TE TUPU NGĀTAHI
SUPPORTING GROWTH

VOLUME 4

Takaanini Level Crossings
Assessment of Construction Noise and Vibration Effects

October 2023

Version 1.0

WAKA KOTAHI NZ TRANSPORT AGENCY

AT

New Zealand Government

Document Status

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Glossary of Defined Terms and Acronyms

We note that 'Takaanini' (with double vowels is used throughout the Report Acknowledging the ongoing kōrero and guidance from Manawhenua on the cultural landscape. 'Takanini' is used where reference is made to a specific and existing named place (e.g., Takanini Road, Takanini Town Centre etc.). Manawhenua is also used throughout the Report as while gifting the programme name as Te Tupu Ngātahi, Manawhenua confirmed this was an appropriate spelling (capital 'M' and one word). Notwithstanding this, the term is spelled as two words in other fora and the proposed designation conditions – Mana Whenua.

Acronym/Term	Description
AEE	Assessment of Effects on the Environment report
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan: Operative in Part
A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
BOL	Block of Line – closure of the NIMT
BPO	Best Practicable Option
BS5228-1	British Standard BS5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*
BS5228-2	British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*
CNVMP	Construction Noise and Vibration Management Plan
CRL	City Rail Link
dB	Decibel. The unit of sound level.
DIN4150-3	German Standard DIN 4150-3 (1999): *Structural Vibration – Part 3 Effects of Vibration on Structures*
L_{A90}	The A-weighted sound level exceeded for 90% of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e., L_{AFmax}
MDA	Marshall Day Acoustics
N/A	Not Applicable
NIMT	North Island Main Trunk rail line
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
NPS	National Policy Statement

Acronym/Term	Description
NPS-UD	National Policy Statement on Urban Development
NoR	Notice of Requirement
NZS6801	New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound*
NZS6802	New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*
NZS6803	New Zealand Standard NZS 6803: 1999 *Acoustics - Construction Noise*
PC78	Plan Change 78 to the Auckland Unitary Plan (Operative in Part)
PPV	Peak Particle Velocity. The measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.
RMA	Resource Management Act 1991
Te Tupu Ngātahi	Te Tupu Ngātahi Supporting Growth
TLC / the Project	Takaanini Level Crossings Project
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).
Waka Kotahi	Waka Kotahi New Zealand Transport Agency

Executive Summary

This report provides an assessment of the construction noise and vibration effects for the Takaanini Level Crossings Project (**TLC / the Project**) to inform the Assessment of Effects on the Environment (**AEE**) for two Notices of Requirement (**NoR**) being sought by Auckland Transport (**AT**).

Methodology

We applied the following methodology for the construction noise and vibration assessment for the Project:

- Following review of relevant standards and guidelines appropriate for the assessment of construction noise and vibration, we recommended the following standards be applied to the Project:

– **Construction noise:** NZS 6803:1999 Acoustics – Construction Noise. This standard is referenced in the Auckland Unitary Plan (Operative in Part) (**AUP:OP**). The criteria are generally 70 dB L_{Aeq} and 85 dB L_{AFmax} during daytime; and

– **Construction vibration:** a two-tiered approach has been adopted of Category A (generally to protect amenity) and Category B (to protect buildings from any, including cosmetic, damage). The criteria are generally based on those of DIN4150-3 (1999) Structural vibration – Part 3 Effects of vibration on structures and British Standard (BS) 5228-2: 2009 "Code of practice for noise and vibration control on construction and open sites". The above criteria are referenced in AUP:OP E25.6.30. The criteria range from 0.3 to 2 mm/s PPV for Category A, to 5 mm/s PPV for occupied buildings for Category B, and potentially higher for unoccupied buildings.

- We reviewed noise and vibration emission data for each construction task / process based on equipment data previously measured by Marshall Day Acoustics (**MDA**) for similar activities. Data from appropriate noise and vibration standards (e.g., BS5228-1:2009) has also been considered, where relevant.
- We predicted noise and vibration levels from construction based on relevant standards and guidelines and determined setback distances where compliance with the relevant standards can be achieved. These setback distances have been plotted on the Project drawings and are shown in **Appendix A** of this report for noise and **Appendix B** of this report for vibration.
- Where construction is predicted to infringe the noise or vibration standards, we recommend management and mitigation through a framework of a Construction Noise and Vibration Management Plan (**CNVMP**) and Schedules.

Effects analysis

Construction noise and vibration is generally higher than that of ongoing continuous activities. Therefore, while effects are based on how people are likely to react to equivalent internal noise levels, one needs to keep in mind that construction is a temporary activity with a finite duration. Most people are more likely to accept increased noise or vibration levels if durations and magnitudes are well communicated prior to works occurring.

Overall, predicted noise levels for the majority of works will be able to comply with the relevant daytime limits, which means that effects are generally acceptable inside neighbouring buildings. Where high noise activities would occur (e.g., demolition of close by buildings, piling of bridges or retaining walls, and earthworks), these activities would be completed within limited periods (e.g.,

weeks) with highest noise levels for only some hours during the workdays. Overall construction of the bridges will take between 1 to 2 years for active mode brides and 2.5 to 3 years for road bridges.

Effects can be managed through the application of management and mitigation measures through a CNVMP and Schedules as discussed below. Overall, we consider the effects will generally be reasonable for most activities provided that common best practice measures are applied and ongoing communication with affected parties is undertaken.

Management and mitigation recommendations

Management and mitigation measures should be implemented as a matter of good practice and are considered the baseline mitigation for most circumstances, irrespective of compliance with the limits.

Where an infringement of the construction noise or vibration standards is likely due to a specific activity or in a specific area, and the general mitigation measures as discussed below are not sufficient to achieve full compliance, further mitigation and management should be investigated and implemented where practicable. Such information would be contained in the Schedule as an attachment to the CNVMP. Depending on the final construction methodology and receivers in the vicinity, mitigation and management measures may also include the offer of temporary relocation. The appropriate mitigation measures will be determined on a case-by-case basis throughout construction using the CNVMP and/or site-specific schedules as the implementation tool.

Summary of construction noise and vibration effects and recommendations

Effect	Assessment	Recommendation
Construction noise – all Crossings	All crossings are located in well-established residential or commercial areas, with buildings in close proximity to construction works. Largest effects anticipated from: • Demolition of houses in the designation boundary – limited duration and localised, but close to remaining houses; • Earthworks to prepare alignment, service relocations, establishment of service lanes – longer duration but not stationary in any one location for extended periods; • Bridge piling and installation – limited duration and localised effects only, but night/weekend works likely required; and • Final surfacing – likely to be done at night-time. Limited duration and moving along the alignments.	Management and mitigation through the CNVMP Schedules for any specifically noisy activities or where receivers are particularly affected, e.g.: • Any night-time works in the vicinity of residential areas; and • Any specifically high noise works where they affect sensitive receivers (e.g., retirement village or childcare). Communication and consultation prior to high noise works
Construction vibration – all Crossings	All crossings are located in well-established residential and commercial areas, with buildings in close proximity to construction works. Largest effects anticipated from: • Demolition of houses inside designation – limited duration and localised, but close to remaining houses;	Management and mitigation through the CNVMP Choice of piling methodology to be bored rather than impact or vibrated Use of non-vibratory compaction close to buildings where required to ensure compliance

Effect	Assessment	Recommendation
	• Road preparation: use of vibratory rollers – along all crossing alignments, therefore limited duration but affecting all immediately fronting houses; and • Construction of bridge piles and retaining walls. Nevertheless, compliance with the Category B criteria is generally predicted.	
Night-time / long weekend construction noise – All crossings	Bridge construction across the North Island Main Trunk Line (**NIMT**) will likely require night-time works during a Block of Line (**BOL**)	Consider offer of temporary relocation to most affected residents to manage sleep disturbance, depending on duration and noise level
Construction noise – Manuroa Road crossing	Works close to educational facility (childcare at 18 Manuroa Road)	Consult with the educational facility and schedule works to avoid sensitive times. Offer noise barrier if this is effective for this facility.
Construction noise – Taka Street crossing	Works close to Takanini Care Centre (9 Taka St)	Consult with care centre to avoid sensitive times. Offer noise barrier to mitigate construction noise.

1 Introduction

1.1 Purpose and scope of this Report

This Assessment of Construction Noise and Vibration report (**Report**) has been prepared to inform the Assessment of Effects on the Environment (**AEE**) for two Notices of Requirement (**NoR**) being sought by Auckland Transport (**AT**) for the Takaanini Level Crossings Project (**TLC / the Project**) under the Resource Management Act 1991 (**RMA**). The Project proposes to construct five new bridges across five project areas: NoR 1 relates to four of the proposed project areas (referred to as Spartan Road, Manuia Road, Manuroa Road and Taka Street) while NoR 2 relates to the remaining project area (referred to as Walters Road). Specifically, this report considers the actual and potential effects associated with the construction and operation of the TLC on the existing and likely future environment as it relates to construction noise and vibration effects and recommends measures that may be implemented to avoid, remedy and/or mitigate these effects.

This report should be read alongside the AEE, which contains further details on the history and context of the TLC. The AEE also contains a detailed description of works to be authorised within each NoR, and the typical construction methodologies that will be used to implement this work. These have been reviewed by the author of this report and have been considered as part of this assessment of construction noise and vibration effects. As such, they are not repeated here. Where a description of an activity is necessary to understand the potential effects, it has been included in this report for clarity.

1.2 Report Structure

The structure of the report is set out in Table 1 below. The assessment considers the actual and potential effects of the Project as a whole in the first instance. Where required, the assessment then focusses on the actual and potential effects arising within individual project areas (i.e., Spartan Road, Manuia Road, Manuroa Road, Taka Street which falls within NoR 1 and Walters Road which falls within NoR 2). Where appropriate, measures to avoid, remedy or mitigate effects are also recommended.

Where the individual project areas are discussed, sub-sections are arranged by project area in geographical order along the North Island Main Trunk line (**NIMT**) moving north to south.

Table 1: Report Structure

Sections	Section number
Description of the TLC	2
Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines	3, 4
Identification and description of the existing and likely receiving noise environment	5
Assessment of general construction noise and vibration matters for the overall TLC network	6

Sections	Section number
Assessment of specific construction noise and vibration matters for Spartan Road (NoR 1)	7
Assessment of specific construction noise and vibration matters for Manuia Road (NoR 1)	8
Assessment of specific construction noise and vibration matters for Manuroa Road (NoR 1)	9
Assessment of specific construction noise and vibration matters for Taka Street (NoR 1)	10
Assessment of specific construction noise and vibration matters for Walters Road (NoR 2)	11
Overall conclusion of the level of potential adverse construction noise and vibration effects of the TLC.	13

2 Project description

The overall Project proposes the removal and/or replacement of four existing road over rail level crossings at Spartan Road, Manuroa Road, Taka Street and Walters Road in Takaanini. As further discussed in the AEE, the Project responds to functionality and safety issues anticipated at these crossings from the increasing number of train movements along the NIMT. The Project and indicative design also take into account the long-term planned expansion of the NIMT from the current two rail tracks to up to four tracks. The increased rail frequency will lead to greater barrier arm down-time and therefore increased severance and congestion in the area.

The Project primarily involves the construction of five new bridges to support safe and reliable east-west transport movement across the NIMT in Takaanini. This includes dedicated active mode bridges at Spartan Road and Manuroa Road, and two-lane arterial road bridges with active mode facilities at Manuia Road, Taka Street and Walters Road. Manuia Road is a new east-west connection in the network, acting as a replacement for vehicular trips that would have used the closed Spartan and Manuroa Road level crossings. The bridges and associated works/improvements are located across five project areas and will be progressed as two NoR packages (refer to Figure 1 and Table 2).

The indicative design has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final design will be refined and confirmed at the detailed design stage. Key features of the works common across the project areas include the following:

- Bridge structures across the NIMT with a vertical clearance from existing ground level to road surface of approx. 7.8m;
- Works to tie in with existing roads;
- Batters and/or retaining and associated cut and fill activities;
- Vegetation removal within the project areas to enable construction; and
- Areas identified for construction related activities including site compounds, construction laydown, alternative access, and construction traffic manoeuvring.

Further details of each project area are provided in the following sections below.

Table 2: The TLC project areas and NoR packages

NoR Reference	Project area	Description	Requiring Authority
Takaanini Level Crossings Project NoR 1	**Spartan Road**	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	Auckland Transport
	Manuia Road	Construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
	Manuroa Road	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	
	Taka Street	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
Takaanini Level Crossings Project NoR 2	**Walters Road**	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	

