise limits. Where noise levels at receivers are predicted to exceed these are identified in **bold.**

Designation Condition 3.6 does not apply to the Project design as there are no receivers located within 12 m of the new road alignment.

Dwelling A, 1695 East Coast Road, has been purchased by Waka Kotahi and will be removed, as such the Designation condition does not apply for this property.

Table 5-1: Predicted noise levels (dB $L_{Aeq(24h)}$) at representative PPFs

Address	Designation Noise limit	Floors	NoR design (PA10)	Tolled 2038 Do Minimum	Tolled 2038 with BPO mitigation
s 9(2)(a)	55	GF	63	**60**	**57**
301 Duck Creek Road	55	GF	57	**57**	55
236 Duck Creek Road	55	GF	58	**58**	55
275 Duck Creek Road	55	GF	58	**58**	54
250 Duck Creek Road	55	GF	49	53	49
s 9(2)(a)	55	GF	60	**60**	**57**
39D Cedar Terrace	57	GF	56	**59**	56
39C Cedar Terrace	57	GF	56	**59**	56
9B Cedar Terrace	62	GF	62	61	58
562 Whangaparāoa Road	71	1F	66	63	63
566 Whangaparāoa Road	71	1F	67	61	60
598 Whangaparāoa Road	68	1F	65	67	66
589 Whangaparāoa Road	70	GF	67	63	63

All PPFs along Whangaparāoa Road are predicted to be below the Designation noise limits. No mitigation options are required around the Whangaparāoa intersection.

Seven PPFs identified in **Table 5-1** are predicted to exceed the applicable noise limits and mitigation options, as discussed in Section 6, have been applied.

6 DESIGN AND MITIGATION

Mitigation was required for receivers where predicted noise levels exceed the Designation noise limits. BPO was considered in accordance with the designation conditions and to achieve compliance with NZS 6806:2010.

In order to identify BPO, different mitigation options were developed and compared not only in terms of absolute noise levels, but also in relation to other Project wide considerations such as urban design, safety, visual landscaping, costs and others. The process of identifying BPO is interactive with collaboration between several disciplines, usually discussed at a workshop, and the preferred option developed by the entire Project team. As such, the chosen mitigation option may not be the option providing the greatest noise level reduction, but an option which is considered an optimal and practicable balance when evaluated against relevant criteria across the Project team.

One aspect to achieve noise level reduction is through structural mitigation as described in NZS 6806:2010. Road traffic noise mitigation measures can be broadly categorised into three methods; low noise road surfaces, traffic noise barriers, and building modification which are described below.

6.1.1 Road surfaces

The choice of road surface material can have a significant influence on road traffic noise levels.

The majority of the state highway network has chipseal surfaces, with porous asphalt surfaces used on parts of the network generally with higher traffic volumes and sometimes for their noise reduction benefits.

Porous asphalt surfaces are significantly more expensive than chipseal and there are often engineering constraints limiting their use. They are currently mainly applied on busier highways in urban areas. The most common porous asphalt types on the network tend to use a 10 mm aggregate with the surface around 30 mm thick (30 mm PA10).

Waka Kotahi has been actively researching ways to optimise types of porous asphalt surfaces to achieve improved noise reduction for communities. This work has included extensive testing and trials over recent years. From this

research, Waka Kotahi has found that a significant noise reduction can be achieved, compared to 30 mm PA10, by using a smaller aggregate (7 mm) and increasing the thickness (50 mm). Trials for noise have coincided with use of "epoxy modified" porous asphalts (EPA) such that the optimised surfaces tested for noise are "50 mm EPA7".

During current development, 50 mm EPA7 has been conservatively assumed to provide an additional 3 dB reduction at nearby houses compared to 30 mm thick PA10. However, research indicates that slightly better performance is likely to be achieved and future surface noise corrections for this surface type are likely to show a slightly greater reduction.

50 mm EPA7 is currently the lowest noise surface type that is used on the state highway network. It is being proposed on current projects[12] and on new existing roads[13] as a key noise mitigation measure including for this Project.

6.1.2 Noise barriers

If low-noise road surfaces alone do not provide the required level of noise mitigation, traffic noise barriers may be considered alongside road surfaces. Generally, barriers will only mitigate noise if they block the line-of-sight between the noise source and receiver. They are most effective and provide the widest area of mitigation when placed immediately adjacent to traffic lanes. In order to provide the most effective noise level reduction, an acoustic barrier must be constructed of solid material (i.e. have no gaps) and have a minimum surface density of 10 kg/m^2 (e.g. 15 mm solid timber, 9 mm fibre cement, concrete, etc.). Earth bunds are also an effective barrier if space is available.

6.1.3 Building modification

NZS 6806:2010 requires that structural mitigation, such as noise barriers and low-noise road surfaces, should be implemented in preference to enhancing the acoustic performance of a building. Building modification can potentially inconvenience residents and does not provide any protection to outdoor amenity areas. However, if low-noise road surfaces and noise barriers are not practicable or do not provide the required level of noise reduction, building modification to PPFs may be considered. This is also acknowledged in Designation Condition 3.7.

Depending on the level of reduction required, building modification measures may range from provision of mechanical ventilation only (to allow doors and windows to be closed), to the upgrade or replacement of windows, wall linings, floors and ceiling linings. The necessary improvements vary from building to building depending on the build material, state of repair and location.

Due to the more stringent external noise limits for this Project, it may be that building modifications to the existing structure is not required to achieve the internal noise limits, as New Zealand standard[14] and Transit Guideline states façades typically achieve 15-20 dB reduction with windows closed. A case-by-case assessment is, therefore, required for those buildings identified for potential building modification to determine the specific level of reduction required to meet internal noise limits.

The assessment and implementation of building modification mitigation would require several steps to be undertaken and these would involve but not limited to:

- Identification of PPFs which are predicted to receive external noise levels above the Designation limits following the implementation of the preferred mitigation option(s)/BPO. Predictions will be made through computer noise modelling once the preferred mitigation option(s) are finalised through detailed design.
- Project team to notifying the owner of the property identified in the above step regarding mitigation option(s) and request to visit and enter the building in order for a noise level survey to be undertaken which can determine the building envelope noise reduction performance. At this stage, information about the building envelope can be gathered, including joinery and glazing, wall and ceiling construction, insulation or the lack thereof, etc.
- Following the site visit and noise survey, determine whether the existing building structure meets the requirements of NZS 6806:2010 with an internal noise level in habitable rooms of 40 dB LAeq(24h), or if

[12] Parts of Takitimu North Link
[13] Sections of WEX Hamilton Section and Christchurch Northern Corridor
[14] NZS6083:1999 Acoustics – Construction Noise

building modification mitigation is required. Several building modification mitigation options may then be developed, which may comprise of glazing, ventilation, insulation, or different types of glazing and joinery or a combination of different options.

- The building modification mitigation options would then be provided to the building owner, and discussions held between Waka Kotahi and the building owner to determine a satisfactory outcome and reach agreement as to the choice of mitigation option.
- Waka Kotahi would ensure that the agreed building modification mitigation option would be implemented at an agreed time. This may be prior to, during or following construction of the Project, in discussion with the building owner.

6.2 MITIGATION OPTIONS

The Project was separated into four discrete areas as shown in **Figure 6-1** to test mitigation options as listed in **Table 6-1**.

The mitigation options for each Project area for noise were assessed on the basis of:

- Compliance with the designation conditions
- Achievement of the NZS 6806:2010 structural mitigation performance standards
- Effectiveness of noise mitigation
- Requirement for building modification measures
- Value for money, including maintenance cost and consideration of benefit-cost analysis (using the benefit-cost ratio (BCR) calculation from NZS 6806:2010).

The mitigation options were circulated to the Project team for assessment against other factors, and responses were compiled within an assessment matrix for each area. Each discipline rated their assessment topics using a seven point scale (- - - through to + + +) and provided commentary explaining the rating where required. The completed options matrices were then circulated to the Project team and Waka Kotahi for discussion at a noise mitigation workshop.

The noise mitigation workshop was undertaken on 19 April 2023. The completed assessment matrix, mitigation options and attendees to the workshop, meeting notes are documented and contained in **Appendix F.**

