

17. NOISE & VIBRATION

Overview

Existing ambient traffic noise levels at dwellings along the proposed route are influenced by their proximity to existing roads. Away from busy roads, traffic noise levels are in the order of 50 dB $L_{Aeq(24hr)}$. Dwellings close to Main South, Shands and Springs Roads currently experience noise levels of around 70 dB $L_{Aeq(24h)}$.

An assessment of predicted traffic noise level generation has been conducted in accordance with the requirements of NZS6806:2010 "Acoustics - Road-traffic noise - New and altered roads" ("NZS6806 or the standard"). NZS6806 provides a framework by which a number of noise mitigation measures are assessed in line with the best practicable option ("BPO") approach outlined in the RMA. This assessment process has resulted in a number of preferred mitigation options for various sections of the Project, including extending the use of low noise road surface, Open Graded Porous Asphalt ("OGPA"), on the southern approach to the overbridge at Springs Road, and acoustic fences. OGPA has already been nominated for use on the majority of MSRFL and CSM2 as part of the Do-Minimum Scenario for maintenance purposes. Comprehensive design of the proposed noise control measures will be completed during the detailed design phase of the Project.

The operational noise assessment has identified that through the application of the BPO, all Protected Premises and Facilities ("PPFs") will meet the Category A (quietest) noise criteria for new and altered roads. Only two dwellings will have a minor adverse effect. In addition, the risk of adverse operational traffic vibration effects is considered to be minor and can be mitigated through standard road maintenance procedures.

Construction noise has been predicted using noise sources contained in relevant construction noise standards. General noise management and mitigation measures are recommended to be implemented throughout the construction period as a best practice option. Where there is a risk that the limits in construction noise standards will be exceeded, recommendations for specific noise mitigation and management methodologies are provided.

Construction vibration effects have been assessed through on-site measurement of identified machinery, as well as the review of data from relevant standards and previous measurements. This data has been analysed and processed to establish setback distances for building vibration risk assessments. Predictions of construction vibration levels indicate there is a degree of risk for dwellings within 20m of the MSRFL alignment. The effects of construction noise and vibration will require active management through the implementation of a Construction Noise and Vibration Management Plan ("CNVMP").

Overall, it is considered that the Project can be constructed and operated such that adverse noise and vibration effects will be acceptable and not significant by utilising the BPO approach to avoid, remedy or mitigate effects, and achieve compliance with the relevant standards.

17.1. Operational noise

The following matters have been considered in the assessment of operational noise effects:

- relevant traffic noise assessment criteria;
- a description of the existing noise environment and recommended mitigation measures;
- an assessment of the potential traffic noise effects and proposed mitigation measures; and
- a discussion of the potential traffic vibration effects.

Technical Report 8, Assessment of Operational Noise, is appended in Volume 3 and provides full details with respect to the assessment of operational noise.

17.2. Operational noise assessment criteria

17.2.1. New Zealand Standard NZS6806:2010

NZS6806 was published in April 2010 and sets the standard for the assessment and control of road-traffic noise. The standard does not set rigid noise limits, and instead contains categories (A, B and C) of noise criteria, and requires that the BPO be identified to mitigate road-traffic noise.

The criteria contained in NZS6806 have been developed with the intention that they are reasonable criteria for the road-traffic noise from new or altered roads, taking into account adverse health effects associated with noise; the effects of relative changes in noise levels on people and communities; and the potential benefits of new and altered roads to people and communities. The Standard specifies the types of protected premises and facilities (PPFs) which are to be assessed. Category A and B noise level criteria are assessed at the outside façade of a PPF and if it is not practicably achievable to meet Category A or B, Category C criteria apply inside the PPF. These criteria are differentiated for ‘new’ and ‘altered’ roads as outlined in Table 26.

Table 26: Noise criteria NZS6806:2010

Category	Criterion	Altered Roads	New Roads
A	Primary	64 dB L _{Aeq(24h)}	57 dB L _{Aeq(24h)}
B	Secondary	67 dB L _{Aeq(24h)}	64 dB L _{Aeq(24h)}
C	Internal	40 dB L _{Aeq(24h)}	40 dB L _{Aeq(24h)}

These categories have been developed for design and consenting, rather than assessment purposes.

However, in general terms:

- Category A indicates that a reasonable external noise level is achieved that allows for noise sensitive activities being carried out without adverse effects.
- Category B indicates an increased level of noise compared to Category A but noise sensitive activities would generally be able to be undertaken inside a building with windows open.
- Category C indicates that internal building modification mitigation may be required to achieve an acceptable level of noise inside, with windows closed.

The criteria to be used depend on the application of the best practicable option (BPO) test, with the A criterion being met or bettered if this is consistent with the BPO, the B criterion to be met or bettered if criterion A is not achievable with the BPO, and criterion C to be achieved, if criterion B is not achievable with the BPO.

For a road to be assessed as an “Altered Road” under NZS 6806 it must have both physical changes to the horizontal or vertical alignment, and have an effect on the noise environment. For MSRFL, the Altered Road criteria apply to all Protected Premises and Facilities (PPFs) along Main South Road. For CSM2, the Altered Road criteria have been applied at PPFs that are within 200 m of a new road, and which are significantly affected and which are significantly affected by noise from existing roads (e.g. within 100 m of an existing road). For other PPFs along CSM2, the New Road criteria apply. The application of new and altered roads is shown in Appendix C of Technical Report 8.

This process promotes integrated design encompassing a wide range of factors as well as noise levels. The NZTA has adopted this Standard for assessment of road-traffic noise from all new and altered State highways.

As notices of requirements for designations are being sought, it is noted that road-traffic noise is exempt from assessment against District Plan noise provisions in both the Christchurch City and Selwyn District Plans.