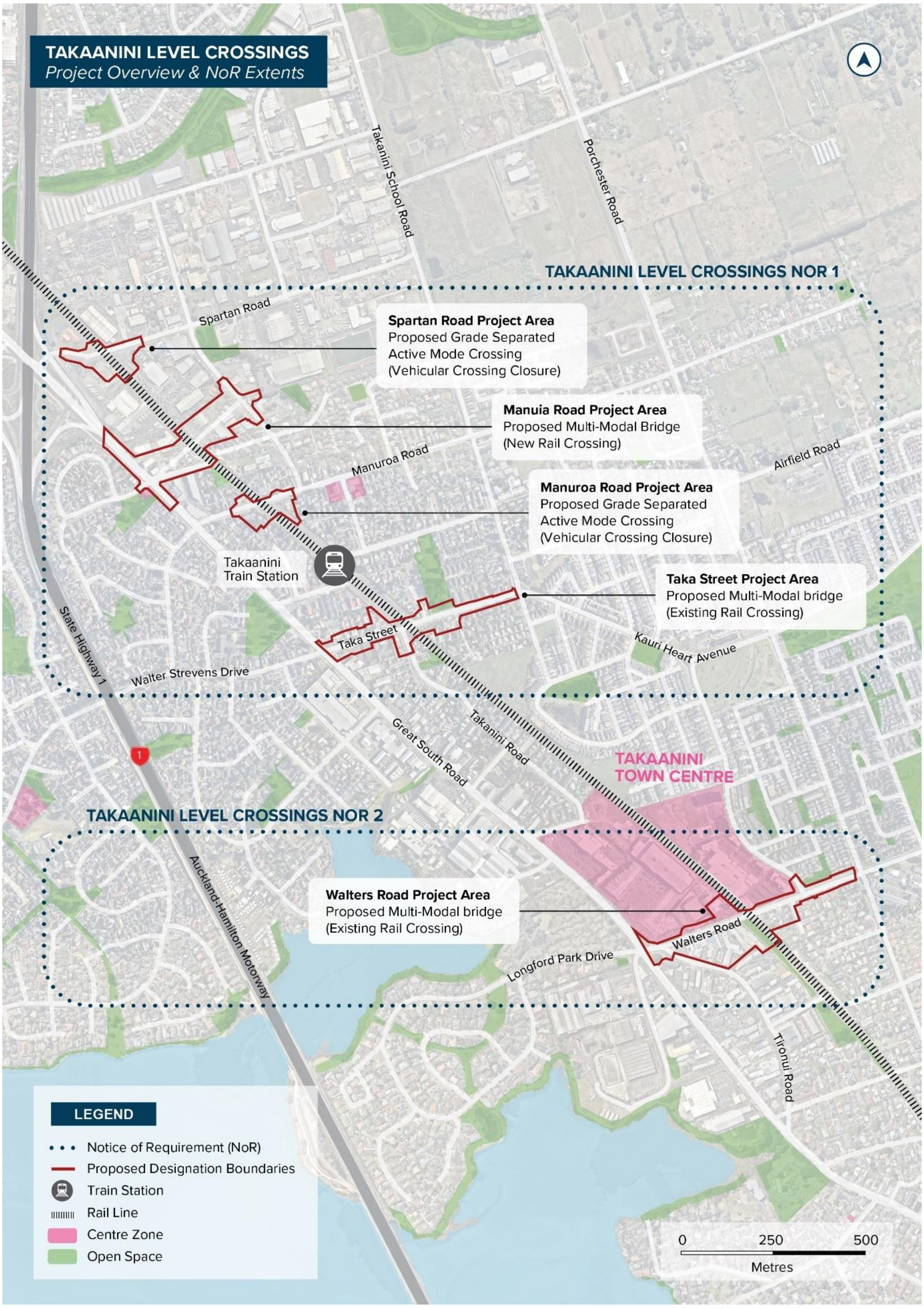


Figure 1: Overview of the Project, project areas and extent of NoR packages

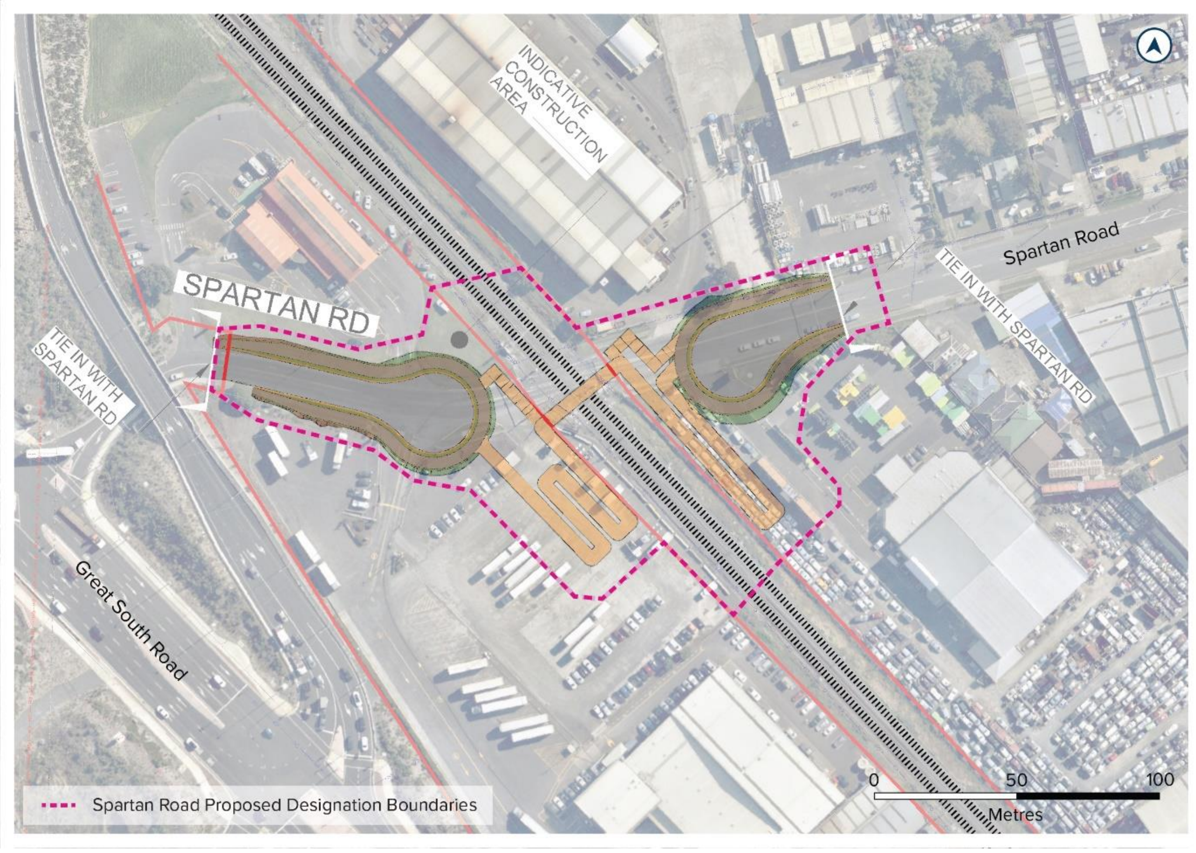
2.1 NoR 1 – Spartan Road, Manuia Road, Manuroa Road and Taka Street

2.1.1 Spartan Road project area

As set out in Table 3 below, the proposed works within the Spartan Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

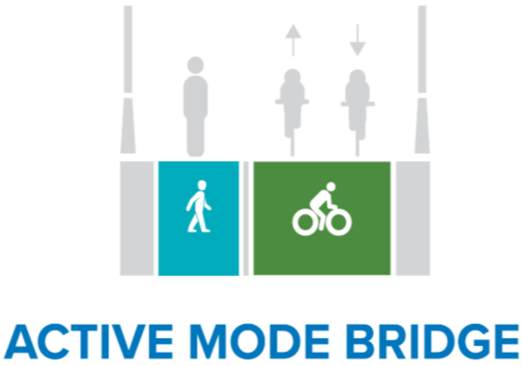
Table 3: Overview of Spartan Road project area

NoR 1 - Spartan Road project area



Key features

Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Spartan Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sacs	• None

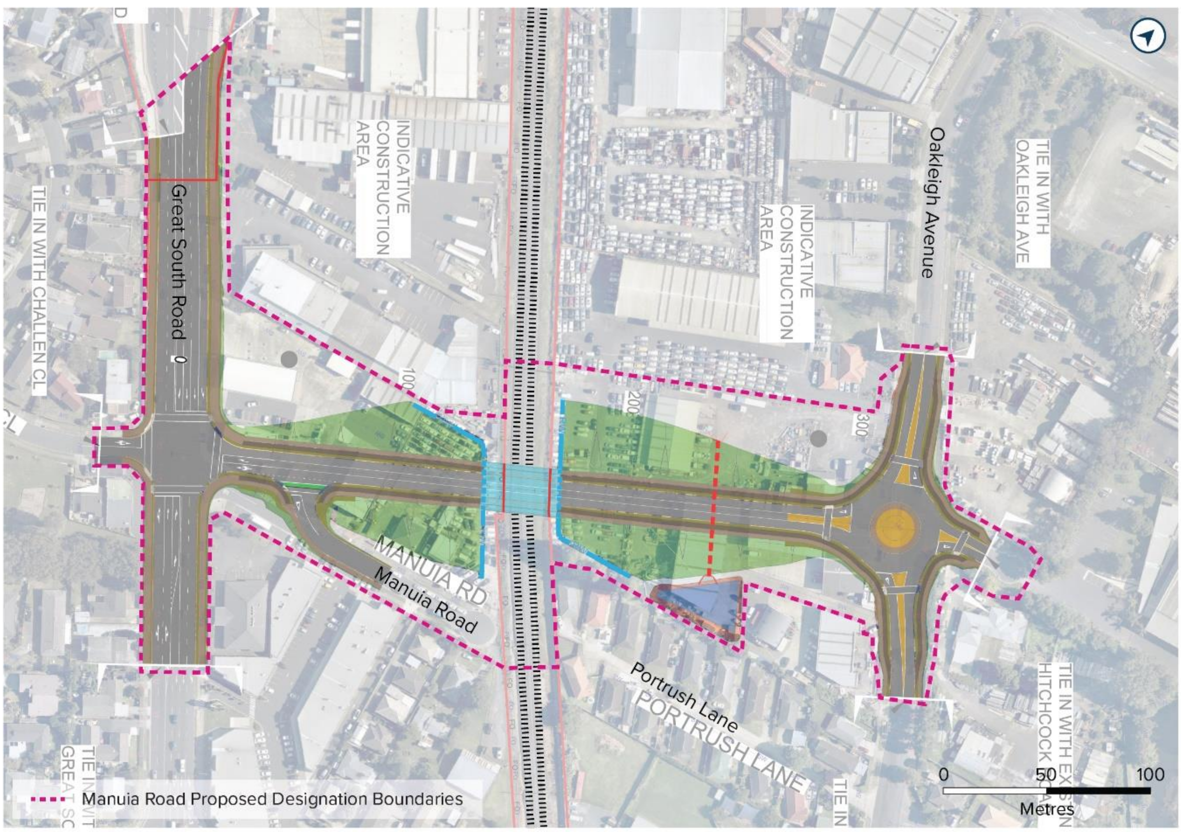
Speed environment	• 50km/h (where it is trafficked)
Access lanes	• None
Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge
Typical cross sections	

2.1.2 Manuia Road project area

As set out in Table 4 below, the proposed works within the Manuia Road project area include construction of a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

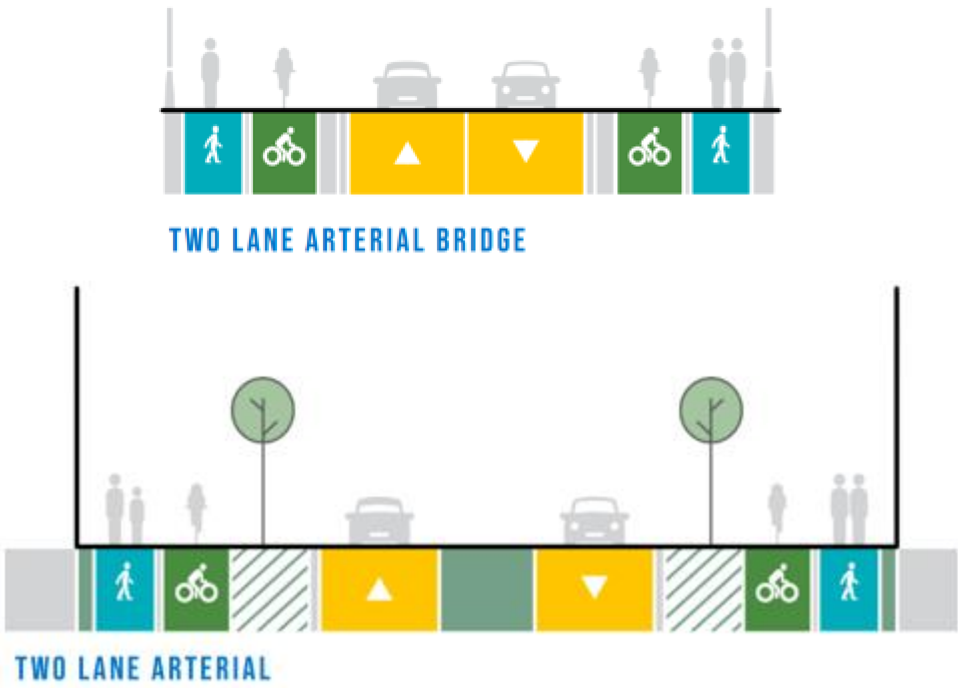
Table 4: Overview of the Manuia Road project area

NoR 1 – Manuia Road project area



Key features

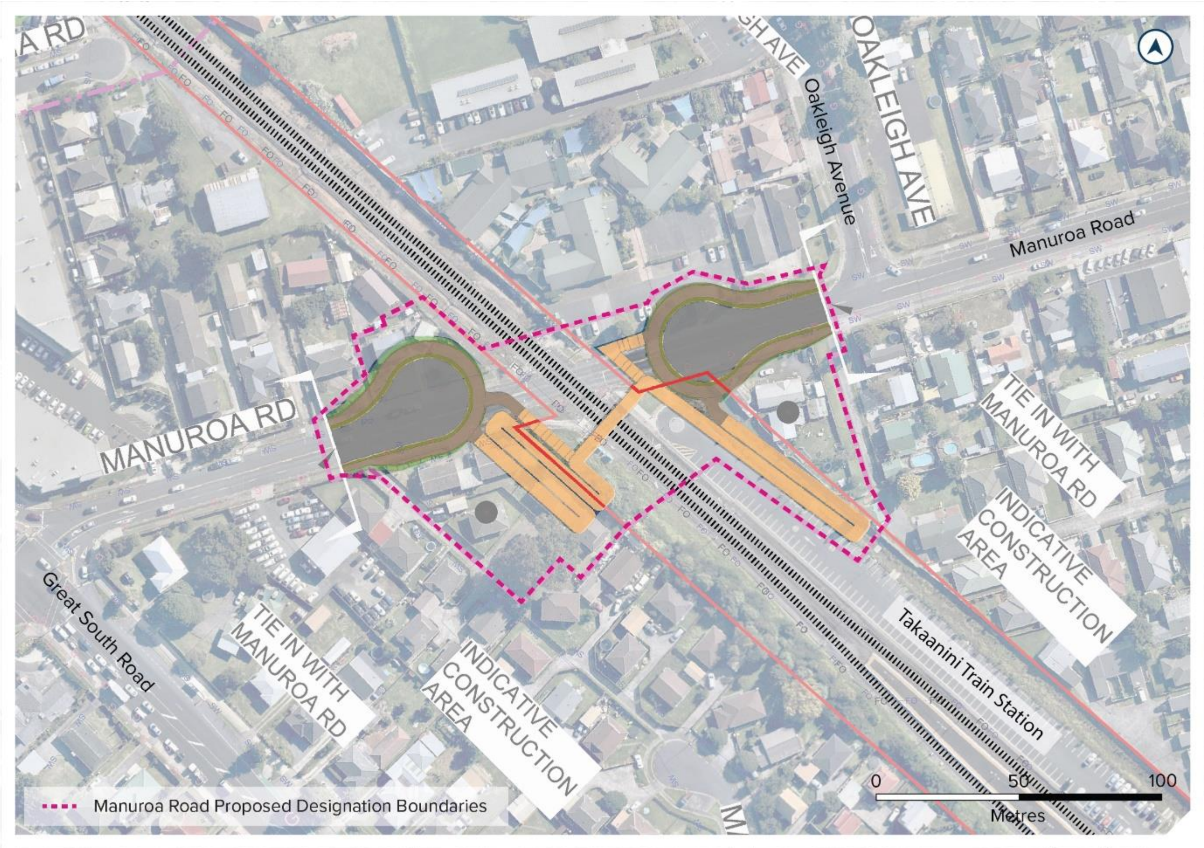
Overview	• There is currently no existing east-west corridor / level crossing across the NIMT in this project area. • Construction of a new arterial road bridge across the NIMT accommodating two lanes (one in each direction) and separated active mode facilities. • Construction of new arterial road corridors tying into either side of the bridge (east and west of the NIMT) accommodating two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls (either side of the NIMT)
Other road closures / cul-de-sac	• Reconstruction of existing cul-de-sac at Hitchcock Road (east of the NIMT) to tie into the new intersection at Oakleigh Avenue / Manuia Road / Hitchcock Avenue (as described below) and upgrade with footpath.
Speed environment	• 50km/h

