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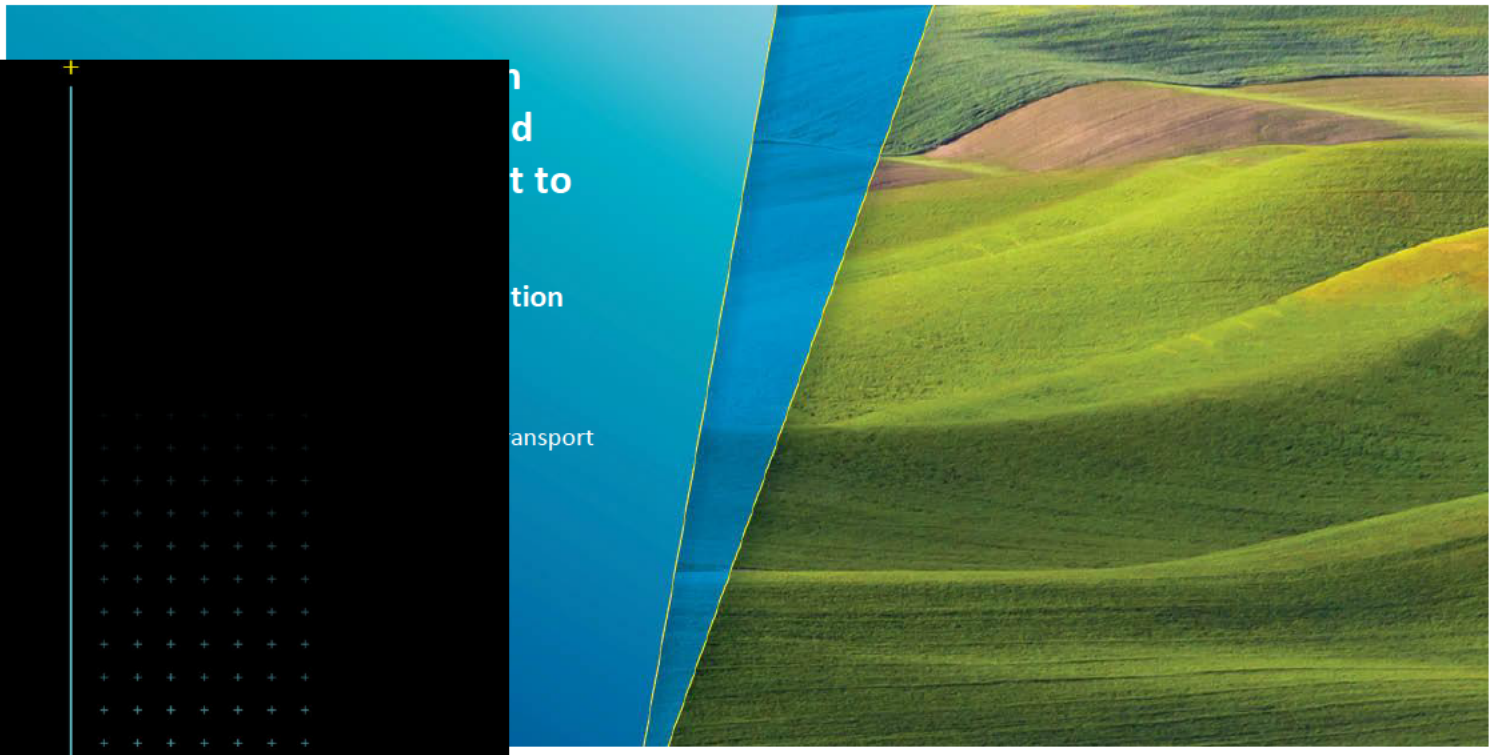

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Abbreviations and definitions

Term	Description
A-weighting	Human hearing is less sensitive at very low and very high frequencies. Noise measurements capture all frequencies and therefore need to be adjusted to correspond to human hearing. This adjustment is called 'A-weighting'.
Barrier	A structure that is placed between a noise source and a receiver to reduce the noise. Barrier refers to both wall type structures and berms/bunds.
Best Practicable Option (BPO)	The best method for preventing or minimising the adverse effects on the environment, having regard, among other things, to: • The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and • The financial implications, and the effects on the environment, of that option when compared with other options; and • The current state of technical knowledge and the likelihood that the option can be successfully applied.
CNVMP	Construction Noise and Vibration Management Plan - A document detailing the obligations towards noise and vibration of the NZTA and its consultants and contractors.
CNVTA	Construction Noise and Vibration Technical Assessment (this report).
Component vibration	The ppv for one measurement direction.
Conditions	Conditions of the designation (pursuant to subsection 171(2)(c) or subsection 149P(4)(b) of the RMA).
Continuous vibration	Vibration that is maintained for an indefinite period of time.
DC	Dynamic Compaction
Decibel (dB)	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa).
dB(A)	The A-weighted sound pressure level.
DIN 4150-3:2016	Structural vibration Part 3: Effects of vibration on structures.
Detailed design for construction	The final design that forms the basis for noise mitigation and management on site.
Designation	"Defined in section 166 of the RMA as: "a provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of schedule 1."
Façade Level	The outside of an external wall of a building. A +3 dB difference is used between the facade noise level (building present) and the free-field noise level (no building). This difference is known as the 'facade correction'.
Free-Field Level	Description of a location which is at least 3.5 m from any significant sound-reflecting surface other than the ground.
LAeq(t)	The A-weighted time-average sound pressure level over a period of time (t), measured in units of decibels (dB). Typically, 15 minutes for construction.
LAmax	The maximum A-weighted sound pressure level, measured in units of decibels (dB).
MNL	Main North Line (railway).
MSE	Mechanically stabilised earth.

Term	Description
NoR	Notice of Requirement
Notional Boundary	Means a line 20 metres from any side of a residential unit or other building used for a noise sensitive activity, or the legal boundary where this is closer to such a building.
NZTA	New Zealand Transport Agency Waka Kotahi
NZS 6803:1999	New Zealand Standard NZS 6803:1999 'Acoustics – Construction Noise'
OWDP	Operative Waimakariri District Plan
PPF	Protected Premises and Facilities - spaces in buildings used for: • Residential activities • Marae • Overnight medical care • Teaching (and sleeping) in educational facilities • Playgrounds that are part of educational facilities that are within 20m of buildings used for teaching purposes.
PPV	Peak particle velocity. This is the instantaneous maximum velocity reached by the vibrating surface as it oscillates about its normal position. Units in mm/s.
Project	State Highway 1 North Canterbury – Woodend Bypass Project (Belfast to Pegasus) (the construction, operation, and maintenance thereof).
Project designation	Designation D058A under the OWDP, which came into effect in 2015.
POWDP	Partially Operative Waimakariri District Plan
Requiring authority or consent holder	The New Zealand Transport Agency Waka Kotahi
Receiver	A location for where sound pressure levels from a noise source could be assessed – interchangeable with PPF.
Resultant PPV	The combination of the velocity of three orthogonal directions using a 'root-mean-squared' summation.
RMA	Resource Management Act 1991
SAR	Substantive Application Report
SH1	State Highway 1
Sound power level, LwA	A measure of the energy of a sound source per time unit expressed as an A-weighted level – units dB.
Sound pressure	The local pressure deviation from the ambient (average or equilibrium) atmospheric pressure caused by a sound wave. Measured in Pascals.
Sound pressure Level SPL	The sound pressure measured in decibels (dB).
Transient vibration	Transient vibration is temporarily sustained vibration but which may be frequently repeated. For example, the vibration resulting from impact piling.
WDC	Waimakariri District Council

Executive summary

The New Zealand Transport Agency Waka Kotahi is developing the State Highway 1 North Canterbury – Woodend Bypass Project (Belfast to Pegasus), an approximately 11 km, four-lane grade-separated motorway extension from Belfast to Pegasus, bypassing Woodend Township. Construction will include the development of five new bridges, dynamic compaction across the southern Quarry Lake to form a causeway, and other significant earthwork improvements, as well as road construction, with completion expected over 3-4 years.