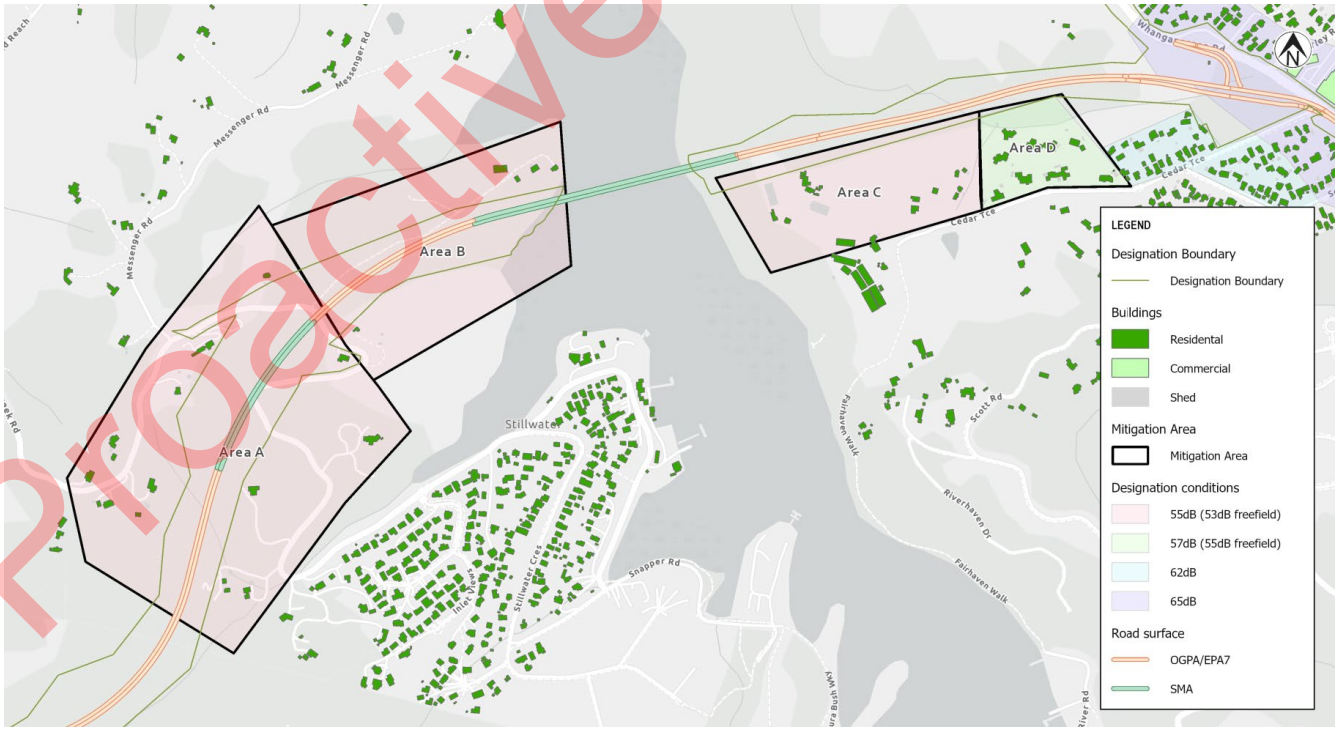


Figure 6-1 Mitigation Assessment Areas

Table 6-1: Noise mitigation options

Mitigation assessment area	Noise mitigation options
A	Option 1 –PA10 replacing SMA with 5 m barriers Option 2 – 50mm EPA7 replacing PA10 and SMA Option 3 – 50mm EPA7 with 2/4m barriers
B	Option 1 – PA10 replacing SMA with 2m barrier Option 2 – 50mm EPA7 replacing PA10 and SMA Option 3 – 50mm EPA7 with barrier (further reduction)
C	Option 1 – 50mm EPA7 Option 2 – 50mm EPA7 with 3m barrier at designation boundary
D	Option 1 – 50mm EPA7 Option 2 – PA10 with 2m barrier

Each assessment area was reviewed at the noise mitigation workshop and in each case an option was selected as representing the BPO. In some instances, this was subject to confirmation following further investigation by the Project team and Waka Kotahi.

Following the workshop, meetings with the owners of the PPFs that may require building modification acoustic treatment were undertaken to discuss mitigation options.

The following sections provide a summary of the design issues for each assessment area and the reasons for the selected BPO.

6.3 AREA A

Area A comprises the main alignment around the proposed Duck Creek Road intersection. Options considered, listed in **Table 6-1**, included noise walls along the edge of the carriageway just before and at the intersection, replacing SMA with OPGA 10 and the use of 50 mm EPA7.

The main alignment is situated in a cut relative to the nearest properties, which are situated on higher elevations overlooking the alignment.

At the workshop, the three options were discussed in detail, in particular the use of noise walls which has significant negative effect in terms of the urban and landscape context. It was identified whilst Option 3 provided the best noise reduction, the installation of a 4 m high noise wall in the remote location will have major maintenance issues, as well as negative impacts on visual amenity for road users. The constructability of the noise wall in the location identified is also an issue being on the edge of a cut/fill. A bund of 4 m high would also not be constructable in the area due to the width required for stability not being available. It was considered the noise walls/bund only benefited one property which was not BPO when factoring in all design aspects.

A discussion regarding the replacement of SMA to PA10 or 50 mm EPA7 around the intersection area for durability and safety reasons was undertaken. It was confirmed cured 50mm EPA7 has high durability and is suitable for intersections use.

When factoring in discussions concerning the noise walls and considering their negative impacts whilst only providing a marginal acoustic benefit, it was agreed Option 2 with 50 mm EPA7 replacing SMA and PA10 sections through this whole area was BPO.

With Option 2, all PPFs with the exception of one property s 9(2)(a) will meet the Designation noise limits.

Consultation with the property owners of s 9(2)(a) *regarding building modifications as mitigation in addition to the road surface is currently underway. The Alliance is still in discussion with the property owners regarding the mitigation option available to them. The final mitigation solution will be documented once an agreement with the property owners has been reached.*

6.4 AREA B

Area B follows directly to the east of Area A comprising a handful of PPFs. The main alignment for this area comes out of the cut formed for the Duck Creek Road intersection as it approaches onto the Wēiti River bridge.

A similar discussion regarding the use of acoustic barriers within this area took place, with a negative assessment for visual and urban landscape provided. A 2 m high noise would block the visual connection of the Wēiti River bridge for both existing properties and for future road and SUP users. Furthermore, the noise walls along the SUP increases crime/vandalism implications. However, barriers do allow for SMA (which is the typical road surface for bridges) to be used on the Wēiti River bridge.

A detailed discussion regarding the feasibility of having 50 mm EPA7 on the bridge concluded that porous asphalt road surface was feasible for the bridge. The transition between the bridge surface and the main alignment surface is currently being designed and subject to further work to ensure a smooth transition between the two.

Option 2 was considered BPO as the barriers were considered to have a more significant negative implication than 50 mm EPA7 on the bridge. The investment in the bridge as a landmark is highly important.

With Option 2, all PPFs within the area can meet Designation conditions.

Initial consultation with the owner representative of s 9(2)(a) was undertaken on 10 May 2023 in relation to the proposed noise mitigation affecting s 9(2)(a). The consultation memo provided to s 9(2)(a) is appended to this report as required by Designation Conditions 3.8 and 3.9. The s 9(2)(a) representatives had no additional queries in regard to noise upon receipt of the memo.

6.5 AREA C

Area C is east of the Wēiti River bridge. The alignment is set into a cut with one PPF located at the top of the cut. As such a barrier at the road carriageway edge will not be effective for this area.

As 50 mm EPA7 was considered BPO for Area B for the bridge, it was considered that the same road surface should flow through to Area C as a default. With this mitigation option applied, this results in one PPF (s 9(2)(a) exceeding the Designation noise limit. Discussion took place at the workshop regarding a 3 m barrier at the top of the cut close to the PPF in regard to its constructability and the potential negative visual and shadow cast effects of a high wall on the property. The possibility of a 2 m property fence was discussed or building modification.

Option 1 with 50 mm EPA7 was considered BPO with consultation required with the owner of s 9(2)(a) to confirm preferred mitigation in addition to the road surface at this PPF.

Consultation with the property owners s 9(2)(a) regarding building modifications or barrier option in addition to the road surface is currently underway. The Alliance is still in discussion with the property owners regarding the mitigation option available to them with preference for a 3 m timber barrier at the designation boundary. The final mitigation solution will be documented once an agreement with the property owners has been reached.

6.6 AREA D

Area D is directly east along the alignment approaching Whangaparāoa intersection. This area is considered urban land use with flatter terrain.

Option 2 was highlighted as providing additional noise mitigation. It was considered that a 2 m barrier in this area along the carriageway was constructable and visual amenity would not be significantly impacted. However, it was considered best practice to not include a 2 m property fence at the property boundary and a 2 m barrier at the carriageway edge due to whole of life maintenance issue. There are issues associated with having only the 2 m property fencing as the noise wall. In order to construct the noise wall at the property/designation boundary, a large quantity of vegetation (classified as SEA) is required to be removed. The location of the Designation boundary is also likely to increase the height of the noise wall in order to be effective due to the elevated alignment in this area. Clearing vegetation to build a noise wall is not good practice in this situation as road surface alone can reduce noise levels to meet the Designation noise limits.

Option 1 was selected as BPO as it achieves the required acoustic results and is consistent with the remainder of the alignment as discussed within the workshop.

With Option 1, all PPFs within the area can meet the noise limits.

6.7 SUMMARY OF MITIGATION

A summary of noise mitigation to be implemented to meet Designation noise limits are presented in **Table 6-2** and **Appendix G**.

Table 6-2: Summary of BPO noise mitigation options

Area	Low noise road surface	Barriers	Building modification
A	50 mm EPA7 (Start CH 4320)	Not BPO due to significant visual/landscape/urban/constructability and maintenance issue	Required at 1 PPF s 9(2)(a) [redacted]
B	50 mm EPA7	Not BPO due to significant visual/landscape issues (not required to meet Designation condition limits)	No
C	50 mm EPA7	Barrier design for Area C still uncertain. A possible barrier at top of cut on the property/designation boundary but could be an issue for constructability and visual impact. Discussions with Property Owner taking place.	Required at 1 PPF s 9(2)(a) [redacted]
D	50 mm EPA7 (Ends CH 6700)	Issues with barrier location and maintenance (not required to meet Designation condition limits)	No

6.7.1 Design details

The extent of the 50 mm EPA7 low noise road surface is shown on the drawing provided in **Appendix G**. Use of this road surface represents BPO.