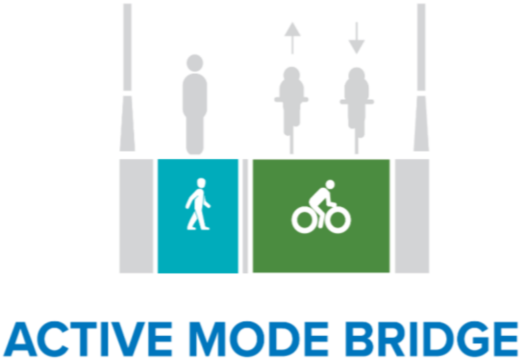
Access lanes	• Existing Manuia Road will be reconfigured into an access lane for remaining properties, tying in with the new Manuia Road corridor/ bridge (west of NIMT).
Intersections	• Upgrade of the existing Great South Road / Challen Close / Manuia Road intersection to provide for signalisation, footpath upgrades and tie in works with the existing roads. • New roundabout intersection at Oakleigh Avenue / Manuia Road / Hitchcock Avenue with active mode facilities and tie in works.
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

2.1.3 Manuroa Road project area

As set out in Table 5 below, the proposed works within the Manuroa Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

Table 5: Overview of the Manuroa Road project area

NoR 1 – Manuroa Road project area	
	
Key features	
Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Manuroa Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h (where it is trafficked)
Access lanes	• None

Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge
Typical cross sections	

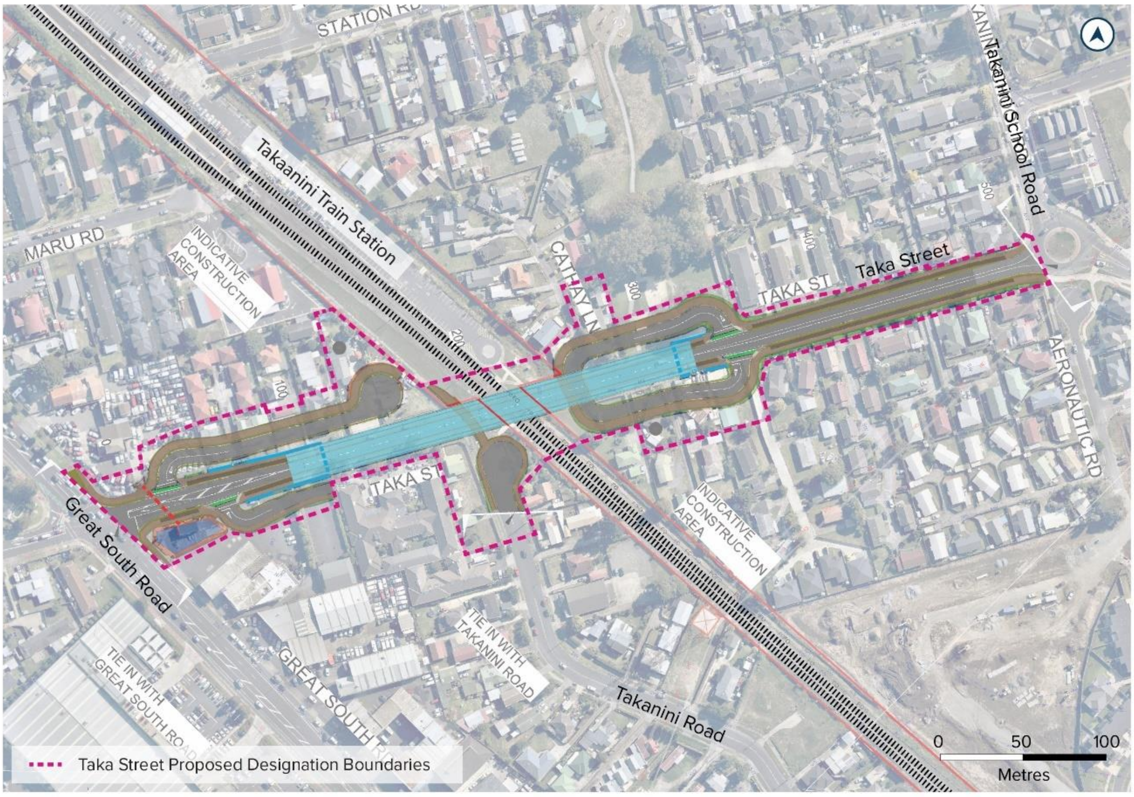
2.1.4 Taka Street project area

As set out in

Table 6 below, the proposed works within the Taka Street project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

Table 6: Overview of the Taka Street project area

NoR 1 – Taka Street project area

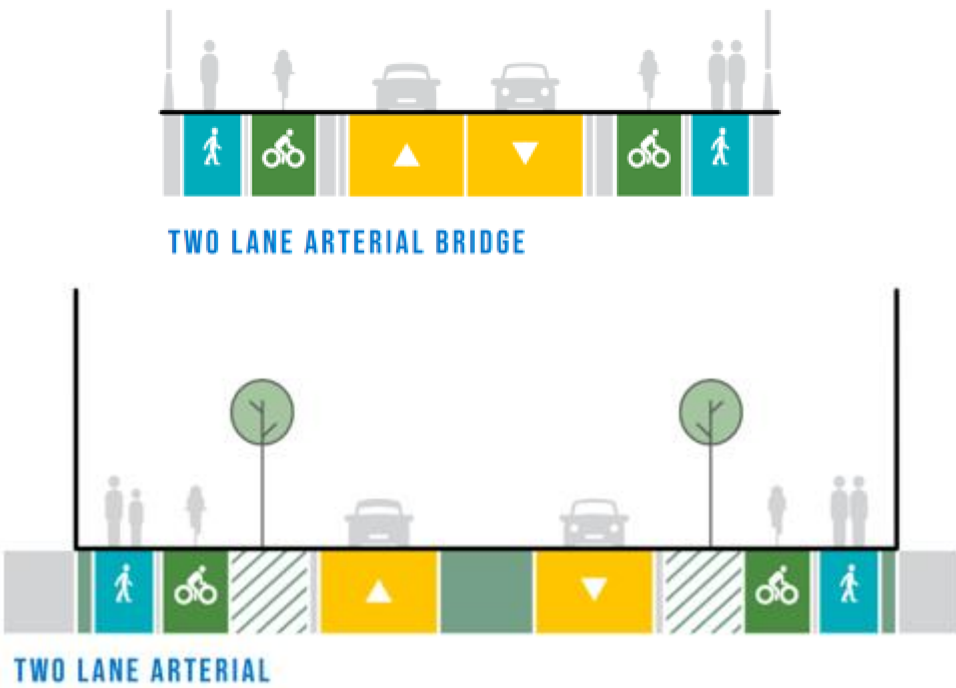


Key features

Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls
Other road closures / cul-de-sac	• Closure of existing Takanini Road (north) to vehicular traffic at the intersection with Taka Street bridge i.e., no through-traffic provision. Replacement with a cul-de-sac and works to tie into the existing corridor of Takanini Road to the south. Active modes connection from Takanini Road to Takaanini Station (under the new Taka Street bridge).

Speed environment	• 50km/h

Access lanes	• Construction of four access lanes:
	  ◦ Construction of a new access lane (cul-de-sac) located west of the NIMT and north of the Taka Street road corridor. It accommodates a footpath on the northern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain and Takaanini Station.
	  ◦ Construction of a new access lane located west of the NIMT and south of the Taka Street road corridor. It accommodates a footpath on the southern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain.
	  ◦ Construction of two access lanes located west of the NIMT (north and south of the Taka Street road corridor and looping under the new Taka Street bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Taka Street corridor and allows access to existing properties to remain including Takaanini Reserve and Cathay Lane.

Intersections	• None
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

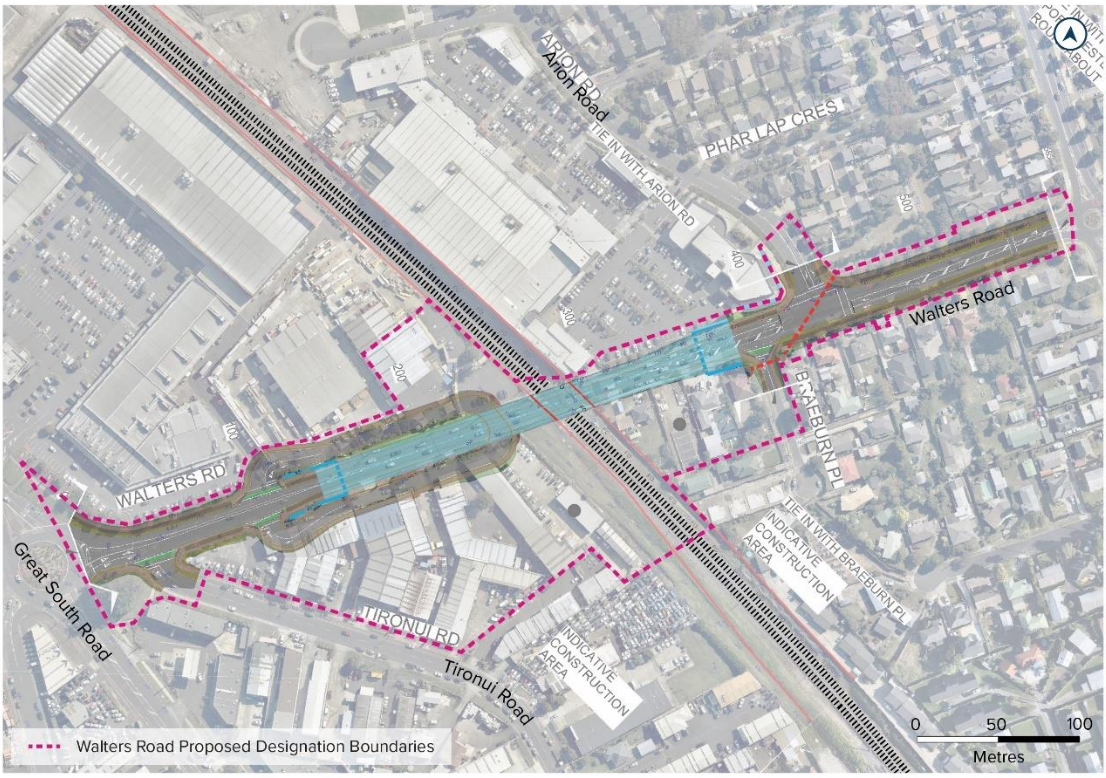
2.2 NoR 2 – Walters Road

2.2.1 Walters Road project area

As set out in Table 7 below, the proposed works within the Walters Road project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lanes in each direction and active mode facilities.

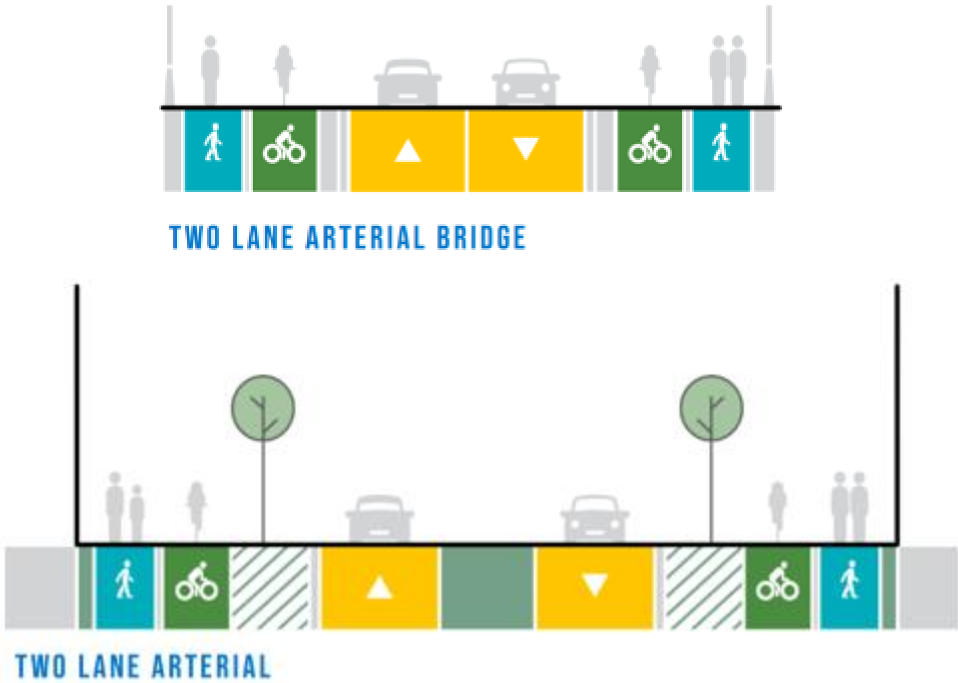
Table 7: Overview of Walters Road project area

NoR 2 – Walters Road project area



Key features

Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h

Access lanes	• Construction of two access lanes located west of the NIMT (north and south of the Walters Road corridor and looping under the new Walters Road bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Walters Road corridor and allow access to remaining properties.
Intersections	• Upgrade of the existing Arion Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Arion Road. • Upgrade of the existing Braeburn Place / Walters Road intersection to provide for footpath upgrades and works to tie into existing Braeburn Place. • Upgrade of the existing Tironui Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Tironui Road.
Stormwater infrastructure	• Stormwater culvert • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

3 Performance standards

Construction noise and vibration levels are generally higher than would be expected from ongoing day to day operations of a site or transport corridor. However, higher noise and / or vibration levels are not necessarily unreasonable if they are managed and mitigated by implementing the best practicable option (**BPO**).

A new designation is sought to enable the construction, operation and maintenance of the Project. Therefore, we have reviewed a variety of criteria and standards and have recommended construction noise and vibration performance standards that in our opinion should apply to the NoRs.

3.1 Noise

3.1.1 Guidelines and standards reviewed

We reviewed the following guidelines and standards for the assessment of construction noise:

- Auckland Unitary Plan Operative in Part (**AUP:OP**), specifically rule E25.6.27 relating to construction noise in all zones except the City Centre and Metropolitan Centre zones, and rule E25.6.29 relating to construction noise in the road; and
- New Zealand Standard NZS6803:1999 *Acoustics – Construction Noise* (**NZS6803**).

The AUP:OP construction noise criteria are largely the same as NZS6803, with any differences (generally night-time criteria) having no effect on the outcome of the assessment.

3.1.2 Recommended noise criteria

Table 8 below shows the relevant noise standards for long duration works (more than 20 weeks), which applies to this Project. These criteria are those of NZS6803, and largely reflect the AUP:OP criteria.