The existing Designation for the Project was confirmed in the Waimakariri District Plan in 2015. The Designation is subject to a comprehensive suite of conditions, including those managing construction and operational noise and vibration.

This Construction Noise and Vibration Technical Assessment (CNVTA) has been prepared by Tonkin & Taylor Ltd (T+T) to support a proposed change to the boundaries of the existing Designation. It assesses the potential effects of construction related noise and vibration on sensitive receivers - referred to as Protected Premises and Facilities (PPFs), such as residential properties. Additionally, the CNVTA considers impacts from construction activities that were not included in the 2013 Notice of Requirement, which preceded the 2015 Designation.

The assessment identifies that activities such as ground improvement (e.g., stone columns, dynamic compaction) and night works for bridge construction have the potential to generate significant noise and vibration at specific locations. While construction works will comply with the Designation's noise and vibration criteria in most cases, effects may occur for nearby PPFs during certain tasks. Measures to avoid, remedy or mitigate these effects have been identified and will be implemented via the Project's Construction Noise and Vibration Management Plan to ensure best practicable measures are adopted. These measures are already anticipated by the scope of the existing Designation, such as the need for communication, defining hours of operation, the need for surveys and adopting the best practicable option.

Construction noise and vibration effects are expected to be appropriately managed by the existing Designation conditions, ensuring impacts on adjacent communities and structures are minimised while maintaining construction efficiency.

1 Introduction

1.1 Project overview

The New Zealand Transport Agency Waka Kotahi (**NZTA**) proposes to construct, operate, and maintain the State Highway 1 (**SH1**) North Canterbury – Woodend Bypass Project (Belfast to Pegasus) (the **Project**).

The Project will extend the State Highway 1 (**SH1**) Christchurch Northern Corridor between Belfast and Pegasus and spans a linear length of approximately 11 kilometres (**km**), commencing from approximately 600 metres (**m**) south of the Kaiapoi River Bridge and ending approximately 700 m north of the Pegasus/Ravenwood intersection. The Project includes upgrades to approximately 4 km of the existing SH1 and a new approximately 7 km bypass of Woodend township.

Key features of the Project are shown in Figure 1.1.

The purpose of the Project is to provide an efficient and reliable state highway connection between Belfast and Pegasus, while delivering improved access, community safety and public health outcomes, and reduced severance through Woodend.

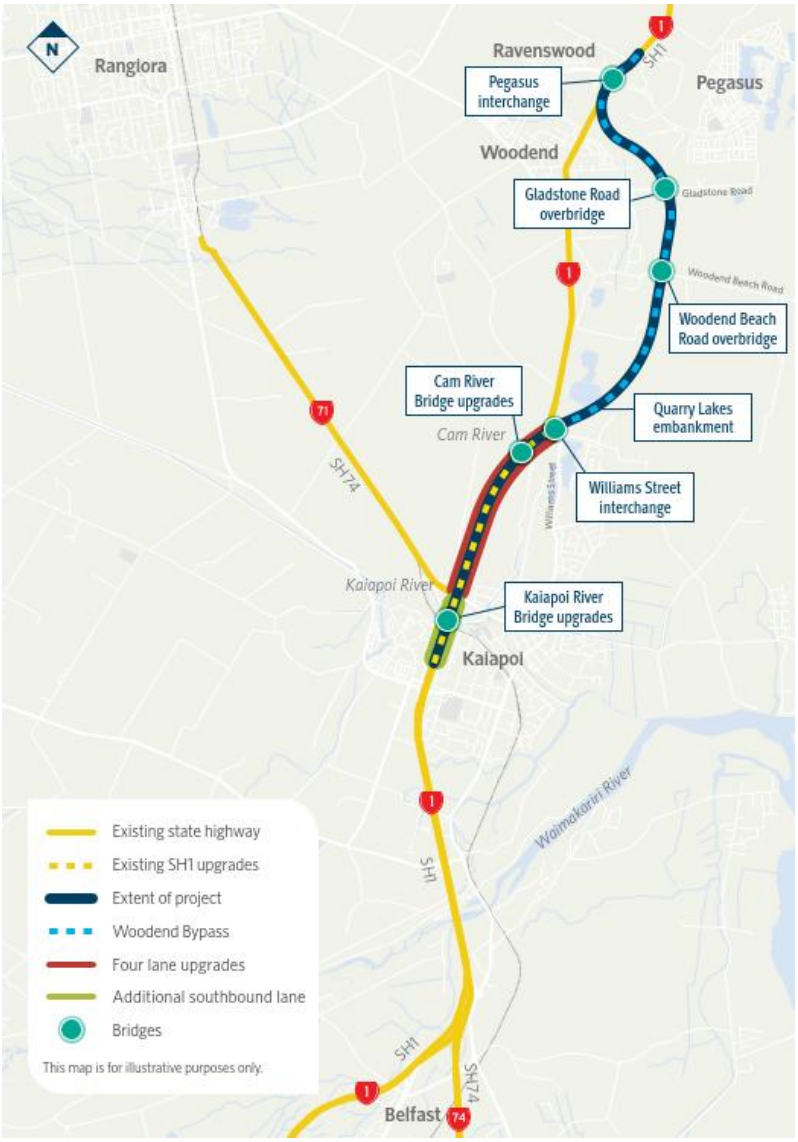

Figure 1.1: Project alignment and key features of the Project.

1.2 Purpose and scope of this assessment

This construction noise and vibration technical assessment (**CNVTA**) provides technical support to the Substantive Application Report (**SAR**) for applications made by the NZTA under the Fast-track Approvals Act 2024 (**FTAA**).

The existing Designation for the Project was confirmed in the Waimakariri District Plan in 2015. The Designation is subject to a comprehensive suite of conditions, including those managing construction and operational noise and vibration. The construction noise and vibration conditions include a requirement to prepare and implement a Construction Noise and Vibration Management Plan (**CNVMP**) to manage noise and vibration effects.

This CNVTA has been prepared to support a proposed alteration to the boundaries and conditions of the existing Designation. It assesses the potential effects of construction noise and vibration on sensitive receivers. Additionally, the CNVTA considers impacts from construction activities that were not considered in the 2013 Notice of Requirement (**NoR**) (preceding the 2015 Designation).

A noise and vibration sensitive receiver is defined as a Protected Premises and Facilities (**PPF**). It has the same definition as a noise and vibration receiver in an operational road-traffic noise assessment report. It includes, residential activities, marae, overnight medical care, teaching (and sleeping) in educational facilities and playgrounds that are part of educational facilities that are within 20 m of buildings used for teaching purposes. As construction activities are temporary, noise and vibration effects (affecting people) are only relevant when PPFs are occupied.

This CNVTA report includes a description of the construction methodology with respect to noise and vibration. A more comprehensive background and description of the Project is contained in the SAR.

While this is not a matter before the Environment Court, the authors of this report have each read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023 ('Code'). The authors have each complied with the Code in the preparation of this report.

The data, information, facts and assumptions the authors have each considered as part of this report are set out in this report. The reasons for the conclusions of the report are also set out in this report. Unless stated otherwise, this report is within each of the authors' expertise and the authors have not omitted to consider material facts known to them that might alter or detract from the opinions expressed.

1.3 Activities

For the purposes of this CNVTA, the Project's Construction Methodology Statement[1] describes how the Project will be constructed, including standard work practices and those specific to this Project. At a high level, standard roading construction includes:

- Site establishment and laydown areas – including vegetation clearance, surface treatment, deliveries and vehicle movements.
- Earthworks – comprising stripping topsoil and bulk earthworks.
- Pavements – comprising preparation of the sub-grade layers and basecourse and pavement preparation and laying asphalt.

These activities are already authorised under the Project Designation, and therefore this CNVTA does not reassess the noise and vibration effects of these works.

[1] Volume 3A.

Activities that were either not considered, or not wholly considered under the Project Designation, include:

- Construction of bridge structures (four bridge structures under the existing Designation and one additional bridge – Pegasus Interchange) – specific activities include ground improvement requirements (stone columns) and night time working.
- Dynamic compaction (**DC**) of the embankment (causeway) infill across the Quarry Lakes.[2]

Figure 1.2 highlights these key areas. Further details are provided in the construction assessment section.

