REPORT

Tonkin+Taylor

May Road Stream Enhancement Project

Construction noise and vibration technical assessment

Prepared for
Watercare Limited
Prepared by
Tonkin & Taylor Ltd
Date
December 2024
Job Number
1015172.1701 v2.1

Together we create and sustain a better world
www.tonkintaylor.co.nz

Document control

Title: May Road Stream Enhancement Project					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
Aug 2024	2.0	Final for lodgement	S Yung	D Humpheson	K Baverstock
Dec 2024	2.1	Updated after pre-app	S Yung	D Humpheson/ M Woods	K Baverstock

Distribution:

Watercare Limited	1 PDF copy
Tonkin & Taylor Ltd (FILE)	1 PDF copy

Table of contents

1 Introduction

1.1 Overview

This report has been prepared by Tonkin & Taylor Ltd (T+T) to inform a resource consent application by Watercare Services Ltd (Watercare) for the proposed stream enhancement works at 54 Roma Road, Mt Roskill (the Site or 'May Road').

This report provides an assessment of the noise and vibration effects associated with the stream enhancement works at the Site. In particular, this report:

- Establishes the relevant noise and vibration limits for the site set out in the Auckland Unitary Plan (AUP);
- Identifies the construction activities that will generate noise and vibration;
- Identifies nearby receivers;
- Predicts construction noise and vibration levels at identified receivers and determines compliance with relevant noise and vibration limits;
- Discusses potential noise and vibration effects; and
- Provides recommendations to avoid, remedy or mitigate these effects.

A glossary of terms is included at the end of this report (Appendix A).

This report has been prepared in accordance with T+T's proposal dated 3 May 2024.

1.2 Background

The Site is currently being used for the construction of the Central Interceptor (CI) and is one of the main shaft sites for the CI. The Site is designated under the AUP by Watercare for the purposes of the construction, operation and maintenance of wastewater infrastructure. Designation 9466 together with a suite of regional and district consents authorise the CI works at the Site including the site reinstatement works post-construction.

While the Site reinstatement works are within the scope of the CI project and required by consent conditions and the designation at the May Road site, some of the works are outside the scope of the existing regional resource consents and designation. Specifically:

1 The regional consent application and associated consents broadly provide for works across the CI sites. However, the consent application specifically identified sites where in-stream works would be required and this does not include the proposed enhancement works at Roma Road. Consent is therefore being sought for in-stream works under the relevant rules in the AUP.

2 The works extend beyond the designation boundary into the neighbouring Goodman's property. A standalone land use consent is therefore being sought to authorise the enhancement works.

The relationship of these works to the wider CI work have been considered throughout this assessment, particularly at Section 3.4 below, and in the Assessment of Environmental Effects (AEE). The CI work forms part of the existing environment at the site.

2 Project overview

2.1 Proposed work and overview

As part of stream enhancement work at the CI May Road site, excavation and amendment of the existing stream channel is required. Basalt is anticipated (and can be seen on the surface in places) within the northern half of the site as indicated by the red shaded areas in Figure 2.1. Therefore, rock breaking is anticipated within the area where basalt is present (to a depth of approximately 1 m from the top of the existing bank). The Civil drawings attached at Appendix A of the AEE show the proposed finished ground profile compared to the existing profile.

Space within the site is constrained so the construction equipment will mainly be placed on the bank opposite to the nearest residential receivers. Rock breaking noise source will be predominately generated at ground level where breaker tool and rock come into contact. Where the stream is located on the neighbouring property boundary at the northern end, works will only take place on the southern bank of the stream and within the stream channel, and not on the northern bank (refer to site ecological enhancement cross sections[1]).

Supporting works of vegetation clearance, minor earthworks such as excavation and soil removal will also be required within the Site.

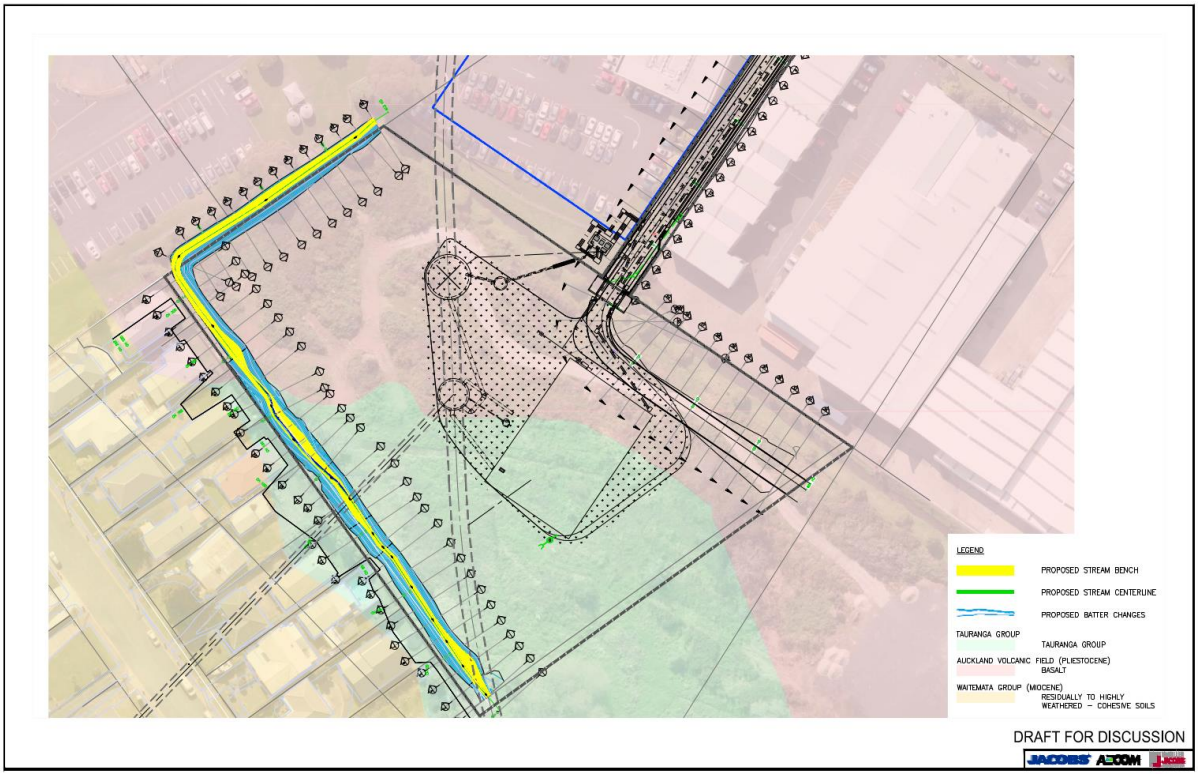


Figure 2.1 Map of approximate basalt location.

[1] Watercare, May Rd – Central Interceptor (DSCIN), 11 Stormwater, site ecological enhancement cross sections, Ref no CI-Civil, Dwg no. 2011806.061-066.

2.1.1 Duration of works

The construction programme is currently unknown, however Watercare has indicated the stream enhancement work is anticipated to occur over an approximately 2-month period.

2.1.2 Construction hours of operation

Noise generating activities and truck movements will typically occur during the standard construction hours for the wider CI construction works, which are as follows:

- Monday to Friday: 7.30 am to 6.00 pm (site mobilisation and pack down works are proposed to occur 30 mins before and after these windows consistent with existing CI activities);
- Saturdays: 8.00 am to 6.00 pm.

Works outside of these hours are not anticipated but can be provided for via a permit to work out of hours process consistent with existing CI activities.

3 Performance Standards

3.1 AUP requirements

3.1.1 Construction noise

The AUP contains relevant limits for construction noise (E25.6.27) which are reproduced in Table 3.1 and Table 3.2**:**

- The limits in Table 3.1 apply at 1 m from the façade of any building that contains an activity sensitive to noise that is occupied during the works.
- The limits in Table 3.2 apply to noise affecting any other activity when measured 1 m from the façade of any other building that is occupied during the works.