Table 8: Construction noise criteria at occupied buildings (at 1m from the most affected façade)

Day of week	Time period	Noise criteria	
		dB L_{Aeq}	dB L_{AFmax}
Dwellings and other buildings containing activities sensitive to noise			
Weekdays	0630 – 0730	55	75
	0730 – 1800	70	85
	1800 – 2000	65	80
	2000 – 0630	45	75
Saturdays	0630 – 0730	45	75
	0730 – 1800	70	85
	1800 – 2000	45	75

Day of week	Time period	Noise criteria	
		dB L_{Aeq}	dB L_{AFmax}
	2000 – 0630	45	75
Sundays and public holidays	0630 – 0730	45	75
	0730 – 1800	55	85
	1800 – 2000	45	75
	2000 – 0630	45	75
Other occupied buildings			
All days	0730 – 1800	70	n/a
	1800 – 0730	75	n/a

While construction of the entire Project would be generally of longer duration (more than a decade), buildings around each crossing would be affected only for the time that construction occurs at this location, which would be approximately 2.5 to 3 years per road bridge at Manuia Road, Taka Street and Walters Road, and approximately 1 to 2 years per active mode bridge at Spartan and Manuroa Roads.

3.1.3 Exceedance of criteria

During construction some activities will occur close to buildings. In some instances, there is the potential for noise levels to exceed the recommended construction noise standards. For most large-scale construction projects, exceedances of the construction noise standards for brief periods of time are common, and management will ensure that effects are reasonable.

NZS6803 anticipates that at times construction noise cannot be made to comply with the recommended criteria. Statements such as *"construction noise from any site should not generally exceed the numerical noise limits"*[1] suggest that intermittent exceedances are not unreasonable, as long as the BPO has been applied to the management and mitigation of that construction noise.

The AUP:OP in its Objectives and Policies also appropriately anticipates exceedances from construction noise and states:

> *(4) Construction activities that cannot meet the noise and vibration standards are enabled while controlling duration, frequency and timing to manage adverse effects.* [2]

And

> *(10) Avoid, remedy or mitigate the adverse effects of noise and vibration from construction, maintenance and demolition activities while having regard to:*
>
> *[…]*
>
> *The practicability of complying with permitted noise and vibration standards.*[3]

1 NZS 6803:1999 Acoustics – Construction Noise, Section 7.1.2.
2 Chapter E25.2 of the AUP:OP.
3 Chapter E25.3 of the AUP:OP.

Whether the duration of a construction activity that exceeds the standards can be considered reasonable, depends on site specific circumstances, and may vary from site to site and activity to activity. For instance, where daytime noise standards are exceeded for several days, but neighbouring residents are not at home, no one would be affected and therefore mitigation may not be required beyond communication with the residents.

We have discussed with the Project team and understand that night-time works in the vicinity of sensitive activities such as dwellings will occur only intermittently as required, for instance when a Block of Line (**BOL**) is required to undertake the works (e.g. when bridges are lifted into place), when essential utilities need to be moved which may cause supply disruption or when road surfacing affects existing roads. This would likely only happen for few nights in any one location. In that instance, this may be acceptable if residents have been informed and a clear time frame has been provided. However, if night-time works are expected to be ongoing for several consecutive nights, and at a noise level that affects residents' ability to sleep, then alternative strategies may need to be implemented, such as offering temporary relocation for those affected residents. Such management measures are further discussed in Section 12.

3.2 Vibration

3.2.1 Guidelines and standards reviewed

We have reviewed the following guidelines and standards for the assessment of construction vibration:

- AUP:OP, specifically rule E25.6.30 relating to construction vibration, with two parts: amenity and avoidance of any damage to buildings;
- German Standard DIN4150-3 (1999) Structural vibration – Part 3 Effects of vibration on structures; and
- British Standard (BS) 5228-2: 2009 "Code of practice for noise and vibration control on construction and open sites".

The AUP:OP references relevant vibration standards for construction works. These criteria address two vibration responses:

- One set of standards are based on the provisions of German Standard DIN 4150-3:1999 "Structural Vibration – Part 3: Effects of Vibration on Structures" which avoids cosmetic building damage (**building standards**); and
- The other set has reference criteria for human amenity which act as trigger levels for consultation and communication (**amenity standards**).

3.2.2 Recommended vibration criteria

AT generally applies the requirements of the AUP:OP.

These criteria are applied progressively, with the focus on achieving compliance with the amenity criteria (Category A) where practicable. Where it is necessary to infringe the amenity standards criteria, the building standards criteria (Category B) are applied. For any occupied buildings, the aim is to not infringe a level of 5 mm/s Peak Particle Velocity (**PPV**), while unoccupied buildings may receive vibration levels that comply with the tables of DIN4150-3. Night-time criteria are lower due to higher sensitivity of residents at that time.

Table 9 below displays the categories and associated vibration standard levels.

Table 9: Vibration standards at all buildings

Receiver	Details	Category A	Category B
Occupied activities sensitive to vibration	Night-time 2000h-0630h	0.3 mm/s PPV	2mm/s PPV
	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
Other occupied buildings	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
All other buildings	At all times	Tables 1 and 3 of DIN4150-3:1999	

The vibration levels of Tables 1 and 3 of DIN4150-3 are set out in Table 10 below.

Table 10: Vibration standards at all buildings

Type of Structure	Short-term vibration*				Long-term vibration
	PPV at the foundation at a frequency of			PPV at horizontal plane of highest floor (mm/s)	PPV at horizontal plane of highest floor (mm/s)
	1-10Hz (mm/s)	10-50Hz (mm/s)	50-100Hz (mm/s)		
Commercial / industrial	20	20 – 40	40 – 50	40	10
Residential / school	5	5 – 15	15 – 20	15	5
Historic / sensitive structure	3	3 – 8	8 – 10	8	2.5

* The Standard defines short-term as "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*."

4 Assessment Methodology

4.1 Preparation for this Report

We commenced work on this Project in August 2022. In summary, we undertook the following work in preparation for this Report:

- Review information from other technical specialists, namely traffic, construction, design and planning, amongst others;
- A site visit of the Project areas in November 2022;
- Meeting with the design team on 29 September 2022
- Review of equipment data for similar projects; and
- Computer noise modelling and vibration predictions.

Where we rely on information provided by other experts, this is noted in the Report.

4.2 Methodology

We applied the following methodology for the construction noise and vibration assessment:

- We analysed the ambient noise level data from the surveys (refer Section 5 of this Report) to determine if the recommended noise performance standards are appropriate (e.g. if night-time noise levels are already elevated above the noise limit of 45 dB L_{Aeq}).
- We reviewed noise and vibration emission data for each construction task / process based on equipment data previously measured by Marshall Day Acoustics (**MDA**) for similar activities. Data from appropriate noise and vibration standards (e.g., BS5228-1:2009) has also been considered, where relevant.
- We predicted noise and vibration levels from construction based on relevant standards and guidelines and determined conservative setback distances where compliance with the relevant standards can be achieved. These setback distances have been plotted on the Project drawings and are shown in **Appendix A** of this Report for noise and **Appendix B** of this Report for vibration.
- Where construction activities are predicted to exceed the noise or vibration standards, we recommend management and mitigation through a framework of management plans and schedules.

4.3 Assumptions

To undertake our work, we had to make several assumptions as no contractor has been engaged and therefore only limited construction details are known. We therefore based our assessment on similar projects MDA has been involved with, such as City Rail Link (**CRL**), Wiri to Quay Park Third Main and a multitude of roading projects within Auckland.

We understand from the Project team that the crossings are unlikely to be constructed concurrently, but that it is likely that one crossing after another will be constructed. Irrespective of the construction sequence, the individual crossings are sufficiently distant from each other so that there will be no cumulative effects from concurrent construction.

We have also assumed that all existing buildings within the proposed designation boundary will be removed or will be vacant during the time of construction. We have therefore not assessed effects at these buildings. Should they be retained and occupied during construction, they will need to be assessed at the time of construction.

Although contractors have not been appointed, it is considered that the methodology set out is representative of activity that has occurred on similar projects and forms a reasonable baseline for the purposes of assessment during the design phase of the Project. The construction methodology for the proposal will be confirmed during the detailed design phase and finalised once a contractor has been engaged for the work.

Information sufficient for the NoR stage has been provided in a Construction Method Statement (refer to Section 4.4 of this Report and Construction methodology section of the AEE for more detail) and drawings provided by the Project team (refer to Volume 3 – General Arrangement Drawings) and has been incorporated in this assessment, where relevant.

Given the recent National Policy Statement on Urban Development (**NPS-UD**) and the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021, we primarily comment about effects on currently existing buildings potentially affected by construction noise and vibration. However, we are aware that many of the sites neighbouring the corridor may be redeveloped in the future, with higher density residential development. Therefore, our recommendations require a reassessment of the buildings present at the time of construction to ensure that mitigation and management takes account of the environment as it exists at the time of construction.

4.4 Construction Sequence and Methodology

We have based our assessment on the following assumed construction methodology.

4.4.1 Sequence and duration

Each road crossing will require approximately 2.5 to 3 years to construct, while active mode crossings will require approximately 1 year for construction.

For a road bridge (e.g., Manuia Road), the general sequence of construction is likely to be as follows:

- Site establishment – approximately 3 months
- Main works (some concurrently) – approximately 2 to 2.5 years
    - Ground improvements, preloading, drains, soil stabilisation etc – approximately 1 year
    - Civil works, stormwater drainage, pavement construction and new intersections – approximately 1 year
    - Bridge abutment and embankment construction (including piling) – approximately 20 months
    - Superstructure construction, including bridge installation and bridge deck construction – approximately 6 months
- Finishing works and demobilisation – approximately 3 to 6 months

4.4.2 Construction methodology

We understand that there are two possible methodologies to construct the bridges:

- Offline bridge construction, with only partial road closure (i.e., a temporary road is built on one side of the bridge works, allowing reduced flows), or
- Online bridge construction, with a full road closure which will require traffic to use an alternative route

In addition, the crossings can be constructed in sequence, one at a time, or two or more crossings simultaneously. Since the works are generally well separated, we have considered each crossing site separately. Should works occur on two or more crossings simultaneously, this will have no significant impact on our assessment.

4.4.3 Construction times

Construction hours will generally be 7am to 6pm, Monday to Saturday.

Only critical work will occur outside these hours (or on public holidays) where it cannot be undertaken safely within normal working hours. This would generally be the case where the works will have to occur close to the rail corridor when a BOL is required for the works to be safely carried out.

Similarly, night-time works will only be undertaken where it is impractical to undertake the works during daytime, e.g., where rail closures are required. We understand that rail closures will be limited only to those times when the bridge deck will be lifted across the rail corridor.

Where works are undertaken outside normal working hours, they will need to be assessed and mitigated through a Schedule (refer Section 12).

4.5 Construction noise

4.5.1 Predictions

Noise level predictions for construction projects take into account the sound power levels of each item of equipment, and model the noise propagation characteristics over distance, including the effects of ground and air absorption. We have calculated indicative noise levels in accordance with NZS6803:1999 and ISO 9613-2:1996 *"Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation"* for all relevant construction scenarios, assuming multiple items of equipment operating simultaneously, but taking account of spatial separation and a time component. This approach is deliberately conservative to represent the reasonable worst-case noise levels that may infrequently occur.

Other than the variations in noise level due to the factors discussed above, there are numerous additional aspects that affect construction noise generation. Some of these aspects are variations among individual items of equipment, the state of equipment repair, exact locations of each item and operator idiosyncrasies. Generally, these factors cannot be accounted for as they cannot be reasonably quantified. However, the conservative approach outlined above is considered to generally provide for these variables.

Our predictions are based on the existing buildings in the vicinity of the Project. However, if new buildings in the vicinity of the Project are occupied by the time of construction, these should also be assessed and considered when mitigation is determined.

4.5.2 Activity noise levels

We have predicted construction noise levels based on experience with similar projects and in similar circumstances. We assembled a list of likely equipment that would be used on similar large-scale infrastructure projects throughout New Zealand. Table 11 sets out this list of equipment and its respective sound power levels. It is important to keep in mind that this list is indicative only and is essentially the "best estimate" of equipment that could be used.

Table 11: Construction Equipment Noise Levels

Activity	Plant type	Sound power level (dB L_{WA})
Site establishment (clearance, demolition, compound construction)	Chainsaw	114
	Chipper	117
	Dump trucks	106
	Hydraulic excavator	113
	Vibratory roller	108
Earthworks	Dump truck	106
	Hydraulic excavator	113
	Compactor	112
	Water truck	105
Retaining wall construction	Rotary Piling Rig	111
	Concrete trucks	107
	Crane	106
	On road trucks	100
Bridge foundation piling	Rotary piling rig	111
	Concrete trucks	107
Bridge foundations and structures	Crane	106
	Concrete pump	100
	Vibratory pokers	114
	Concrete trucks	107
Pavement preparation	Vibratory roller	108
	Water trucks	105

Activity	Plant type	Sound power level (dB L_{WA})
Surfacing	Paver	113
	Road rollers	106
	Asphalt delivery trucks	108
Walking and cycling facilities	Small excavator	102
	Plate compactor	108
	Small roller	101
	Paving machine	103
Yard activities	Vehicle movements	102
	Material handling	105
	Administration area	50
	Workshop	80

Based on the sound power levels in Table 11, we predicted combined “activity sound power levels” (refer Table 12). The activity sound power levels represent the overall most common noise level from an activity as a whole, i.e. is more than the sum of its parts. There is a time component included since most equipment will not operate continuously, as well as a spatial component as not all equipment will operate consecutively and continuously in the same place. For instance, for the site establishment, the chainsaws and chipper will generally operate at the same time, but trucks and vibratory rollers will be used at a later stage of the site establishment when site compounds are constructed. During vegetation clearing, for instance, chainsaws will operate for intermittent periods, chippers at other periods. Both will not be located in the same location. Chippers can be located so that the noisiest direction faces away from receivers and levels are reduced (which is a common mitigation measure and best practice). For that reason, the activity sound power level is not the sum of all equipment during that phase, but the most common and likely noise level that will occur for the longest period of that construction phase.

Although the contractor may use different plant and equipment from what is on this list, based on experience with other large scale infrastructure construction projects we consider that noise emissions will be similar for each activity.

From the activity sound power levels, we determined the distance at which the 70 dB L_{Aeq} day-time noise criterion can be complied with, without mitigation by noise barriers.

Table 12: Activity Sound Power Levels and Compliance Distance

Activity	Activity Sound Power Level	Distance at which compliance with day-time limit (70 dB L_{Aeq}) is achieved without noise barriers/ intervening buildings
	dB L_{wA}	**metres**
Site establishment/demolition	115	76
Earthworks	111	52
Retaining wall construction	111	52
Bridge foundations	111	52
Foundations and structures (concreting)	108	40
Pavement preparation	108	40
Surfacing	110	48
Walking and cycling facility works	103	25
Compounds/construction yard	100	18

Some buildings are close to the potential works. While some may receive screening from intervening buildings, others will be exposed to the works and will need mitigation as set out in Section 12.

4.6 Construction vibration

4.6.1 Predictions

Construction vibration is a separate issue from construction noise. Construction equipment that produces high noise levels does not necessarily also produce high vibration levels and vice versa.