17.2.2. Assessment positions

The Standard defines a list of sensitive receivers, known as PPFs, which are assessed in accordance with the provisions of the Standard. PPFs include dwellings, educational facilities, marae, hospitals containing in-patient facilities, motels and hotels in residential zones and playgrounds within 20m of educational facilities.

The assessment position for existing buildings is at the façade. For the Project, each two storey dwelling has an assessment location on each floor, with the worst-affected position at each floor considered. The Standard states that in an ‘urban’ area, all PPFs within 100m of the alignment shall be assessed. In ‘rural’ areas, PPFs within 200m of the alignment shall be assessed, with the classifications for ‘rural’ and ‘urban’ as defined by Statistics New Zealand. For this Project, the majority of PPFs along the CSM2 part of the Project are characterised by similar noise environments even though they may be classified differently. Therefore, the NZTA has elected to

assess all PPFs within 200m in both urban and rural areas. Where altered roads and new roads intersect in rural areas, altered road criteria typically apply to PPFs within the closest 100m in line with the urban criteria.

Commercial and business uses are not considered to be noise sensitive receivers under NZS6806 and are therefore excluded from the assessment.

17.2.3. Traffic noise modelling

The traffic noise prediction method used takes into consideration multiple factors which affect road noise level. These include:

- traffic volume;
- vehicle speed;
- road gradient;
- angle of view,
- percentage of heavy vehicles; and
- road surface material.

The selection of road pavement has a significant effect on traffic noise generation as road tyre interaction is the major source of traffic noise at open road speeds (40 km/h and above).

17.3. Existing noise environment

The existing noise environment in the vicinity of the Project has been investigated extensively by means of noise level surveys, which have in turn been used to calibrate the computer traffic noise modelling of the existing environment. Traffic is the dominant noise source affecting the ambient noise environment for dwellings close to roads. The further a dwelling is located from a road, the greater the influence of other environmental sounds such as birdsong and rustling leaves.

Noise measurements were generally conducted at positions that are representative of the façades of dwellings. Noise levels at dwellings that are located close to Main South Road, Springs Road and Shands Road are subject to relatively high ambient noise levels in excess of 70 dB $L_{Aeq(24h)}$.

Noise levels are in the order of 50 dB $L_{Aeq(24h)}$ where dwellings are set back further from less busy roads. Noise measurements were conducted between 1 to 3 October 2011 inclusive.

17.4. Noise assessment sections and identification of PPFs

In order to assist with the noise assessment, potentially affected locations along the route have been considered in a number of sections as detailed in the table below. The majority of dwellings in the assessment sections are accessed directly from, or are in close proximity to existing roads, most notably Main South Road, Springs Road and Shands Road. Ambient noise levels at these locations are directly affected by traffic flow and by local obstacles such as perimeter fences and other dwellings. Dwellings in these locations are in both *Inner Plains* and *Rural 2* zones under the Selwyn District Plan and Christchurch City Plan respectively. These sections are mapped in

Appendices B and C of the Assessment of Operational Noise Effects, Technical Report 8 (appended in Volume 3).

Table 27: Description of assessment areas with each section

Name	Section	Statistics NZ	Description
CSM2/MSRFL interchange to Weedons Road Interchange	5, 6 & 7	Rural	There are 29 dwellings (and correspondingly 29 PPFs) in these sections that are similarly affected by relatively high existing traffic noise levels. Of these 29 PPFs, one is a two-storey giving a total of 30 assessment positions. These totals do not include the dwellings along the route that have been identified for Crown purchase.
Waterholes & Hamptons Roads	4	Urban (east) & Rural (west)	In this section there are four dwellings, two of which are two-storey. This corresponds to four PPFs and six assessment locations. These totals do not include dwellings that are to be purchased by the Crown.
Trents & Blakes Roads	3	Urban	Trents Rd will pass over CSM2 and Blakes Rd terminates. Four of the eight dwellings that are closest to CSM2 are to be purchased by the Crown. Trents estate has been included in the assessment, but it is not identified as a PPF. A total of four PPFs have been assessed giving a total of five assessment positions.
Shands Road	2	Urban	With CSM2, Shands Rd will be accessed via a grade separated interchange. This section contains three PPFs/ assessment positions,. Three additional dwellings will be purchased by the Crown.
Springs Road	1	Urban	There are five dwellings within this section with access off Springs Road. Two of the dwellings are two storey, however one of these will be purchased by the Crown. A Springs Road bridge will be built over CSM2. This section contains four PPFs and five assessment positions.

In total, 34 PPFs have been identified within the seven sections of the Project route including four that are two-storey dwellings. These PPFs are identified in Appendices C and E of Technical Report 8. Not included in this total are those dwellings located on Crown owned land or those that it is intended the Crown will purchase. The Crown purchase dwellings will be relocated or demolished. Alternatively, they may be on-sold following completion of the construction of the

Project. In this situation, noise mitigation measures may be required prior to sale of those properties with dwellings, to meet the appropriate noise criteria category in NZS 6806: 2010.

17.5. Assessment of traffic noise effects and proposed mitigation

The existing noise situation has been assessed for each section by means of noise level surveys and computer noise modelling. The potential effects on sensitive receivers as a result of traffic noise have also been assessed. Based on the outcome of the assessment, mitigation measures are recommended where necessary.

NZS 6806 requires that several mitigation options be developed and compared in order to determine the BPO in accordance with the RMA, not only in terms of noise level reductions but also in relation to other considerations such as urban design, safety, cost etc. The process of comparing mitigation options is interactive, involving a number of project disciplines. Therefore, the assessment result generally consists of a number of options and a nominated preference developed by the entire Project team. For this reason, the preferred mitigation option may not provide the greatest noise level reduction, but is considered optimal and practicable on balance when evaluated against relevant criteria.