The scope of this CNVTA also includes consideration of extensions to the existing Designation, i.e. where construction activities are proposed that currently sit outside the existing Designation boundary. These extensions are limited to north of Pegasus Interchange Overbridge, in the vicinity of 5 Wards Road, and 1271, 1273, 1275 and 1279 Main North Road, and the Lees Road Construction Service Area, and the filling and creation of a wetland in the Southern Remnant Lake. The five named properties will be removed, therefore the buildings will no longer be occupied when works commence – no longer defined as PPFs.

Figure 1.2: Construction areas.

[2] Initial deposition of fill authorised as part of the Early Works.

2 Construction methodology

2.1 Hours of working

Condition 8e of the existing Designation currently restricts the hours of construction activities to 0700h to 1900h, Monday to Saturday. Changes are being sought, as detailed below, for certain works to occur outside these hours.

Some night works will be required for specific activities and will generally be limited to key activities that cannot be undertaken during the day due to safety and operational impact on traffic along SH1, such as:

- General traffic switching along SH1.
- Bridge beam and truss installation at key structures, as well as installation of overhead gantry(s) and signal poles where adjacent to live traffic.
- Utility service connections and switches.
- Final surfacing and lane marking works along the existing SH1.

Some pre-start activities may occur before 0700h, including the arrival of staff to site.

Weekend and overnight closures/block of lines of the Main North Line (**MNL**) railway will also be required to enable safe working conditions during construction of the Kaiapoi River Bridge widening works. In addition, extended working times between 0500h and 2200h resulting in double shifts may also be needed to achieve the construction programme dates and / or critical path items.

The Project duration is estimated to take 3-4 years.

2.2 Bridges

The existing Designation included the construction of four new bridges, strengthening of one existing bridge, and rearrangement of an existing bridge over the Kaiapoi River. There is only one new bridge, Pegasus Interchange, that was not included under the existing Designation. Working at night was not considered for any bridge under the existing Designation.

It is estimated that construction of each new bridge structure will take 18-24 months to complete.

Ground improvement works are required for all new bridges to ensure the ground has sufficient bearing to support the bridge abutments. Ground improvements will be specific to each bridge and comprise either reinforced undercuts, stone columns, or installation of displacement rigid inclusions such as continuous flight auger or displacement piles. Ground improvement design and construction is bespoke to each bridge abutment, as noted below in Table 2.1. The installation of stone columns has the potential to generate the greatest noise and vibration levels. This activity was not anticipated in the 2013 NoR.

Table 2.1: Bridge details

Structure	Foundations	Ground improvement
Cam River/Ruataniwha	New bored pile foundations	Rigid inclusions - 510 mm diameter, 1.5 m centre-to-centre, 11 m long.
Wiliams Street	Shallow footings on mechanically stabilised earth (**MSE**) abutment walls	Stone columns (8.5 m deep).
Woodend Beach Road	Shallow footings on MSE embankments	Ground improvements beneath embankments (6.5 m stone columns of rigid inclusions 16 m and 1.8 m centre-to-centre).
Gladstone Road Bridge	Shallow footings on MSE embankments	No ground improvement beneath embankments, but dig out 1.5 m and replace with geogrid raft 1.2 m -3 m thick.
Cam River/Ruataniwha	New bored pile foundations	Rigid inclusions - 510 mm diameter, 1.5 m centre-to-centre, 11 m long.
Pegasus Interchange	Shallow footings on MSE embankments	Ground improvements beneath embankments (6.5 m stone columns of rigid inclusions 16 m and 1.8 m centre-to-centre).

The following bridge construction methodology is likely:

1 Clearing and stripping.

2 Hardstand working area.

3 **Ground improvement – specifically stone columns.**

4 **Piling – bored (Cam River/Ruataniwha only).**

5 **Abutment and construction.**

6 Bearing seat construction.

7 **Lifting in bridge beams (constructed offsite, night works and land/road closures required to lift due to proximity of live traffic).**

8 Pouring concrete bridge deck.

9 Pavement works.

10 Barriers, lighting and signage.

11 Landscaping and planting.

Those tasks marked in **bold** are considered to generate the highest levels of noise/vibration, noting that only task 7 is likely to occur outside standard construction hours – hence its inclusion.

The Kaiapoi River Bridge will be widened to three lanes in the southbound direction. The bridge comprises prestressed and reinforced concrete elements. No piling is necessary.

A noise and vibration assessment of bridge construction activities is presented in Section 5.2. Only those activities which were not considered under the existing Designation have been assessed - ground improvement works and lifting bridge at night.

2.3 Quarry Lakes causeway

The existing Designation and proposed road alignment traverses two lakes formed by quarry operations – known as the Quarry Lakes. The construction noise assessment in the 2013 NoR noise assessment was high level and did not consider how the alignment would pass over the Quarry Lakes. A number of crossing options (ground improvement and bridges) have been considered, and

the preferred solution is to construct a causeway with dynamic compaction ground improvements. Authorisation of the infilling of the Quarry Lakes embankment being sought separately. These works are being completed as Early Works.

The proposed ground improvement will consist of a dynamically compacted hardfill embankment with 1V:3H permanent side slopes. The embankment will be overfilled laterally, to enable DC of the underlying 1V:3H slopes. DC would comprise dropping a 30T weight from a height of 30 m using a crane on a grid pattern with multiple drops at each point. Works would commence at the northern end of the crossing and progress in a southerly direction, i.e. starting furthest from the nearest PPFs. Suitable material (river run/cobbles gravel) would be tipped on top of the Early Works infilling working area and progressively compacted. A basecourse of AP65 would be constructed on top by conventional compaction methods prior to the installation of pavement and services. Pavement works are authorised by the existing Designation.

DC works would only take place during standard construction hours and works are estimated to be completed within three months.

A noise and vibration assessment of DC works is presented in Section 5.4.

In addition to the construction of the causeway, the Project will construct a wetland area in the area that would be occupied by the southerly part of the lake (Southern Remnant Lake). Material will be filled as a rate of 1,000 to 2,000 m^3 per day and would be trucked along the haul road and tipped from the causeway. Top soil (~200 mm) will then be laid on top of the un-compacted river run material. Plant will likely include trucks, excavators and dozers, i.e. similar to standard earthworks. As these works fall outside the existing Designation, an assessment is provided in Section 5.5.

2.4 Construction compound and laydown areas

The Project's main Construction Support Area (CSA) will be situated in the area as highlighted in pink in Figure 2.1. The existing Designation will be altered to include this area. The CSA will accommodate site offices, storage facilities and parking. A compacted surface will be provided prior to site occupation. Noise and vibration generating activities will be limited to the construction of the surface and the delivery of portable offices and welfare buildings. Once constructed, noise generating activities will be predominately due to movement of vehicles. The effects of the CSA are outside the scope of the existing Designation and have been assessed in this report.

Other areas to be used for materials laydown will be distributed within the existing Designation boundary. Noise generating activities in these areas will comprise movement of vehicles, stockpiling of materials and their redistribution when required. The effects of these activities are within the scope of the existing Designation and have not been assessed in this report.

Figure 2.1: Construction site compound – Quarry Lakes. Red areas are Work sites, green are laydown areas, and orange are stockpile areas. Existing designation boundary is shown, which is proposed to be extended around the work sites.

3 Planning framework and guidance

This section introduces relevant statutory requirements and relevant noise and vibration performance standards, including the appropriate conditions of the Designation.

3.1 Fast Track Approvals Act 2024 (New Zealand)

Clause 7(f) of Schedule 5 of the FTAA addresses environmental effects that must be considered when assessing applications under the fast track process. Specifically, it requires panels to evaluate whether the proposed activity would result in "any unreasonable emission of noise."

This clause ensures that noise impacts, especially those that could be disruptive or harmful to communities or ecosystems are not overlooked, even in a fast track process. The term "unreasonable" is not explicitly defined in the FTAA, so panels are expected to interpret it in context, and by referencing other standards and guidance.