Vibration prediction is less reliable than noise prediction as it is dependent on accurate modelling of ground conditions. Ground conditions are often non-homogeneous and complex in three dimensions, and consequently difficult to quantify across large construction extents.

As a result, we have determined "safe distances" based on vibration measurements[4] previously performed for high vibration sources such as vibratory rollers. The safe distances are based on vibration prediction tools as contained in Hassan (2006).[5] These have been cross-checked against empirically derived relationships as contained in BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites* Part 2: Vibration, the Transport Research Laboratory

4 Measurements performed at State Highway 18, MacKays to Peka Peka, AMETI and other projects

5 Hassan, O., "Train Induced Groundborne Vibration and Noise in Buildings", Multi-Science Publishing Co Ltd, ISBN 0906522 439, 2006.

Report referenced by that standard, and previous measurements carried out by MDA. In addition, a 100% safety margin has been applied to the regression curve derived from the measured data, to take account of ground condition uncertainty and reduce residual risk for assessment against the Category B (building damage) criteria, which in our opinion make the predictions conservative. That means that measured vibration levels were not used directly to predict potential vibration levels, but rather that the measured levels have been increased by 100%.

We have used the results from these measurements and predictions to determine risk radii within which buildings are at medium or high risk of receiving vibration levels within Category B (refer Section 3.2.2). The risk radii also consider human annoyance effects.

4.6.2 Equipment vibration levels

The activities that pose the greatest risk of exceeding the vibration criteria (human annoyance and building damage as set out in Section 3.2) are vibratory rolling and vibropiling, however, we have included the regression curves for other activities also. The regression curves for vibratory rollers, bored piling, and vibropiling are shown in Figure 2.

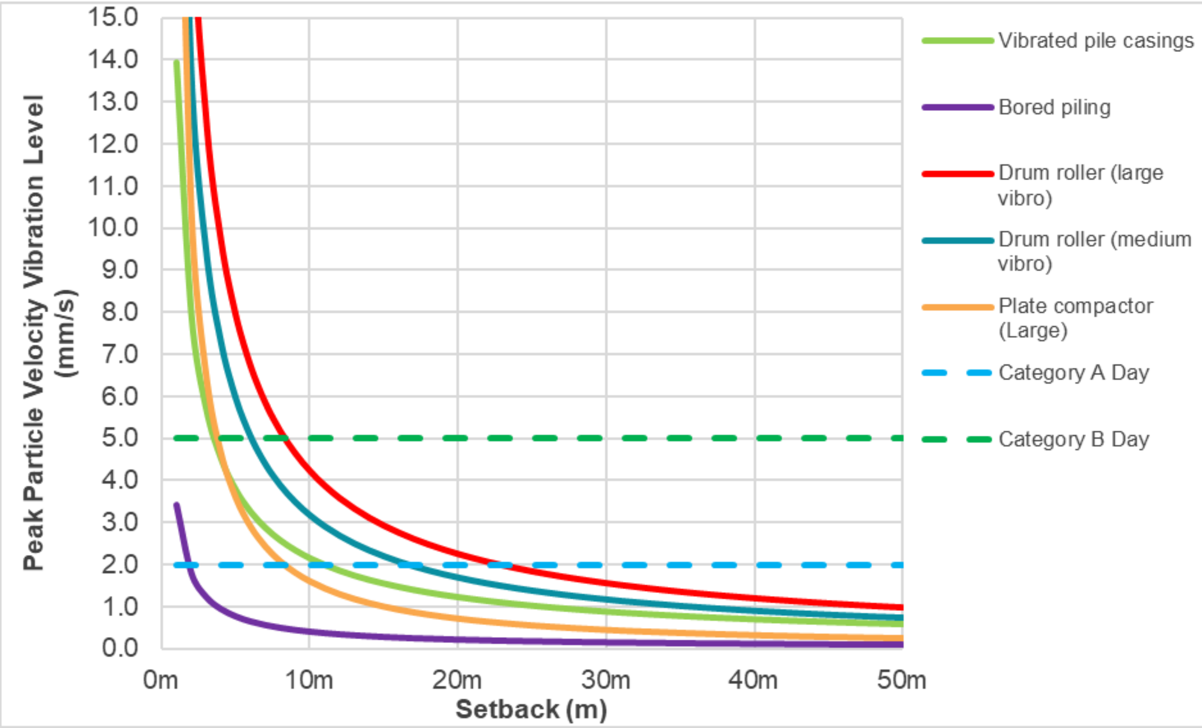


Figure 2: Vibration Regression Curves

5 Existing and likely environment

The overview of project and approach to assessing likely receiving environment sections in the AEE outline the key attributes of the existing and likely future environment of the Project across each of the five project areas.

We note that the proposed project areas are located within a predominantly urban landscape which will evolve over time and is likely to experience change before the implementation of the Project. The NPS-UD enables higher density dwellings within a walkable catchment of rapid transit stops. Four of the proposed project areas (Manuia Road, Manuroa Road, Taka Street and Walters Road) are within a walkable catchment of Takaanini Train Station. In the context of this Project, it is anticipated that the following urban intensification will take place in line with proposed Plan Change 78 to the Auckland Unitary Plan (Operative in Part) (**PC78**):

- Zoning within a walkable catchment of a rapid transit stop in the project areas will enable, at minimum, apartment buildings of six storeys: and
- Beyond walkable catchments, residential zoning will provide for three dwellings up to three storeys in height (subject to meeting the relevant development standards).

Based on the above, we anticipated that intensification and redevelopment could occur around the project areas in the near to medium future.

Therefore, while we have assessed existing buildings in this report, we recommend that where the existing environment is materially different at the time of construction, any new occupied buildings will need to be assessed against the relevant noise and vibration limits and managed at the receivers that are present at the time of construction as set out in Section 12. Any additional occupied buildings at the time of construction will be captured in the Construction Noise and Vibration Management Plan (**CNVMP**) recommended to be prepared for the Project, and appropriate mitigation and management will be determined at that time.

Ambient noise level measurements showed that noise levels close to existing roads are elevated in the mid- to high 60 dB L_{Aeq} while those locations away from roads (e.g., Portrush Lane) receive lower noise levels in the 50 dB L_{Aeq} (except when trains are passing). Construction noise will always be higher than ongoing existing noise levels, and of different character. Therefore, irrespective of the existing ambient noise levels, construction noise will be noticeable to occupiers of buildings in the vicinity of the works.

6 The TLC NoRs – Overall network

This section assesses common or general construction noise and vibration matters across the entire TLC network (NoR 1 and NoR 2), i.e. the combination of road closures and/or grade separated crossings across the five project areas. This section also recommends measures to avoid, remedy, or mitigate actual or potential adverse effects considering the network as a whole. Project area-specific matters are further discussed in the following report sections.

6.1 Buildings within designation

The following Table 13 shows the buildings that are within the proposed designation. We have not assessed these buildings further as we understand that AT will acquire the parcels of land that these buildings are located on, or the buildings will be unoccupied during construction.

Table 13: Buildings inside designation (not assessed)

Address	Address
Businesses	
20B, 24, 26, 28, 30, 38 Oakleigh Avenue (NoR 1)	102 Great South Road (NoR 1)
4, 8, 10 Manuia Road (NoR 1)	4, 6, 8, 10 Tironui Road (NoR 2)
1-3, 9 11 Walters Road (NoR 2)	
Noise sensitive	
8 Manuia Road (NoR 1)	1/12 Manuroa Road (NoR 1)
1/15, 2/15, 3/15, 4/15, 5/15 Manuroa Road (NoR 1)	17 Manuroa Road (NoR 1)
1 and 2/6, 1/10, 1/12, 1 and 2/16 Taka Street (NoR 1)	2/18, 22 Taka Street (NoR 1)
14 Taka Street (childcare centre) (NoR 1)	15, 19, 23, 31 and 33 Taka Street (NoR 1)
21, 23, 27 Walters Road (NoR 2)	20A, 25 Walters Road (two childcare centres) (NoR 2)
15 – 17 Walters Road (Education Facility) (NoR 2)	

6.2 Construction noise

6.2.1 Envelope of noise effects

We have predicted noise levels that include existing buildings (excluding those to be demolished) for shielding. Based on these predicted noise levels, we have developed effects envelopes, i.e. distances at which compliance with the daytime noise criteria can be achieved without noise mitigation in place. The envelopes have been plotted onto aerial photographs to show those areas where mitigation would need to be considered and implemented (refer Appendix A).

For those areas not included in the envelopes, we predict that noise levels will comply with the relevant limits, and no noise mitigation beyond normal best practice site management would be required (refer Section 12). In any event, Section 16 of the RMA (duty to avoid unreasonable noise) applies and the BPO will need to be implemented to manage noise effects on all areas, irrespective of compliance.

The following activities have been used to determine the envelope of noise effects. These are the activities we consider have the greatest impact on construction noise or will be used across the widest part of the NoRs:

- Construction of bridges and retaining walls may generate high noise levels due to the likely direct line-of-sight between buildings and machinery and the high sound power levels of the equipment;
- Night-time construction of bridges (e.g., lifting of bridge decks). While this would occur over a small number of nights only, the impacts will need to be managed to avoid sleep disturbance for neighbouring residents; and
- Surfacing of the roads.

Note that while demolition and site preparation is predicted to generate higher noise levels than the later ongoing construction activities, demolition works only take a very limited time of a few days, while all future works will be ongoing for months. Therefore, we have focussed on the long duration works that people will experience.

6.2.2 Noise effects

6.2.2.1 Daytime

Noise levels affect people in their place of residence or work. Construction noise is inherently higher than ongoing operational noise, which is widely considered reasonable due to its limited and finite duration.

Generally, construction noise is assessed in relation to people inside buildings. We have therefore assumed that people will choose to not spend any extended periods in an outdoor area next to high noise construction activities. We have also assumed that people will keep their windows and doors closed to reduce internal noise levels. Generally, New Zealand dwelling facades reduce noise levels by 20 to 25 decibels. We have assumed conservatively a noise level reduction of 20 decibels, though any new dwellings would achieve 25 to 30 decibels noise level reduction, and commercial buildings with concrete or brick façades can even achieve noise level reductions of more than 35 decibels if there are no windows or doors facing to the works.

How people may experience noise inside or outside a building is described in Table 14. It should be noted that Table 14 does not take account of non-sensitive activities such as factories, storage spaces and similar uses.

Table 14: Potential noise effects for varying noise levels

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
Up to 65	Conversation becomes strained, particularly over longer distances.	Up to 45	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
65 to 70	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75	Businesses that involve substantial outdoor use (for example garden centres such as Bunnings) would experience considerable disruption.	50 to 55	Face to face and phone conversations and TV watching would continue to be affected. Office work can generally continue.
75 to 80	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60	Phone conversations would become difficult, and face to face conversations would need slightly raised voices. For residential activities TV and radio sound levels may need to be raised. Continuing office work may become difficult.
80 to 90	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70	Face to face conversations would require raised voices. In a residential context, people may actively seek respite if these levels are sustained for more than a period of a few hours. Concentration would start to be affected, continuing office work would be difficult and may become unproductive.

6.2.2.2 Night-time

The noise level received inside a noise sensitive space (e.g., bedroom) will depend on the external noise level, sound insulation performance of the façade (particularly the glazing) and room constants (such as the room dimensions and surface finishes). These factors can vary widely.

The Construction Noise Standard (NZS6803) recommends noise limits assessed at 1 m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, a 20-decibel reduction is particularly conservative for modern buildings. The sound insulation performance can be measured, or generally be estimated with knowledge of the façade glazing type as follows:

- Sealed glazing: 30 decibels façade sound level difference
- Closed windows (openable): 20 – 25 decibels façade sound level difference

- Open windows: 15 decibels façade sound level difference

Table 15 provides guidance on the potential night-time effects inside sensitive spaces, depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

- Typically acceptable (green)
- Sleep disturbance for some occupants (orange)
- Sleep disturbance for most occupants (red)

Table 15: Night-time noise levels in bedrooms of dwellings

External Noise Level (dB L_{Aeq})	Estimated Internal Noise Level (dB L_{Aeq})			
	Sealed glazing	Openable windows (modern building)	Openable windows (older style building)	Open windows
70 – 75	40 – 45	45 – 50	50 – 55	55 – 60
65 – 70	35 – 40	40 – 45	45 – 50	50 – 55
60 – 65	30 – 35	35 – 40	40 – 45	45 – 50
55 – 60	25 – 30	30 – 35	35 – 40	40 – 45
50 – 55	20 – 25	25 – 30	30 – 35	35 – 40
45 – 50	15 – 20	20 – 25	25 – 30	30 – 35

Table 15 shows that consultation and management will be required when night-time works occur in the vicinity of dwellings, where internal noise levels would affect sleep.

6.3 Construction vibration

6.3.1 Envelope of vibration effects

There is a risk that the Category A criteria may be exceeded at dwellings where vibratory rollers are used for compaction. We understand that piling for the bridge construction will prioritise bored rather than impact or vibratory piling. Bored piling is a relatively low vibration activity and we have not included it in the assessment below.

We use risk categories to define the risk of exceeding Category A and B criteria for occupied buildings at various distances from the vibration inducing works.

The distances for Category B (building) criteria include a 100% safety factor as described in Section 4.6.2 above. However, the Category A (amenity) criteria do not include the safety factor as they are a trigger for management and consultation, and we consider that the conservative 100% safety margin is not necessary.

Vibration criteria are significantly more stringent at dwellings during the night (0.3 mm/s PPV) and have the potential to be exceeded at distances greater than 200 m from any works using vibratory rollers (see Table 16). On this basis, vibration intensive activities adjacent to residential areas should be scheduled for the daytime wherever practicable. Note that for night-time both Category A and B relate to amenity rather than the avoidance of any building damage, and therefore the night-time criteria do not include any safety margin.

The risk categories are defined as follows:

- High Risk — Predicted to exceed both Category A (amenity) and Category B (building) criteria (refer Section 3.2);
- Medium Risk — Predicted to exceed Category A (amenity) criteria, but comply with the Category B (building) criteria; and
- Low Risk — Predicted to comply with both Category A and B criteria.

Table 16: Activity and vibration risk zones

Activity/Equipment	Risk Zones	
	Daytime	Night-time
Vibratory Roller	High: <10 m Med: 10 – 15 m Low: >15 m	High: <15 m Med: 15 – 105 m Low: >105 m

Drawings showing the approximate risk zones for the highest vibration inducing equipment (vibratory rollers and piling rigs) for each level crossing are shown in Appendix B of this report. A significant number of dwellings and other noise sensitive buildings (e.g. a retirement village) are within 15 mfrom the closest extent of the works, which means that these buildings will likely be affected by construction vibration at times. Therefore, it is critical that the construction methodology be reviewed closer to the time of construction to ensure that vibration levels are managed appropriately.

6.3.2 Vibration effects

Vibration levels can be perceived well below a level at which cosmetic building damage may occur. For structural damage to occur, vibration levels would need to be magnitudes higher again. People tend to react to low vibration levels, and it is important to inform residents in the vicinity of the works of the potential for construction vibration to be felt.