Overall, the two mitigation measures identified as being the BPO for the Project are:

- the use of Open Graded Porous Asphalt (OGPA) surfacing (shown on the pavement drawings and Appendix C of the Assessment of Operational Noise); and
- 1.8 m high acoustic fences (shown in Appendix C of the Assessment of Operational Noise).

Both of these measures are defined as structural noise mitigation measures. With respect to surfacing, the NZTA has determined that the Project will be paved with OGPA for the majority of the mainline carriageway for maintenance purposes. Appendix D of NZS6806 contains extensive discussion of the application of low noise road surfaces and confirms that OGPA, a porous and smooth layered asphalt surface, can reduce noise levels by around six decibels when compared with 'chip seal' surfacing - a noticeable difference. However, in order for this reduction in noise level to be achieved and maintained, OGPA must be laid to a sufficient depth, properly drained and regularly cleaned.

17.5.1. CSM2/MSRFL interchange to Weedons Rd Interchange - Section 5, 6 & 7

The noise environment at dwellings in sections 5, 6 and 7 is dominated by traffic noise from Main South Road, so the Altered Road criteria have been applied (Table 26). There are a total of 29 dwellings in these sections including one that is two-storey. This gives a total of 29 PPFs with 30 assessment positions in these sections.⁷⁷ It is also understood that four dwellings along Main South Road are to be relocated to the rear of their respective sites. Whilst these dwellings' final

⁷⁷ Note that for each two-storey PPF there are 2 assessment positions

locations are uncertain, traffic noise levels are likely to meet the Category A criteria for Altered Roads without any additional specific noise mitigation.

Existing noise environment “Do-Minimum”⁷⁸ scenario

The existing noise environment at the 29 PPFs has been predicted to range between 51 and 71 dB $L_{Aeq(24h)}$, depending on the distance from Main South Road. For dwellings close to Weedons Road and Weedons-Ross Road, only the contribution from the existing traffic noise from Main South Road has been calculated. This has resulted in a conservative estimate (lower) background noise level being used in the assessment of mitigation options.

The Do-Minimum scenario shows that the operation of the Project would have a negligible to slight effect on noise levels at dwellings in these sections. Noise levels would remain similar to existing levels for most dwellings with changes in noise levels ranging from a 5 decibel decrease up to an increase of 4 decibels. Most dwellings will experience a slight decrease in traffic noise levels from Main South Road. In these sections, three of the assessment positions would be within Category B (between 64 and 67 dB $L_{Aeq(24hr)}$). All of the remaining assessment positions would be within Category A (up to 64 dB $L_{Aeq(24hr)}$).

Proposed mitigation

The selection of OGPA as the Do-Minimum surface for the alignment means that traffic noise emissions from the main alignment are much lower than would generally be expected. However, further mitigation in the form of 1.8 metre high acoustic fences is proposed for three dwellings (1528 Main South Road (along 2 boundaries), 95 Berketts Road (along road boundary) and 1213 Main South Road (along road boundary)). Once the selected mitigation is in place, the three Category B assessment positions would meet criterion A, so all assessment positions would achieve Category A for these sections which is considered acceptable⁷⁹. Noise levels are predicted to increase by 2 decibels at one dwelling in these sections (1300 Main South Road). This is considered to be an insignificant change with a less than minor effect. Noise levels at the remainder of the PPFs are predicted to remain the same or decrease.

17.5.2. Section 4 – Waterholes & Hamptons Roads

The noise environment at dwellings in this section is dominated by traffic noise from Waterholes Road, Hamptons Road and SH1. As traffic on the local roads is intermittent and only seriously affects PPFs within 50m of the road, the more stringent New Road criteria has been applied (Table 26). There are five dwellings in this section, of which two are two-storey. It is understood that

⁷⁸ The predicted noise level at the design year with the Project implemented, including safety barriers and other structures, which may provide incidental noise mitigation. It also includes the use of OGPA for the majority of the mainline carriageway. It does not include any other mitigation that would be undertaken for the sole purposes of reducing noise effects.

⁷⁹ The criteria contained in NZS 6806 have been developed with the intention that they are “reasonable criteria for the road-traffic noise from new or altered roads taking into account health issues associated with noise, the effects of relative changes in noise levels on people and communities, and the potential benefits of new and altered roads to people and communities” – NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads, Section 1.1.4

one single-storey dwelling is to be purchased by the Crown, giving a total of four PPFs and six assessment positions in this section.

Existing noise environment and “Do-Minimum” scenario

The existing noise environment at the four dwellings has been predicted to be between 51 and 53 dB $L_{Aeq(24h)}$. Therefore, in this section all four assessed PPFs are within Category A. The Do-Minimum scenario shows that the operation of CSM2 would have a negligible to slight effect on the dwellings with noise levels remaining similar to existing levels for most dwellings, with changes in noise levels ranging from a 1 decibel decrease up to an increase of 4 decibels.

Proposed mitigation

The selection of OGPA as the Do-Minimum surface for the alignment means that traffic noise emissions from the main alignment are much lower than would generally be expected from a road of this size. Under the proposed Do-Minimum scenario the noise level at one PPF in this section is predicted to slightly decrease by up to 1 decibel. Noise levels at the other PPFs in this section are predicted to increase by between 1 (16 Devine Drive) and 4 decibels (883 Waterholes Road and 904 Waterholes Road). The 1 decibel increase is considered to be a less than minor effect, while the 4 decibel increase will lead to a perceptible change which is considered to be a minor effect. As all four PPFs in this section are within Category A, no further mitigation is required.