3.2 Resource Management Act

Section 16(1) of the Resource Management Act 1991 (**RMA**) sets out the duty to avoid unreasonable noise:

> *Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*

Noise includes vibration as per section 2. The best practicable option (BPO) is also defined in Section 2:

> *In relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—*
>
> a *the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and*
>
> b *the financial implications, and the effects on the environment, of that option when compared with other options; and*
>
> c *the current state of technical knowledge and the likelihood that the option can be successfully applied.*

There are no relevant National Environmental Standards for construction noise or construction vibration.

3.3 Designation conditions

Of relevance to this CNVTA are conditions 11 to 14 of the existing Designation (NZTA-3):

11. The Requiring Authority shall implement a Construction Noise and Vibration Management Plan (CNVMP) throughout the entire construction period of the Project. The CNVMP shall be provided with and form part of the CESMP for certification that it addresses Conditions 11 to 14 prior to the Commencement of Works.

The CNVMP shall describe the measures adopted to meet:

a *the noise criteria set out in Condition 13 below, where practicable. Where it is not practicable to achieve those criteria, alternative strategies should be described to address the effects of noise on neighbours, e.g. by arranging alternative temporary accommodation; and*

b *the Category A vibration criteria set out in Condition 14 below, where practicable. Where it is not practicable to achieve those criteria, an independent, experienced and suitably qualified expert shall be engaged to assess and manage construction vibration during the activities that exceed the Category A criteria. If predicted construction vibration exceeds the Category B criteria then construction activity should, where practicable, only proceed if approved by the District Council officer and if there is appropriate monitoring of vibration levels and effects on buildings at risk of exceeding the Category B criteria, by independent, experienced and suitably qualified experts.*

The CNVMP shall, as a minimum, address the following:

i Description of the works, anticipated equipment/processes and their scheduled durations.

ii Hours of operation, including times and days when construction activities causing noise and/or vibration would occur.

iii The construction noise and vibration criteria for the Project.

iv Identification of affected houses and other sensitive locations where noise and vibration criteria apply.

v Requirement for building condition surveys at locations close to activities generating significant vibration, prior to and after completion of the works (including all buildings predicted to exceed the Category A vibration criteria in Condition 14).

vi Mitigation options, including alternative strategies where full compliance with the relevant noise and/or vibration criteria cannot be achieved.

vii Details of which operational road-traffic noise mitigation options as required by Condition 12 below will be implemented early enough to also mitigate construction noise.

viii Management schedules containing site specific information.

ix Methods and frequency for monitoring and reporting on construction noise and vibration.

x Procedures for maintaining contact with stakeholders, notifying of proposed construction activities and handling noise and vibration complaints.

xi Construction equipment operator training procedures and expected construction site behaviours.

xii Contact numbers for key construction staff, staff responsible for noise assessment and District Council officers.

12. The Requiring Authority should, where practicable, implement those Structural Mitigation measures for operational noise detailed in Conditions 92 to 96 which are identified in the CNVMP as also providing construction noise mitigation, prior to commencing major construction works that would be attenuated by these mitigation measures.

13. Construction noise shall be measured and assessed in accordance with NZS 6803:1999 'Acoustics – Construction Noise'. The construction noise criteria for the purposes of the CNVMP are:

Time of week	***Time period***	***"Long term" duration construction dBA***	
		L_{Aeq}	L_{AFmax}
Noise criteria at residential buildings			
Weekdays	*0630-0730*	*55*	*75*
	0730-1800	*70*	*85*
	1800-2000	*65*	*80*
	2000-0630	*45*	*75*
Saturdays	*0630-0730*	*45*	*75*

Time of week	*Time period*	*"Long term" duration construction dBA*	
		L_{Aeq}	L_{AFmax}
	0730-1800	*70*	*85*
	1800-2000	*45*	*75*
	2000-0630	*45*	*75*
Sundays and public holidays	*0630-0730*	*45*	*75*
	0730-1800	*55*	*85*
	1800-2000	*45*	*75*
	2000-0630	*45*	*75*
Noise criteria at commercial / industrial buildings			
Any day	*0730-1800*	*70*	-
	1800-0730	*75*	-

14. Construction vibration shall be measured in accordance with ISO 4866:2010 Mechanical vibration and shock —Vibration of fixed structures — Guidelines for the measurement of vibrations and evaluation of their effects on structures. The construction vibration criteria for the purposes of the CNVMP are:

Receiver	*Details*	*Category A*	*Category B*
Occupied dwellings	*Night-time 2000h-0630h*	*0.3 mm/s PPV*	*1 mm/s PPV*
	Daytime 0630h-2000h	*1 mm/s PPV*	*5 mm/s PPV*
Other occupied buildings	*Daytime 0630h-2000h*	*2 mm/s PPV*	*5 mm/s PPV*
All other buildings	*Vibration – transient*	*5 mm/s PPV*	*BS 5228-2 [*1], Table B.2*
	Vibration – continuous		*BS 5228-2 [*1], 50% of Table B.2*

**1 BS 5228-2:2009 'Code of practice for noise and vibration control on construction and open sites — Part 2: Vibration'*

Conditions 13 and 14 set noise and vibration limits respectively for construction activities, including stricter limits for works outside core hours. Condition 8e currently restricts construction hours to 0700h to 1900h Monday to Saturday. It is proposed to remove this restriction so that working hours are managed through compliance with Conditions 13 and 14. Where noise or vibration limits cannot be met, the CNVMP will outline measures to manage and mitigate effects.

3.4 Construction noise - NZS 6803:1999

Designation Condition 13 refers to NZS 6803:1999 *Acoustics – Construction noise.* The Standard sets out procedures for the measurement and assessment of noise from existing and proposed construction work, including maintenance and demolitions. The Standard recommends noise limits for construction noise and provides guidance on methods of predicting and managing construction noise. These noise limits are specified in terms of the time of day and the duration of work, recognising that residential receivers will be more sensitive at night, and that lower limits are appropriate for longer duration works. These limits are consistent with those in Designation Condition 13.

The Standard's noise limits apply at 1 m from external façades of occupied buildings, hence noise limits are not applicable if a building is unoccupied. Noise is typically assessed over a representative 15-minute period of construction activity, recognising that construction noise sources will vary with the types and numbers of equipment operating for the activities being undertaken.

3.5 Construction vibration

Unlike construction noise, there is no New Zealand Standard for vibration. The NZTA has prepared a construction noise and vibration guide[3] (NZTA Construction Guide). While ISO 4866:2010 is referenced in Designation Condition 14, the international standard does not include vibration limits. The NZTA Construction Guide references German Standard DIN 4150 when considering the effects of vibration on buildings, and British Standard BS 5228-2 when considering the effects on people, buildings, building contents and underground services. The following sections introduce these two standards.

3.5.1 DIN 4150-3:2016

DIN 4150:2016-12 *Vibration in buildings – Part 3: Effects of vibration on structures* (DIN 4150-3:2016) is an internationally recognised standard used to assess the effects of vibration on structures. The DIN 4150-3:2016 criteria to evaluate the effects of short-term vibration on structures are shown in Table 3.1 and summarised in Figure 3.1. Short-term vibration is vibration that does not occur often enough to cause structural fatigue, and which does not induce resonance in a building structure.

The table and figure show the recommended vibration limits in terms of Peak Particle Velocity (**PPV**) as this is directly related to strain, and hence potential for damage to structures. They are lowest in the frequency range of 1-10 Hz, which is the normal range of natural frequency of most structures. The limits increase at higher frequencies where the potential harmonic effects are reduced. The guideline values for PPV are at the foundation and in the plane of the highest floor of various types of building.

Table 3.1: DIN 4150-3:2016 guidelines for evaluating the effects of short-term vibration on structures

Line	Type of structure	Vibration at the foundation at a frequency of			Vibration at horizontal plane of the highest floor
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or occupancy	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

[3] NZ Transport Agency (2019) State highway construction and maintenance noise and vibration guide, August 2019, Version 1.1.