Detailed building modification designs, barriers and legal agreements will be updated to this report on agreement of the final noise mitigation solution with the Property Owners of s 9(2)(a) [redacted] *, respectively. Final mitigation for the properties will not affect the BPO mitigation for the rest of the alignment.*

7 POST-CONSTRUCTION REVIEW

A post-construction review of the modelling assumptions will be made to confirm the basis of this mitigation design, and to specifically confirm that the barriers and road surfaces have been constructed as specified. The review will be undertaken in accordance Section 8 of P40 [and the relevant designation conditions] and will be completed and reported at least three months prior to the end of the defect's liability period. The post-construction review report will be submitted to Waka Kotahi, and where necessary to the Auckland Council.

A site inspection will be performed by an acoustics specialist to confirm that the noise mitigation has been installed as documented in the final NMP. For any noise barriers installed this will involve the reviewer standing at the far end of the carriageway with a printout / display of the computer acoustics model showing the 3D view from the inspection point looking towards the PPF. The visibility / screening of the PPF from the road will be visually compared to the model.

The reviewer will walk along the full length of each noise barrier and:

- Measure the height above ground each 100 m, or at any change in height over 0.5 m. The measured heights will be compared to the NMP.
- Confirm that all noise barriers are approximately in the positions and of the lengths shown in the final NMP.

- Inspect the noise barrier construction for gaps, and confirm that the materials are in accordance with the design.

A road surfacing specialist will inspect the low-noise surfaces as indicated in **Table 6-2** and confirm they have been installed as specified.

8 LIMITATIONS

This report has been prepared in general accordance with Waka Kotahi guidance and accepted practices and standards. This report is based on the 100% detailed design and is intended to be used to document and inform the Project's Outline Plan and Project design team of noise mitigation requirements.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report has been prepared for the benefit of Waka Kotahi, NZ Transport Agency. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval or to fulfil a legal requirement.

APPENDIX A – Whangaparāoa Road Dwellings Designation Noise Limits

APPENDIX B – Project Traffic Volumes

Tolled 2038 traffic volumes and Reference ID – source Nov 2022 Waka Kotahi

Reference design traffic volumes – source Penlink – Assessment of Acoustic Effects, Ep 002 R04 2014038A, Marshall Day Acoustics, 6 November 2014

Table 5: Annual daily traffic volumes at design year

Road section	Designated Road (Design year 2008)	Proposed Road (Design year 2031)
Penlink: East Coast Road to Weiti Station	12,700	19,900
Penlink: Weiti Station to Duck Creek Road	12,700	15,700
Penlink: Duck Creek Road to Whangaparaoa Road	12,700	14,900
Whangaparaoa Road: West of Penlink	17,800	18,800
Whangaparaoa Road: East of Penlink	23,400	30,300

APPENDIX C – Predicted Noise Levels

Predicted noise levels for Do Minimum and BPO Mitigation at PPFs (façade levels)

Address	Noise Limit, dB $L_{Aeq(24h)}$	Do Minimum scenario, dB $L_{Aeq(24h)}$	BPO Mitigation, dB $L_{Aeq(24h)}$
Main Alignment			
2B Beverley Road	69	57	57
4 Beverley Road	65	52	52
6 Beverley Road	65	54	54
8 Beverley Road	65	51	51
10 Beverley Road	65	49	49
12 Beverley Road	65	52	52
21 Cedar Terrace	62	58	57
22 Cedar Terrace	62	58	57
2/27 Cedar Terrace	62	54	53
39G Cedar Terrace	57	58	55
39D Cedar Terrace	57	59	56
39B Cedar Terrace	57	56	54
39B Cedar Terrace	57	59	57
39C Cedar Terrace	57	59	56
39E Cedar Terrace	57	58	56
39H Cedar Terrace	57	55	52
39F Cedar Terrace	57	56	53
39 Cedar Terrace	57	57	54
41 Cedar Terrace	55	54	52
s 9(2)(a)	55	60	57
2/43 Cedar Terrace	55	59	55
161 Duck Creek	55	54	53
165 Duck Creek	55	51	49
167 Duck Creek	55	53	51
s 9(2)(a)	55	60	57
236 Duck Creek	55	58	55
250 Duck Creek	55	53	49
266 Duck Creek	55	46	42
275 Duck Creek	55	58	54
287 Duck Creek	55	56	52
296 Duck Creek	55	38	36
301 Duck Creek	55	58	55
305 Duck Creek	55	57	54
307 Duck Creek	55	54	50
524A Whangaparāoa Road	65	48	46
528 Whangaparāoa Road	65	45	45
529 Whangaparāoa Road	65	53	52
2/532 Whangaparāoa Road	65	46	45

Address	Noise Limit, dB $L_{Aeq(24h)}$	Do Minimum scenario, dB $L_{Aeq(24h)}$	BPO Mitigation, dB $L_{Aeq(24h)}$
564 Whangaparāoa Road	65	54	53
592L Whangaparāoa Road	65	54	53
4 Wiriana Place	65	47	46

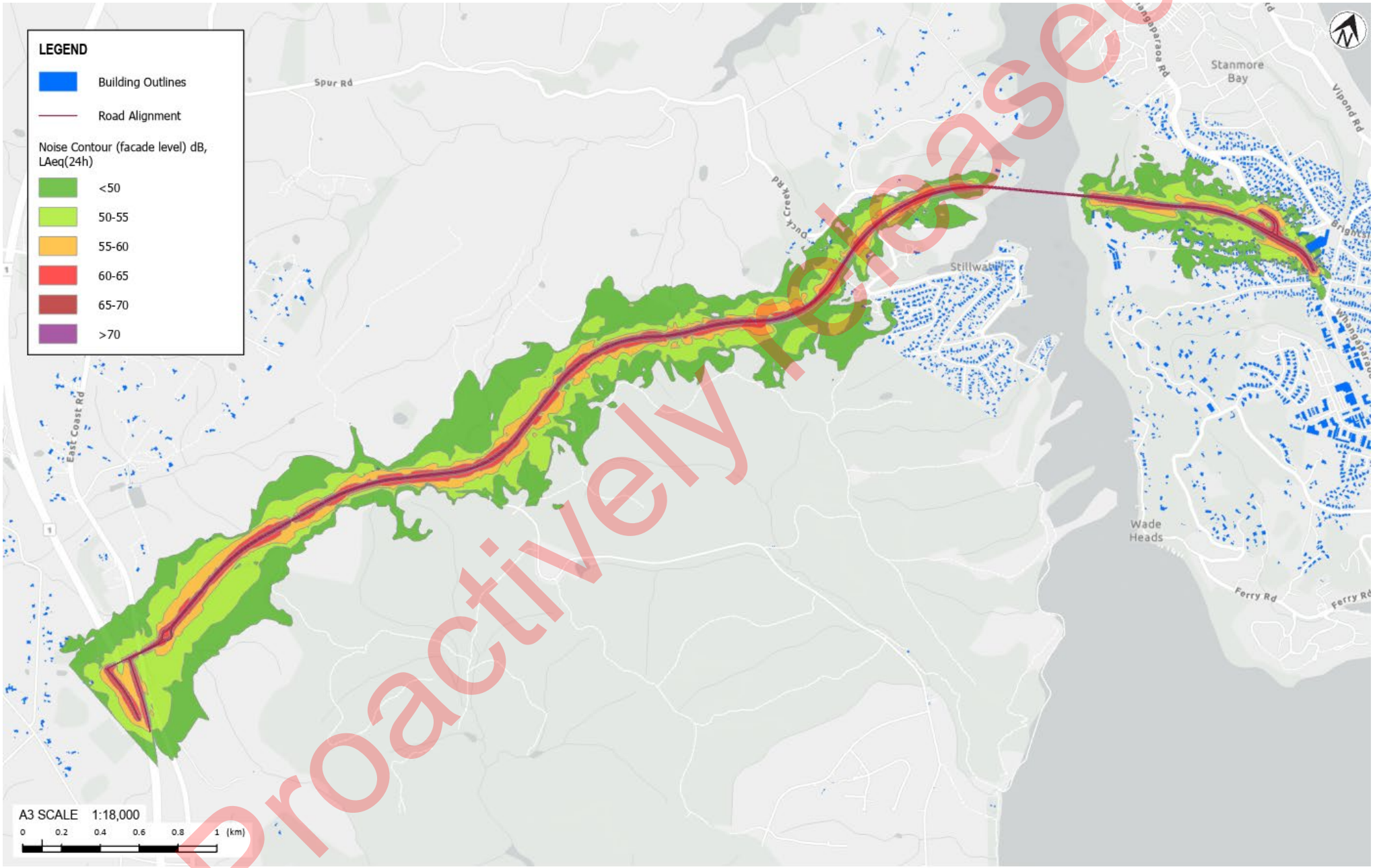
Address	Noise Limit, db $L_{Aeq(24h)}$	Do Minimum scenario, db $L_{Aeq(24h)}$
Whangaparāoa Intersection		
2 Cedar Terrace	67	64
4 Cedar Terrace	66	63
6A Cedar Terrace	65	55
6 Cedar Terrace	65	60
7A Cedar Terrace	62	57
7B Cedar Terrace	62	59
8 Cedar Terrace	62	55
9B Cedar Terrace	62	61
9B Cedar Terrace	62	58
10B Cedar Terrace	62	49
10A Cedar Terrace	62	51
11 Cedar Terrace	62	57
11 Cedar Terrace	62	55
12 Cedar Terrace	65	60
12A Cedar Terrace	62	56
13 Cedar Terrace	62	55
14 Cedar Terrace	62	49
15 Cedar Terrace	62	56
16C Cedar Terrace	62	51
16C Cedar Terrace	62	50
17 Cedar Terrace	62	57
18 Cedar Terrace	62	59
19 Cedar Terrace	62	58
20 Cedar Terrace	62	55
21 Cedar Terrace	62	57
22 Cedar Terrace	62	59
23 Cedar Terrace	62	52
25 Cedar Terrace	62	53
26 Cedar Terrace	62	56
2/27 Cedar Terrace	62	54
28 Cedar Terrace	62	56
29 Cedar Terrace	62	52
30 Cedar Terrace	62	56