Whilst the anticipated construction duration for this project is less than 20 weeks, CI has been operating on the May Road site for a few years. It is therefore appropriate to consider the works in line with the CI conditions (by applying a 5 dB reduction) to take into account the cumulative effects of noise already experienced for the nearby receivers. For this reason, while the works are anticipated to take approximately 2-months a conservative approach has been taken, and the limits in both Table 3.1 and Table 3.2 are reflective of works lasting more than 20 weeks.

Table 3.1: Construction noise levels - Applies to buildings containing noise sensitive activities AUPP Table 25.6.27.1)

Time of week	Time period	Noise limit dB	
		L_{Aeq}	L_{Amax}
Weekdays	6:30 am – 7:30 am	55	70
	7:30 am – 6:00 pm	70	85
	6:00 pm – 8:00 pm	65	80
	8:00 pm – 6:30 am	45	75
Saturdays	6:30 am – 7:30 am	45	75
	7:30 am – 6:00 pm	70	85
	6:00 pm – 8:00 pm	45	75
	8:00 pm – 6:30 am	45	75

Table 3.2: Construction noise limits for noise affecting any other activity (AUP Table E25.6.27.2)

Time period	Noise limit dB L_{Aeq}
7:30 am – 6:00 pm	70
6:00 pm – 7:30 am	75

3.1.2 Construction vibration

The AUP E25.6.30(1) requires construction activities to not exceed the vibration limits set out in German Industrial Standard DIN 4150-3:1999 when measured in accordance with that Standard on any structure not on the same site. The applicable vibration limit for a residential receiver is 5 mm/s Peak Particle Velocity (PPV) at the lowest frequencies.

Table E25.6.30.1 of the AUP-OP provides amenity vibration limits in buildings in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500 mm of ground level at the foundation of a single storey building. The applicable amenity vibration criterion is 2 mm/s PPV between 7 am and 10 pm, or 0.3 mm/s PPV between 10 pm and 7 am for occupied dwellings. Exceedance of these criteria should result in management and mitigation measures being implemented such as communication and consultation.

3.2 NZS 6803 Construction noise standard

NZS 6803:1999 *Acoustics – Construction noise* sets out procedures for the measurement and assessment of noise from existing and proposed construction work, including maintenance and demolitions. The Standard is referenced in the AUP and recommends noise limits for construction noise which the AUP-OP construction noise limits align with (see Table 3.1 and Table 3.2) 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 to noise at night, and that lower limits are appropriate for longer duration works.

For typical daytime working hours, construction noise limits are less restrictive than the typical operational noise limits, on the basis that the effects of construction activities are of limited duration.

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.

3.3 DIN 4150-3 vibration standard

The German Standard 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 AUP-OP references the previous version of this Standard. The Standard is commonly used across New Zealand as there are no vibration standards specific to New Zealand. The DIN 4150-3:2016 criteria to evaluate the effects of short-term vibration on structures are shown in Table 3.3 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 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 3.3 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

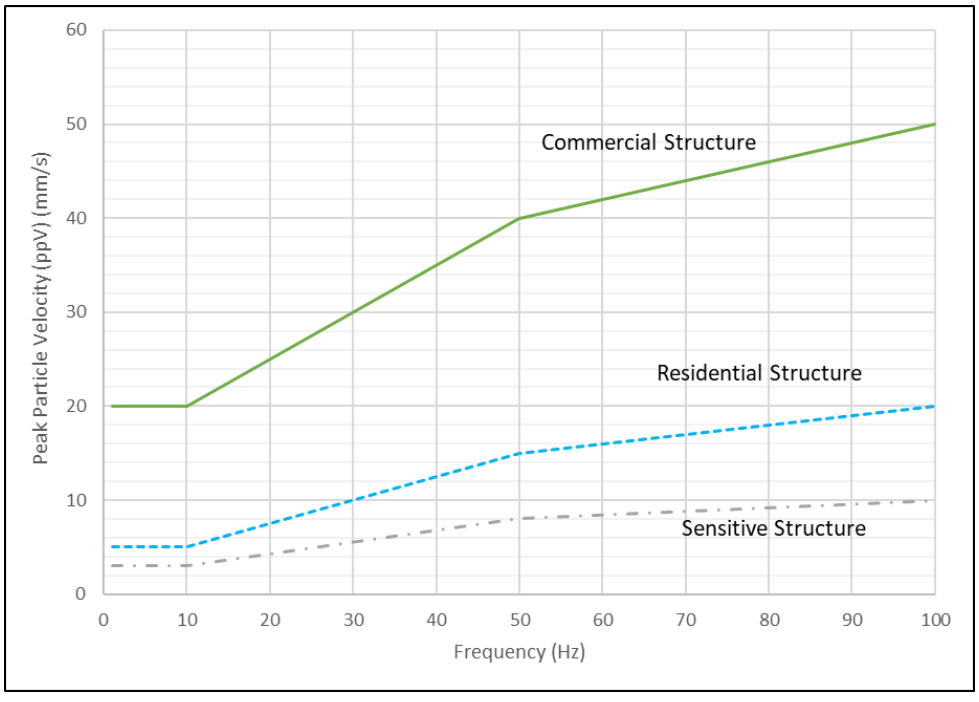


Figure 3.1: DIN 4150-3:2016 Short-term standard baseline curves.

3.4 Existing CI consent limits

The CI project was granted consent in 2013 and construction commenced in 2019. The requirements relating to construction noise and vibration are set out CI Designation 9466 (conditions 3.2 to 3.11) and Resource Consents (conditions 1.11 to 1.21) and reproduced in Table 3.4 below.

Table 3.4: construction noise limits

Time and day	Noise limits	
	L_{Aeq} dB	L_{Amax} dB
Monday to Saturday 7:30 am – 6 pm	70	85
At all other time and Public Holidays	45	75

These construction noise limits are more stringent than the permitted activity levels for construction noise in the AUP outside of daytime working, i.e. the night time limit of 45 dB L_{Aeq} applies at all times rather than the relevant early morning or evening shoulder-period noise limits of the AUP.

More recent consents issued for projects associated with CI, including the CC9 project at Keith Hay Park and the CI Point Erin Extension, set noise limits which align with the permitted activity standards for construction noise in the AUP. Requiring compliance with the AUP permitted activity standards and the limits set out in NZS 6803:1999 is considered to be appropriate for this Project.

The designation conditions require construction vibration to comply with the guideline vibration limits set out in DIN 4150-3 with the conditions providing an exception to this under certain circumstances where the Requiring Authority demonstrates that the potentially affected buildings can withstand higher vibration levels and has obtained the written approval of the building owner.

Whilst some vibrations for these works may be above the vibration limits set out in the AUP, low-level vibrations are generally considered acceptable and can be tolerated provided that prior warning and explanation of the operation are provided to the residents.

The respective CI conditions provide for the preparation of an Activity Specific Construction Noise Management Plan (ASCNMP) where a particular activity is unable to meet relevant noise and vibration limits.

3.5 Project criteria

A summary of the most stringent noise and vibration standards for the core proposed hours of construction (Monday to Friday 7:30 am to 6 pm with potential weekend works) is provided in Table 3.5. For construction works at other times of day, the noise limits in Table 3.1 and Table 3.2 apply.

Table 3.5: Project criteria for construction noise and vibration

Day of week	Time of work	Noise dB		Vibration mm/s PPV	
		L_{Aeq}	L_{Amax}	Amenity	Effects on structures
Monday to Saturday	7.30 am to 6 pm	70	85	2	5*

* Guideline value increases with high frequency (5 mm/s PPV for residential properties 1-10 Hz and 20 mm/s for commercial properties), see DIN 4150-3:2016

4 Receivers

The stream enhancement works are primarily located within the property boundary of the May Road CI site at 54 Roma Road (Designation 9466 Marked in Figure 4.1 below), slightly extending into the watercourse channel located within the Goodman's site along the north west boundary[2]. The work sits within the Business – Light Industry Zone which neighbours the Residential – Mixed Housing Urban Zone to the south west boundary.