17.5.3. Trents Road and Blakes Roads – Section 3

The noise environment at dwellings in this section is affected by traffic on Blakes Road, Trents Road and SH1. As traffic on Blakes and Trents Roads is intermittent and only seriously affects properties within 50m of the road, the more stringent New Road criteria is has been applied (Table 26).

There are a total of eight dwellings, including three two-storey dwellings. It is understood that four dwellings (including two two-storey dwellings) are to be purchased by the Crown and do not require assessment. This gives a total of four PPFs and five assessment positions in this section. Given the proposed alignment, Blakes Road will not cross CSM2 and therefore will no longer function as a through road. The resulting decrease in traffic along Blakes Road will cause a decrease in traffic noise level from this road for properties close to the road.

Trents Estate Winery lies within this section, although is not considered a PPF as it is a commercial activity. Furthermore, it lies outside the 200m assessment area. However, the potential noise effects of the Project on this property have been considered in the assessment.

Existing noise environment and “Do-Minimum” scenario

The existing noise environment at the five assessment locations has been predicted to be between 52 and 54 dB $L_{Aeq(24h)}$. Therefore, all four PPFs are within Category A. The existing noise environment at Trents Estate Winery has been measured to be 47 dB $L_{Aeq(24h)}$. The Do-Minimum

scenario shows that the operation of the Project would have a negligible effect on dwellings, with noise levels remaining similar to existing levels for most dwellings, with increases in noise levels of up to 2 decibels.

Proposed mitigation

The selection of OGPA as the Do-Minimum surface for the alignment means that traffic noise emissions from the main alignment are much lower than might otherwise be the case if a noisier Do-Minimum surface had been selected (e.g. asphaltic concrete or chip seal). Under the proposed Do-Minimum scenario noise levels at assessed PPFs in this section are predicted to increase by up to 2 decibels (240 Blakes Road increase by 1 dBA, 260 Blakes Road by 2 dBA, 100 Trents Road by 1 dBA and 108 Trents Road by 2 dBA). This is considered to be an insignificant change and a less than minor effect. All PPFs in this section are within Category A under the Standard and therefore no further mitigation is required.

17.5.4. Shands Rd – Section 2

The noise environment at dwellings in Section 2 is dominated by Shands Road traffic and therefore the Altered Road have been criteria applied (Table 26). There are a total of six single-storey dwellings. One dwelling is owned by the Crown and two others are to be purchased by the Crown and do not require assessment. This gives a total of three PPFs in this section and correspondingly three assessment positions.

Existing noise environment and “Do-Minimum” scenario

The existing noise environment at the six dwellings has been predicted to be between 54 and 66 dB $L_{Aeq(24h)}$, depending on the distance to Shands Road.

The Do-Minimum scenario includes low noise road surface material (OGPA) along the main CSM2 alignment. In addition, Stone Mastic Asphalt (SMA) has been proposed for the overbridge and its approaches. In this section, all PPFs achieve the Category A criterion (up to 64 dB $L_{Aeq(24h)}$).

Proposed mitigation

The selection of OGPA and SMA as the Do-Minimum surface means that all three assessment positions are within Category A with the noise levels at all assessed PPFs predicted to decrease by between 1 and 4 decibels which is considered to be a slight positive effect.

17.5.5. Springs Rd - Section 1

The noise environment at dwellings in this section is dominated by Springs Road traffic and therefore, the Altered Road criteria generally apply (Table 26). There are a total of five PPFs with two two-storey dwellings in this section. One two-storey PPF (two assessment positions) is subject to the New Road criteria. The other three PPFs have been assessed against the Altered Road criterion. This gives a total of five assessment positions in this section.

Existing noise environment and “Do-Minimum” scenario

The existing noise environment at the five dwellings has been predicted to be between 52 and 69 dB $L_{Aeq(24h)}$, depending on the distance to and elevation above Springs Road. The Do-Minimum scenario includes OGPA along the main CSM2 alignment. SMA is proposed for the Springs Road overbridge and its approaches. The Do-Minimum scenario shows that the operation of CSM2 would have a negligible to moderate effect on dwellings within 100m of Springs Road and noise levels would slightly increase or decrease depending on the proximity to Springs Road. There are two dwellings within 20 m of Springs Road with lower existing noise levels, and these would experience a noise level increase of up to 7 decibels and would be within Category C (greater than 67 dB $L_{Aeq(24hr)}$). The PPF approximately 50m from Springs Road would be Category A (up to 64 dB $L_{Aeq(24hr)}$ under the Altered Road criteria) and the two remaining assessment positions would be Category A (up to 57 dB $L_{Aeq(24hr)}$ under the New Road criteria).

Proposed mitigation

The selection of OGPA as the Do-Minimum surface for the Project means that traffic noise emissions from the main alignment are much lower than might otherwise be the case if a noisier Do-Minimum surface had been selected (e.g. asphaltic concrete or chip seal). Further to the Do-Minimum approach above, OGPA surfacing of the southern approach to the CSM2 overbridge along Springs Road is recommended as additional mitigation. In addition, a 1.8 metre high acoustic fence on the road boundary of 312 Springs Road is proposed.

With the selected mitigation option in place noise levels at all assessed PPFs in this section are predicted to decrease by between 2 and 11 decibels, which is considered to be a slight positive, to a substantially positive effect.

17.6. Summary of Operational Noise Effects and Proposed Mitigation

Table below provides a summary of Preferred Mitigation Options that have been selected for the Project.