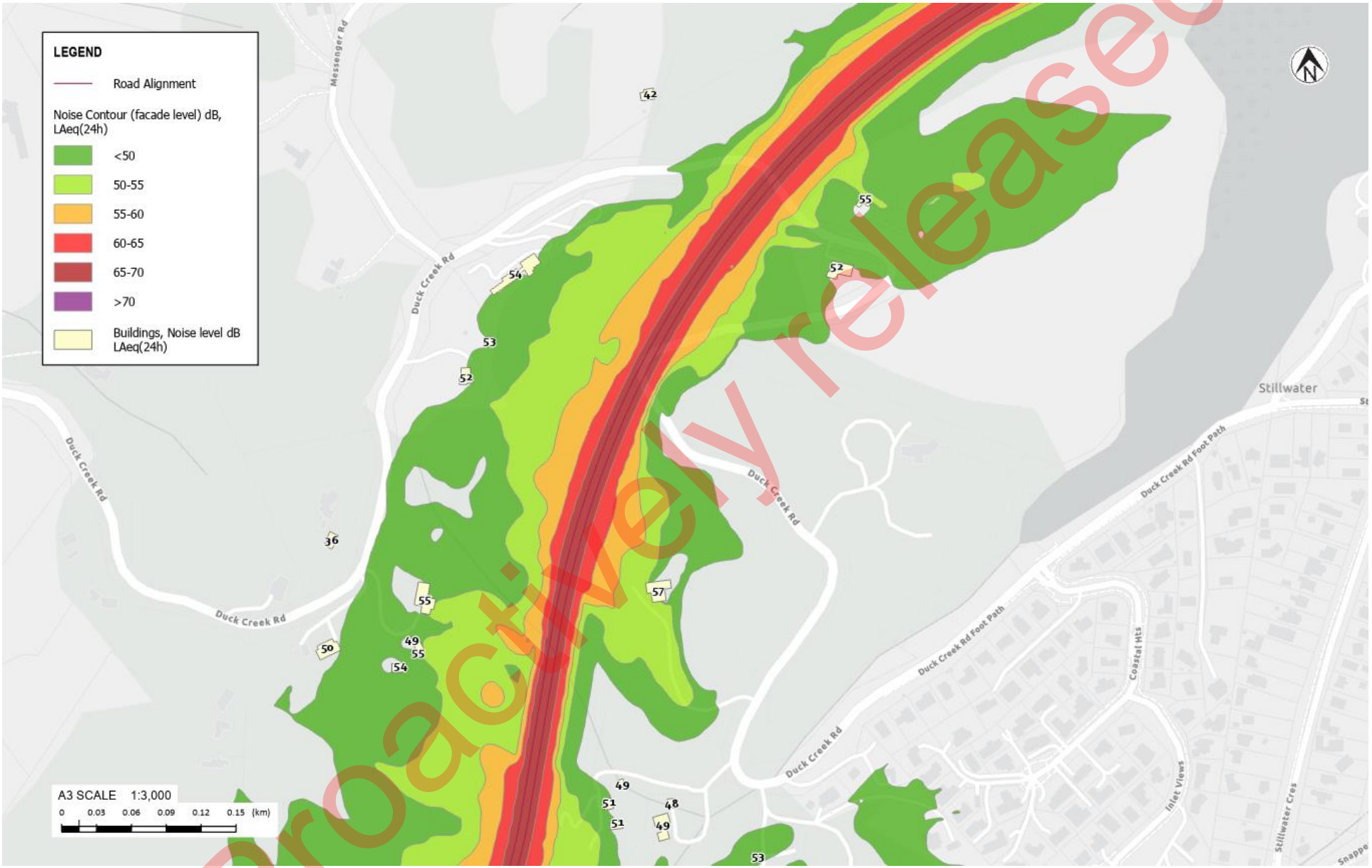
Address	Noise Limit, db $L_{Aeq(24h)}$	Do Minimum scenario, db $L_{Aeq(24h)}$
31 Cedar Terrace	62	55
32 Cedar Terrace	62	56
33C Cedar Terrace	62	56
33B Cedar Terrace	62	55
33A Cedar Terrace	62	51
35 Cedar Terrace	62	54
36 Cedar Terrace	62	47
37 Cedar Terrace	62	53
39A Cedar Terrace	57	53
40B Cedar Terrace	62	52
3 Hiwi Crescent	65	49
4/602 Hiwi Crescent	68	46
5 Hiwi Crescent	65	45
7 Hiwi Crescent	65	44
3 Norfolk Road	62	47
5 Norfolk Road	62	50
7 Norfolk Road	62	44
7 Norfolk Road	62	50
9 Norfolk Road	62	50
11 Norfolk Road	62	49
12 Norfolk Road	62	51
13 Norfolk Road	62	49
14 Norfolk Road	62	51
15 Norfolk Road	62	52
1/16 Norfolk Road	62	51
18 Norfolk Road	62	54
7B Ozone Road	65	45
9 Ozone Road	65	42
11 Ozone Road	65	43
14 Ozone Road	65	45
1 Scott Road	67	58
3 Scott Road	65	49
4 Scott Road	65	47
5 Scott Road	65	50
7 Scott Road	65	50
522A Whangaparāoa Road	65	49
524A Whangaparāoa Road	65	49
526 Whangaparāoa Road	65	47
528 Whangaparāoa Road	65	51
529 Whangaparāoa Road	65	53

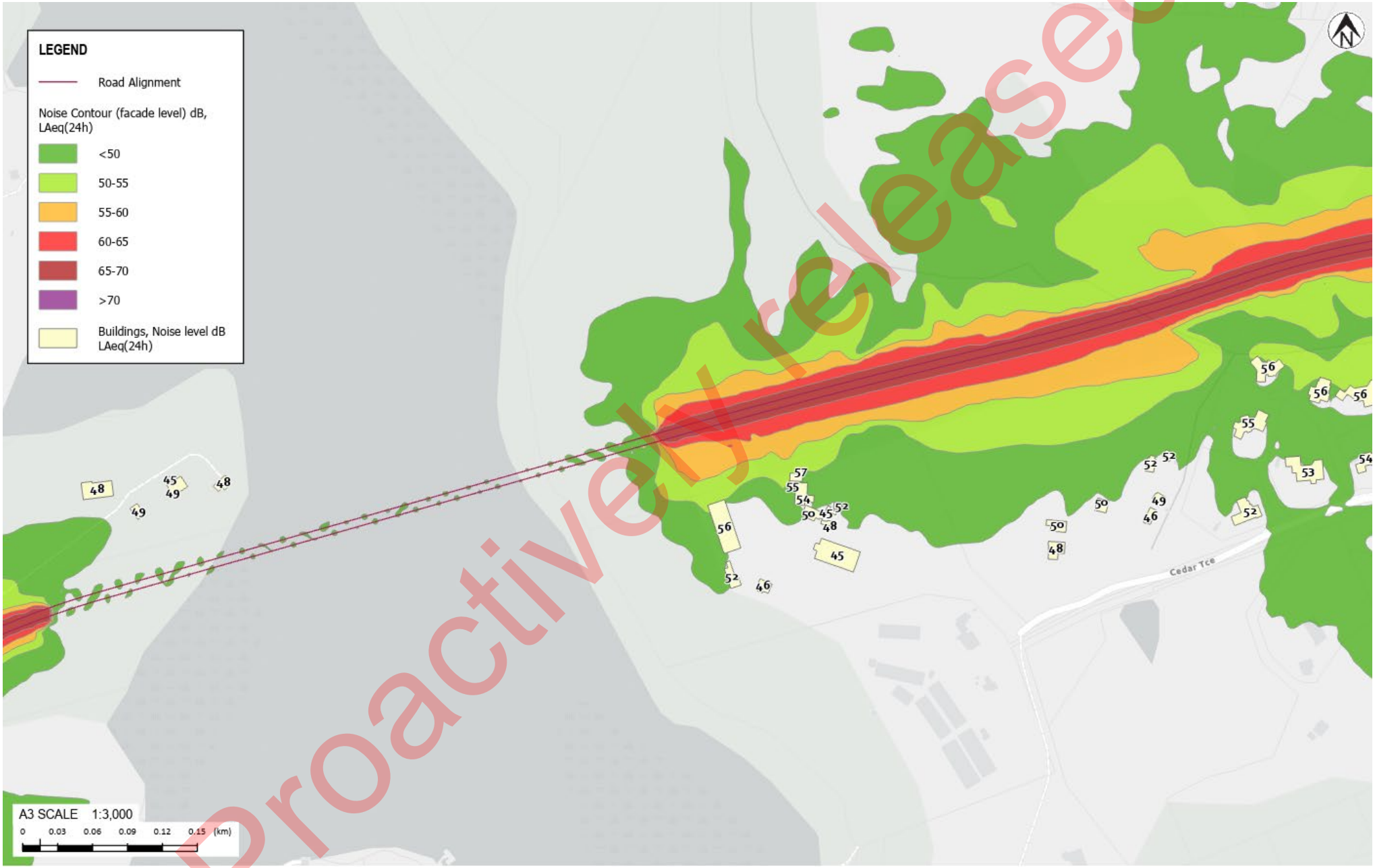
Address	Noise Limit, db $L_{Aeq(24h)}$	Do Minimum scenario, db $L_{Aeq(24h)}$
1/532 Whangaparāoa Road	65	48
2/532 Whangaparāoa Road	65	45
3/532 Whangaparāoa Road	65	53
4/532 Whangaparāoa Road	65	54
5/532 Whangaparāoa Road	65	51
534 Whangaparāoa Road	65	43
536 Whangaparāoa Road	65	44
538 Whangaparāoa Road	65	51
540 Whangaparāoa Road	67	59
540A Whangaparāoa Road	65	55
542A Whangaparāoa Road	65	50
544 Whangaparāoa Road	65	61
546 Whangaparāoa Road	65	60
548 Whangaparāoa Road	65	61
550 Whangaparāoa Road	65	55
552 Whangaparāoa Road	65	53
554 Whangaparāoa Road	65	60
556A Whangaparāoa Road	66	55
556 Whangaparāoa Road	65	50
558 Whangaparāoa Road	65	57
1/558 Whangaparāoa Road	69	62
564 Whangaparāoa Road	72	62
566 Whangaparāoa Road	71	60
568 Whangaparāoa Road	73	60
585 Whangaparāoa Road	68	64
587B Whangaparāoa Road	65	55
587 Whangaparāoa Road	70	66
589 Whangaparāoa Road	70	63
591 Whangaparāoa Road	68	60
592L Whangaparāoa Road	71	68
595 Whangaparāoa Road	67	55
596 Whangaparāoa Road	69	66
2/596 Whangaparāoa Road	65	55
3/596 Whangaparāoa Road	65	49
598 Whangaparāoa Road	68	67
600 Whangaparāoa Road	71	63
604 Whangaparāoa Road	65	49
1/7 Wiriana Place	65	49
1A Wiriana Place	65	56
662 Whangaparāoa Road	71	63