The nearest surrounding receivers to the site are shown in Figure 4.1. Noise sensitive receivers are any occupied building that contains noise sensitive activities, e.g. dwellings. Other occupied buildings such as commercial or industrial properties are not noise sensitive but are considered receivers for construction noise and fall under Table 3.2 "all other activities" criteria.

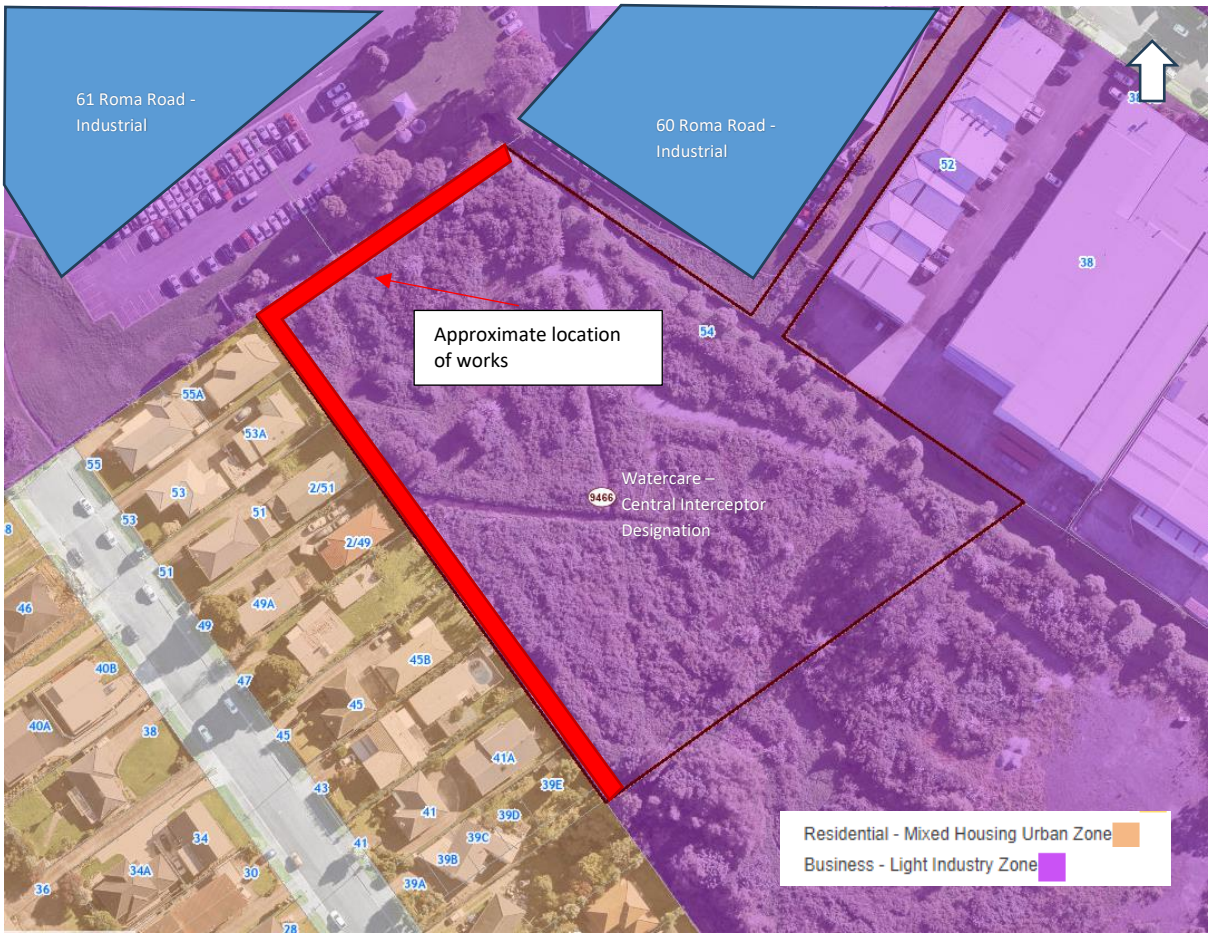


Figure 4.1 Location of works with receivers and zones of area surrounding site (taken from AUP online planning maps June 2024).

Roma Road Estate (also known as Goodman's site), located to the north of the stream works, is currently under development and four large industrial warehouse spaces are confirmed to be constructed on site, with the buildings at 60 and 61 Roma Road already completed. These building structures are not currently shown on any Lidar maps, therefore an approximate location based on the masterplan (Appendix B) has been assumed and represented in Figure 4.1.

[2] Approval for these works has been obtained from this property owner (Refer AEE).

Figure 4.1 below lists the receiver distances applicable for construction noise, i.e. from the façades of these receivers to the nearest location of construction works within 50 m. Distances from nearest activities are determined based on Figure 2.1 above, with excavation represented by the green shaded area and rock breaking by the red shaded area.

Noise levels at receivers will be well below the construction noise limits at distances greater than 50 m and have not been considered. All residential receivers identified are single storey buildings.

Table 4.1: Sensitive receivers

Address	Type of property	Nearest distance to rock breaking (m)	Nearest distance to excavation (m)
55A Marion Ave	Residential	5	22
55 Marion Ave ^		28	36
53A Marion Ave (closest works)		6	9
53 Marion Ave ^		29	29
2/51 Marion Ave		5	4
51 Marion Ave ^		32	30
2/49 Marion Ave		16	3
49A Marion Ave ^		36	30
47 Marion Ave ^		40	26
45B Marion Ave		39	9
43 Marion Ave		48	11
41A Marion Ave		62	7
60 Roma Road	Industrial	8	8
61 Roma Road		25	25

^ buildings are either partially or completely shielded from works by other buildings

5 Construction noise and vibration assessment

5.1 Assessment approach

Indicative construction noise levels have been calculated for the main items of equipment based on the outline construction methodology for stream enhancement works.

A cumulative assessment with CI works on site has not been undertaken due to works for stream enhancement being located closer to receivers than the continued operation of CI construction works (which are over 30 m away from residential receivers). The noise effects from the ongoing CI works are taken into consideration by applying a lower AUP noise limit. In addition, the CI site is shielded on all sides by a 2 m high boundary barrier with an additional 5 – 6 m high barrier/enclosures on the residential side (towards receivers on Marion Avenue) providing effective shielding as shown in Figure 5.1. As such rock breaking and excavation works will be the dominant noise source during stream works.

Figure 5.1 Aerial photo of May Road CI site and surrounding receivers (taken by Watercare 2024)

The civil drawings[3] for May Road shows cross sections of the proposed finished ground profile in relation to the property boundary and existing ground profile (example replicated below). The drawings show the majority of works will occur on the opposite bank from the nearest property boundary.

[3] May Rd – Central Interceptor, 11 stormwater, site ecological enhancements layout plan, Ref CI-Civil, Dwg No. 2011806.057-067

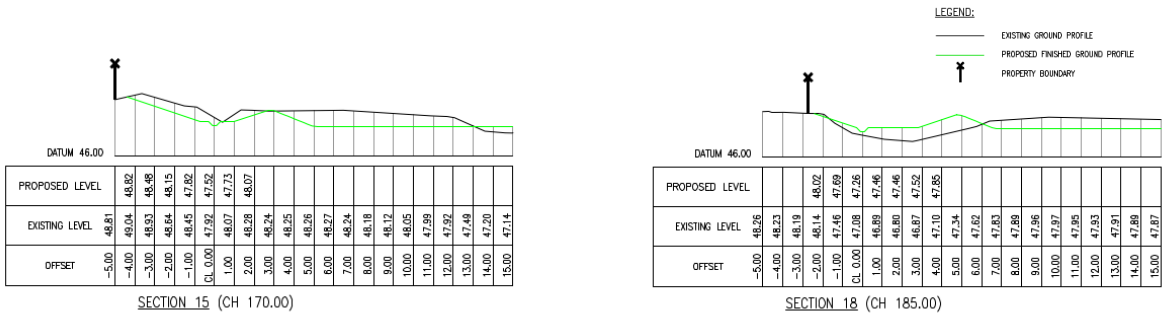


Figure 5.2 Cross section examples of proposed ground profile (replicated from civil drawings).