Table 28: Summary of Preferred Mitigation Options

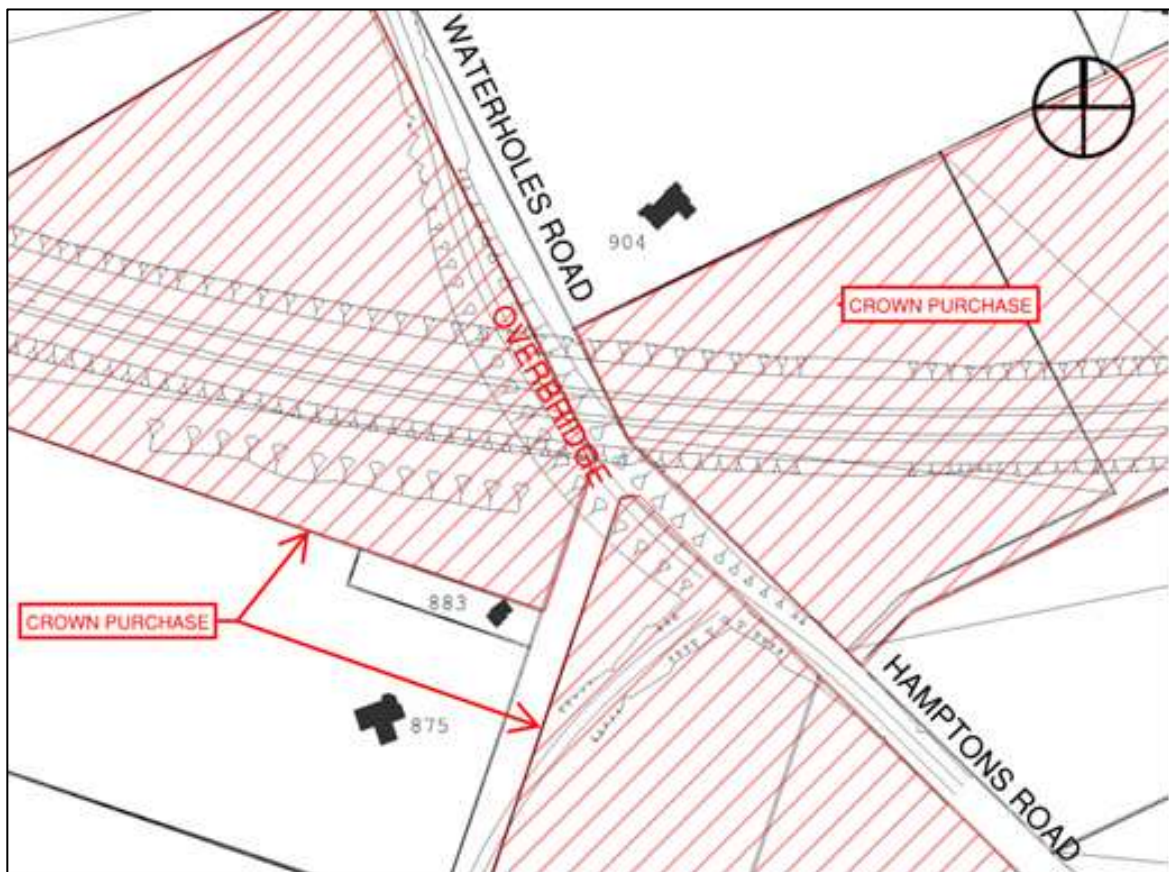
Section	Description of Mitigation Option
7	1.8m high acoustic fence along two boundaries at 1528 Main South Road
6	1.8m high acoustic fence at 95 Berketts Road
5	1.8m high acoustic fence at 1213 Main South Road
4	None (Do- Minimum Scenario)
3	None (Do- Minimum Scenario)
2	None (Do- Minimum Scenario)

Section	Description of Mitigation Option
1	OGPA surface to overbridge southern approach and 1.8m high acoustic fence to road side boundary of 312 Springs Road

The acoustic fences will be subject to detail design. However, fences should generally be constructed of materials that have a surface mass of at least 10 kg/m² and be built with no gaps. Suitable materials can include concrete, fibre cement board, steel and timber. As far as practicable, fences will be located either within or at the edge of the road designation, thereby permitting the NZTA to perform on-going maintenance.

The dwellings located at 883 and 904 Waterholes Road (shown in Figure 49) are likely to experience a change in noise level of 3 decibels or more, corresponding in a minor adverse noise effect. However, in both these locations, road traffic noise levels will achieve the Category A noise criteria of 57 dB L_{Aeq(24hr)} for new roads.

Figure 49: Potentially adversely affected dwellings



17.7. Road traffic vibration effects

Vibration levels from traffic depend primarily on the roughness of the road surface. A smooth road surface results in low levels of vibration being generated by moving traffic.

Historical measurements conducted during detailed analysis of road traffic vibration on other projects has shown that a significant degradation in the surface of a road, or poorly finished road maintenance resulting in bumps or dips in the road surface, are required before vibration from road traffic becomes significant enough to cause even superficial building damage.

Degradation of this magnitude is highly unlikely to occur because standard NZTA maintenance policy requires that that road surfaces are properly maintained. Vibration levels will be acceptable under international standards relating to building damage and human response to transit vibration, such as NS 8176.E:2005 - Vibration and Shock – Measurement of vibration in buildings from land based transport and guidance to evaluation of its effects on human beings.

The risk of adverse effects resulting from road traffic vibration is therefore negligible.

17.8. Construction noise and vibration

The noise and vibration effects associated with construction of the Project have been assessed based on Technical Report 9, Assessment of Construction Noise and Vibration, appended in Volume 3. An assessment methodology for assessing construction noise and vibration effects is set out, and adverse effects have been assessed on a sector by sector basis. Vibration effects have been assessed with respect to the potential for damage to buildings and the effect on people. Based on the assessment, both general and site specific measures are proposed to mitigate the effects of construction noise and vibration.