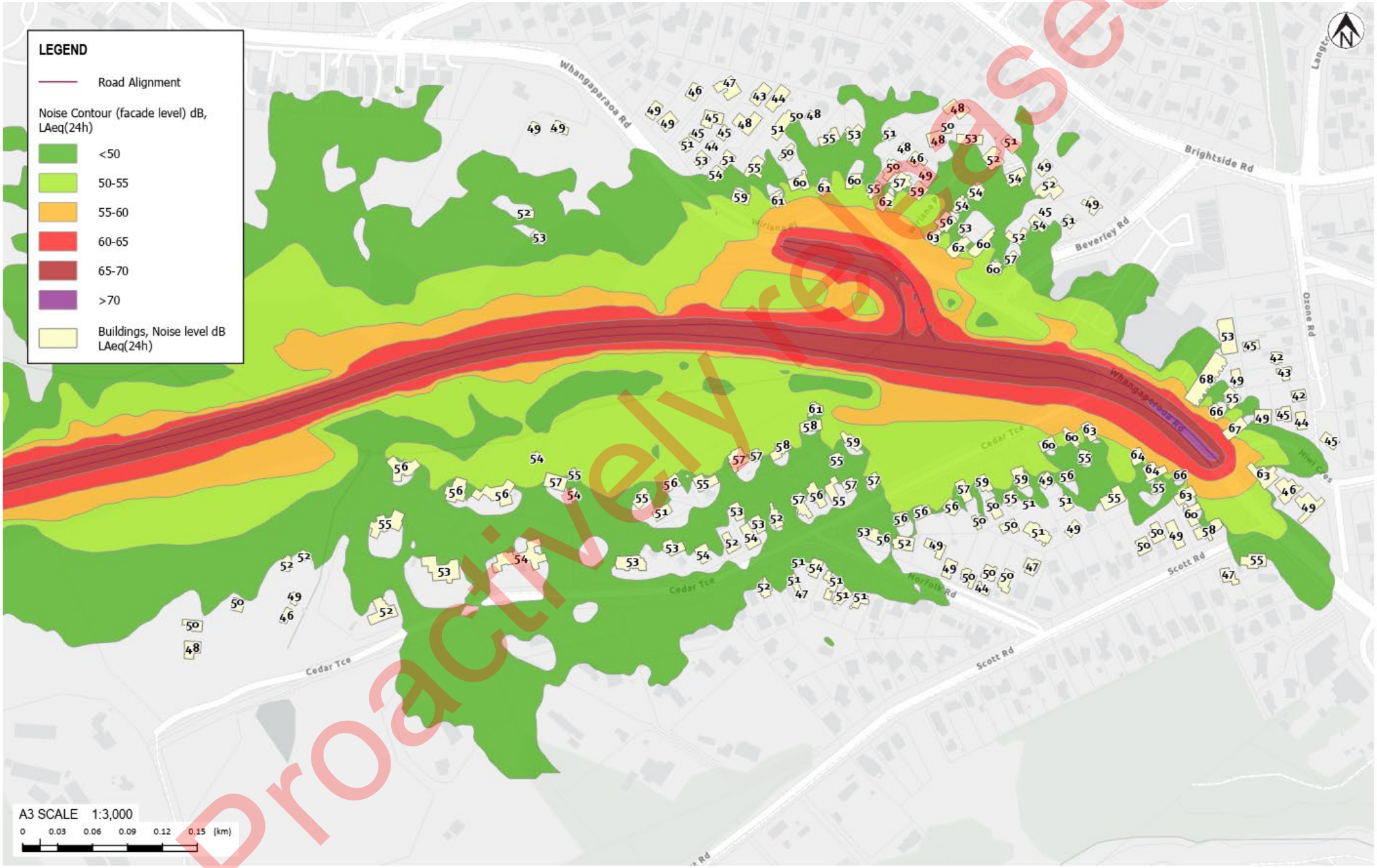
Address	Noise Limit, db $L_{Aeq(24h)}$	Do Minimum scenario, db $L_{Aeq(24h)}$
2 Wiriana Place	66	59
3 Wiriana Place	65	54
4 Wiriana Place	65	49
5 Wiriana Place	65	54
6 Wiriana Place	65	51
7 Wiriana Place	65	54
9A Wiriana Place	65	51
9 Wiriana Place	65	52
10 Wiriana Place	65	48
12A Wiriana Place	65	48
14 Wiriana Place	65	53