In order to provide a reasonable assessment of noise exposure for individual receivers, this assessment has taken the approach of assessing the impact from the main significant noise generating item of construction plant at the closest location. The following assumptions have been made with the construction plant operating at the edge of the construction location to assess a worst case scenario:

- A 30 t excavator with rock breaker attachment for the northern end of the works (where basalt is present) (75% on time within a 15 minute period);
- A 30 t excavator for the southern end of the works on the bank closest to property boundary (softer ground) (100% on time within a 15 minute period);.

It is noted a 30 t excavator with or without a rock breaking attachment may be required on site but where works are within 15 m of a dwelling, a smaller 14 t excavator will be used as part of the best practicable option (BPO). If a 14 t excavator with rock breaker is not feasible due to the ground conditions, then further mitigation measures will need to be employed to minimise effects. Predicted noise levels using a 14 t excavator with rock breaker has also been provided in Table 5.3.

Activities such as vegetation/weed removal and spoil removal is anticipated on the opposite bank to the property boundaries. As the activities are located further away from dwellings it will result in less noise exposure than the excavators and rock breaker used. Therefore, only the works closest to the properties have been assessed.

5.2 Source information

Sound power levels are provided in

Table 5.1 below for the anticipated equipment that will be used for the stream enhancement works. Façade sound pressure levels at different set back distances, calculated using NZS 6803 principles, are also provided to give an indication of likely noise levels for short term activities. Sound power levels are taken from CI activity specific construction noise and vibration management plans (ASCNVMP) for rock breaking and/or from T+T's library of measured levels. No form of mitigation, such as acoustic barriers or enclosures, has been included within these noise levels and they therefore represent a 'worst-case' scenario.

Not all items of construction plant associated with the Project will operate simultaneously or within the same area. Hand tools such as chain saws have the potential to produce relatively high noise levels, however, these are typically used for short durations and are normally straightforward to screen effectively. Only the use of the rock breaker and smaller excavator(s) will work right up to any property boundary along the stream.

Table 5.1: Construction equipment noise levels without mitigation

Equipment	Sound power level dB LWA	Noise level dB LAeq				
		5 m	10 m	20 m	30 m	40 m
Excavator (5 t)	92	76	70	64	60	57
Excavator (14 t)	96	77	71	65	61	58
Excavator (20 t)	102	86	80	74	70	67
Excavator (30 t)	110	91	85	79	75	72
Excavator with rock breaker attachment (5 t)	107	88	82	76	72	69
Excavator with Rock breaker attachment (14 t)	112	92	86	80	76	73
Excavator with Rock breaker attachment (30 t)*	120	101	95	89	85	82
Dump truck (15 t)	105	89	83	77	73	70
Small compactor	108	89	83	77	73	70
Chainsaw (vegetation clearance)	108	89	83	77	73	70

*adjusted for 75% on-time

The following table shows key equipment likely to generate vibration for the Project. Where available, measurements / estimates of vibration from that equipment have been included.

Table 5.2: Construction equipment generating vibration

Equipment	PPV at 10 m
Small compactor	1 – 2 mm/s
Excavator with rock breaker attachment (30 t)	3 - 4 mm/s
Excavator with rock breaker (14 t)	2 – 3 mm/s
20-30 t Excavator	1 – 2 mm/s

5.3 Predicted construction noise and vibration levels

5.3.1 Noise model

A SoundPLAN computer model (version 9.0) implementing ISO 9613-2:1996 *"Acoustics – Attenuation of sound outdoors – Part 2: general method of calculation"* prediction algorithm has been used to predict noise levels from activities associated with the construction of the Project. The noise model takes into account ground contours, ground absorption, terrain, buildings, and the location of works.

The building footprints have been obtained from the LINZ database and adjusted for the height assuming 3 m for a single storey building. New commercial properties (Roma Street modelled at 6 m high) and the existing CI enclosures (6 m high) not captured by the LINZ database have been manually included based on aerial photos. Residential fencing has been modelled as 0.8 m high and CI site barriers at 2 m. A ground absorption of 0.6 has been assumed.

The following scenarios have been modelled for the activities closest to receivers, with the construction plant operating at the edge of the construction location "total sound power located in one point" (i.e. worst-case assessment):

- Rock breaking with 30 t excavator: source height 0.5 m

- Excavation with 30 t: source height 1m

5.3.2 Noise levels

Façade noise maps for each modelled scenario have been calculated for nearby sensitive receivers. The full graphical façade noise maps are presented in **Appendix C.** The façade noise maps show the highest sound level experienced at each building, i.e. the closest and most exposed façade to the source. Colour coding has been used to highlight the range of construction noise levels.

Grid noise maps are modelled at 1.5 m above ground level in line with noise survey measurements undertaken in accordance with NZS 6801:2008 to enable comparison for compliance monitoring.

Predicted noise levels for 14 t rock breaking have been adjusted manually from the 30 t SoundPLAN results based on the source level difference between the two items of plant. Noise levels predicted over the relevant criterion are identified in bold.

Table 5.3: Maximum predicted noise levels at nearest receivers (1 m from building façade) without mitigation

Address	Predicted noise level Rock breaking (30 t) (dB, LAeq)	Predicted noise level Rock breaking (14 t) (dB LAeq)	Predicted noise level Excavation (dB, LAeq)
55A Marion Ave	**97**	**89**	68
55 Marion Ave *	**78**	70	51
53A Marion Ave	**85**	**77**	**74**
53 Marion Ave ^	**74**	66	60
2/51 Marion Ave	**92**	**84**	**84**
51 Marion Ave *	**76**	68	63
2/49 Marion Ave	**83**	**75**	**89**
49A Marion Ave ^	62	54	66
47 Marion Ave ^	67	59	**73**
45B Marion Ave	**74**	66	**80**
43 Marion Ave	**73**	65	**80**
41A Marion Ave	**71**	63	**83**
60 Roma Road	**89**	**81**	56
61 Roma Road	**78**	70	60

* Partial building screening ^ Complete building screening

Predicted noise levels indicates that noise at 12 receivers (10 residential and two industrial) will likely exceed the daytime construction noise limit of 70 dB $L_{Aeq(15min)}$ of up to 97 dB L_{Aeq} during rock breaking using a 30 t excavator attachment without mitigation.

As no contractor has been appointed for this Project at the time of assessment, it has not been possible to confirm which mitigation option(s) are practicable. As such a high level risk hierarchy mitigation plan has been provided in Section 6.1.1 and has been included within the draft CNVMP for implementation on site.

5.3.2.1 Mitigated noise levels

With mitigation of 1.8 m acoustic screens in place along the property boundary, a screening reduction between 5 dB and 10 dB can be achieved for all works (reduction dependent on the location of the works – the closer the source to the screens, the better the sound reduction). An additional 5 dB reduction can be further achieved with a shroud around the rock breaking element. The most practicable option for the works is dependent on the terrain of the stream and location of work.

A minimum 5 dB reduction is therefore achievable for the use of a shroud and/or 1.8 m acoustic barriers. Mitigation options may be used in combination or isolation. Predicted noise levels with mitigation for rock breaking at the receivers predicted to exceed noise limits are shown in Table 5.4. A maximum noise level with mitigation (minimum of 5 dB reduction) of 92 dB L_{Aeq} is predicted.

Where practicable, a 14 t excavator for rock breaking will be used within 15 m of the nearest receiver as part of mitigation. The maximum predicted noise level using a 14 t excavator for rock breaking is 89 dB LAeq without mitigation, and with mitigation (minimum of 5 dB reduction), 84 dB L_{Aeq} is predicted.

Mitigation for rock breaking will also provide a noise reduction for excavation works. Six receivers are predicted to exceed the noise levels for excavations works with shielding. A maximum noise level of 84 dB L_{Aeq} is predicted at 2/49 Marion Avenue with partial shielding in place. Where practicable, a 15 t excavator will be used within 5 m of a receiver.