17.9. Construction noise assessment

17.9.1. Construction noise assessment criteria

Construction noise effects are assessed in relation to the recognised construction noise standard (NZS 6803:1999 Acoustics – Construction Noise), which contains recommended noise criteria that are considered appropriate and applicable to noise from construction operations, excluding blasting.

NZS 6803:1999 provides for higher noise levels during normal working hours for construction noise received in residential areas in order to enable normal construction activity to take place. For commercial and industrial areas, higher noise criteria are allowed during night-time when it is less likely that people or business activity will be affected by construction noise.

The noise criteria in NZS 6803:1999 are widely acknowledged as being appropriate for the control of construction noise, and compliance with these criteria generally ensures acceptability of noise generated by construction activities.

For the purposes of the construction noise and vibration assessment, the Project area has been divided into twelve sections to enable assessment in relation to specific sensitive receptors.

17.9.2. Assessment of construction noise effects by sector

The table below summarises the construction activities and predicted construction noise by sector, with details provided regarding the potential effect on sensitive receptors in each sector. These sectors are shown in the Assessment of Construction Noise and Vibration, Technical Report 9 appended in Volume 3. The table identifies where mitigation is required. The mitigation options available are discussed later in this chapter.

Table 29: Predicted construction noise by assessment sector

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 12: MSRFL South of Weedons Road	Topsoil stripping, general earthworks, pavement construction. There may also be some Enabling Works, noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the four-laning of Main South Road.	The closest dwelling is located at 1528 Main South Road to the north of the main alignment and is around 10m from the edge of the construction area. See Figure 2 in Technical Report 9.	Some construction activities may exceed the noise criteria in this sector. The day time noise criteria has the potential to be exceeded for short periods of time (for enabling works and topsoil stripping) and are likely to exceed the night time noise criteria for all construction activities resulting in potentially significant adverse noise effects requiring mitigation.

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 11: Weedons Road Interchange	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the construction of the Weedons Road interchange.</p>	<p>There are a number of commercial and residential buildings in this Sector (along Weedons Road). See Figure 3 in Technical Report 9.</p>	<p>Construction activities likely to exceed the day time noise criteria in this Sector include enabling works (for short periods of time), topsoil stripping (for receivers within 180 m and for short periods of time), earthworks for bridges (where occurring within 50 m of occupied dwellings), ground improvements, and bridge construction. All construction activities have the potential to exceed the night time noise criteria. These exceedances will result in potentially significant adverse noise effects requiring mitigation.</p>
Sector 10: MSRFL between Berketts Road and Weedons Road	<p>Topsoil stripping, general earthworks, pavement Construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the four-laning of Main South Road.</p>	<p>There are a number of commercial and residential buildings in this sector, including several properties that are intended to be purchased by the Crown. There are two dwellings to be relocated to the rear of the site (1312 and 1310 Main South Road). The closest dwelling is approximately 20m from the edge of the construction area (95 Berketts Road). See Figure 4 of Technical Report 9.</p>	<p>The construction activities which may exceed the day time noise criteria in this Sector include enabling works (for short periods of time) and topsoil stripping (when within 180 m of occupied residential dwellings). The night-time criteria are likely to be exceeded for all construction activities. These exceedances may result in potentially significant adverse noise effects requiring mitigation.</p>

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 9: MSRFL – Robinsons to Berketts	<p>Topsoil stripping, general earthworks, pavement Construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the four-laning of Main South Road.</p>	<p>There are several properties that are intended to be purchased by the Crown. There are also dwellings which will be relocated to the rear of the site prior to commencing construction (1168 and 1160 Main South Road). The closest other dwelling is around 20m from the edge of the construction area (1213 Main South Road). See Figure 5 of Technical Report 9.</p>	<p>Some construction activities may exceed the day time noise criteria (enabling works for short periods of time and topsoil stripping when within 180 m of residential dwellings) in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time noise criteria.</p>
Sector 8: Robinsons Road	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction.</p> <p>The major construction activities in this Sector relate to the construction of the MSRFL/CSM2 interchange (including overbridge) and the Robinsons Road overpass. The main site compound is also located in this Sector adjacent to Robinsons Road</p>	<p>There are a number of commercial and residential buildings in this Sector. Dwellings are located at 1090 and 1033 Main South Road and 979 Robinsons Road. See Figure 6 of Technical Report 9.</p>	<p>Some construction activities may exceed the day-time noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. These activities include enabling works (for short periods of time), topsoil stripping when within 180 m of occupied residential dwellings, general earthworks for bridges where works occur within 50 m of occupied dwellings (northern end of MSRFL overbridge), ground improvements and bridge construction. All construction activities are likely to exceed the night-time noise criterion.</p>

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 7: Waterholes Road	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the construction of the Waterholes Road overbridge.</p>	<p>The closest dwelling to overbridge construction area is located close to the northern end of the overbridge (904 Waterholes Road). There are two dwellings located to the south of the main alignment, on the eastern side of Waterholes Road (883 and 875 Waterholes Road). See Figure 7 of Technical Report 9.</p>	<p>Some construction activities (enabling works for short periods of time and topsoil stripping when within 180 m of dwelling) may exceed the day-time noise criteria in this Sector. All construction activities are likely to exceed the night-time noise criterion resulting in potentially significant adverse noise effects requiring mitigation.</p>
Sector 6: Trents to Waterholes	<p>Topsoil stripping, general earthworks, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the formation of the main CSM2 alignment.</p>	<p>There are a large number of dwellings at the subdivision to the north of this Sector (Claremont). The closest dwelling in the subdivision is around 170m from the edge of the construction area. These dwellings include numbers 14 to 30 Devine Drive. See Figure 8 of Technical Report 9.</p>	<p>Some construction activities (enabling works for short periods of time and topsoil stripping when within 180 m of occupied residential dwellings) may exceed the noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time criteria.</p>