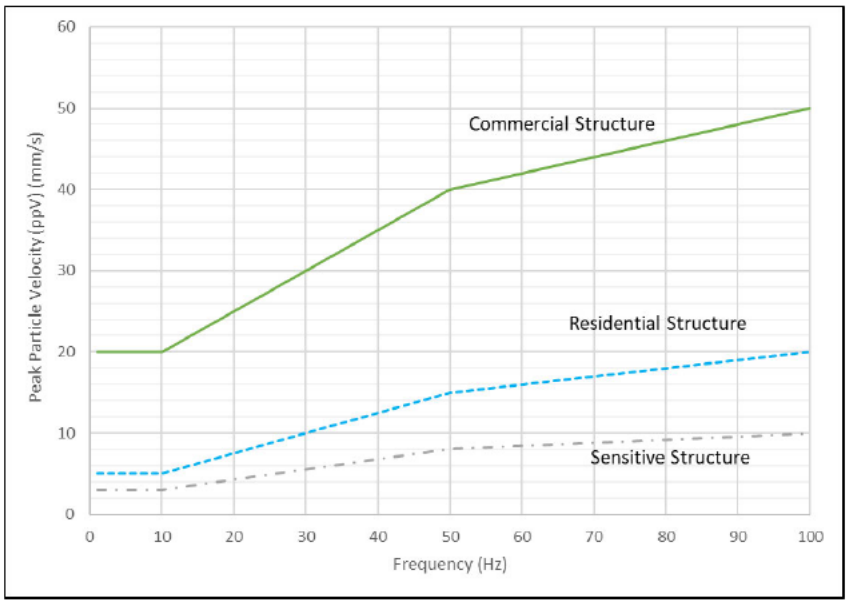

Figure 3.1: DIN 4150-3:2016 Short-term standard baseline curves.

The limits recommended in DIN 4150-3:2016 provide a low probability of cosmetic damage while structural damage is unlikely to occur in both residential and commercial structures at less than 50 mm/s, and for in-ground structures and infrastructure services at less than 100 mm/s.

3.5.2 BS 5228-2:2009

BS 5228-2[4] discusses vibration levels at which adverse comment is likely from building occupants. The guidance values of Table B.1 of BS 5228-2 are provided in Table 3.2.

Table 3.2: Guidance on effects of vibration levels - BS 5228-2:2009

Vibration level (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction[5]. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	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.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

Table B.2 of the Standard includes transient vibration guide values for cosmetic damage. The data for unreinforced structures, which includes residential buildings is shown in Figure 3.2. The data for reinforced or framed structures is a consistent 50 mm/s across all frequencies. The thresholds of Table B.2 are referenced in Designation Condition 14.

[4] BS 5228-2:2009+A1:2014, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

[5] Below 50Hz.

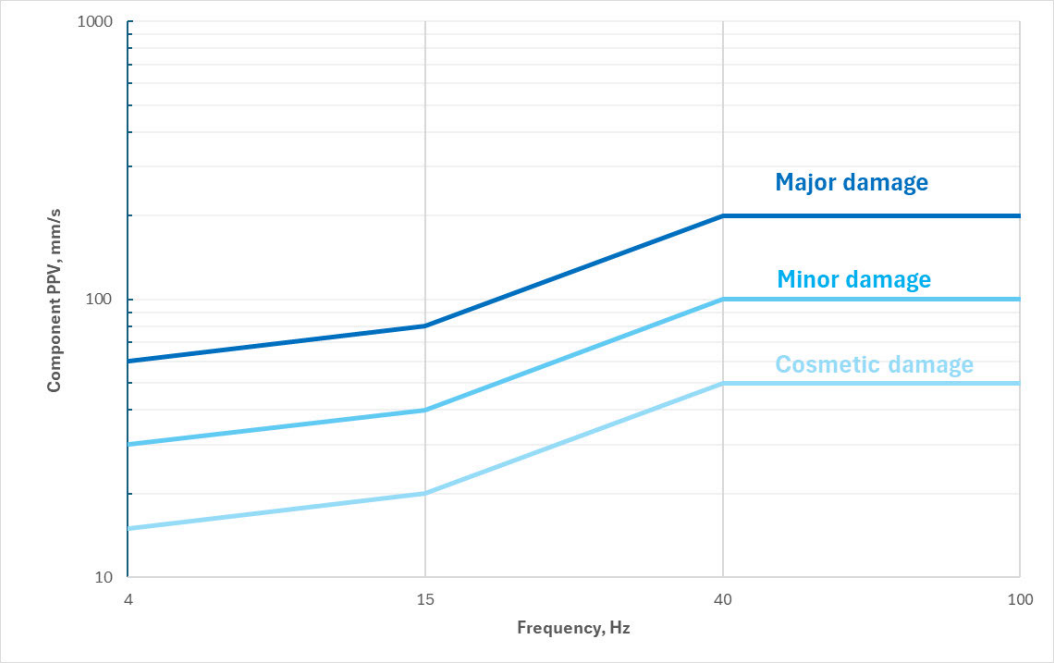

Figure 3.2: Graphical representation of BS 5228-2:2009 Table B.2 and explanation notes.

3.6 NZTA Construction noise

To promote good practice, the NZTA Construction Guide was prepared to assist contractors and consultants when assessing and managing construction noise and vibration from roading projects. Other NZTA resources include templates for preparing CNVMPs, activity specific noise and vibration schedules and monitoring reports; and an online construction noise calculator. The NZTA's construction noise calculator[6] uses the procedures of NZS 6803:1999 to estimate construction noise levels based on:

- Sound power/pressure source data for equipment and processes.
- Sound decay with distance.
- Façade correction.
- Multiple items of equipment.
- Operating period.
- Whether equipment is moving or static.
- Noise reduction from barriers.

T+T has developed a similar tool called AcoustiPlot, which instead of being a tabulated approach to calculating construction noise levels, visualises the results based on mapping data. Compared to detailed modelling using industry standard software, AcoustiPlot will generally produce marginally higher sound levels. Hence, use of AcoustiPlot will result in a more conservative outcome. AcoustiPlot has been used to estimate noise levels in this CNVTA.

3.7 Summary

The Project Designation's conditions detail specific requirements for noise and vibration assessment and management. These requirements are based on NZTA standard conditions that are routinely

[6] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/environment-and-sustainability-in-our-operations/environmental-technical-areas/noise-and-vibration/construction-noise-calculator/

implemented on roading construction projects. The conditions are consistent with the latest best practice guidance, and will appropriately manage noise and vibration effects. Therefore, even though the NoR was confirmed in 2013, the conditions are still applicable (regardless of whether they are applied to the existing or proposed Designation).

A summary of the relevant noise and vibration conditions is set out in the table below. While Condition 8e currently restricts construction activities to standard construction hours, the table includes relevant limits for other time periods during which construction activities may occur.[7]

Table 3.3: Summary of noise and vibration standards

	Limits
Weekday and Saturday time noise limit – 0730h-1800h	70 dB LAeq
Weekday noise limit – 0630h-0730h	55 dB LAeq
Weekday noise limit – 1800h-2000h	65 dB LAeq
Weekday noise limit – 2000h-0630h	45 dB LAeq
Assessment location	1 m from façade of occupied building
Vibration – human comfort	Based on BS 5228-2:2009 guidance
Vibration - structural	Table B.2 of BS 5228-2:2009

[7] The noise limits outside the period 0700h-1900h are defined in Condition 13. Vibration limits (night) are defined in Condition 14.

4 Receiving environment

The Project area is sparsely populated along sections of the alignment, most notably north of the Cam Road to south of the Quarry Lakes and north of the Quarry Lakes to just north of Gladstone Road. North of Gladstone Road the density of residential PPFs increases. Where improvements are being made to the existing SH1 between Ohoka Road overpass and the Kaiapoi Bridge, there are residential PPFs along both sides of the state highway.

As construction noise thresholds are absolute, comparison to the existing noise environment is not required. For locations near the existing SH1, road-traffic noise may mask the noise of some construction activities. Whereas for those locations which do not experience SH1 road-traffic noise, construction noise may be perceived as being more dominant. Road-traffic noise contours are shown in Figure 4.1 and have the greatest footprint where the posted speed limit is more than 50 kmh. The effects assessment section of this report considers these matters.

Figure 4.1: NZTA National road-traffic noise mapping data (2019 data).