Table 5.4: Maximum predicted noise level for rock breaking (30 t) with mitigation

Address	Predicted noise level (no mitigation) (dB, L_{Aeq})	With acoustic screening and/or shrouding (5-10 dB reduction) (dB, L_{Aeq})	With both acoustic screening and shroud (dB, L_{Aeq}) (10-15 dB reduction)
55A Marion Ave	**97**	**87 - 92**	**82 - 87**
55 Marion Ave *	**78**	68 - **73**	63 - 68
53A Marion Ave	**85**	**75 - 80**	70 - **75**
53 Marion Ave ^	**74**	64 - 69	59 - 64
2/51 Marion Ave	**92**	**82 - 87**	**77 - 82**
51 Marion Ave *	**76**	66 - **71**	61 - 66
2/49 Marion Ave	**83**	**73 - 78**	68 - **73**
49A Marion Ave ^	62	52 - 57	47 - 52
47 Marion Ave ^	67	57 - 62	52 - 57
45B Marion Ave	**74**	64 - 69	59 - 64
43 Marion Ave	**73**	63 - 68	58 - 63
41A Marion Ave	**71**	61 - 66	56 - 61
60 Roma Road	**89**	**79 - 84**	**74 - 79**
61 Roma Road	**78**	68 - 73	63 - 68

* Partial building screening ^ Complete building screening

5.3.3 Vibration

Predicted vibration levels are provided in Table 5.5. For rock breaking, four residential receivers at 2/49, 2/51, 53A and 55A Marion Avenue are predicted to experience vibration levels above the 2 mm/s PPV amenity level but not the 5 mm/s PPV DIN 4150-3 threshold for cosmetic structural damage. Commercial properties are not subjected to the amenity limits and are not predicted to exceed the DIN limit of 20 mm/s for commercial properties. Vibration levels predicted to exceed the 2 mm/s PPV amenity level has been identified in bold.

Table 5.5: Predicted vibration levels at nearest receivers

Address	Predicted vibration levels Rock breaking (30 t) (mm/s PPV)	Predicted vibration level Excavation (mm/s PPV)
55A Marion Ave	**4 - 5**	1 - 2
55 Marion Ave	1 - 2	< 1
53A Marion Ave	**4 - 5**	1 - 2
53 Marion Ave	1 - 2	< 1
2/51 Marion Ave	**4 - 5**	2 - 3
51 Marion Ave	1 - 2	< 1
2/49 Marion Ave	**2 - 3**	2 - 3
49A Marion Ave	1 - 2	< 1
47 Marion Ave	1 - 2	< 1
45B Marion Ave	1 - 2	1 - 2
43 Marion Ave	1 - 2	1 - 2
41A Marion Ave	1 - 2	1 - 2
60 Roma Road	3 - 4	1 - 2
61 Roma Road	2 - 3	< 1

5.4 Construction effects

5.4.1 Noise effects – residential occupiers

The degree of the Project's noise effects will depend upon the magnitude, frequency of occurrence and duration of the noise exposure. The effects of noise are also dependent upon the time of day at which it occurs. This is due to acoustic factors, such as the relative level of background noise, and non-acoustic factors, such as the activities being disturbed and people's expectations of noise levels at different times of the day.

Residents will experience noise inside and outside their dwellings if they are at home. An indication of the potential effects is provided in Table 5.6. Depending on the construction of the building, facades may provide a 25 – 30 dB reduction for typical residential buildings.

Note the adjustment factor between the external noise level and the internal noise level in Table 5.6 is based on a 20-decibel reduction as allowed for in NZS 6803. The table does not correct for façade effects – to simplify the presentation of internal noise levels.

Table 5.6: Subjective response to environmental noise (daytime) – residential building occupiers

External sound level (LAeq)	Potential daytime effects outdoors	Corresponding internal sound level (LAeq)	Potential daytime effects indoors
Up to 65 dB	Conversation becomes strained, particularly over longer distances.	Up to 45 dB	Noise levels would be noticeable but unlikely to interfere with residential activities.
65 to 70 dB	People would not want to spend any length of time outside.	45 to 50 dB	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB	Outdoor users would experience considerable disruption.	50 to 55 dB	Phone conversations would become difficult. Personal conversations would need slightly raised voices. For residential activity, TV and radio sound levels would need to be raised.
75 to 80 dB	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60 dB	People would actively seek respite when exposed for a long duration.
80 to 90 dB	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70 dB	Untenable for residential environments. Unlikely to be tolerated for any extent of time.

Note - this table relates to noise experienced during non-sleeping hours.

5.4.2 Noise effects - commercial occupiers

Unlike residents, the occupants of commercial and industrial premises may have a lower sensitivity to noise as the places of work are not used for resting or relaxation. Similar to Table 5.6, Table 5.7 considers the likely effects for occupiers of commercial and industrial buildings assuming a lower level of noise sensitivity and different building construction compared to residential buildings. The indoor sound levels and the likely effects have been informed by AS/NZS 2107:2016 '*Acoustics – Recommended design sound level and reverberation times for building interiors*. For manufacturing premises internal noise levels can be greater than external noise levels and therefore there would be a negligible effect from construction works.

Table 5.7: Subjective response to environmental noise (daytime) – commercial building occupiers

External sound level (LAeq)	Corresponding internal sound level (LAeq)	Potential daytime effets indoors
Up to 65 dB	Up to 40 dB	Noise unlikely to interfere with day-to-day activities.
65 to 70 dB	40 to 45 dB	Noise unlikely to interfere with day-to-day activities.
70 to 75 dB	45 to 50 dB	Concentration may start to be affected. Telephone conversations may begin to be affected.
75 to 80 dB	50 to 55 dB	Phone conversations become difficult. Personal conversations may need slightly raised voices.
80 to 90 dB	55 to 60 dB	People would seek respite when exposed for a long duration.

Note: The adjustment factor between the external noise level and the internal noise level is based on a 25-decibel reduction, which reflects a commercial building with minimal windows facing the noise source.

5.4.2.1 Rock breaking

External noise levels with minimum mitigation (5 dB reduction) in place are predicted to exceed the construction noise criterion of 70 dB L_{Aeq} at 10 residential properties (41A, 43, 45B, 2/49, 51, 2/51, 51, 53A, 55 and 55A Marion Avenue) and two industrial properties at 60 and 61 Roma Road due to rock breaking works along the northern end of the stream. A maximum noise level of 92-97dB L_{Aeq} is predicted at 2/51 and 55A Marion Avenue - located less than 10 m from the rock breaking locations when using a worst case assumption of a 30 t excavator attachment.

Noise levels will vary during rock breaking activities. Due to the uncertainty in the ground conditions, a worst case assessment has been made using a 30 t excavator with breaking attachment. The maximum noise levels presented in Table 5.4 are only likely to occur when the rock breaking works are on the opposite bank, and where only partial screening is achieved. In reality, maximum noise levels from using a 30 t may only occur for a relatively short period for the majority of receivers (a few hours in one day across 3-4 days at each receiver) and intermittently within the total duration of the works. Due to the layout of the stream, rock breaking within 17 m of 55A Marion Avenue will likely be for a longer duration of approximately 1-2 weeks at noise levels above 90 dB L_{Aeq} without mitigation. As works move along the stream and moves away from the closest distances, noise levels will decrease.

For the residential receivers, a predicted external noise level of 97 dB L_{Aeq} without mitigation would usually equate to an internal noise level 20 - 25 dB lower, i.e. 67 - 77 dB L_{Aeq} depending on the glazing and façade construction. An internal noise level greater than 60 dB L_{Aeq} is likely only to be tolerable for short periods of time with advance notification. At these high noise levels, properties with a predicted external level of 80 dB LAeq or higher will potentially need to be vacated for the duration of the rock breaking works if a 30 t excavator is being used.