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 5: Trents Road	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the construction of the Trents Road overbridge.</p>	<p>There are five dwellings that are intended to be purchased by the Crown. The closest dwellings to overbridge construction area is located close to the northern end of the Trents Road overbridge (104 and 106 Trents Road). See Figure 9 of Technical Report 9.</p>	<p>Some construction activities (enabling works, topsoil stripping, earthworks for bridges, ground improvements and bridge construction) may exceed the day-time noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time noise criteria.</p>
Sector 4: Shands to Trents	<p>Topsoil stripping, general earthworks, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the formation of the main CSM2 alignment.</p>	<p>There are three dwellings that are intended to be purchased by the Crown. The nearest other dwellings lie to the south of the main alignment and are around 100m to 120m from the edge of the construction area. These dwellings are located at 273, 260 and 240 Blakes Road. See Figure 9 of Technical Report 9.</p>	<p>Enabling works and topsoil stripping construction activities for short periods of time may exceed the day-time noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time criteria.</p>

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 3: Shands Rd	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction, enabling works.</p> <p>The major construction activities in this Sector relate to the construction of the Shands Road Interchange and the Shands Road and Marshs Road overbridges. The main civil/earthworks compound will also be located in this Sector.</p>	<p>There are three dwellings that are intended to be purchased by the Crown in this Sector and other rural dwellings located close to the Marshs Road / Shands Road junction. These are identified as 523 Shands Road and 181, 183, 191 and 197 Marshs Road. See Figure 10 of Technical Report 9.</p>	<p>Enabling works and topsoil stripping construction activities for short periods of time may exceed the day-time noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time criteria.</p>
Sector 2: Shands to Marshs	<p>Topsoil stripping, general earthworks, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the formation of the main CSM2 alignment.</p>	<p>There are two dwellings that are intended to be purchased by the Crown. Other dwellings lie to the south of the main alignment and are around 120m to 150m from the edge of the construction area (along Shands Road). See Figure 10 of Technical Report 9.</p>	<p>The only construction activities that may exceed the daytime noise criteria are top soil stripping within 180 m of dwellings. Other activities are likely to exceed the noise criteria in this Sector if undertaken at night. These exceedances will result in potentially significant adverse noise effects requiring mitigation.</p>

Sector	Construction Activities	Location of receivers	Predicted Noise Effects
Sector 1: Halswell Junction/ Springs Road	<p>Topsoil stripping, general earthworks, ground improvements, bridge construction, pavement construction.</p> <p>There may also be some Enabling Works noise generation associated with small staging areas as required by the contractors. The major construction activities in this Sector relate to the construction of the Halswell Junction Road overbridge and the Springs Road overbridge. There will also be one of the main stormwater pond systems in this Sector.</p>	<p>There are less than 5 dwellings close to the construction zone in this Sector. The critical dwellings are those dwellings on Springs Road to the south of the main CSM2 alignment (312, 314, 318 and 333 Springs Road), as they are close to the overbridge construction area. See Figure 11 of Technical Report 9.</p>	<p>Some construction activities (enabling works, topsoil stripping, earthworks for bridges, ground improvements and bridge construction) may exceed the day-time noise criteria in this Sector resulting in potentially significant adverse noise effects requiring mitigation. All construction activities are likely to exceed the night-time noise criteria.</p>

17.9.3. Summary of effects

In all sectors, construction activities have the potential to exceed recognised construction noise criteria as set out in NZS 6803:1999, resulting in potentially significant adverse effects of a temporary nature for nearby dwellings and residential areas.

17.10. Construction noise measures

17.10.1. General measures to manage effects

The table below provides a summary of general construction noise mitigation measures:

Table 30: Noise mitigation summary

Construction Activity	Mitigation / Management	Sector
Enabling Works	Restrict use of heavy machinery to 0730 - 2000 Monday to Friday and 1730 - 1800 on Saturday.	ALL
Topsoil Stripping	Restrict motor scraper use to 0730 - 1800 Monday to Saturday.	ALL

Construction Activity	Mitigation / Management	Sector
General Earthworks	Restrict use of heavy machinery to 0730 - 2000 Monday to Friday and 1730 - 1800 on Saturday, or ensure minimum setback distance of 900m to any occupied residential dwelling and 50m from any occupied commercial building.	ALL
Ground Improvements	Ground Improvements and Piling Techniques are outlined in Technical Report 9 and include the selection of a “quieter” method where alternative methods are available.	1, 3, 5, 7, 8, 11
Bridge Construction	Noise mitigation and management for night-time work are outlined in Technical Report 9 and include preparation of site specific noise management plans and consultation and communication with sensitive receivers.	1, 3, 5, 7, 8, 11
Pavement Construction	Restrict use of loud construction machinery to 0730 - 2000 Monday to Saturday.	ALL

Further general mitigation measures are proposed to be included in a CNVMP, and as per the measures set out in detail in Technical Report 9. These are summarised as follows:

- training of personnel with respect to implementing the CNVMP;
- maintenance of equipment;
- equipment enclosures to attenuate noise at source;
- selection of low noise plant;
- avoiding night time activities;
- temporary relocation of residents (only where absolutely necessary);
- noise level monitoring;
- alternatives to tonal reversing alarms;
- monitoring and reporting; and
- consultation and communication with sensitive receivers.