Table 17 shows how people may react to various vibration levels. These effects do not consider less sensitive uses such as factories, manual works (e.g. the concrete batching plant) and similar.

Table 17: Vibration effects

Vibration level (mm/s PPV)	Potential effects indoors
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments This is the AUP:OP limit for construction vibration generated at night-time for sensitive receivers.
1	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents. What people feel would be subject to the source/activity (i.e., continuous motion or a one-off event) and associated frequency (i.e., fast or slow vibration), but could include a steady vibration from sources such as vibratory compaction, or a small jolt such as from the movement of a large digger. Vibration at this level could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2	Vibration would clearly be felt in all situations. Can be tolerated in indoor environments such as offices, houses, and retail, where it occurs intermittently during the day and where there is effective prior engagement. This is the AUP:OP limit for occupied buildings for construction projects generating vibration.
5	Unlikely to be tolerable in a workplace or residential environment without prior warning and explanation. If exposure was prolonged, some people could want to leave the building affected. Computer screens would shake, and light items could fall off shelves. This is the AUP:OP limit for construction activities generating vibration for three days or less between the hours of 7:00 am – 6:00 pm
10	Likely to be intolerable for anything more than a very brief exposure.

For dwellings where the Category A (amenity) criteria are predicted to be exceeded, residents may be disturbed by vibration if no prior warning is given. We recommend notification to avoid such a situation. It is noted, however, that vibration inducing equipment generally moves along the alignment, i.e. vibration levels will not remain high for any length of time.

7 Spartan Road

This section assesses specific construction noise and vibration matters relating to the Spartan Road project area.

7.1 Assessment features

This project area is located in a business area (both light and heavy industry zones). No buildings will need to be removed for the construction of this corridor, and closest neighbouring receivers are not generally noise sensitive. There are a small number of dwellings in this business area.

Refer to the AEE in Volume 2 for a detailed description of the existing and likely receiving environment for the TLC.

7.2 Assessment of construction noise and vibration effects

Most works will occur in the existing road corridor. The road closure will require the uptake of the surfacing, installation of new footpaths and landscaping. The active mode bridge construction will be of lower impact than for the road bridges, with limited width and length. However, the bike ramps will require piling over a more extended area, with some piles relatively close to the building at 21 Spartan Road. We understand that bored piling will be prioritised for the bridge construction works.

The indicative location of piles is shown in Figure 3 below.

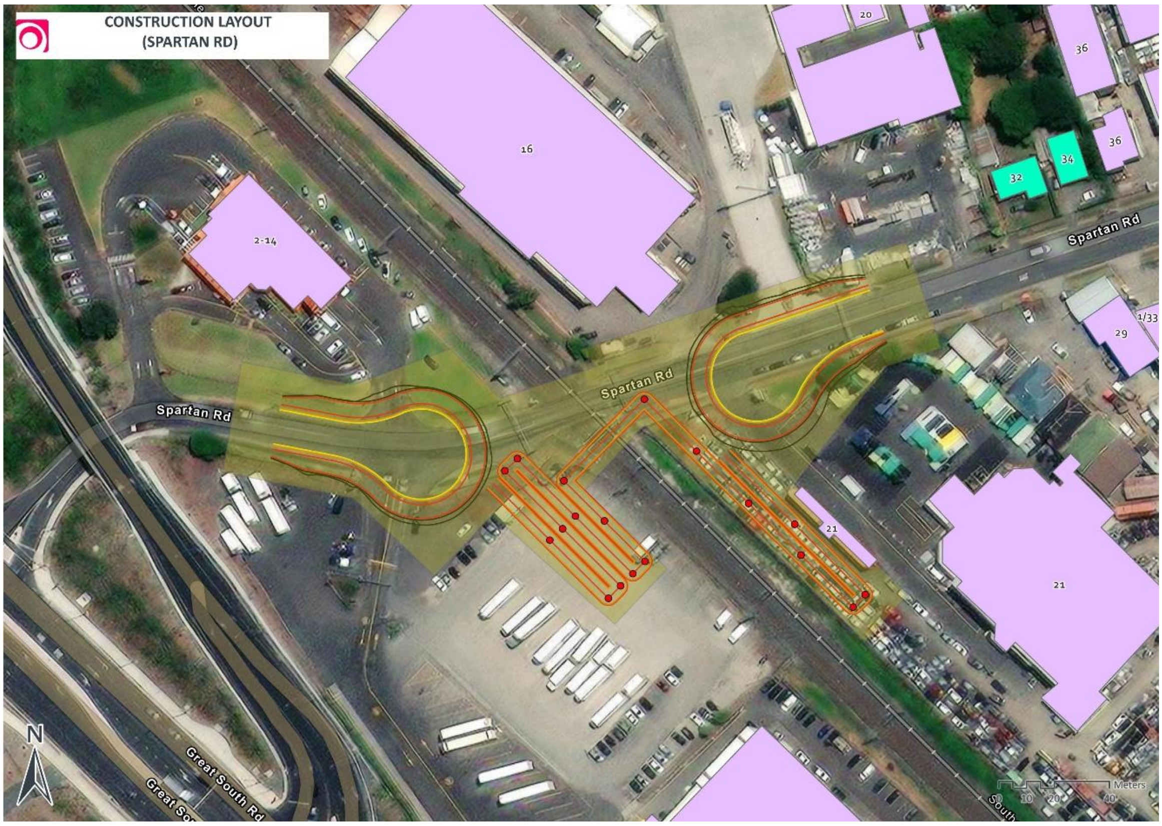


Figure 3: Indicative piling locations and designation overlay (Spartan Road)

We have predicted noise levels from construction works at the Spartan Road bridge, based on bored piling works. The closest sensitive building (32 Spartan Road) is some 100 m from the closest piling works, and about 30 m from the closest extent of works. Other closest buildings are the commercial buildings at 1, 16 and 21 Spartan Road. Both are warehouse style buildings housing non-noise sensitive activities.

Due to the distance of buildings from the works, we predict compliance with the 70 dB L_{Aeq} noise limit.

Where night-time works are required for the placement of the bridge across the rail line for a small number of nights, this would occur during a BOL. Noise level at the dwellings at 32 and 34 Spartan Road are predicted to be up to 50 dB L_{Aeq}. At these levels, no sleep disturbance is anticipated as internal noise levels, even with windows ajar, would be around 35 dB L_{Aeq} and less with windows closed. Train passes that do normally occur, would generate higher noise levels than those predicted from the bridge placement.

The most stringent Category A (amenity) vibration standards are predicted to be complied with at all buildings.

The figures in Appendix 1 of this report show an overview of the predicted noise level contours for piling and the figures in Appendix 2 of this report show the vibration envelope.

Irrespective of the overall predicted compliance, noise and vibration levels should be managed and mitigated through normal processes as set out in Section 12.

8 Manuia Road

This section assesses specific construction noise and vibration matters relating to the Manuia Road project area.

8.1 Assessment features

The project area is located within a light industry area but borders the south residential zone. Closest dwellings are in Portrush Lane, with a childcare centre at 8 Oakleigh Avenue (which is at a sufficient distance from the works). Other residential sites close to the works are on the far side of Great South Road.

Refer to the AEE in Volume 2 for a detailed description of the existing and likely receiving environment for the TLC.

8.2 Assessment of construction noise and vibration effects

The construction of a two-lane road bridge with active mode provisions requires only limited piling. Some demolition will be required of commercial buildings north of Manuia Road and Portrush Lane. Closest sensitive receivers are at 10 to 16 Portrush Lane (even numbers) and 17 Portrush Lane. The closest dwelling is approximately 35 m from the closest works (specifically piling for the bridge).

The indicative location of piles is shown in Figure 4 below.

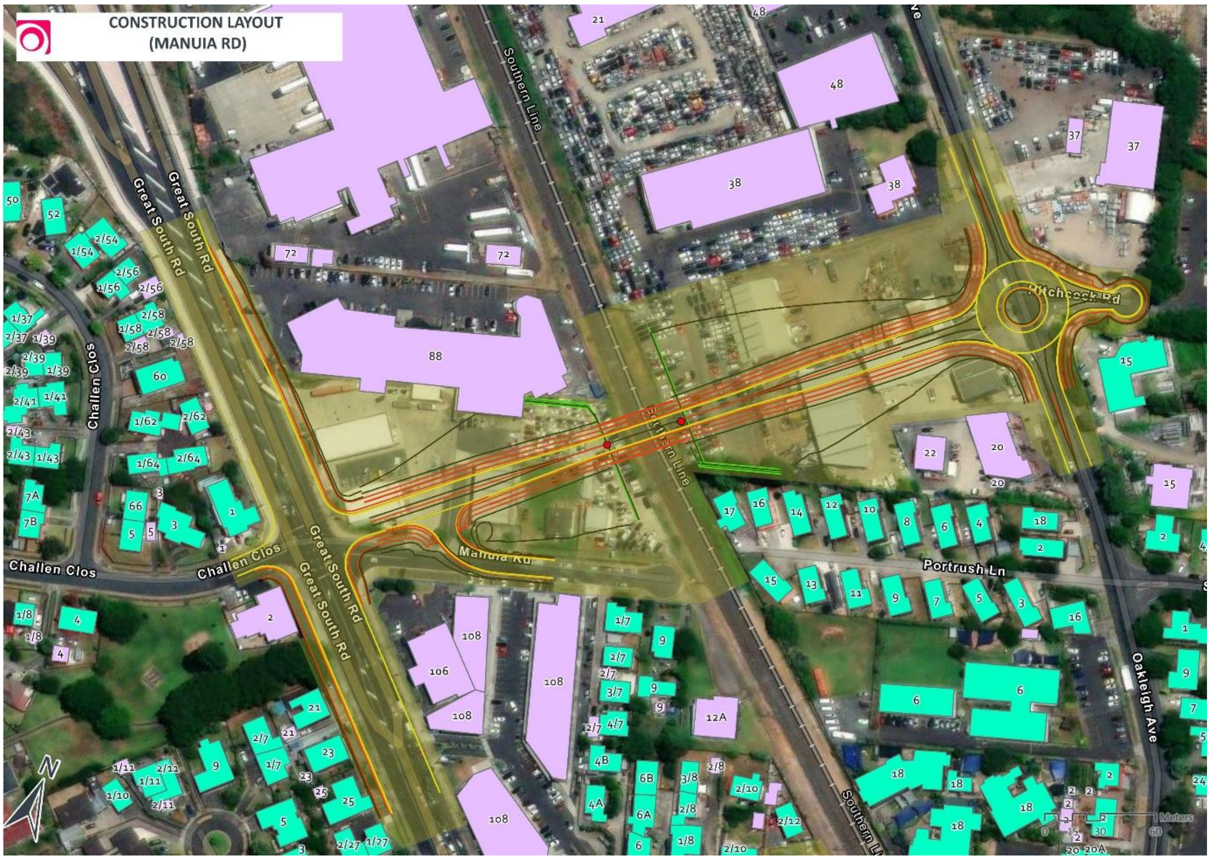


Figure 4: Indicative piling locations and designation overlay (Manuia Road)

Another potentially affected dwelling at 15 Oakleigh Avenue is close to the proposed roundabout that will be constructed as part of this Project. This will involve earthworks and compaction. The dwelling is approximately 15 m from the closest works.

We predict compliance with the construction noise criteria at all but two dwellings. At 16 and 17 Portrush Lane, we predict noise levels of up to 75 dB L_{Aeq} during piling for the bridge supports. We consider this noise level is acceptable given its short overall duration (a few days only) and since the works will only occur during daytime.

Where night-time works are required for the placement of the bridge across the rail line for a small number of nights, this would occur during a BOL. The noise level at the dwelling at 17 Portrush Lane is predicted to be up to 50 dB L_{Aeq}. At this level, no sleep disturbance is anticipated as internal noise levels, even with windows ajar, would be around 35 dB L_{Aeq} and less with windows closed. Train passes that would normally occur, would generate higher noise levels than those predicted from the bridge placement.

During the construction of the roundabout with Oakleigh Ave, noise levels at 15 Oakleigh Ave may be as high as 78 dB L_{Aeq} during some earthworks, however, this noise level would only be experienced for a brief period of a few days. We note that all works would occur during daytime only.

We predict that compliance with the vibration standards (both Categories A and B) can be achieved at all times.

9 Manuroa Road

This section assesses specific construction noise and vibration matters relating to the Manuroa Road project area.

9.1 Assessment features

The project area is located in the residential zone. Closest dwellings are those just outside the designation in Manuroa Road. A large childcare centre at 18 Manuroa Road is in close proximity to the works.

The proposed ramps onto the bridge require more extensive piling for the switch backs, which brings piling close to some dwellings.

Refer to the AEE in Volume 2 for a detailed description of the existing and likely receiving environent for the TLC.

9.2 Assessment of construction noise and vibration effects

Most works will occur in the existing road corridor. The road closure will require the uptake of the surfacing, installation of new footpaths and landscaping. Some building demolition will be required close to the units at 5 and 17 Manuroa Road.

The bridge construction will be of lower impact than for the road bridges, with limited width and length. However, the bike ramps will require piling over a more extended area, with some piling relatively close to the buildings at 17 and 19 Manuroa Road. We understand that bored piling will be prioritised for the bridge construction works.

The indicative location of piles is shown in Figure 5.