Whilst the use of a 30 t excavator will generate louder noise levels, the duration of works will be significantly shorter than the use of smaller 14 t excavator. Experience has shown that residents would prefer a higher noise level for shorter periods over a lower noise level for a longer duration. As such, consistent with CI's current practice, advance communication and consultation with the affected parties will be required to determine whether to schedule works outside of sensitive hours and/or when the dwelling is occupied, the duration of noise exposure, and the possibility of installing temporary acoustic barriers on the property side. If the property is unoccupied, noise levels do not apply.

Varying depths of rock breaking of up to 1 m is required and the use of shroud and/or 1.8 m acoustic barriers may be used in combination or isolation based on the most practicable option for the works which is dependent on the terrain of the stream. A minimum 5 dB reduction is therefore achievable for either of these mitigation options (with a maximum 15 dB reduction possible). Where practicable, a 14 t excavator with attachment will be used when rock breaking within 17 m of any occupied receivers to reduce noise levels by 7- 8 dB. Best practicable options will be determined prior to work commencing.

High external noise levels for rock breaking are not uncommon for this type of works close to residential receivers and have been successfully managed on this site and on other CI sites, which includes industry standard practice for rock breaking mitigation and consultation with receivers around timing and duration.

For the industrial receivers, maximum internal noise levels are anticipated to be around 53-64 dB L_{Aeq} or lower. Typically, industrial environments will have higher levels of internal ambient sound levels than residential dwellings due to sources such as air conditioning, equipment and machinery operating and conversations. As such there will usually be a greater tolerance to sources of external noise than in a residential setting. As the primary use of the buildings closest to the works are understood to be warehouses i.e. storage purposes, it is likely spaces will only be occupied at scheduled times.

Overall, due to the reasonably limited duration and intermittent nature of rock breaking, it is considered noise levels can be effectively managed by the implementation of the CNVMP along with engagement with local receivers to manage noise effects. A risk hierarchy of mitigation has been provided in Section 6.1.1.

5.4.2.2 Excavations

Noise levels for excavation works (using a 30 t) with minimum mitigation in place is predicted to exceed the daytime limit of 70 dB L_{Aeq} at seven residential receivers within 10 m of the works at 41A, 43, 45B, 47, 2/49, 2/51 and 53A Marion Ave. A maximum noise level of 84 dB L_{Aeq} is predicted at 2/49 Marion when only partial screening is used. With all mitigation screening options implemented and use of a 14 t excavator, then the daytime limit can be met with the exception of 2/49 Marion Ave. However this is dependent on the feasibility and practicability on site due to the terrain. It is anticipated an external noise level of 74 dB L_{Aeq} can be tolerable for the limited duration of the stream works with advance notice.

5.4.3 Potential vibration effects

Human perception and response to vibration varies depending upon the sensitivity of the individual, the tasks being performed, the magnitude, frequency and duration of the vibration, whether the vibration is expected, and whether there is concern that structural damage may occur.

Low levels of vibration can cause fixtures and fittings, such as door and windows, to rattle and the noise that is sometimes generated by the 'rattling' can draw an individual's attention to the original source of the vibration. Humans perceive vibration at much lower magnitudes than the levels of

vibration that are likely to cause building damage and as such homeowners are likely to complain about vibration significantly below the levels likely to result in cosmetic damage of buildings.

Within New Zealand there are no national vibration standards for the effects on human exposure within buildings, however, it is accepted practice to apply the guidance from British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* (BS 5228-2)[4]. BS 5228-2:2009 discusses vibration levels at which adverse comment is likely from building occupants, see Table 5.8.

Table 5.8: Subjective response to vibration within buildings, after Table B.1 of BS 5228-2:2009

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

Construction activities may generate vibration. For rock breaking, four residential receivers at 2/49, 2/51, 53A and 55A Marion Avenue are predicted to experience vibration levels above the 2 mm/s PPV amenity level but under the 5 mm/s PPV DIN 4150-3 threshold for cosmetic structural damage. Vibration levels of 2 mm/s PPV may be perceivable by occupants and they may be disturbed by such occurrences, but based on experience with other construction projects, vibrations at these levels will generally be acceptable to receivers provided they have received prior warning. Vibration effects can be effectively managed via the CNVMP, through vibration monitoring and consultation with the occupants prior to construction works starting.

Whilst the assessment results in Table 5.3 indicate only four receivers will exceed 2 mm/s, there is an element of uncertainty[5] associated with the site which could result in slightly higher level of vibrations being experienced. As such, all receivers predicted to experience vibration levels between 1-2 mm/s could potentially exceed the 2 mm/s PPV amenity limit and should be considered as such for a potential worst case scenario.

Predicted vibration levels are well below the DIN 4150-3 limit for cosmetic building damage at all receivers.

[4] The previous version of this standard is referenced extensively throughout NZS 6803 as a method for predicting the noise levels from specific construction activities. The current version is considered appropriate.
[5] Vibration levels vary greatly depending on the geology makeup, equipment used, the nature of works etc.

6 Noise and vibration management

6.1 Construction Noise and Vibration Management Plan (CNVMP)

It is common practice for construction projects to implement a CNVMP as part of the construction management plan. Implementing noise and vibration 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 should be to provide a framework for the development and implementation of best practicable options to avoid, remedy or mitigate the adverse effects on receivers of noise and vibration resulting from construction.

The existing CI May Road CNVMP is fit for purpose for the proposed work site but a draft CNVMP identifying the minimum level of information as set out in AUP E25.6.29(5) specific to the Project is prepared with this report. The May Road stream enhancement works CNVMP will be kept up to date regarding actual timing/equipment used and methodologies and submitted to council prior to works commencing.

The CNVMP includes, but not be limited to, the following recommended mitigation and management measures.

6.1.1 Specific mitigation

Table 6.1: Risk hierarchy of noise mitigation and management

Risk	Properties affected for rock breaking	Hierarchy of mitigation*
Low (70 - 80 dB L_{Aeq})	55 Marion Ave 53 Marion Ave 51 Marion Ave 45B Marion Ave 43 Marion Ave 41A Marion Ave 61 Roma Road	General measures: • Staff training and awareness. • Stakeholder/community engagement (section 6.1.3) • General equipment measures (section 6.1.2) • Utilisation of 1.8 m acoustic barriers along the property boundaries where practicable. (section 6.1.5)
Medium – within 47m (80 - 85 dB L_{Aeq})	53A Marion Ave 2/49 Marion Ave	Further mitigation measures: • Stakeholder engagement and confirmation of occupancy and times of greatest sensitivity to noise exposure (both residential and commercial). • Use of low vibration equipment or alternative construction methodology.
High – within 30m (>85 dB L_{Aeq})	55A Marion Ave 2/51 Marion Ave 60 Roma Road	Enhanced mitigation measures (in addition to the above): • Further engagement with affected parties for works to be arranged around times when properties will be unoccupied; • All works within 17 m which will generate noise levels greater than 90 dB LAeq (for 55A and 2/51 Marion Ave), schedule works to be completed efficiently within 1-2 days if practicable; and/or • Use of lower noise and vibration generating equipment where practicable, such as the 14 t excavator with rock breaker attachment. • Offer temporary relocation during times of high noise levels

Risk	Properties affected for rock breaking	Hierarchy of mitigation*
		• Where practicable place additional acoustic screens including at the source of the noise, i.e., if percussive breaking use a shroud • Methodology to be changed e.g., to crushing/grinding or hand breaking if practicable.

*for further details of specific mitigations refer to main sections of the management plan

6.1.2 General noise mitigation

General noise mitigation and management measures similar to the CI May Road CNVMP section 8.4.1:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets;
- Orient machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators);
- Selection of equipment and methodologies to restrict noise;
- Locate equipment at a distance greater than the minimum set back distances where practicable;
- Utilise noise barriers and/or enclosures where appropriate; and
- Liaising with neighbours so they can work around specific activities.

6.1.3 Communication and Consultation

Standard CI processes to be implemented as per section 10 of the CI CNVMPs:

- Written communication (e.g. newsletter) shall be provided to occupiers of buildings within 100m of the site at least 1 week prior to the Project works commencing. It will acknowledge that some activities are predicted to generate high noise and/or vibration levels that may result in disturbance for short periods. It will include details of the overall works, its timing, duration and contact details for where complaints and enquiries should be directed.