5 Assessment

Construction noise and vibration effects are already anticipated by the existing Designation. Measures to avoid, remedy and mitigate these effects are addressed by the relevant conditions of the Designation. Accordingly, this CNVTA focuses on those activities / elements of the Project that were not (wholly) anticipated when the Designation was confirmed. These matters include:

- Bridge crossings, specifically the new Pegasus Interchange, where stone column ground improvements will take place, and for night works.
- Quarry Lakes – dynamic compaction works.
- Extensions to the existing Designation boundary.

Each of these elements has been assessed individually.

Although the construction methodology for these elements has not been finalised, an effects envelope has been developed to account for potential changes to the activities and programme. As such, minor changes to the final construction methodology and programme are unlikely to change the overall envelope of effects as presented in this report. A detailed construction programme and methodology will be finalised by the contractor prior to the commencement of the works.

Condition 12 requires the construction of noise walls provided to mitigate the noise effects of operational road traffic to occur early on in the construction phase if practicable. As noisy earthworks will take place before it is practicable to construct any vertical structures, this assessment assumes that the noise walls are not provided until the main works are completed. This results in a conservative assessment.

5.1 Source information

Activity based sound power levels are provided in the relevant sections for the likely significant construction noise sources on site, and are summarised below in Table 5.1. These levels have been derived from BS 5228-1:2009 or from T+T's library of measured levels. Activity based sound power levels may include multiple items of plant, which will operate more or less at the same location or across multiple locations. For example, ground improvement works involving stone columns would likely have two rigs operating either side of the alignment with truck movements for delivery of infill (stones). Noise from DC works is considered separately in Section 5.4.

No form of physical mitigation, such as acoustic barriers or enclosures, has been included within these noise levels and they therefore represent a 'worst-case' scenario. Relevant compliance distances have been included for day time and night time (as defined as 2000h-0630h in the conditions) works. For night works only those activities that are likely to occur at night have been identified.

Table 5.1: Activity sound power levels – no shielding

Activity	Sound power level / LwA dB	Freefield level at 10 m / dB(A)	Daytime compliance distance / m	Night time compliance distance / m
Site establishment	104	76	28 m	-
Site compounds	93	65	8 m	100 m
Stone columns	116	88	83 m	-
Pegasus Interchange	111	83	52 m	-
Bridge decks - cranes	104	76	28 m	275 m

5.2 Bridge crossings

As outlined earlier in Section 2.2, there are two main sources of noise associated with bridge construction - as noted in **bold** below:

- **Ground improvement** – stone columns rigs and trucks (only applicable to three bridge structures).
- Bridge abutment construction – excavators, compactors and trucks.
- Piling (Cam River/Ruataniwha only) – bored piling rig and cranes, which may include vibrating pile casings.
- **Lifting in bridge beams during the night to minimise traffic disruption.**

In comparison with other ground improvement options, stone columns works will generate the highest levels of noise and vibration. As these works were not wholly identified under the existing Designation, an assessment of stone columns works has been undertaken.

5.2.1 Stone columns

Stone column installation is a ground improvement technique that typically involves high-energy vibration to introduce stone/gravels into the ground via a vibrating probe. This process generates both airborne noise and ground vibration.

Stone columns are required for the following bridges:

- Williams Street.
- Woodend Beach Road.
- Pegasus Interchange.

T+T has measured both noise and vibration during stone column works on other projects. Noise levels can reach 88 dB LAeq(15min) at a distance of 10 m from the source during operation. Noise levels may approach or slightly exceed the 70 dB LAeq(15min) limit, particularly for properties located within approximately 80 m of the works. There are limited PPFs that are likely to be affected by noise from stone column works:

- Williams Street works – 565 and 567 Williams Street.
- Woodend Beach Road - 14 Evergreen Drive.
- Pegasus Interchange – no PPFs identified however, the McDonald's Restaurant on Bob Robertson Drive, Harvey Norman (Garlick Street) will require notification of stone columns works.

The effect of noise at the PPFs will be managed by the Project's CNVMP.

Ground vibration levels from stone column installation have been measured at approximately 13 mm/s PPV at a distance of 10 m. Using empirical attenuation models for construction vibration in granular soils[8], PPV values typically reduce by half to two-thirds with each doubling of distance. This suggests approximate PPV levels of:

- 6-7 mm/s at 20 m.
- 3-4 mm/s at 40 m.
- 1.5-2 mm/s at 80 m.
- ~1 mm/s or less at 100 m.

[8] Appropriate approximation of the soil conditions at the three bridge locations.

PPV levels of 5 mm/s (Category B threshold of the Designation) or less are generally considered safe for residential buildings in terms of avoiding cosmetic damage. Vibration levels may be noticeable for building occupants within 100 m.

There is no requirement for building conditions surveys if properties are further than 20 m from where stone column works will occur. There are no identified properties within this distance. Monitoring of vibration from stone columns is not warranted as no properties are expected to experience vibration levels at or above the Category B criterion of 5 mm/s PPV.

5.2.2 Bridge abutments

Bridge abutments will be constructed by importing and compacting bulk fill material. The noise characteristics are similar to standard earthworks that will occur along the length of the Project. However, the plant will operate at an elevated level compared to works along the alignment as the bridge abutments increase in height. The opportunities for noise mitigation are limited as any shielding effects (use of noise barriers) will be negligible.

Construction noise levels are unlikely to exceed 70 dB LAeq(15min) limit at any PPF near bridge abutments even when plant operates at its highest point. Similarly, compaction of bulk fill via vibratory rollers is highly unlikely to exceed Category A criterion for day time works.

5.2.3 Cam River bridge

The closest PPFs to the crossing are over 200 m from any noisy works. Construction noise levels will be below 70 dB LAeq(15min) during daytime piling works. Vibration levels will be below the Category A criteria.

5.2.4 Night works

Night works will be required when installing bridge decks. It is estimated that PPFs within 275 m of bridge deck works may experience noise levels greater than 45 dB LAeq(15min) between 2000h and 0630h.

For any other planned night works, such as repaving the existing SH1, noise effects will be managed by the Project's CNVMP – see Section 6 for details.

5.3 Bridge improvements

Kaiapoi River Bridge widening works will use the existing support piers to support the 4 m wide bridge deck of the new south bound lane.

The Annaliese Haven Rest Home is the closest PPF to the bridge improvement works and would be approximately 50 m from the nearest works. At this distance noise levels would be less than 70 dB LAeq(15 min) and vibration levels would be negligible. Construction noise during daytime hours is considered reasonable. Standard consideration work practices would apply – see Section 6 for details. Night works are likely when working over the MNL railway. Due to the distances involved night time noise levels will exceed 45 dB LAeq(15 min) at PPFs within 275 m of the works.

5.4 Quarry Lakes - dynamic compaction

Dynamic compaction involves the repeated dropping of a heavy weight onto the ground surface to densify loose soils. It is expected that DC works would progress in a southerly direction along the Early Works causeway with additional fill material being tipped prior to being compacted (repeatedly). DC would only take place above the water level of the lake. As the Project will construct a wetland area in the area that would be occupied by the southerly part of the lake, the

timing of this infill could occur before or after DC works. As ground vibration is more of a concern for DC works than noise, this assessment initially considers vibration from DC works.

Ground vibration can propagate through the ground via different mechanisms and the transmissibility can vary depending upon the ground conditions, including the effects of water bodies. As either infill option could occur (transmission through ground v transmission through water), it is helpful to understand these pathways when considering the effects of vibration on structures and other features above and below ground level.

5.4.1 Vibration propagation

Ground vibration propagates through soil or rock as waves, so that the vibration amplitude generally decreases with distance from the source. The three most important types of ground vibration waves are:

1 Compressional waves - primary ('P') - waves;

2 Shear waves - secondary ('S') - waves; and

3 Rayleigh waves - 'R' - waves (surface waves)

Rayleigh waves generally give rise to the most energy, however their depth of penetration is approximately equal to their wavelength. They travel along the surface, and for typical sources of vibration from ground improvements the amplitude of the R-waves tends to zero at around 10 m to 20 m below ground level depending upon the stratigraphy. Ground vibration is dominated by the near surface R-waves and these waves are often the most damaging type of vibration for nearby structures due to their relatively high amplitudes and persistence near the surface.