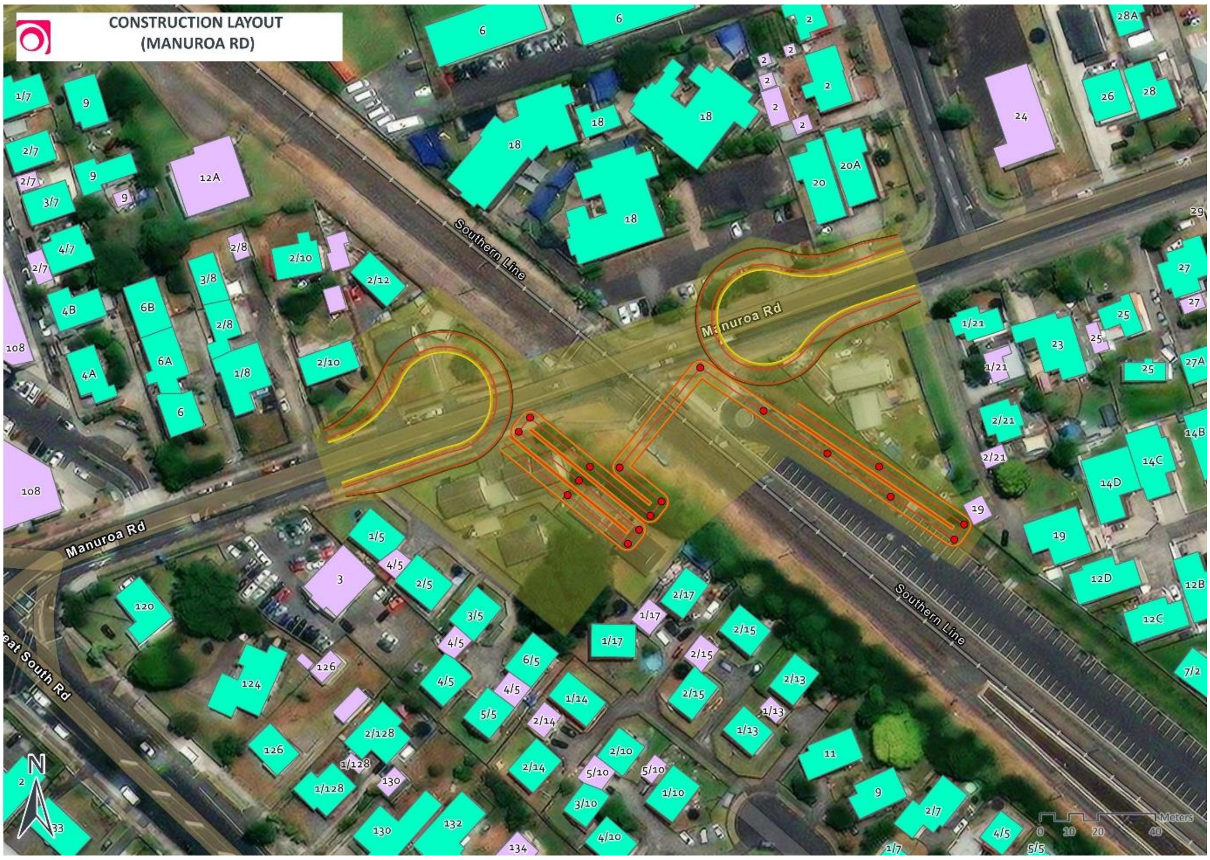


Figure 5: Indicative piling locations and designation overlay (Manuroa Road)

We have predicted noise levels from construction works at the Manuroa Road bridge, based on bored piling works. Due to the distance of buildings from the works, we predict compliance with the 70 dB L_{Aeq} noise limit for all buildings except for 1 and 2/17 Matawalu Place and 19 Manuroa Road, where the noise level during closest piling is predicted to be up just above 70 dB L_{Aeq} (around 71 to 72 dB L_{Aeq}).

Where night-time works are required for the placement of the bridge across the rail line for a small number of nights, this would occur during a BOL. The closest sensitive receiver is 18 Manuroa Road, however, since the childcare will be closed at night, this means there will be no actual effects. The next closest sensitive receivers are at 20 an 2/10 Manuroa Road, some 50 m from the closest work position. Noise levels at these dwellings are predicted to be up to 50 dB L_{Aeq}. At these levels, no sleep disturbance is anticipated as internal noise levels, even with windows ajar, would be around 35 dB L_{Aeq} and less with windows closed. Train passes that would normally occur, would generate higher noise levels than those predicted from the bridge placement.

The most stringent Category A (amenity) vibration standards are predicted to be complied with at all buildings.

The figures in Appendix 1 of this report show an overview of the predicted noise level contours for piling and the figures in Appendix 2 of this report show the vibration envelope.

Irrespective of the overall predicted compliance, noise and vibration levels should be managed and mitigated through normal processes as set out in Section 12.

10 Taka Street

This section assesses specific construction noise and vibration matters relating to the Taka Street project area.

10.1 Assessment features

The project area is surrounded by a variety of zones and land uses, including residential, light industry and open space. The closest affected receivers are the Takanini Care Centre at 9 Taka Street and all dwellings fronting the designation. Given the length and height of the bridge required, and the construction of the service lanes this is the project area with the highest number of closures.

Refer to the AEE in Volume 2 for a detailed description of the existing and likely receiving environment for the TLC.

10.2 Assessment of construction noise effects

While most works will comply with the noise limits, the following activities are predicted to infringe the 70 l L_{Aeq} criterion:

- Demolition of existing buildings inside the designation: there are a number of buildings north of Taka Street that will be demolished. While demolition is a high noise activity, it will occur over a very limited time period, and levels will only be high while the immediately closest building is demolished.
- Piling of bridge piers. There are many bridge piles that will be installed, owing to the bridge's long span. Due to its height, we have assumed the use of a large piling rig which increases the noise generation in the area.
- Construction of the service lanes either side of the bridge. Earthworks and road construction (including compaction) may cause elevated noise levels for the closest dwellings.

The indicative location of piles is shown in Figure 6.

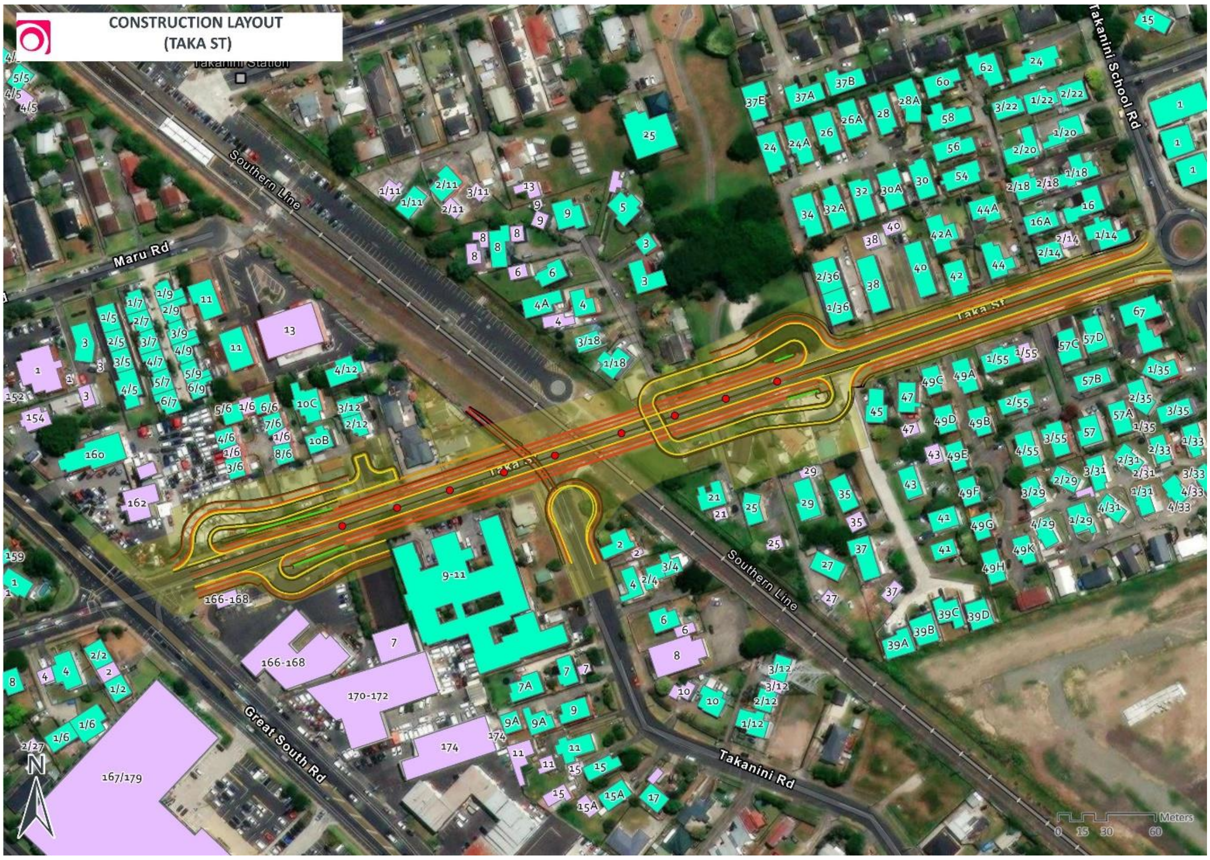


Figure 6: Indicative piling locations and designation overlay (Taka Street)

Our predictions show that all houses fronting Taka Street would receive noise levels above 70 dB L_{Aeq} at some stage of the works. While the exceedances may be limited in duration (e.g. some days or at most weeks), levels may be as high as 80 dB L_{Aeq} when works are closest.

Such levels can cause annoyance inside where noise levels may be up to 60 dB L_{Aeq} inside for uninsulated buildings. Management of these crossing works will need to be particularly well managed, with extensive consultation and communication throughout the works and complimented by reduction in noise level where practicable (e.g. by choosing lower noise equipment). Temporary barriers may be used where activities are stationary, but for activities moving along the alignment, they will be less appropriate.

The care home at 9-13 Taka Street is a single level building. We recommend that a temporary construction barrier is considered for the northern and part of the eastern boundary to protect the residents from construction noise as far as practicable. This should be investigated in consultation with the care home to ensure that vehicles can continue to enter the site unimpeded while receiving the most effective noise level reduction by a barrier.

Night-time works will be limited to the lifting of the bridge span across the rail line. This would likely occur during a BOL. The closest sensitive receivers are 9-13, 1/18, 21 Taka Street and 2 Takanini Road. Noise levels at potentially occupied sensitive receivers are predicted to be up to 55 dB L_{Aeq}. At these levels, sleep disturbance is not anticipated as internal noise levels would be less than 35 dB L_{Aeq} with windows closed. Train passes that at present normally occur, would generate higher noise levels than those predicted from the bridge placement.

10.3 Assessment of construction vibration effects

While the bridge piling is anticipated to achieve full compliance with the Category A and B vibration criteria, the use of vibratory rollers for the compaction of the service lanes may result in an exceedance of the amenity criteria. With the correct size roller, vibration levels can be managed to comply with the building damage criteria of Category B (i.e. 5 mm/s PPV).

Where vibratory rolling is undertaken in the vicinity of the childcare centre, this should be timed to avoid sleep time for the children as vibration can disturb sleep even at low levels.

Overall, effects can be managed using the processes set out in Section 12.

11 Walters Road

This section assesses specific construction noise and vibration matters relating to the Walters Road project area.

11.1 Assessment features

The project area is surrounded by a variety of zones and land uses, including residential, light industry, open space and town centre zones. Closest affected receivers are the dwellings in Walters Road fronting the designation. Given the length and height of the bridge required, and the construction of the service lanes this project area is predicted to have a high number of affected buildings.

Refer to the AEE in Volume 2 for a detailed description of the existing and likely receiving environment for the TLC.

11.2 Assessment of construction noise and vibration effects

Similar to the Taka Street bridge, the Walters Road bridge has a long span and requires a large number of piles.

The indicative location of piles is shown in Figure 7.

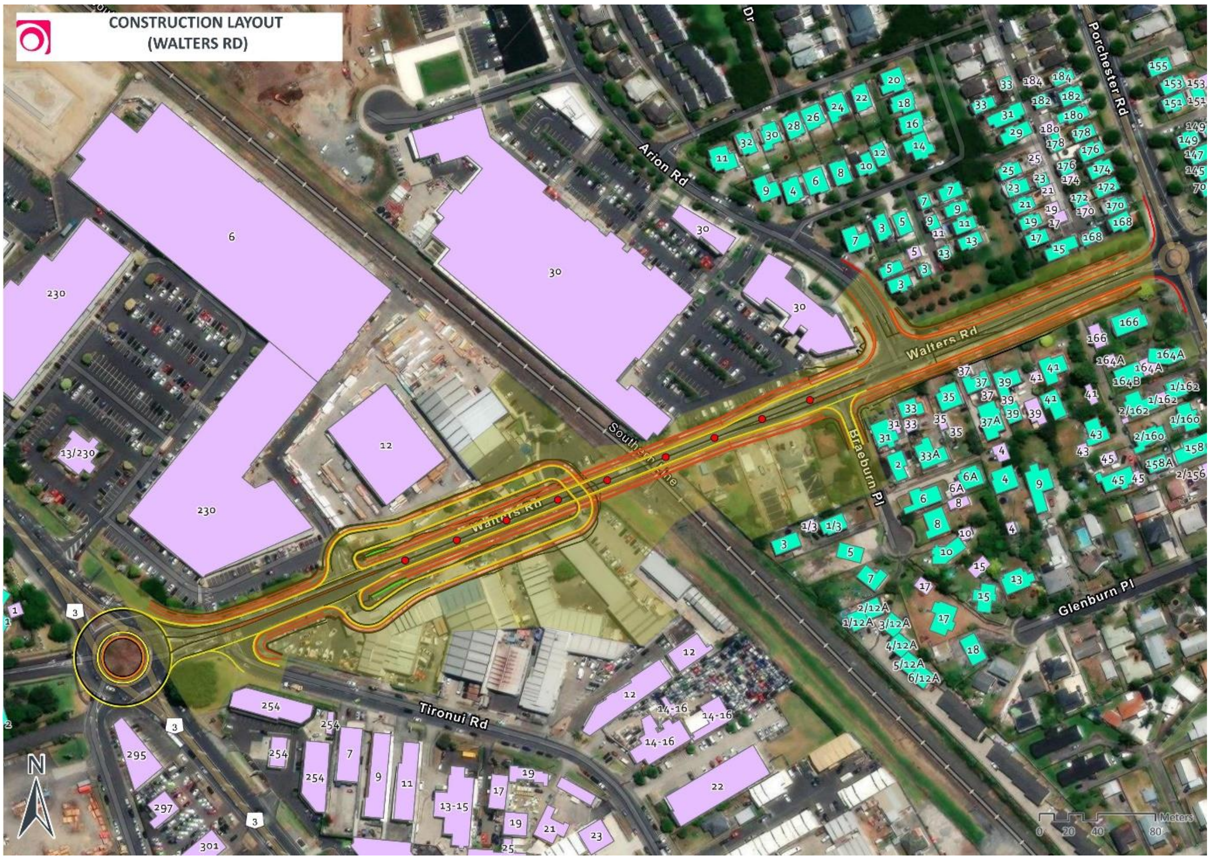


Figure 7: Indicative piling locations and designation overlay (Walters Road)

Other high noise activities include the demolition of buildings on the corner of Walters Road and Braeburn Place. Demolition occurs only for limited times at the onset of construction and will be completed within a few days.

The construction of the service lanes west of the NIMT are located in a commercial area that does not contain any noise sensitive activities. We anticipate that construction noise and vibration will be within an acceptable range for the receiving environment.

The bridge placement across the NIMT will occur during a BOL at night-time. However, there are no sensitive receivers close by, with the closest dwelling (1/3 Braeburn Place) approximately 75 m from the works. At this distance, we predict a noise level of less than 55 dB L_{Aeq} which would not cause sleep disturbance inside.

Noise and vibration levels should be managed and mitigated through normal processes as set out in Section 12.

12 Management and mitigation

The most effective way to control construction noise and vibration is through good on-site management and communication between managers, staff and affected receivers. We have included recommended measures in this Report, based on the assumed construction equipment and methodologies.

Good noise and vibration management is essential in reducing adverse effects as far as practicable, irrespective of the low number of dwellings potentially affected or if noise levels may already be compliant with the relevant criteria.