Written communication during the works:

- Regular project updates will include details of impending activities that may result in disturbance, including rock breaking. It will include scheduled timing and duration of these activities and contact details where complaints and enquiries should be directed.

6.1.4 Scheduling

Scheduling of construction activities can be a key tool for managing construction noise and vibration effects. 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.

6.1.5 Noise Barriers

Where practicable, panels should be positioned as close as possible to the construction activity to block line-of-sight between the activity and noise sensitive receivers. Additional local barriers or a shroud around the rock breaking element may be necessary to ensure effective mitigation for sensitive receivers. The panels should be a minimum height of 1.8 m, and higher if practicable to

block line-of-sight[6]. The panels must be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels.

Examples of temporary noise barriers include the following proprietary 'noise curtains':

- Echo Barrier Temporary Acoustic Noise Barrier (http://www.supplyforce.co.nz/);
- Duraflex 'Noise Control Barrier - Performance Series' (www.duraflex.co.nz);
- Soundex 'Acoustic Curtain - Performance Series' (NZ); and
- Flexshield 'Sonic Curtain with 4 kg/m^2 mass loaded vinyl backing' (NZ).

Movable plywood screens may also be suitable. The panels should be constructed from materials with a minimum surface mass of 10 kg/m^2, such as 18 mm plywood or 20 mm pine.

6.1.6 Vibration mitigation

A hierarchy of vibration mitigation measures should be adopted through the CNVMP as follows:

- Managing times of activities to avoid sensitive times where practicable (communicated through community liaison);
- Prior notification and consultation with neighbours prior to commencing works for vibration generating activities;
- Selecting equipment and methodologies to minimise vibration; and
- Monitoring of vibration during activities predicted to exceed the 2 mm/s PPV amenity limit.

Mitigation will therefore focus on effective communication with neighbours, and selection of appropriate equipment and methods.

6.1.7 Monitoring procedure

Construction noise and vibration levels will be monitored as follows:

- At the start of high noise and vibration activities;
- As required by the CNVMP;
- In response to a reasonable noise or vibration complaint;
  - For noise – at 1 m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate;
  - For vibration – at the foundation of the building or in accordance with DIN 4150-3;
- By a suitably qualified and experienced practitioner (e.g., Member of the Acoustical Society of New Zealand);
- For a representative duration, reported with the measured level (e.g., 70 dB $L_{Aeq\ (15\ min)}$); and
- The results should be used to update the noise and vibration source data used in the calculations if appropriate.

Noise and vibration monitoring will be undertaken in accordance with the requirements of NZS 6803 and DIN 4150-3 respectively.

[6] Temporary barriers greater than 3-4 m are generally impracticable to construct due to wind loading constraints.

7 Conclusion

An assessment of noise and vibration has been carried out for the stream enhancement construction works at the May Road site. The works described in this report are typical for construction works carried out for similar infrastructure projects across Auckland including at this and other CI sites.

Predicted noise and vibration levels have been assessed against relevant AUP performance standards in line with CI conditions. The assessment is based on an indicative construction methodology for a worst case scenario with rock breaking activities being the dominant noise and vibration generating source.

Ten residential receivers (41A, 43, 45B, 2/49, 51, 2/51, 51, 53A, 55 and 55A Marion Avenue) and two industrial receivers (60 and 61 Roma Road) are predicted to exceed the daytime construction noise limit of 70 dB L_{Aeq}, with a maximum predicted noise level of 92 dB L_{Aeq} with partial screening in place. A resource consent is therefore required to exceed AUP Rule E25.6.27 during rock breaking activities and excavation. The use of a larger 30 t excavator with attachment allows for shorter duration (generally a few hours a day for 3-4 days). With the intermittent nature of the rock breaking and excavation activities, it is considered noise effects can be effectively managed via the CNVMP and standard CI processes including advance communication, scheduling of works and asking for the property to be vacated during noisy works.

Four receivers (2/49, 2/51, 53A and 55A Marion Avenue) are predicted to experience vibration levels above the 2 mm/s PPV amenity limit but below the DIN 4150-3 standard of 5 mm/s PPV. Due to uncertainties associated with vibration, the 2 mm/s PPV limit may be exceeded at other nearby properties. As exceedances are anticipated to last more than 3 days across the Project duration, resource consent is required to exceed the amenity limit of 2 mm/s PPV for more than 3 days. Vibration effects will be managed via consultation and addressed in the CNVMP. Predicted vibration levels are well below the DIN 4150-3 limit for cosmetic building damage at all receivers.

With mitigation in place, overall effects can be appropriately managed and reduced to ensure construction noise and vibration effects are acceptable for the duration of works. This is supported by practical on-the-ground experience gained through the CI project to date which provides a solid ‘real-world’ basis for understanding the nature of activities, the actual and potential noise and vibration effects of those activities, and how the effects are best managed and mitigated to cause the least disruption to surrounding residents and to minimise environmental effects.

8 Applicability

This report has been prepared for the exclusive use of our client Watercare Limited, 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 our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

.....

Sharon Yung
Senior Acoustic Consultant

Authorised for Tonkin & Taylor Ltd by:

.....

Karen Baverstock
Project Director

Technical Review by:

.....

Darran Humpheson

Technical Director - Acoustics

SHYU
\\ttgroup.local\corporate\auckland\projects\1015172\1015172.1701 may rd stream rc\issueddocuments\final noise\1015172.1701 may road noise and vibration assessment v2.1 - final.docx

Appendix A Glossary

Term	Definition
dB	A unit of measurement on a logarithmic scale which describes the magnitude of sound pressure with respect to a reference value (20 µPa)
$L_{Aeq(t)}$	The A-weighted time-average sound level over a period of time (t), measured in units of decibels (dB)
L_{WA}	Sound power level
PPV	Peak particle velocity. This is the instantaneous maximum velocity reached by the vibrating surface as it oscillates about its normal position
Noise	Unwanted sound

Every 10 dB increase in sound level doubles the perceived noise level. A sound of 70 dB is twice as loud as a sound level of 60 dB and a sound level of 80 dB is four times louder than a sound level of 60 dB. An increase or decrease in sound level of 3 dB or more is perceptible. A change in sound level of less than 3 dB is not usually discernible.

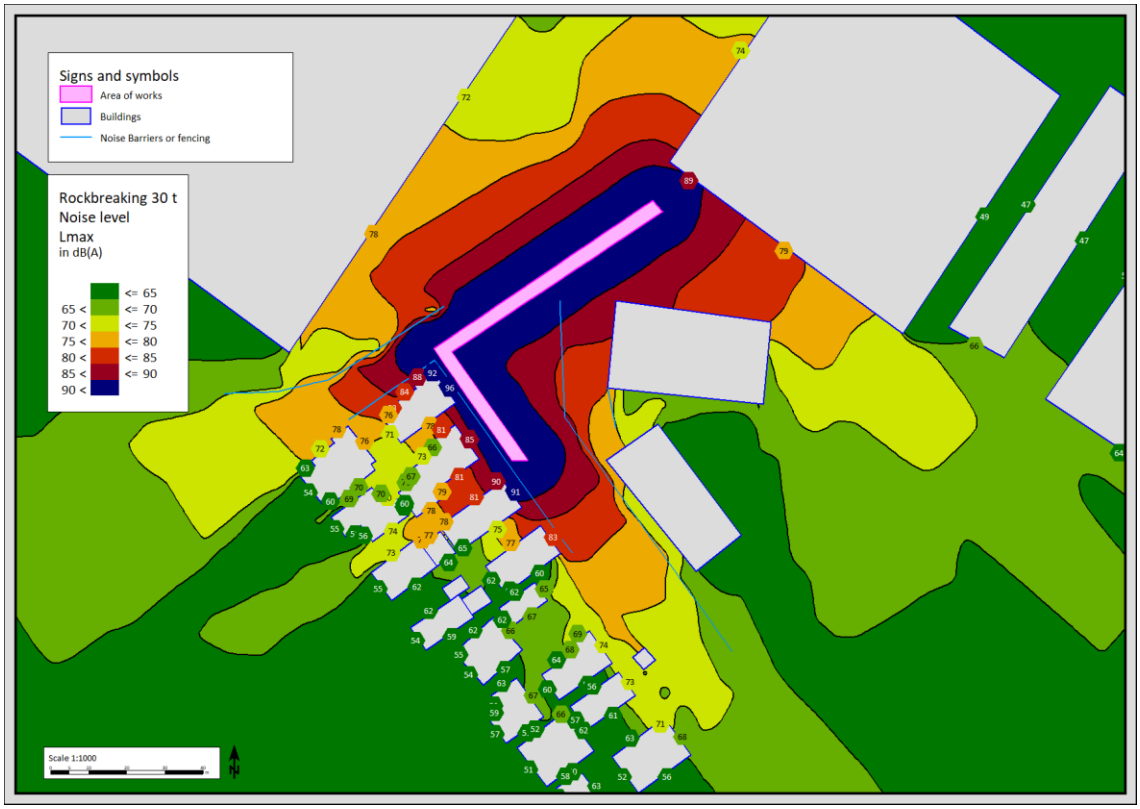
As sound level is measured on a logarithmic scale, the following table provides examples of typical sources of noise.