The (surface) vibration velocity in mm/s for DC works can be calculated according to the following equation (after BS 5228-2:2009):

$$\mathrm{Vres} \leq 0.037 \left[\frac{\sqrt{\mathrm{W_h}}}{d}\right]^{1.7} \quad \text{Equation 1}$$

Where V_{res} is the resultant PPV, W_h is the potential energy in J and d is the horizontal distance to the assessment location. The equation is based on empirical surface vibration measurements and is valid for horizontal distances less than 100 m and for potential energies less than 12MJ. The equation is not applicable to the assessment of P or S-waves.

Dynamic compaction will produce transient event vibration, meaning the vibrations are isolated from one another (due to time between drops to allow for pore pressure dissipation). This means there is low risk of the dynamic compaction reaching nearby building resonance frequencies.

5.4.2 DC assessment – surface vibration

Construction of the causeway would comprise dropping a 30T weight from a height of 30 m using a crane on a grid pattern of tipped fill with multiple drops at each point. A 30T weight dropping 30 m has a potential energy of approximately 9 MJ. Figure 5.1 shows how V_{res} would reduce with distance according to Equation 1.

When acoustic energy is travelling through one medium and encounters a discontinuity, such as the interface of air or water, part of the wave energy will be transferred across the boundary (into water) and part will be reflected into the original medium (into air). The greater the difference between the characteristic impedances, the greater will be the percentage of energy reflected. When a sound wave is travelling through air and it reaches the surface of the water, only a small amount is transmitted into the water, significantly less than 1%. Similarly, for acoustic energy (vibration waves) travelling through water the characteristic impedance compared to gravels /

granular soils is approximately 60% lower. This means that vibration propagation will be highly variable depending upon where compaction occurs.

Figure 5.1 includes a conservative reduction factor of 50%, as predominantly DC works will occur either side of water; the water will create an impedance mismatch between the material that is being compacted and the existing land such that surface vibration waves will be attenuated as they encounter the water. It is only at the ends of the causeway that there will be no significant ground impedance mismatch. As the Southern Remnant Lake will be infilled but not compacted, vibration levels will likely fall between the two vibration curves if the lake is infilled prior to DC works. These vibration levels would only be applicable for PPFs in a southerly direction to the works.

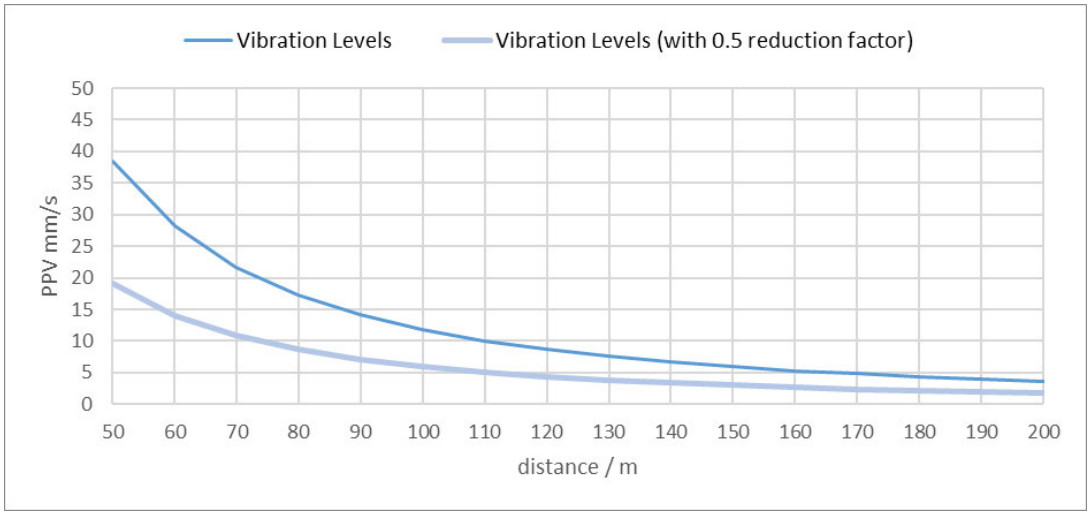

Figure 5.1: Resultant PPV level for DC works – surface vibration.

Nearby PPFs include the Pineacres Holiday Park, located northwest of the lakes, the two dwellings identified in Figure 5.2 (236 Lees Road and 47 Barkers Road), a portal frame commercial shed located west of lakes, and residential properties on Lees Road (closest at ~200 m). From aerial photographs (2024), at the closest point the nearest accommodation site at the Holiday Park is approximately 30 m from where DC activities are planned.

Figure 5.2: Dynamic compaction works.

Table 5.2 compares the expected vibration levels experienced at each structure against the threshold for annoyance (Category A) and potential cosmetic damage (Category B) for each structure / property type assuming DC will only occur during daytime hours. The transient vibration thresholds of BS 5228-2:2009 Table B.2 are relevant for the portal framed shed. The V_{res} range represents the two vibration curves shown in Figure 5.1.

Occupied properties within 270 m of DC works will experience perceptible vibration. Vibration effects will be managed via the CNVMP.

There is the potential for building damage to occur for light-weight buildings within 100 m of the works. Only permanent buildings within the Holiday Park fall within this range. The risk of damage at the Portal frame shed is unlikely.

Vibration effects will be managed via the CNVMP.

Table 5.2: Predicted vibration levels

Structure / property	Closest distance (m)	V_{res} (mm/s)	Threshold PPV mm/s		Potential cosmetic damage?
			Category A	Category B	
Portal frame reinforced shed	78	9-18	n/a	n/a	Unlikely – 50 mm/s PPV threshold
Holiday Park	42 120	26-52 4-9	2	5	Potential for occupied sites within 100 m of works to experience shaking and movement of objects.
236 Lees Road	268	1-2	1	5	Unlikely
47 Barkers Road	110	5-10	1	5	Unlikely
Lees Road properties	200	2-4	1	5	Unlikely

5.4.3 DC assessment - below surface vibration

While there are no in-ground vibration sensitive structures in the vicinity of the DC works, the effects of DC on aquifers and ground water are a consideration. As noted, R-waves will dominate near the surface and their vibration magnitude will tend to zero at depth. It is likely that this will occur for sand and gravels at depths of 10 m to 20 m. Below these depths P-waves and S-waves can still carry vibration energy.

Potential impacts on groundwater systems are primarily associated with pore pressure responses in saturated soils and disruption of confining layers. In granular soils (sandy soils or loose, saturated strata - gravels), transient increases in pore water pressure may occur due to vibration-induced densification or rearrangement of soil particles. If the aquifer is confined by a relatively thin or weakly consolidated layer (e.g., silt or clay), there is a potential, albeit limited, for vibration to reduce the integrity of that confining unit. This could allow vertical water migration or temporary rises in groundwater levels if preferential flow paths are created. The likelihood of this occurring is considered low due to the depth of the confining layer being approximately 20 m depth and at the assessed limit of the vibration effects. Further information on groundwater systems is provided in the Hydrogeology Assessment (SAR Volume 3, K).

5.4.4 Vibration monitoring

Given the predominantly granular soil profile, presence of water (lakes) and the energy levels involved, it is recommended that surface vibration monitoring be undertaken during DC activities.

Monitoring would be undertaken at multiple locations in an array arrangement to establish the ground attenuation rates. At least three locations should be simultaneously monitored in accordance with ISO 4866:2010. The derived relationships would then be used to establish appropriate management set-back distances, i.e. whether the distances mentioned above in Section 5.4.2 should be revised.

5.4.5 DC – noise

DC also generates significant airborne noise, particularly at the moment of impact when a 30T weight strikes the ground from a height of 30 m. The resulting sound is impulsive in nature; short in duration but high in peak sound pressure level.