APPENDIX D – Façade Noise Level Maps

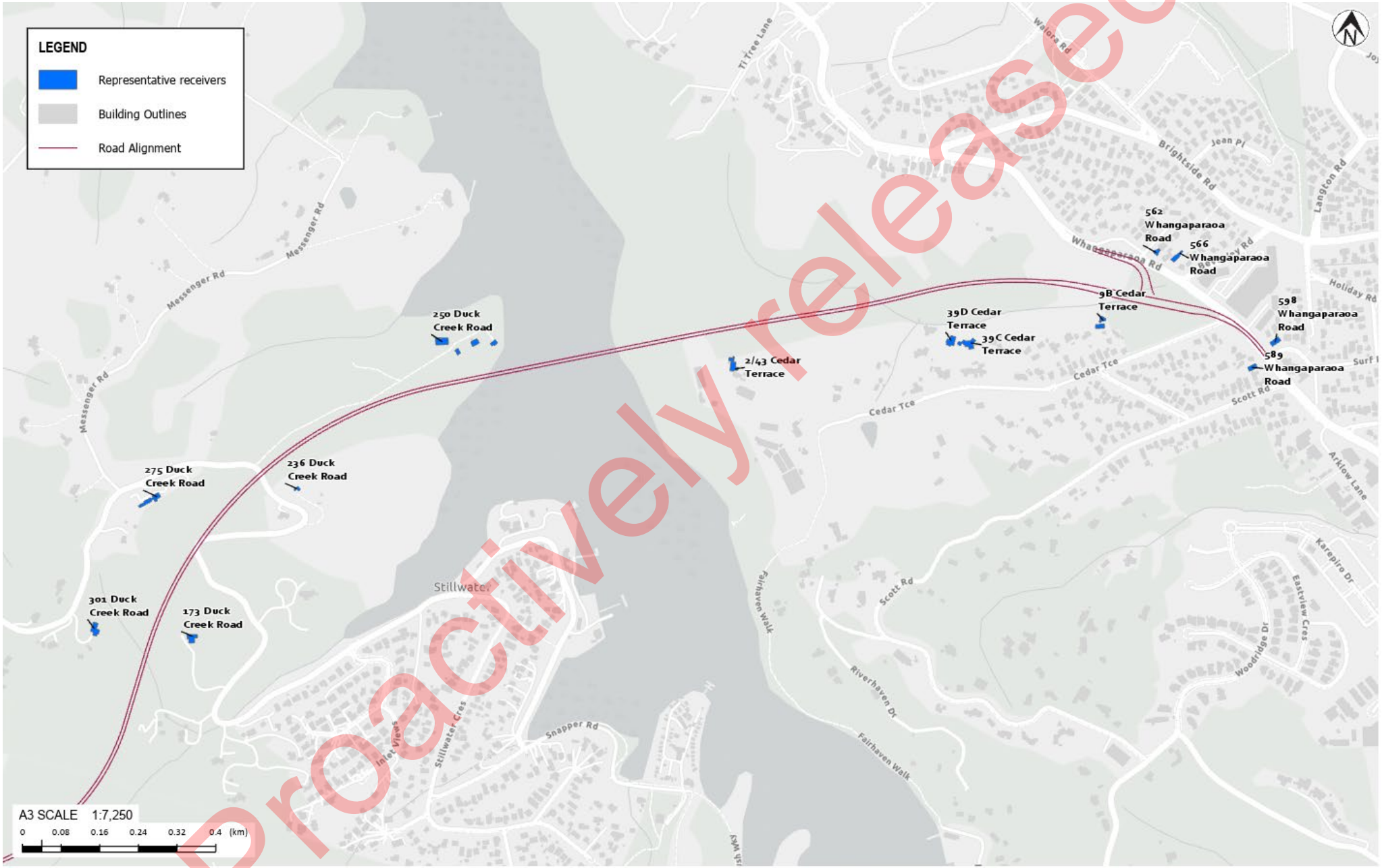








APPENDIX E – Representative Receivers



APPENDIX F – Mitigation Matrix

NZS 6806 - Assessment matrix

Project	Assessment area
Penlink	A - Duck Creek

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Effectiveness of noise mitigation	Acoustics	Most effective structural solution does not achieve designation conditions - building modification will still be required	o Least reduction achieved with 5m high walls.	o Provides an average 3 dB reduction across the area	+ Provides 3 dB reduction generally with additional targeted reduction of 2 dB - Risk of 'tunnelling effect' due to parallel noise walls
Achievement of the NZS 6806 structural mitigation performance standards	Acoustics	5m high walls may be problematic in terms of visual, constructability and ongoing maintainance. One property s 9(2)(a) would prefer a bund.	o Barriers within road reserve. Reducing on average between -2 and -3dB. One property increases due to barrier reflections	o low noise road surface only - overall 3 dB reduction across cluster	+ Combination of road surface and 4 + 2m barriers. barriers within road reserve,. >3 dB reduction
Compliance with designation conditions	Acoustics	Designation conditions are more stringent than NZS6806 CAT A criteria	– One PPF does not meet compliance	– One PPF does not meet compliance	+ + + All PPFs meet compliance
Requirement for building-modification measures	Acoustics	Building modification plus barrier is not likely a preferred option.	– One PPF require Building modification a reduction of 4-5 dB to meet conditions	– One PPF require Building modification a reduction of 2-3 dB to meet conditions	o None required
Value for money, including maintenance costs and consideration of benefit cost analysis	Acoustics	Calculation of indicative Benefit cost ratio for comparison purposes only - maintainence cost not factored in	+ Highest cost for barrier requirements with minimal additional benefit. Building modification and barriers required BCR (1.1)	+ + + Best value for money compared to benefit achieved - no barriers (BCR 4.88)	+ + + Balance cost against benefit - barriers will need mantenance cost (BCR 1.82)
Alignment with Designation conditions and minimum requirement policies	Planner	•Ability to comply with Designation 3.5, however Designation Condition 3.7 then comes into play if the adoption of the BPO for noise mitigation within the road corridor is insufficient to meet the Design Limits in condition 3.5, agreement with landowner re: insultation or impracticable so property purchase is required. •Potential impact on SEA vegetation but as seeking to place barriers adjacent road, should be within area already cleared for construction, therefore, no additional loss.	– – Does not achieve DC3.5 for one property (#301 DCR) still and building modifications would be required. Ability to agree this with landowner a risk.	– – Does not achieve DC3.5 for one property (#301 DCR) still and building modifications would be required. Ability to agree this with landowner a risk.	+ + + •Achieves compliance with DC 3.5 for all properties, with no building modifications. •Potential impact on SEA vegetation but as seeking to place barriers adjacent road, should be within area already cleared for construction, therefore, no additional loss.
Planning authorisation required	Planner	Need to demonstrate in Outline Plan ability to comply with Designation 3.5 or what BPO measure has been adopted and why. Council's Acoustic Advisor may challenge BPO decision - protected discussions. Similarly, stakeholders may challenge/not agree to BPO decision with need for Peer review and protected discussion.	– – Does not achieve DC3.5 for one property (#301 DCR) still and building modifications would be required. Ability to agree this with landowner a risk.	– – Does not achieve DC3.5 for one property s 9(2)(a) still and building modifications would be required. Ability to agree this with landowner a risk.	+ + + •Achieves compliance with DC3.5 for all properties, with no building modifications. Support through OP process would be achieved.

Project	Assessment area
Penlink	A - Duck Creek

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Potential effects of operational noise on known heritage or cultural values	Planner	No heritage buildings or items in Area A. No known items of cultural value within Area A and no flags from iwi partners re potential for cultural sites.	o None present in subject area.	o None present in subject area.	o None present in subject area.
Effects of mitiation structures on cultural values (e.g bund or barrier traverses on an important site)	Planner	No known items of cultural value within Area A and no flags from iwi partners re potential for cultural sites.	o None present in subject area.	o None present in subject area.	o None present in subject area.
Social effects of mitigiation	Planner	Balance between reduction in noise amenity effects and increase in effects associated with other amenity (eg. outlook, shadown cast)	– – •Positive benefit to those properties gaining a noise reduction, adverse effect to #301 unless agreement reached for building modifications. •While the proposed noise barrier is below properties, potential reduction in outlook amenity due to height (5m) of the necessary structures	– – •Positive benefit to those properties gaining a noise reduction, adverse effect to #[redacted] unless agreement reached for building modifications. •While the proposed noise barrier is below properties, potential reduction in outlook amenity due to height (5m) of the necessary structures	+ •Positive benefit to those properties gaining a noise reduction, without need for building modifications. •While the proposed noise barrier is below properties, potential reduction in outlook amenity due to height (4m) of the necessary southern barrier.
Constructability/Engineering degree of difficulty	Road Engineering		– – Structurally hard to do, with barriers on edge of large fill	– construction requires specalist subbie, but OK once approval obtained	– – – Structurally hard to do, with BIG barriers on edge of large fill
Requirement of additional fill	Road Engineering		– some additional fill likely required	o no change	– some additional fill likely required
Opportunity for use as a spoilt site (resource efficiency)	Road Engineering		o no opportunity	o no change	o no opportunity
Maintenance or enhancement of the convenience and attractiveness of pedestrian and cycle networks	Road Engineering		– – barrier immediately adjacent to path, a lot of length to maintain	o no change	– – barrier immediately adjacent to path, a lot of length to maintain
Stormwater treatement and/or potential flooding effects	Road Engineering		o OK if a nominal gap under barrier can be included? Could be maint. issue in large events, need special detail	o no change	o OK if a nominal gap under barrier can be included? Could be maint. issue in large events, need special detail
Compliance with minimum road requirements - surfacing	Road Engineering		– Need acceptance of OGPA in intersection areas	– Need acceptance of 50mm EPA7	– Need acceptance of 50mm EPA7
Effects on road / cycle land user safety and security	Road Engineering		o barrier immediately adjacent to path not pretty but not unsafe	o no change	o barrier immediately adjacent to path not pretty but not unsafe
The extent to which the mitigation option promotes integration and establishes visual coherence and continuity in form, scale and appearance of structures and landscape proposals along the route	Urban and Landscape		– – – Significant loss of continuity of the "greenway" experience, would be improved if timber not concrete, and would require visual mitigation in the form of urban or cultural design to highway faces	o No impact	– – – Significant loss of continuity of the "greenway" experience, would be improved if timber not concrete, and would require visual mitigation in the form of urban or cultural design to highway faces

Project	Assessment area
Penlink	A - Duck Creek

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Road users' views to the surrounding landscape and key features/ locations in particular	Urban and Landscape		– – –	o	– –
			Wall highs and block visual connection the landscape. Have significant scale and visual impact on SUP users	No impact	Walls high to see over and block visual connection to landscape, reduced scale less visual impact on SUP users.
Impacts on visual amenity of surrounding residents	Urban and Landscape		–	o	–
			Quite visible scale at 5m tall but below the wider views from existing houses	No impact	Less visible, 2m and 4m height better scale less visible from existing houses
Achieves good urban design outcomes	Urban and Landscape		– – –	+	– – –
			Poor outcome in the Greenway context - less imapct as future urban develops	Yes positive	Poor outcome in the Greenway context - less imapct as future urban develops