17.10.2. Site specific mitigation measures

In addition to the general mitigation measures outlined above, site specific mitigation for operational noise is proposed in the form of acoustic fencing for residential dwellings within close proximity to the Project area. Where practicable, acoustic fencing should be installed prior to construction works commencing, to reduce construction noise to more acceptable levels for these dwellings. The affected dwellings have been identified as follows:

- Sector 1 – one dwelling on the western side at 312 Springs Road close to the overbridge will require a noise control fence;
- Sector 9 – the dwelling situated at 1213 Main South Road will require a noise control fence;
- Sector 10 - the dwelling situated at 95 Berketts Road (on the corner of Berketts and Main South Road) will require a noise fence. The closest dwelling along this section is approximately 20m from the construction area; and
- Sector 12 - the dwelling situated at 1528 Main South road will require noise control fencing.

Furthermore, the Crown will purchase some properties with dwellings within the Project area prior to construction works commencing, therefore avoiding construction effects on these dwellings, which will be removed.

17.11. Construction vibration assessment

17.11.1. Construction vibration assessment criteria

The draft NZTA vibration guidelines provide the basis for assessing vibration effects. The draft guidelines adopt criteria from recognised international standards in a management-based framework designed to address both human response and building damage effects. These international standards include DIN 4150-3:1999 - Effects of Vibration on Structures and BS 5228-2:2009 - Code of Practice for Noise and Vibration Control on construction and open sites.

The Project vibration criteria from the draft NZTA vibration guidelines selected for the construction phase are as follows:

- Category A: adopts criteria from British Standard BS 5228-2:2009 and is designed to practically address the human response effects in dwellings during the daytime and night-time periods, and offices during the daytime. For other building types, and offices during the night-time (i.e. unoccupied), the policy reverts to the residential building damage criterion from German Standard DIN 4150-3:1999.
- Category B: is generally designed to protect buildings against damage and adopts criteria from DIN 4150-3:1999 and BS 5228-2:2009, but retains a higher degree of night-time protection for occupied dwellings at night using human response criteria of BS 5228-2:2009. If measured or predicted vibration levels exceed the Category A criteria then a suitably qualified expert shall be engaged to assess and manage construction vibration and to comply with the Category A criteria. If the Category A criteria cannot be practicably achieved, the Category B criteria shall be applied.

17.11.2. Assessment of vibration effects

The Project's construction phase will involve the use of heavy machinery operating for extended periods during the day in relatively close proximity to some sensitive buildings, namely dwellings. Night-time construction may also be required in some areas, in particular for bridge construction.

The following definitions have been used to classify the vibration risk and potential effect on dwellings:

- ‘High Risk’ – Dwellings where vibration levels are likely to exceed the risk assessment criteria. This does not necessarily imply damage to the building structure, but these are the receivers subject to the highest vibration levels;
- ‘Medium Risk’ – Dwellings close to the risk contour with some construction activities producing vibration levels close to the risk assessment criteria with possible intermittent exceedance; and
- ‘Others’ – No significant risk.

Potentially significant sources of vibration and the most sensitive receivers for each Sector have been predicted. These results are provisional however, and must be refined and supported by site-specific measurements once construction begins, as recommended in the CNVMP. For crucial activities such as excavating, vibratory compacting and pile driving, measurements of the initial works are recommended and as the repository of on-site measurements increases, the risk categories can be refined and improved controls can be achieved.

It is unlikely any buildings along the CSM2 alignment have a high risk of suffering from vibration effects, although some buildings have a medium risk of suffering from vibration effects. A detailed assessment of all dwellings along the MSRFL alignment should be undertaken during the preparation of the detailed construction programme, and all dwellings within 20m should be marked on a plan for reference. There is the potential for vibration associated with construction activities to have adverse effects on people.

17.12. Vibration measures

The most effective way to control construction noise and vibration is through good on-site management, with measures to be implemented through the CNVMP.

For crucial activities, such as vibratory compacting and piling where large vibration energy is typically produced, test measurements of the initial works are recommended. As the number of on-site measurements increases, the models can be refined to allow more accurate prediction of the subsequent construction stages and improved controls can be achieved.

17.13. Conclusion

The existing ambient noise environment for dwellings adjacent to existing busy roads (Main South Road, Springs Road and Shands Road) is such that the Project will not result in an appreciable change in noise environment for the majority of residents near the Project. Dwellings adjacent to less busy roads, or set back a significant distance from the carriageway edge, will be largely unaffected by any increase in operational noise. Low road noise surfacing (OGPA) has been nominated for use on the majority of the MSRFL and CSM2 carriageway as part of the Do-Minimum scenario. Additional mitigation measures proposed are acoustic fences for a limited number of dwellings (1213 Main South Road, 95 Berketts Road, 1528 Main South Road and 312

Springs Road) and extending the use of OGPA on the southern approach to the overbridge at Springs Road. With mitigation measures in place only two dwellings will be potentially adversely affected by an increase in noise level (883 and 904 Waterholes Road) but the noise levels at those dwellings will achieve the Category A noise criteria.

Operational vibration levels generated by moving traffic are significantly lower than for construction activities, and will be sufficiently managed through on-going road maintenance.

Construction activities have the potential to exceed recognised construction noise criteria resulting in potentially significant adverse effects of a temporary nature for dwellings situated near the Project area. A range of general mitigation measures are proposed to be implemented through the CNVMP, along with site specific mitigation for affected dwellings in the form of acoustic fencing and the preparation of management schedules outlining site specific construction noise management measures. Overall, it is considered that the Project can be constructed such that adverse construction noise effects can generally be avoided, remedied or mitigated using best practicable options to achieve compliance with the Project criteria.

The most effective way to control vibration is through good on-site management and rigorous monitoring, with mitigation measures proposed to be implemented through the CNVMP. Vibration during the construction phase has a finite timeframe.