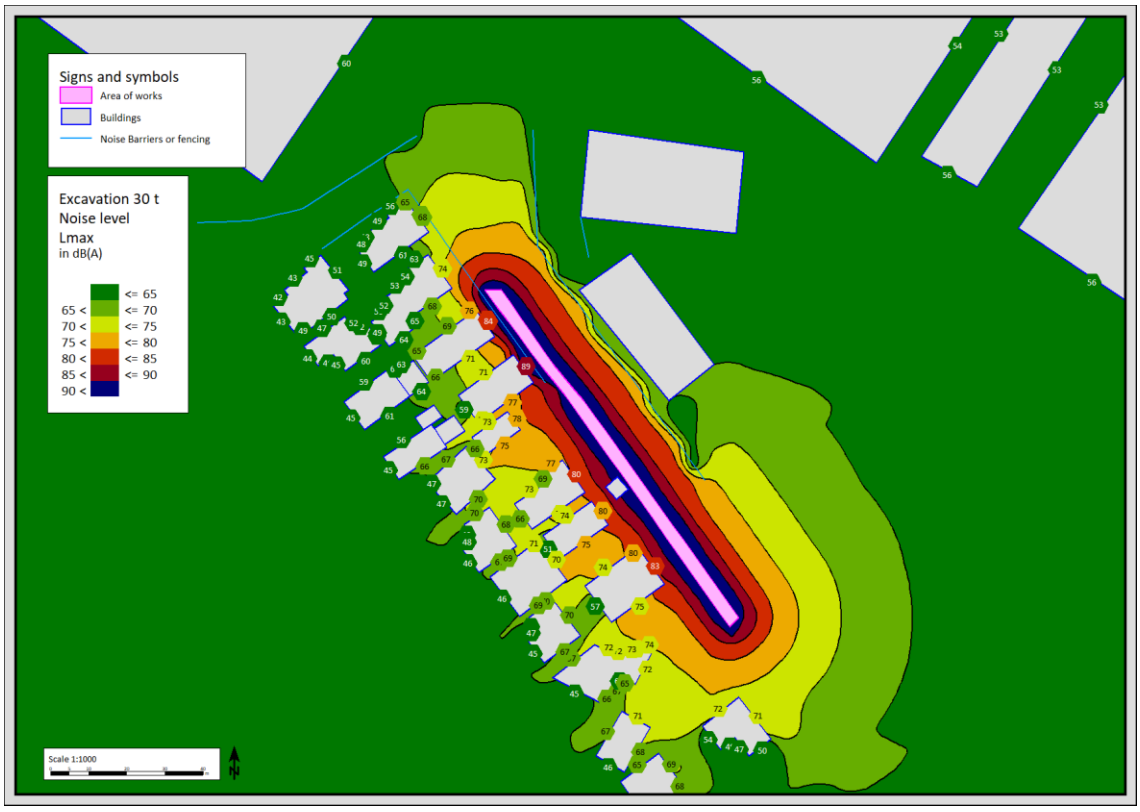
Decibel (dB)	Example
0	Hearing threshold
20	Still night-time
30	Library
40	Typical office room with no talking
50	Heat pump running in living room
60	Conversational speech
70	10 m from edge of busy urban road
80	10 m from large diesel truck
90	Lawn mower - petrol
100	Riding a motorcycle at 80 kph
110	Rock band at a concert
120	Emergency vehicle siren
140	Threshold of permanent hearing damage

Appendix B Roma Road Estate Development

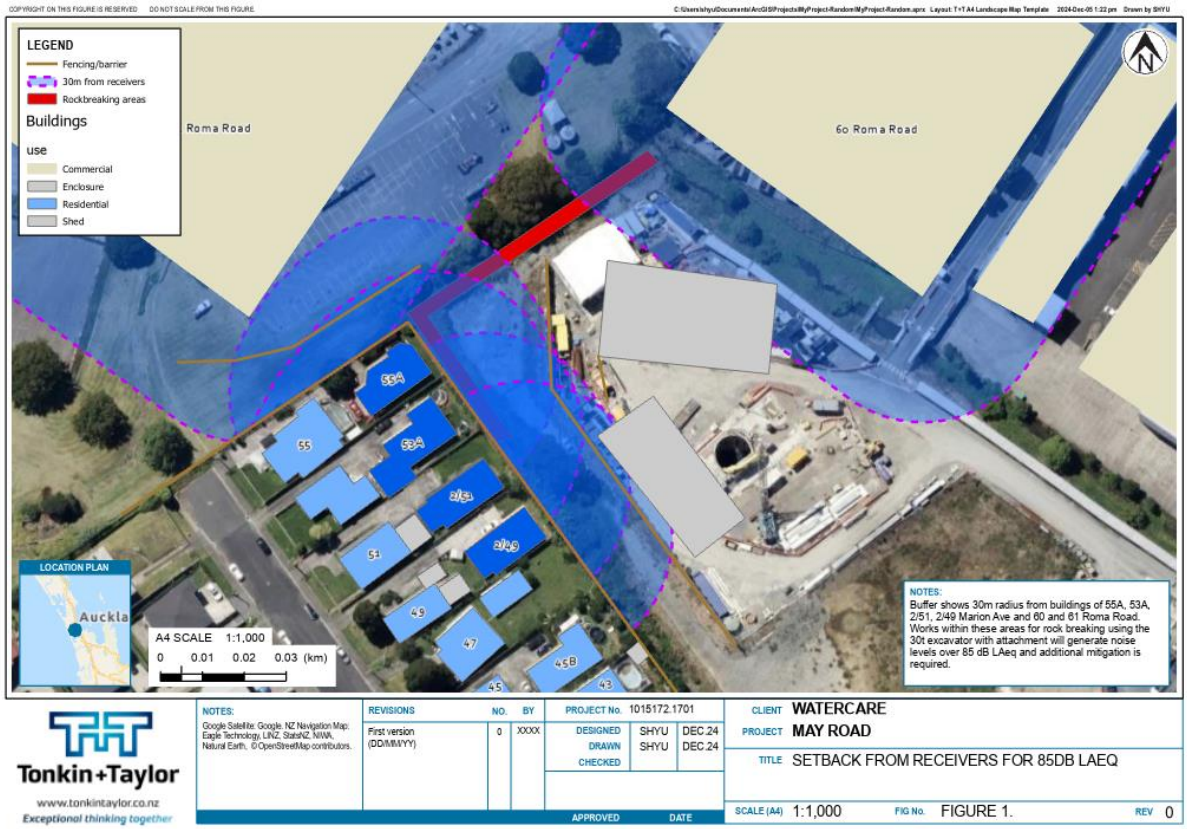
Source: Website [Roma Road (goodman.com)]

Appendix C Noise contour maps





Appendix D Setback from recievers



www.tonkintaylor.co.nz