NZS 6806 - Assessment matrix

Project	Assessment area
Penlink	B - 236 Duck Creek

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Effectiveness of noise mitigation	Acoustics	Targeted mitigation with barriers - low density of buildings within the area - Dependent on the bridge being 50mm EPA7	+	o	+
			average 3.5 dB reduction	average 3 dB reduction	average 4 dB reduction
Achievement of the NZS 6806 structural mitigation performance standards	Acoustics	Barrier options provide additional mitigation for 236 Duck Creek (plot)	+	o	+
			Barrier within road reserve - 4 dB achieved for one PPF only	Road surface alone meets designation conditions - 3 dB reduction achieved for wider area	Barrier with 50mm EPA7 - 7 dB achieved for one PFF
Compliance with designation conditions	Acoustics	Designation conditions are more stringent than NZS6806 CAT A criteria	+ + +	+ + +	+ + +
			Complies	Complies	Complies
Requirement for building-modification measures	Acoustics		o	o	o
			Not required	Not required	Not required
Value for money, including maintenance costs and consideration of benefit cost analysis	Acoustics	Calculation of indicative Benefit cost ratio for comparison purposes only - maintainence cost not factored in - Option 2+3 considers providing wider benefit for 236 Duck Creek	– –	–	–
			Poor BCR due to low housing density. (BCR 0.47)	Poor BCR due to low housing density. (BCR 0.64)	Poor BCR due to low housing density. (BCR 0.65) High cost for higher benefit
Alignment with Designation conditions and minimum requirement policies	Planner	Ability to comply with Designation 3.5, however Designation Condition 3.7 then comes into play if the adoption of the BPO for noise mitigation within the road corridor is insufficient to meet the Design Limits in condition 3.5, agreement with landowner re: insultation or impracticable so property purchase is required.	+ + +	+ + +	+ + +
			Achieves compliance with DC 3.5 for all properties, with no building modifications.	Achieves compliance with DC 3.5 for all properties, with no building modifications.	Achieves compliance with DC 3.5 for all properties, with no building modifications.
Planning authorisation required	Planner	Need to demonstrate in Outline Plan ability to comply with Designation 3.5 or what BPO measure has been adopted and why. Council's Acoustic Advisor may challenge BPO decision - protected discussions. Similarly, stakeholders may challenge/not agree to BPO decision with need for Peer review and protected discussion.	+ + +	+ + +	+ + +
			Achieves compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved.	Achieves compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved.	Achieves compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved.
Potential effects of operational noise on known heritage or cultural values	Planner	No heritage buildings or items in Area B. No known items of cultural value within Area B where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o	o	o
			None present in subject area.	None present in subject area.	None present in subject area.
Effects of mitiation structures on cultural values (e.g bund or barrier traverses on an important site)	Planner	No known items of cultural value within Area B where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o	o	o
			None present in subject area.	None present in subject area.	None present in subject area.

Project	Assessment area
Penlink	B - 236 Duck Creek

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2	Option 3
Social effects of mitigiation	Planner	Balance between reduction in noise amenity effects and increase in effects associated with other amenity (eg. outlook, shadown cast)	+ + •Positive benefit to those properties gaining a noise reduction, without need for building modifications. •While the proposed noise barrier is below Webster property and visual outlook is a concern to them (cf Designation Condition set), the proposed barrier height at 2m is not dissimilar to permitted activity fence height - consider ability to green/screen it from their views.	+ + + •Positive benefit to #236 DCR gaining a noise reduction, without need for building modifications or any barriers.	+ + + •Positive benefit to those properties gaining a noise reduction (greatest), without need for building modifications. •While the proposed noise barrier is below Webster property and visual outlook is a concern to them (cf Designation Condition set), the proposed barier height at 2m is not dissimilar to permitted activity fence height - consider ability to green/screen it from their views.
Constructability/Engineering degree of difficulty	Road Engineering		– – barriers on edge of large fill	o	– – barriers on edge of large fill
Requirement of additional fill	Road Engineering		– some additional fill likely required	o no change	– some additional fill likely required
Opportunity for use as a spoilt site (resource efficiency)	Road Engineering		o no opportunity	o no change	o no opportunity
Maintenance or enhancement of the convenience and attractiveness of pedestrian and cycle networks	Road Engineering		– – barrier immediately adjacent to path, a lot of length to maintain	o no change	– – barrier immediately adjacent to path, a lot of length to maintain
Stormwater treatement and/or potential flooding effects	Road Engineering		– OK if a nominal gap under barrier can be included? Could be maint issue in large events, need special detail	o no change	– OK if a nominal gap under barrier can be included? Could be maint issue in large events, need special detail
Compliance with minimum road requirements - surfacing	Road Engineering		– Need acceptance of OGPA in intersection areas	– Need acceptance of 50mm EPA7	– Need acceptance of 50mm EPA7
Effects on road / cycle land user safety and security	Road Engineering		o barrier immediately adjacent to path not pretty but not unsafe	o no change	o barrier immediately adjacent to path not pretty but not unsafe
The extent to which the mitigation option promotes integration and establishes visual coherence and continuity in form, scale and appearance of structures and landscape proposals along the route	Urban and Landscape		– – – Significant loss of continuity of the "greenway" experience, would be improved if timber not concrete, and would require visual mitigation in the form of urban or cultural design to highway faces	o No impact	– – – Significant loss of continuity of the "greenway" experience, would be improved if timber not concrete, and would require visual mitigation in the form of urban or cultural design to highway faces
Road users' views to the surrounding landscape and key features/ locations in particular	Urban and Landscape		– – – Blocks the veiw on approach to Weiti River and the Bridge significant loss on visual connection to the principle landscape amenity element and landmark structure.	o No impact	– – – Blocks the veiw on approach to Weiti River and the Bridge significant loss on visual connection to the principle landscape amenity element and landmark structure.
Impacts on visual amenity of surrounding residents	Urban and Landscape		– – – Webster properties have designation conditions that this will effect, would require planting mitigation	o No impact	– – – Webster properties have designation conditions that this will effect, would require planting mitigation
Achieves good urban design outcomes	Urban and Landscape		– – – significant impact on visual connection to landmarks	+ Yes positive	– – – significant impact on visual connection to landmarks

NZS 6806 - Assessment matrix

Project	Assessment area
Penlink	C - s 9(2)(a)

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Effectiveness of noise mitigation	Acoustics	Dependant on bridge being 50mm EPA7	–	–
			2-3 dB reduction for cluster	2-3 dB reduction for cluster plus additional 3dB for one PPF
Achievement of the NZS 6806 structural mitigation performance standards	Acoustics	Targeted barrier	–	–
			Overall reduction achieved for cluster	Barrier on designation boundary at top of terrain cut - not next to the carriageway. Barrier provides additional 3 dB for one property only
Compliance with designation conditions	Acoustics	Designation conditions are more stringent than NZS6806 CAT A criteria	–	+ + +
			One PPF s 9(2)(a) does not comply. Exceeds by 1dB	Complies at all PPF
Requirement for building-modification measures	Acoustics	Building modification is more feasible than barrier on top of cut	–	o
			One PPF require Building modification a reduction of 1-2 dB to meet conditions	None required
Value for money, including maintenance costs and consideration of benefit cost analysis	Acoustics	Calculation of indicative Benefit cost ratio for comparison purposes only - maintainence cost not factored in	+ + +	+
			BCR(3.95) - mitigation benefits cluster	BCR 1.10 - high cost of barrier to benefit one PPF
Alignment with Designation conditions and minimum requirement policies	Planner	Ability to comply with Designation 3.5, however Designation Condition 3.7 then comes into play if the adoption of the BPO for noise mitigation within the road corridor is insufficient to meet the Design Limits in condition 3.5, agreement with landowner re:	– –	+ + +
			Does not achieve DC3.5 for part of one property (#s 9(2)(a) still and building modifications would be required. Ability to agree this with landowner a risk.	Achieves compliance with DC 3.5 for all properties, with no building modifications.
Planning authorisation required	Planner	Need to demonstrate in Outline Plan ability to comply with Designation 3.5 or what BPO measure has been adopted and why. Council's Acoustic Advisor may challenge BPO decision - protected discussions. Similarly, stakeholders may challenge/not agree to BPO decision with need for Peer review and protected discussion. Provided any barrier required is within designation, no additional	– –	+
			Does not achieve DC3.5 for part of one property (#s 9(2)(a) still and building modifications would be required. Ability to agree this with landowner a risk.	•Achieves compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved. •Concern that required barrier cannot be located within designation and will trigger the need for a resource consent (height, SEA removal and possible earthworks)
Potential effects of operational noise on known heritage or cultural values	Planner	No heritage buildings or items in Area C. No known items of cultural value within Area C where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o	o
			None present in subject area.	None present in subject area.

Project	Assessment area
Penlink	C - s 9(2)(a)

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Effects of mitiation structures on cultural values (e.g bund or barrier traverses on an important site)	Planner	No known items of cultural value within Area C where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o	o
			None present in subject area.	None present in subject area.
Social effects of mitigiation	Planner	Balance between reduction in noise amenity effects and increase in effects associated with other amenity (eg. outlook, shadown cast)	– –	–
			•Positive benefit to those properties gaining a noise reduction, without need for building modifications.	•Positive benefit to those properties gaining a noise reduction, without need for building modifications. •Likely reduction in outlook amenity due to height (3m) and proximity of the necessary barrier and impact in usability of this area for the landowner– northern aspect.
Constructability/Engineering degree of difficulty	Road Engineering		– –	–
			construction requires specalist subbie, but OK once approval obtained	barriers on top of large cut, OK if staged well, i.e. barrier built first
Requirement of additional fill	Road Engineering		o	o
			no change	no change
Opportunity for use as a spoilt site (resource efficiency)	Road Engineering		o	o
			no change	no change
Maintenance or enhancement of the convenience and attractiveness of pedestrian and cycle networks	Road Engineering		o	o
			no change	no change
Stormwater treatement and/or potential flooding effects	Road Engineering		o	–
			no change	OK if a nominal gap under barrier can be included? Could be maint issue in large events, need special detail
Compliance with minimum road requirements - surfacing	Road Engineering		–	–
			Need acceptance of 50mm EPA7	Need acceptance of 50mm EPA7
Effects on road / cycle land user safety and security	Road Engineering		o	o
			no change	no change
The extent to which the mitigation option promotes integration and establishes visual coherence and continuity in form, scale and appearance of structures and landscape proposals along the route	Urban and Landscape		o	–
			No impact	Could be screened by planting and would be very minor effects
Road users' views to the surrounding landscape and key features/ locations in particular	Urban and Landscape		o	o
			No impact	No impact