12.1 General mitigation and management measures

The following general noise mitigation measures will be required to be implemented throughout the construction of the Project. These measures should be implemented as a matter of good practice and are considered the baseline mitigation for most circumstances.

Where an exceedance of the construction noise or vibration standards is likely due to a specific activity or in a specific area, and the general mitigation measures as discussed below are not sufficient to achieve full compliance, further mitigation and management should be investigated and implemented where practicable. Such information would be contained in the Schedule as an attachment to the CNVMP.

12.1.1 Communication and consultation

The most important and effective management measure is public liaison and communication with people occupying buildings in the vicinity of the Project. Providing timely and detailed information to those potentially affected helps to alleviate uncertainty and concerns and builds trust between the contractor and the receivers.

A contractor environmental manager or appointed representative should be available for residents to contact by phone and/or email at times when construction occurs. Communication also includes complaint responses, which should be included in the CNVMP.

At sensitive times (e.g. when night-time or public holiday works are required), communication is particularly important, and needs to increase in frequency and content, to ensure residents have the ability to plan around the works where that is practicable.

12.1.2 Training

All staff should participate in an induction training session prior to the start of construction, with attention given to the following matters:

- Construction noise and vibration limits;
- Activities with the potential to generate high levels of noise and/or vibration;
- Noise and vibration mitigation and management procedures; and
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation.

Awareness of current noise and vibration matters on, or near active worksites, should be addressed during regular site meetings and/or ‘toolbox’ training sessions.

12.1.3 Equipment selection

When selecting construction equipment, where practicable:

- Prioritise quieter construction methodologies (e.g. bored piling instead of drop hammer piling);
- Prioritise electric motors over diesel engines;

- Prioritise rubber tracked equipment over steel tracked equipment;
- Equipment will be suitably sized for the proposed task;
- Equipment will be maintained and fitted with exhaust silencers and engine covers; and
- Avoid tonal reversing or warning alarms (suitable alternatives may include flashing lights, broadband audible alarms or reversing cameras inside vehicles).

12.1.4 Timing of works

Where practicable, we recommend that night-time works are avoided. However, where projects affect existing major transport corridors (e.g. at tie ins and intersections or during the construction of new bridges) where potential closures or limitations are required to construct the Project, night-time works will likely be required from time to time. Where necessary, noisy works should be prioritised early in the evening or night-time period to avoid sleep disturbance. People tend to be less disturbed by low frequency, continuous engine noise, than intermittent noise or activities with special audible character (e.g. reversing beepers, whistling, banging tailgates or shouting).

Stakeholder engagement should be undertaken for occupiers of properties within 200 m of any high noise night (and weekend) works and within the setback distance for buildings receiving vibration levels meeting or exceeding 2 mm/s PPV (Category A for occupied PPFs).

12.1.5 Noise barriers

Temporary noise barriers should be used where a construction noise limit is predicted to be exceeded and the barriers would noticeably reduce the construction noise level. They should be installed prior to the relevant works commencing and maintained throughout those works. Effective noise barriers typically reduce the received noise level at ground level by up to 10 decibels.

Where practicable, the following guidelines should be incorporated in the design and utilisation of temporary noise barriers:

- To be constructed from materials with a minimum surface mass of 6.5 kg/m^2;
- A minimum height of 2 m, and higher if practicable to block line-of-sight;
- Abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels; and
- Positioned as close as practicable to the noisy construction activity to block line-of-sight between the activity and noise sensitive receivers. Where positioned on the site boundary, additional local barriers will be considered near the activity to ensure effective mitigation for sensitive receivers on upper floor levels.

12.1.6 Alternative mitigation options

Where all practicable noise and vibration mitigation measures have been implemented and considered, and noise or vibration levels are predicted to exceed relevant limits by a significant margin or for an extended period (e.g. more than two consecutive nights), an offer of temporary resident relocation should be considered. Such a measure should be considered as a last resort as it will generally inconvenience the building occupiers. Note that temporary relocation offers are generally associated with night-time works and sleep disturbance rather than daytime noise levels, and that this will be similar for the Project. Any such alternative mitigation options would be assessed on a case-by-case basis and be recorded in a schedule.

12.1.7 Best practice general measures

Complaints can arise irrespective of compliance with the noise and vibration limits. To minimise complaints, general mitigation and management measures include, but are not limited to, the following:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets;
- Avoid high engine revs through appropriate equipment selection and turn engines off when idle;
- Maintain site accessways to avoid potholes and corrugations;
- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly);
- Minimise construction duration near sensitive receivers;
- Stationary equipment (e.g. generators) will be located away from noise sensitive receivers and site buildings and material stores used to screen them;
- Locate mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators);
- Utilise noise barriers where appropriate;
- Implement specialised mitigation measures for particularly high noise and vibration generating activities such as concrete breaking, piling and vibratory roller use;
- Ensure advanced communication is complete prior to commencing activities that are predicted to exceed the noise and vibration performance standards; and
- Undertake monitoring as appropriate.

12.2 Construction Noise and Vibration Management Plan

All appropriate mitigation and management are generally set out in a CNVMP, which would be used to manage works on site and sets out how the construction contractor interacts with the neighbouring affected parties.

The CNVMP should include information as set out in NZS6803:1999 (refer to Section 8 and Annexure E) and the requirements of the AUP:OP such as:

- Summary of noise and vibration standards;
- Summary of assessments/predictions;
- General construction practices, management and mitigation that will be used for the Project;
- Noise management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and all night-time works;
- Monitoring and reporting requirements;
- Procedures for handling complaints; and
- Procedures for review of the CNVMP throughout the works.

Each crossing should have its own CNVMP depending on the time when the work occurs and the sensitivity of the receiving environment. While the base information in each CNVMP will be similar, management and mitigation depend on the works undertaken and the receiving environment. The construction methodology is not yet finalised, therefore, the CNVMPs should be prepared when more detail is available.

12.3 Schedules

In addition, Site Specific Noise and/or Vibration Management Schedules (**Schedules**) are a useful tool in determining how the noise and vibration effects from specific activities or in specific areas will be managed and potentially affected parties communicated with. Schedules would generally be prepared where there is a high risk of exceeding the noise and/or vibration standards.

The Schedules are specific to the activity or receiver they relate to, and would therefore contain detailed information on communication, management and mitigation specific to a certain task or area.

The following information would normally be included in a schedule:

- The activity start and finish dates;
- The nearest neighbours to the activity;
- A location plan;
- The activity equipment and methodology;
- Predicted noise/vibration levels;
- Recommended BPO mitigation;
- Documented communication and consultation with affected persons;
- Monitoring details; and
- Any pre-activity building condition survey for any buildings predicted to receive vibration levels exceeding the Category A criteria and receiving noise levels towards the Category B criteria.

They would be attached to the CNVMP, providing additional information that would sit alongside the general management and mitigation options within the CNVMP.

13 Conclusions

We assessed construction noise and vibration effects for the Project based on indicative information available at the NoR stage. In the future, during detailed design, construction noise and vibration management will need to consider the receivers as they exist at that time and the confirmed construction methodology, and the results reflected in the CNVMP.

Assessment across the entire Project (i.e. all crossings) indicates likely infringement of the noise criteria for residential and commercial receivers where works are close to buildings, and where large structures such as bridges are required. In addition, the amenity vibration criteria may be infringed during the use of vibratory rollers for the road surface finishing works. Infringements are also predicted for any night-time works such as where bridges are constructed across the NIMT.

Mitigation measures are required to manage effects on receivers in the vicinity of the Project. We have recommended common measures, such as the use of barriers, communication and consultation with affected receivers, appropriate choice of equipment and timing of works. All of these measures will be included in the CNVMP, with the details responding to the detailed design works and equipment to be used, and the receiving environment how it exists at the time of construction.

We have recommended that a CNVMP is prepared for each crossing individually as this is the most effective way to manage construction noise and vibration effects on sensitive receivers with the necessary agility and responsiveness required by large construction projects. Where further infringements are predicted or determined throughout the construction phase, Schedules will be prepared. Schedules are mini-CNVMPs that respond to a specific activity or area and set out detailed measures for that activity or area. Any Schedules would be attached to the CNVMP.

Specific recommendations for the entire Project and individual crossings are set out in Table 18 below.

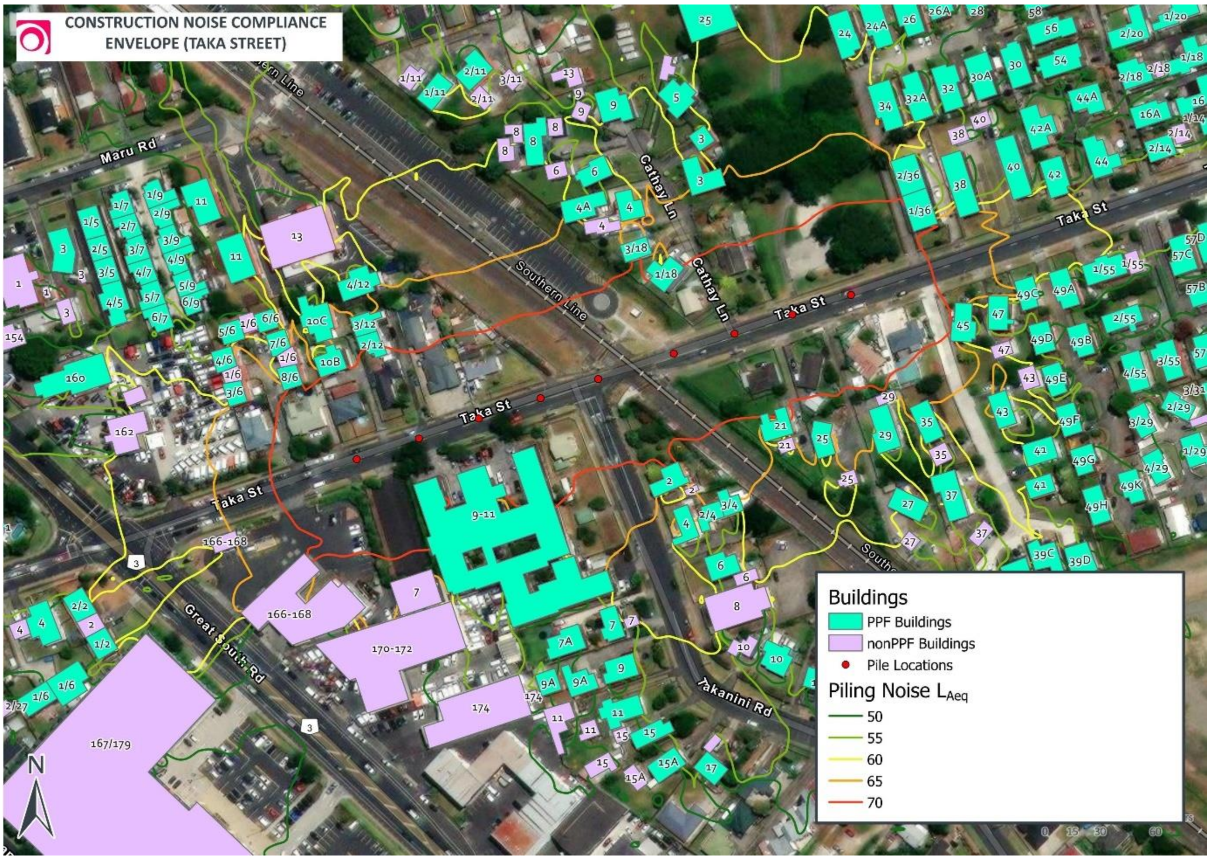
Table 18: Summary of effects, assessment and recommendations

Effect	Assessment	Recommendation
Construction noise – all Crossings (NoR 1 and NoR 2)	All crossings are located in well-established residential or commercial areas, with buildings in close proximity to construction works. Largest effects anticipated from: • Demolition of houses in the designation boundary – limited duration and localised, but close to remaining houses; • Earthworks to prepare alignment, service relocations, establishment of service lanes – longer duration but not stationary in any one location for extended periods; • Bridge piling and installation – limited duration and localised effects only, but night/weekend works likely required; and Final surfacing – likely to be done at night-time. Limited duration and moving along the alignments.	Management and mitigation through the CNVMP Schedules for any specifically noisy activities or where receivers are particularly affected, e.g.: • Any night-time works in the vicinity of residential areas; and • Any specifically high noise works where they affect sensitive receivers (e.g. retirement village or childcare). Communication and consultation prior to high noise works
Construction vibration – all Crossings (NoR 1 and NoR 2)	All crossings are located in well-established residential and commercial areas, with buildings in close proximity to construction works. Largest effects anticipated from: • Demolition of houses inside designation – limited duration and localised, but close to remaining houses; • Road preparation: use of vibratory rollers – along all crossing alignments, therefore limited duration but affecting	Management and mitigation through the CNVMP Choice of piling methodology to be bored rather than impact or vibrated Use of non-vibratory compaction close to buildings where required to ensure compliance

Effect	Assessment	Recommendation
	all immediately fronting houses; and • Construction of bridge piles and retaining walls. Nevertheless, compliance with the Category B criteria is generally predicted.	
Night-time / long weekend construction noise – All crossings NoR 1 and NoR 2)	Bridge construction across the NIMT will likely require night-time works during a BOL	Consider offer of temporary relocation to most affected residents to manage sleep disturbance, depending on duration and noise level

1 Appendix A – Noise compliance envelope


CONSTRUCTION NOISE COMPLIANCE ENVELOPE (MANUROA ROAD)
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Piling Noise L_{Aeq}
50
55
60
65
70
Manuroa Rd
Southern Line
Great South Rd
Princess St
Matawalu Pl
N


CONSTRUCTION NOISE COMPLIANCE ENVELOPE (TAKA STREET)
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Piling Noise L_{Aeq}
50
55
60
65
70
Maru Rd
Taka St
Cathay Ln
Southern Line
Great South Rd
Takanini Rd
N


CONSTRUCTION NOISE COMPLIANCE
ENVELOPE (WALTERS ROAD)
Walters Rd
Tironui Rd
Braeburn Pl
Arion Rd
Great South Rd
Glenburn
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Piling Noise L_{Aeq}
50
55
60
65
70

2 Appendix B – Vibration compliance envelope


CONSTRUCTION VIBRATION COMPLIANCE ENVELOPE (MANUROA ROAD)
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Vibration levels
2 mm/s
5 mm/s
Manuroa Rd
Southern Line
Great South Rd
Princess St
Station Rd
Matawalu Pl


CONSTRUCTION VIBRATION COMPLIANCE ENVELOPE (TAKA STREET)
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Vibration levels
2 mm/s
5 mm/s
Taka St
Maru Rd
Southern Line
Cathay Ln
Great South Rd
Takanini Rd


CONSTRUCTION VIBRATION COMPLIANCE
ENVELOPE (WALTERS ROAD)
Walters Rd
Tironui Rd
Arion Rd
Braeburn Pl
Southern Line
Great South Rd
Glenburn
Buildings
PPF Buildings
nonPPF Buildings
Pile Locations
Vibration levels
2 mm/s
5 mm/s