Assuming a drop occurs every 45 to 60 seconds, the activity would produce intermittent impulse noise over the compaction period. This pattern is often perceived as more disturbing than continuous noise due to its unpredictability and sharpness. Typical unmitigated maximum noise levels (LAmax) near the source can range from 100 to 120 dB (reference distance being 20 m), depending on the ground conditions (newly tipped to partially compacted).

The following approximate levels might be expected at nearby properties:

- Holiday Park - 50 m: LAmax 90-100 dB.
- 47 Barkers Road - 110 m: LAmax 80-90 dB.

The Project Designation sets a maximum LAFmax of 85 dB during the day (Condition 13), there is a likelihood that the limit will be exceeded at approximately 100 m to 120 m from the activity.

Condition 13 also sets a maximum of 70 dB LAeq(15min), which represents the average sound energy level over a 15-minute period. In the case of DC, where a 30T weight is dropped every 45 to 60 seconds, there will be approximately 15 to 20 individual impact events per 15-minute interval (worst case and not considering relocation of the DC crane). While each impact may produce a short-duration, high-intensity impulsive noise, the LAeq(15min) value accounts for the cumulative energy of these events averaged over time.

Because the impulses are intermittent, the LAeq(15min) will be significantly lower than the maximum sound levels, but still potentially elevated due to the high sound pressure levels of each drop. It is estimated that at distances of 50 m to 110 m, the resulting LAeq(15min) could approach or exceed the 70 dB threshold. As such, meeting the noise criteria of Condition 13 will depend on the number of drops, and their actual maximum sound levels. While the number of drops per hour is relatively low, the intermittent impulsive nature of the noise may still be highly noticeable and potentially disturbing to nearby residents, including those beyond 110 m due to its impulsive nature.

Condition 11a recognises that the noise criteria of Condition 13 may not always be met. The Project's CNVMP will need to identify practicable measures to manage the effects of potential exceedances due to DC works. These measures include:

- Advance community notification.
- Restricting work hours to only compact during the least sensitive period of a construction day, i.e. 0800-1700h.[9]
- Real-time noise monitoring to establish the scale of noise and to review working practices once noise levels are known.

[9] There would be normal setup and 'pack down' time either side of these hours.

5.5 Designation boundary alterations

There are minor proposed alterations to the designation boundaries north of the new Pegasus Interchange. These alterations will not change the degree of noise effects at any PPF. Therefore, there are no noise or vibration constraints with respect to extending the boundary of the designation in the area north of the Pegasus Interchange.

The temporary site compound on Lees Road will be active throughout the construction period of the Project. Noise sources will generally be limited to vehicle movements. To provide a degree of screening to those properties that front Lees Road it is recommended that a 2 m solid hoarding is erected along the southern boundary of the compound. With this mitigation in place, noise effects will be reasonable at all times.

Infilling of the southern lakes will involve tipping of material with no compaction. The spatial separation of the works from the nearest PPF (236 Lees Road) will mean that noise levels remain below the noise criteria of Condition 13.

In conclusion, the proposed adjustments to the Designation boundary will not result in any change to the extent of noise and/or vibration effects experienced at any PPF.

6 Construction noise and vibration management

Condition 11 of the Designation requires the preparation of a CNVMP. Key requirements of the Project's CNVMP will be:

- Overview of works, equipment/processes, and duration.
- Operating hours, including noise/vibration activity times.
- Applicable noise and vibration criteria.
- Identification of affected houses and sensitive sites.
- Building condition surveys near significant vibration sources.
- Mitigation strategies for non-compliance with noise and vibration criteria.
- Site-specific management schedules.
- Monitoring and reporting methods for noise and vibration.
- Stakeholder communication and complaint procedures.
- Training and expected behaviour for equipment operators.
- Contact details for key construction and council personnel.

Implementing noise management and mitigation measures via a CNVMP is the most effective (and best practice) way to control construction noise and vibration impacts. The objective of the CNVMP is to provide a framework for the development and implementation of BPO to avoid, remedy or mitigate the adverse effects on receivers of noise and vibration resulting from construction.

Condition 11 as currently worded satisfies these objectives and no recommendations are made to alter Condition 11 or any of the other conditions.

As identified in this assessment, the following Project specific mitigation and management measures should be included within the CNVMP.

6.1 Communication and consultation

The key element of noise and vibration management is ensuring that appropriate communication occurs with affected neighbours. Such measures include:

- Prior communication (letter drops) to inform building occupiers when DC works will take place and the nature of the effects that will be experienced. There is the potential for the Holiday Park to experience clearly perceptible levels of ground vibration, and it is recommended that engagement takes place with the Holiday Park's managers to establish appropriate setback distances for park visitors (recreational vehicles and campers). As works are scheduled to take place during daytime hours there is the potential for sites to be unoccupied. Therefore, ongoing engagement will be required throughout the works.
- Prior notification when night-time works take place within:
  - 275 m of bridge deck works and Kaiapoi River Bridge widening works; and
  - 150 m either side of SH1 when night time resurfacing takes place.

6.2 Scheduling

The time of day and the duration of the construction activities will be adjusted after consultation, where possible, to avoid particularly sensitive times for affected receivers. This is most applicable to DC works (not commencing DC works prior to 0800h and concluding works by 1700h).

6.3 Construction compound area mitigation

The layout of the support areas will be planned to minimise noise effects, such as placing staff areas and static temporary structures along the perimeter of the site to provide shielding. A 2 m high barrier should be placed around the southern perimeter of the construction compound support area along Lees Road.

6.4 Building condition surveys

Prior to DC works, pre-construction building condition survey should be undertaken at:

- Portal frame reinforced shed.
- 47 Barkers Road.
- Permanent buildings at the Pineacres Holiday Park within 120 m of the works.

The building condition surveys will generally be undertaken as follows:

- The building surveys will be undertaken by a suitably qualified and experienced practitioner.
- Permission shall be sought from the owner of a building, structure or service for a suitably qualified and experienced practitioner to prepare a report that:
  - Describes any information about the type of foundations;
  - The existing levels of damage (cosmetic, superficial, affecting levels of serviceability);
  - Any observed damage is associated with structural damage;
  - Identifies the potential for further damage to occur and describes actions that will be taken to avoid further damage; and
  - Includes photographic evidence.
- The Project team will provide the building condition survey report to the property owner.

A post condition survey will be undertaken after construction works has been completed, unless the landowner agrees otherwise, or if monitoring determines the post condition survey is unnecessary.

During construction if complaints are made about vibration or if monitoring determines it necessary, further building condition surveys may be undertaken. Where further surveys identify damage, relevant suitably qualified specialists will be engaged to investigate the cause. This may include the vibration specialist, building inspector and building condition author. The outcome of the investigation will be shared with the complainant/affected receiver. If it is determined that the Project is responsible for the damage, a plan will be made to rectify it at NZTA's cost.

7 Conclusions

The existing Designation for the Project is subject to a comprehensive suite of construction noise and vibration conditions. This assessment considers that Conditions 11, 12, 13 and 14 are appropriate and no recommendations are made to alter the wording of these conditions. The existing Designation conditions continue to be suitable for managing the effects of construction.

This assessment has assessed potential noise and vibration impacts from activities that were not anticipated by the scope of the 2015 Designation, or where there is a proposed extension to the boundary of the Designation.

It has been identified that while most activities will comply with the relevant noise and vibration standards, some activities, such as dynamic compaction and night works for bridge construction may exceed the relevant criteria. Exceedances are typical for large-scale infrastructure projects and are anticipated by the Designation, specifically Condition 11 which requires the preparation of a CNVMP to manage the predicted exceedances by implementing practicable mitigation measures.

In conclusion, construction noise and vibration effects will be appropriately managed by the existing Designation conditions, ensuring impacts on adjacent communities and structures are minimised while maintaining construction efficiency.

8 Applicability

This report has been prepared for the exclusive use of our client New Zealand Transport Agency Waka Kotahi, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that NZTA will submit this report as part of an application under the Fast-Track Approvals Act 2024 and the appointed panel will use this report for the purpose of assessing that application.

This report has been prepared in accordance with our sub consultancy agreement to "Belfast to Pegasus Motorway & Woodend Bypass pre-implementation & MSQA Professional services contract number 11320", dated 20 May 2025.

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