Project	Assessment area			
Penlink	C - s 9(2)(a)			

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Impacts on visual amenity of surrounding residents	Urban and Landscape		o	- - -
			No impact	Close to house and would impact view and amenity from living areas
Achieves good urban design outcomes	Urban and Landscape		o	-
			No impact	Could be screened by planting and would be very minor effects

NZS 6806 - Assessment matrix

Project	Assessment area
Penlink	D - Cedar terrace

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Effectiveness of noise mitigation	Acoustics	Option 1 allows for clear visual for bike users	–	–
			average 2 dB reduction across cluster	average 2 dB reduction across cluster
Achievement of the NZS 6806 structural mitigation performance standards	Acoustics		–	–
			Low noise road surface only	2m barrier along road reserve
Compliance with designation conditions	Acoustics	Designation conditions are more stringent than NZS6806 CAT A criteria (Designation condition is façade level)	+ + +	+ + +
			All complies	All complies
Requirement for building-modification measures	Acoustics		o	o
			Not required	Not required
Value for money, including maintenance costs and consideration of benefit cost analysis	Acoustics	Calculation of indicative Benefit cost ratio for comparison purposes only - maintainence cost not factored in	+ + +	+ + +
			BCR(4.59) - Low cost for average 2dB reduction across large cluster	BCR (2.19) - slightly better reduction but cost of barrier high
Alignment with Designation conditions and minimum requirement policies	Planner	Ability to comply with Designation 3.5, however Designation Condition 3.7 then comes into play if the adoption of the BPO for noise mitigation within the road corridor is insufficient to meet the Design Limits in condition 3.5, agreement with landowner re: insultation or impracticable so property purchase is required.	+ + +	+ + +
			Achieves compliance with DC 3.5 for all properties, with no building modifications.	Achieves greater compliance with DC 3.5 for all properties, with no building modifications.
Planning authorisation required	Planner	Need to demonstrate in Outline Plan ability to comply with Designation 3.5 or what BPO measure has been adopted and why. Council's Acoustic Advisor may challenge BPO decision - protected discussions. Similarly, stakeholders may challenge/not agree to BPO decision with need for Peer review and protected discussion. Provided any barrier required is within designation, no additional consents / approvals would be required.	+ + +	+ + +
			Achieves compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved.	Achieves greater compliance with DC 3.5 for all properties, with no building modifications. Support through OP process would be achieved.

Project	Assessment area
Penlink	D - Cedar terrace

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
Potential effects of operational noise on known heritage or cultural values	Planner	No heritage buildings or items in Area D. No known items of cultural value within Area D where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o None present in subject area.	o None present in subject area.
Effects of mitiation structures on cultural values (e.g bund or barrier traverses on an important site)	Planner	No known items of cultural value within Area D where noise barrier indicated and no flags from iwi partners re potential for cultural sites.	o None present in subject area.	o None present in subject area.
Social effects of mitigiation	Planner	Balance between reduction in noise amenity effects and increase in effects associated with other amenity (eg. outlook, shadown cast)	+ + + •Positive benefit to those properties gaining a noise reduction, without need for building modifications.	+ + + •Positive benefit to those properties gaining a noise reduction, without need for building modifications. •While the proposed noise barrier is below these properties, the proposed barrier height at 2m is not dissimilar to permitted activity fence height - consider ability to green/screen it from their views.
Constructability/Engineering degree of difficulty	Road Engineering		o	+ barriers doable but another task to programme etc
Requirement of additional fill	Road Engineering		o no change	– some additional fill likely required
Opportunity for use as a spoilt site (resource efficiency)	Road Engineering		o no change	o no opportunity
Maintenance or enhancement of the convenience and attractiveness of pedestrian and cycle networks	Road Engineering		o no change	– – barrier immediately adjacent to path, a lot of length to maintain
Stormwater treatement and/or potential flooding effects	Road Engineering		o no change	– OK if a nominal gap under barrier can be included? Could be maint issue in large events, need special detail
Compliance with minimum road requirements - surfacing	Road Engineering		– Need acceptance of 50mm EPA7	o no change
Effects on road / cycle land user safety and security	Road Engineering		o no change	o barrier immediately adjacent to path not pretty but not unsafe

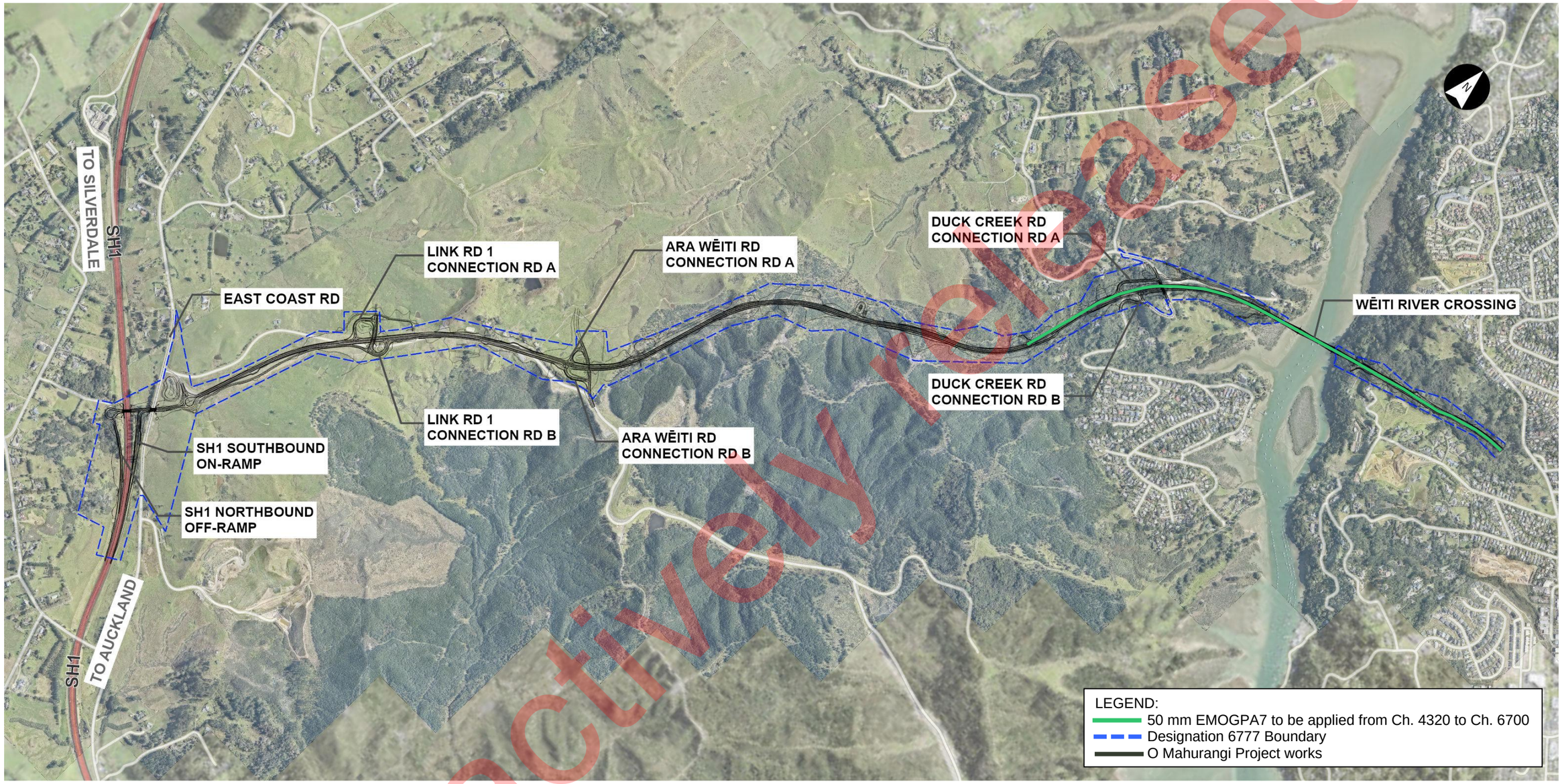
Project	Assessment area
Penlink	D - Cedar terrace

Assesment criteria	Discipline	Issues / Risks	Option 1	Option 2
The extent to which the mitigation option promotes integration and establishes visual coherence and continuity in form, scale and appearance of structures and landscape proposals along the route	Urban and Landscape		o	– –
			No impact	This runs along the SEA section and would benifit from timber rather than concrete, and have visual mitigation in the form of urban or cultural design to highway faces
Road users' views to the surrounding landscape and key features/ locations in particular	Urban and Landscape		o	– –
			No impact	Has moderate impact on visual connection to SEA
Impacts on visual amenity of surrounding residents	Urban and Landscape		o	o
			No impact	No impact
Achieves good urban design outcomes	Urban and Landscape		o	– –
			No impact	Poor outcome in the Greenway context especially in SEA- less imapct as more urban context end of the corridor.

APPENDIX G – Structural Mitigation

WAKA KOTAHI NZ TRANSPORT AGENCY

O Mahurangi Penlink | New Zealand Upgrade Programme



Mitigation Drawings –This Appendix will be updated confirming the agreed mitigation post discussions with the property owners of s 9(2)(a)